LUMMI INDIAN RESERVATION WETLAND MANAGEMENT PROGRAM
Technical Background Document

March 2000

LUMMI INDIAN RESERVATION WETLAND MANAGEMENT PROGRAM
Technical Background Document

Prepared For:
Lummi Indian Business Council

Funded By:
U.S. Environmental Protection Agency
(CD980112-01-0)

Prepared By:
Lummi Water Resources Division

Contributors:

Leroy Deardorff	Environmental Director
Jeremy Freimund	Water Resources Manager
Andy Ross	Water Resources Specialist
John DiGregoria	Water Resources Planner (former)
Keith Tom	Water Resources Technician
Leonard Dixon	Water Resources Planner (current)
Brenna Sterling	GIS Specialist
Mike Simonson	Forester
Gregg Dunphy	Fisheries Biologist
Kim Harper	Contracted Wetlands Specialist (Sheldon and Associates, Inc.)

March 2000

TABLE OF CONTENTS

APPENDICES

LUMMI INDIAN RESERVATION WETLAND MANAGEMENT PROGRAM

EXECUTIVE SUMMARY

The Wetland Management Program is a part of the Comprehensive Water Resources Management Program (CWRMP) being developed by the Lummi Water Resources Division. Pursuant to Lummi Indian Business Council (LIBC) resolutions 90-88 and 92-43, the CWRMP also includes a storm water management program, a wellhead protection program, water quality standards, and a revision of the Lummi Nation Water Code (Title 17).

The Lummi Nation finds that contamination of surface waters on the Reservation, tidelands and estuaries, wellhead areas, and ground water resources has a direct, serious, and substantial effect on the political integrity, economic security, and the health and welfare of the Lummi Nation, its members, and all persons present on the Reservation, and that those activities posing threats of such contamination, if left unregulated, also could cause such adverse impacts.

The goals of the Lummi Nation Wetland Management Program are to: 1) develop technical background information for a Lummi wetland management ordinance consistent with land use and resource management comprehensive plans, and 2) increase public awareness of the importance of Reservation wetlands to promote compliance with the ordinance once it is enacted.

The purposes of the Lummi Nation Wetland Management Program are:

- To protect the functions and values of Reservation wetlands from the impacts of residential and commercial development;
- To encourage residential development by and for tribal members as well as commercial and business growth on the Reservation for tribal employment opportunities by providing defined wetland management standards, requirements, and mitigation alternatives for effective project planning;
- To protect and enhance fish and shellfish resources, wildlife resources, cultural resources, and the quantity and quality of Reservation ground water; and
- To protect surface water quality and enhance storm water management.

This technical background document is the initial stage in the Lummi Nation Wetlands Management Program development. Similar to the process used to develop other elements of the CWRMP, this document is intended to serve as the technical foundation for a wetland management ordinance to be developed and incorporated into the Lummi Water Code (Title 17) by December 31, 2001.

1. INTRODUCTION

The Wetland Management Program is a part of the Comprehensive Water Resources Management Program (CWRMP) being developed by the Lummi Water Resources Division. Pursuant to Lummi Indian Business Council (LIBC) resolutions 90-88 and 92-43, the CWRMP also includes a storm water management program, a wellhead protection program, water quality standards, and a revision of the Lummi Nation Water Code (Title 17).

The Lummi Nation finds that contamination of surface waters on the Reservation, tidelands and estuaries, wellhead areas, and ground water resources has a direct, serious, and substantial effect on the political integrity, economic security, and the health and welfare of the Lummi Nation, its members, and all persons present on the Reservation, and that those activities posing threats of such contamination, if left unregulated, also could cause such adverse impacts.

The goals of the Lummi Nation Wetland Management Program are to: 1) develop technical background information for a Lummi wetland management ordinance consistent with land use and resource management comprehensive plans, and 2) increase public awareness of the importance of Reservation wetlands to promote compliance with the ordinance once it is enacted.

The purposes of the Lummi Indian Reservation (Reservation) Wetland Management Program are:

- To protect the functions and values of Reservation wetlands from the impacts of residential and commercial development;
- To encourage residential development by and for tribal members as well as commercial and business growth on the Reservation for tribal employment opportunities by providing defined wetland management standards, requirements, and mitigation alternatives for effective project planning;
- To protect and enhance fish and shellfish resources, wildlife resources, cultural resources, and the quantity and quality of Reservation ground water; and
- To protect surface water quality and enhance storm water management.

Wetlands are legally defined as, "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (U.S. Army Corps of Engineers [Corps] 1987).

Wetlands perform important functions including: ground water recharge/discharge; flood flow storage (reduction in peak discharge); maintaining base stream flow; shoreline stabilization; food chain support by providing habitat for a variety of terrestrial and aquatic organisms; microbial control; and removal or reduction of sediment, nutrient and toxicants from waters (Brinson 1993b, Granger et al. 1996, Gersib 1997). Wetlands also provide areas of cultural significance, recreation opportunities, and outdoor education opportunities.

The wetland types found on the Reservation vary from freshwater forested wetlands to low salinity saltmarshes. The Lummi Peninsula, Portage Island, and the northern upland of the Reservation contain a variety of forested, scrub-shrub, and emergent wetlands. Strips and islands of high salinity saltmarsh border Lummi Bay in the Lummi River delta. The floodplains of the Lummi and Nooksack rivers contain wetlands, prior converted croplands (i.e., croplands that at one time were wetlands), and inactive agricultural areas that are reverting back to wetlands. The Sandy Point area contains fresh and/or brackish marshes intermixed with dense residential development.

Similar to regional land use patterns, some Reservation wetlands have been eliminated, transformed, or degraded over the years. For example, in the Reservation lowlands, sea wall construction along Lummi Bay, levees along the Lummi and Nooksack rivers, and the clearing and drainage of agricultural lands has resulted in the loss of approximately 95 percent of wetlands in the Lummi River floodplain (Bortleson et al. 1980). In contrast, wetlands in the Nooksack River estuary have increased as the Nooksack River delta has grown (prograded) approximately 1 mile over the 1888 - 1973 period (Bortleson et al. 1980). In the forested upland areas of the Reservation, logging, road construction, and land clearing have both created and degraded wetland communities. Compacted logging roads, skid trails, and Reservation roadways have created numerous surface and subsurface blockages (berms) that prevent or greatly slow the downhill movement of surface and ground water. Wetland areas are created upstream of these blockages in and along the ponded water. As some forested wetlands were inadvertently created, some were also drained as residential development occurred.

To effectively manage Reservation wetlands, the location, extent, and function of wetlands must be known. In the early 1970s, Reservation wetlands were inventoried as part of the U.S. Fish and Wildlife Service National Wetlands Inventory (USFWS 1987). This initial inventory, which was not field verified on the Reservation, has been improved as wetland inventories have been conducted on select areas of the Reservation for various projects.

To support the Lummi Reservation Wetland Management Program, during 1999 a comprehensive inventory of Reservation wetlands was contracted to a private consulting firm specializing in wetlands using grant funding from the Environmental Protection Agency (EPA) General Assistance Program (Assistance ID No. GA990990-01-2). The purpose of the inventory was to accurately identify the location and size of wetland areas throughout the Reservation and to create a Geographic Information System (GIS) database. As part of the inventory contract, four Lummi Natural Resources staff were trained in wetland inventory techniques and wetland function assessment methods. Six Lummi staff members have also participated in the five-day wetland delineation training program offered each year by the U.S. Army Corps of Engineers. As part of the contract, wetland function assessments were conducted on twelve selected Reservation wetlands (see Appendix A).

As detailed in Appendix A, the comprehensive Lummi Reservation wetlands inventory used both the Cowardin Classification System (Cowardin et al. 1979) and the Hydrogeomorphic Classification System (Brinson 1993b) to categorize Reservation wetlands. The wetland function assessments were conducted using the new Hydrogeomorphic Approach to Assessing Wetland Functions for Riverine and Depressional Wetlands developed by Washington State (Ecology 1998a, Ecology 1998b). The Indicator Value Assessment model, as modified and utilized by Snohomish County to assess functions of estuarine wetlands (MacWhinney and Thomas 1996), was identified for use to conduct function assessments for estuarine wetlands and wetlands along the Nooksack River that are influenced by tides.

There are a variety of regulatory and non-regulatory approaches to protect wetlands. Federal, tribal, state, and local governments administer wetland protection programs throughout the United States in accordance with various Executive Orders and the Clean Water Act. The LIBC is in the process of revising the Lummi Nation Water Code to include wetland management provisions. Non-regulatory approaches to protecting wetlands also exist and are often a more effective way to achieve wetland management goals. Non-regulatory approaches include public education campaigns and land acquisition to protect wetland resources.

This technical background document has nine sections and four appendices.

- Section 1 is this introduction section.
- Section 2 describes the topography, watersheds, climate, hydrogeology, soils, land use, surface water, and biological diversity of the Reservation.
- Section 3 defines wetlands and describes wetland functions and values, different approaches for classifying wetlands, and methods for assessing wetland functions.
- Section 4 presents wetland mitigation and restoration concepts.
- Section 5 summarizes current approaches to protecting Reservation wetlands.
- Section 6 describes criteria for protecting wetlands on the Reservation.
- Section 7 identifies the estimated staff, training, and budget needed to implement the Wetland Management Program.
- Section 8 presents the technical background document conclusion.
- Section 9 lists references cited in the report.

2. STUDY AREA DESCRIPTION

The Lummi Indian Reservation is located at the mouth of the Nooksack River and along the western border of Whatcom County, Washington (Figure 1). The Nooksack River drains a 786 square mile watershed and discharges primarily to Reservation waters and Bellingham Bay. Approximately 26 miles of highly productive salt-water shoreline surround the Reservation on all but the north and northeast borders.

The topography, watersheds, climate, hydrogeology, soils, land use, surface water resources, and biological diversity on the Lummi Reservation determine wetland locations and functions. Each of these elements are described in this section.

2.1 TOPOGRAPHY

The Lummi Reservation is comprised of two relatively large upland areas on the mainland, a smaller upland area on Portage Island, and two distinct lowland areas (the floodplains of the Lummi and Nooksack rivers and Sandy Point). The maximum elevation of the northwestern upland area of the Reservation is about 220 feet above mean sea level (ft msl). The southern upland area is the Lummi Peninsula with a maximum elevation of about 180 ft msl. The maximum elevation on Portage Island is about 200 ft msl. The floodplain of the Lummi and Nooksack rivers, with an average elevation of approximately 10 ft msl, lies between the northern and southern upland areas. The Nooksack River and the Nooksack River delta are located along the northeastern extent of the Lummi Peninsula upland. Sandy Point lies to the southwest of the northwestern upland.

The upland and lowland areas of the Reservation comprise about 12,500 acres and there are approximately 8,000 acres of Reservation tidelands. Individual tribal members or the Lummi Indian Business Council (LIBC) own approximately 75 percent of the upland area; 100 percent of the tideland areas are owned by the LIBC.

Short, intermittent streams and numerous springs drain the uplands. The springs occur both above and below the high tide line. These streams and springs discharge onto tribal tidelands along Bellingham Bay, Portage Bay, Hale Passage, Lummi Bay, Onion Bay, Georgia Strait, or to the floodplain of the Lummi and Nooksack rivers. The floodplain is drained by a network of agricultural drainage ditches and the Lummi and Nooksack rivers.

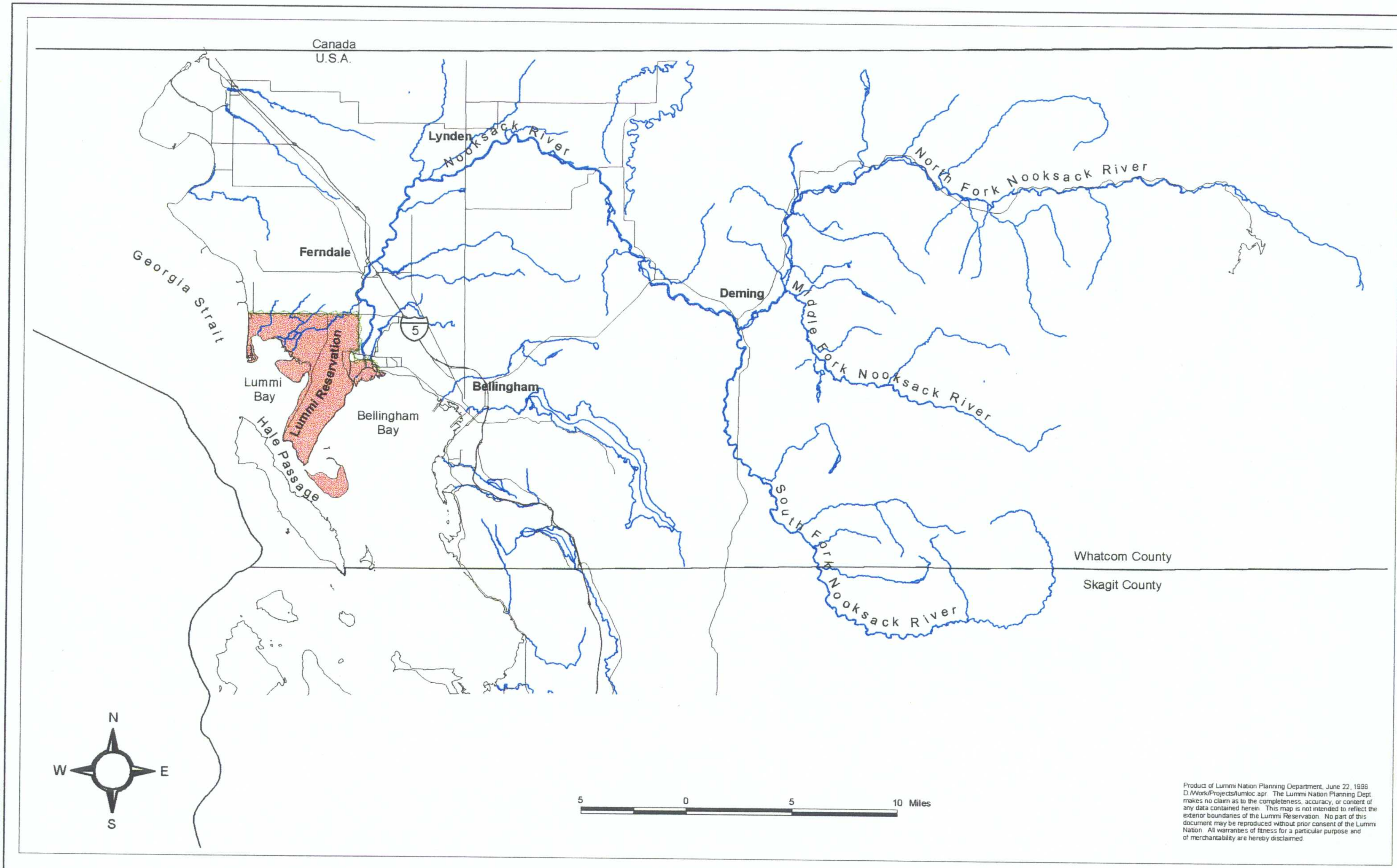


Figure 1. Location Map of the Lummi Reservation, Whatcom County, WA

2.2 RESERVATION WATERSHEDS

Reservation watersheds were delineated and mapped during the development of the Lummi Reservation Storm Water Management Program Technical Background Document [(SWMP) LIBC 1998a]. The watershed boundary map developed as part of the SWMP is a working map that is intended to change as new information is acquired. Field observations made during the field verification element of the Comprehensive Reservation Wetland Inventory resulted in modifications to the working map (Figure 2). Further modifications are anticipated as new Digital Elevation Models are obtained and additional field research is conducted on the Reservation and in the watersheds that extend off-Reservation.

The Reservation watersheds were identified by alphabetic letters (A through S) on an interim basis. It is anticipated that names will be assigned to the watersheds over time. Nineteen watersheds drain the Reservation uplands into Lummi and Bellingham bays. Seven of these watersheds originate off Reservation and the remaining twelve lie wholly within Reservation boundaries. The Comprehensive Wetland Inventory Report (Appendix A) describes the characteristics of wetlands on a watershed by watershed basis.

Modifications were made to the boundaries of Watersheds F, G, M, Q, and R. Watershed F was modified north of Smokehouse Road based on observed drainage of a wetland identified during the inventory. Watershed G was modified north of Cagey Road based on field verification of watershed boundaries delineated during the elevation mapping for the Lummi Shore Road project. Watershed M was modified to include the accretion zone and small saltmarsh adjacent to the Seaponds dike. The Watershed Q boundary was moved around the edge of a large wetland at the base of the northern upland. Watershed R was modified based on field observations of a bench at the western edge of the northern upland.

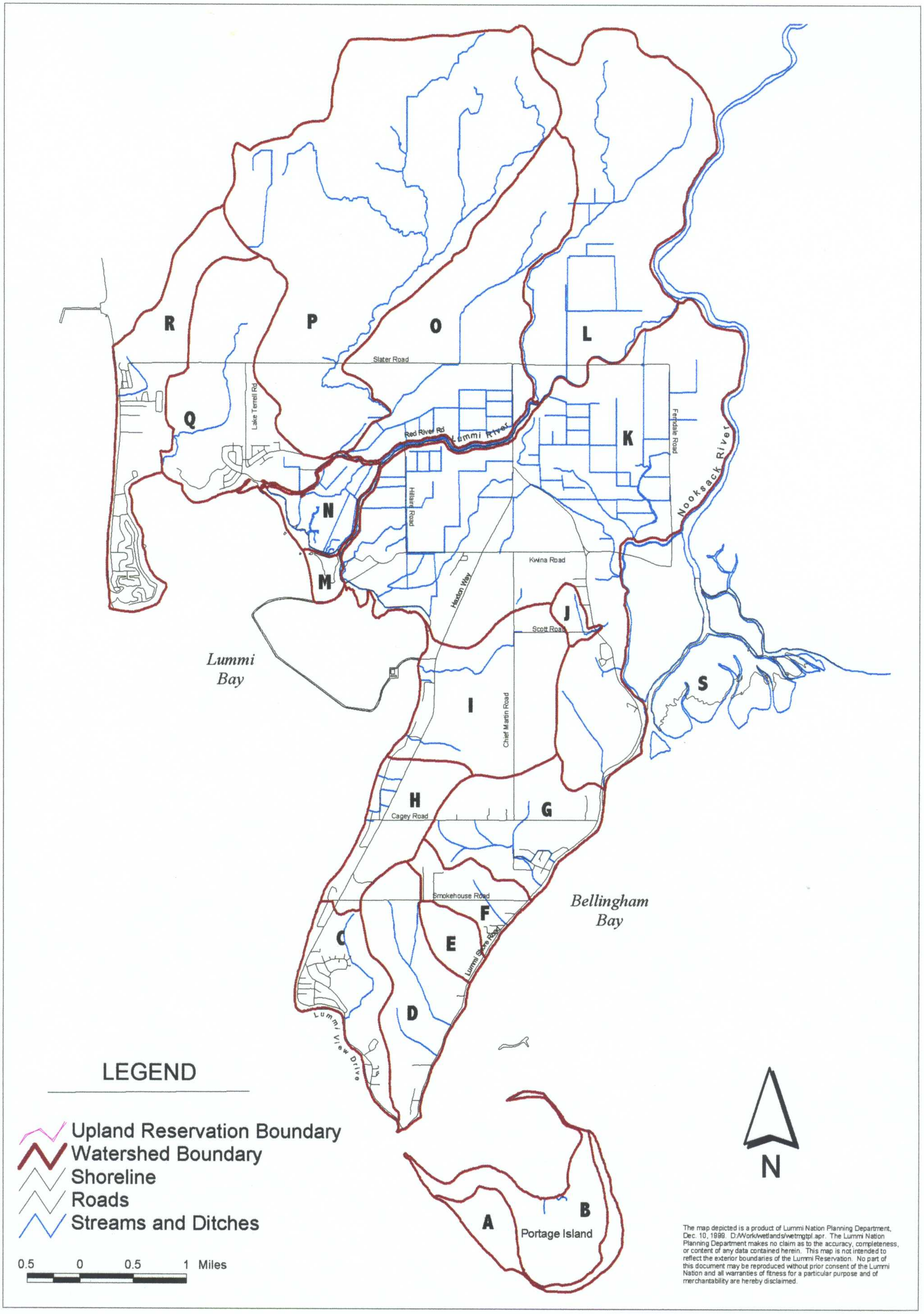


Figure 2. Revised Map of Lummi Reservation Watersheds

2.3 CLIMATE

Based on climate data collected at the Bellingham International Airport, the average annual precipitation adjacent to the Reservation over the 1960-1990 "normal" period is approximately 36.2 inches. On average, November, December, and January are the wettest months; June, July, and August are the driest months. About 75 percent of the average annual precipitation occurs from October through April; the remaining 25 percent occurs from May through September.

Temperature data collected at the Bellingham International Airport over the 1960-1990 period indicate that the warmest months are July and August. During these months the average maximum daily temperature is approximately 71 degrees Fahrenheit (°F). December and January are the coldest months. During December and January the average minimum daily temperature is about 32°F.

The growing season is "the portion of the year when soil temperature (measured 20 inches below the surface) is above biological zero (5°Celsius [C] or 41°F). This period can be approximated by the number of frost free days. Estimated starting and ending dates for the growing season are based on 28°F air temperature thresholds at a frequency of five years in ten" (Corps 1987). For the Reservation, the growing season is 227 days long, beginning on April 8 and ending on October 30 (USDA 1992).

Evapotranspiration has not been measured on the Reservation but has been estimated. Phillips (1966) estimated the average annual evapotranspiration for a 6-inch water holding capacity soil at the Marietta 3 NNW station to be approximately 18.8 inches. This estimate represents about 52 percent of the mean annual precipitation. A review of evapotranspiration estimates from 27 studies conducted in the Puget Sound Lowland (Bauer and Mastin 1997) suggests an average evapotranspiration rate of around 17.3 inches. On average, the estimated mean annual evapotranspiration from the 27 studies compiled by Bauer and Mastin (1997) was about 46 percent of the mean annual precipitation.

Wind data for Bellingham indicates that the prevailing wind direction on the Reservation is from the south and southwest with gusts upward of 80 miles per hour. Winds from the west are not as common and generally not as strong (Corps 1997).

The Reservation experiences a variety of atypical weather patterns. A common but infrequent weather pattern occurs from the northeast. Winds blowing down the Fraser River valley blow across the Whatcom Basin causing damage to the residents and businesses of the Reservation (USDA 1992). Another atypical weather pattern involves continental air masses from the east that bring unusually dry weather that can last a few days or weeks (USDA 1992). During the summer, these air masses bring unusually warm temperatures (mid to upper 90s Fahrenheit). During the winter, these air masses usually bring cold temperatures (0°F and colder).

Because most of the precipitation occurs during the winter months when evapotranspiration demand is low, wetlands can expand beyond their boundaries as defined by soil and vegetation types. After the rainy season and during the summer months when evapotranspiration demand is high and vegetation slows the movement of storm water, the amount of water available for wetlands is small and consequently the wet area may be smaller than the boundaries defined by soil and vegetation. Despite the lush summer vegetation, infrequent cloudbursts and the relatively impervious soils common to the Reservation can combine to produce storm water runoff during the summer months. This storm water runoff can fill the dry depressions of Reservation wetlands.

2.4 HYDROGEOLOGY

The hydrogeologic conditions on the Lummi Reservation have been described previously by the USGS and others (Washburn 1957, Cline 1974, Easterbrook 1973, Easterbrook 1976). In general, the Reservation is underlain by unconsolidated sediments deposited as glacial outwash, glaciomarine drift, glacial till, and floodplain or delta deposits of Quaternary age (Washburn 1957). The unconsolidated deposits consist of clay, silt, sand, gravel, and boulders. Because the composition of the deposits change laterally over short distances, it is difficult to distinguish between the different stratigraphic units from existing well log data.

2.4.1 Geology

The sedimentary units that occur on the Reservation, as described by Cline (1974) and Easterbrook (1976) in order from youngest to oldest, are summarized below.

- **Alluvium:** The alluvium is derived from sediment carried by the Lummi and Nooksack rivers and deposited on the flood plain. It is comprised mostly of clay, silt, sand, and some gravel.
- **Beach Deposits:** The beach deposits are laid down by littoral drift processes. The deposits are mostly sand with some locally abundant gravel and occur mainly at the western part of the Reservation from Neptune Beach to Sandy Point and at Gooseberry Point.
- **Older Alluvium:** The older alluvium was deposited by the Lummi and Nooksack rivers when the valley floor was relatively higher than at present. The unit consists mostly of fine sand with some silt and clay located on stream terraces flanking the uplands above the flood plain. These deposits occur along the southeast flank of the Mountain View Upland and along the northeast flank of the Lummi Peninsula.
- **Gravel:** A thin unsaturated gravel unit is exposed at the surface at several locations on the Reservation. The unit consists of gravel and sand/gravel. In places, this unit appears to have been reworked by beach processes after retreat of the glaciers and overlies glaciomarine drift. In other places, this unsaturated unit appears to overlie or be a part of the Esperance Sand unit (see below) and cannot be distinguished from the lower unit in the well records.
- **Glaciomarine Drift:** The Glaciomarine Drift unit was deposited late in the Fraser Glaciation (from about 20,000 years ago to about 10,000 years ago [Easterbrook

1973]). The drift is comprised of unsorted clay, silt, sand, gravel, and some cobbles and boulders. The deposits include both Kulshan and Bellingham drifts and generally yield little water. Limited sand and gravel lenses may contain small amounts of perched ground water.

- **Glacial Till:** The glacial till from the Vashon Stade of the Fraser Glaciation is comprised of poorly sorted clay, silt, sand, gravel, and some cobbles and boulders. The till deposits generally yield little or no water as till has a compact and concrete-like texture. Because the presence of till is noted in only a few well logs and visible at only a few beach exposures, the occurrence of till on the Reservation is believed to be limited.
- **Esperance Sand:** The Esperance Sand unit (Easterbrook 1976), formerly named Mountain View Sand and Gravel, is an advance outwash deposit comprised of stratified beds of sand and gravel with stratified lenses of sand. The unit is the major water-yielding unit beneath the Reservation.
- **Cherry Point Silt:** The Cherry Point Silt unit is believed to be the oldest known unconsolidated stratigraphic unit in the northern Puget Sound lowland. This unit is comprised of a thick sequence of blue to brownish gray stratified clay and silt with minor sandy beds.
- **Bedrock:** Bedrock underlying the Reservation consists mostly of sedimentary rocks of the Chuckanut Formation such as sandstone, siltstone, shale, and conglomerate. The bedrock does not occur at the surface and is deeply buried by the unconsolidated glacial deposits.

2.4.2 Reservation Aquifers

As noted above, ground water is obtained primarily from sand and gravel outwash deposits in the unconsolidated sediments (i.e., Esperance Sand unit). Glaciomarine drift is at or near the ground surface over much of the upland areas on the Reservation. The glaciomarine drift contains substantial amounts of clay which restricts the recharge to the underlying aquifer and promotes storm water runoff.

Two apparently separate potable ground water systems occur on the Lummi Reservation. One system is located in the northern upland area. This northern system appears to flow onto the Reservation from the north and drains to the west, south, and east. The second potable ground water system is located in the southern upland areas of the Reservation and is completely contained within the Reservation boundaries. The flood plains of the Lummi and Nooksack rivers, which contain an unconfined aquifer that is saline (Cline 1974), separate the two potable water systems. A third potable water system may exist on Portage Island, but information on water quality and the potential yield of this system is limited and inconclusive.

In general, both the northern and southern ground water systems contain two aquifer types (Washburn 1957, Easterbrook 1976). The upper aquifer type is comprised primarily of lenses of sand, or sand and gravel in the glaciomarine drift. These relatively permeable lenses are not continuous throughout the area. The lower aquifer layer is comprised of advance outwash sand and gravel (i.e., Esperance Sand). The thickness of the lower aquifer, which appears to be semi-confined in places and unconfined in other places, is not known. The pebbly clay in the drift sediments and scattered deposits of till greatly slow the downward percolation of water to the lower aquifer and may act as a confining layer.

Because the hydrogeologic conditions on the Reservation vary considerably over short distances, the locations of the aquifer recharge zones are not definitively known at this time. It is likely that aquifer recharge areas are distributed over the upland areas. However, given the high runoff potential of the glaciomarine drift that covers much of the Reservation upland, it is also possible that aquifer recharge areas are of limited areal extent and located primarily in only a few locations around the Reservation. Until more precise information is developed, all of the northern and southern upland areas on the Reservation are assumed to be aquifer recharge zones.

2.5 SOILS

The United States Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS) identified and described 39 different soil map units on the Reservation (USDA 1992). As part of the USDA-NRCS characterization, each soil type was assigned to one of four hydrologic soil groups based on their runoff-producing characteristics.

The primary consideration in assigning a soil to a hydrologic soil group is the inherent infiltration capacity of the soil with no vegetation (USDA 1992). The hydrologic soil groups are labeled A, B, C, or D. In essence, Group A soils have a low runoff potential and a correspondingly high infiltration potential whereas Group D soils have a high runoff potential and a low infiltration potential. Group B and Group C soils have runoff and infiltration potentials between Group A and Group D. About 13 percent of the soils on the Reservation have a low or moderately low runoff potential (Group A or Group B). The remaining 87 percent of the soils on the Reservation have a moderately high or high runoff potential (Group C or Group D). These soil characteristics suggest that less than 15 percent of the Reservation uplands have a good aquifer recharge potential.

As shown in Figure 3, the Group A and B soils are generally found along some of the tideland areas and the glacial outwash terraces of the Reservation. These soils are concentrated along Haxton Way south of Balch Road, along Lummi View Road near the Stommish Grounds, on Portage Island, and near Fish Point. There is an isolated

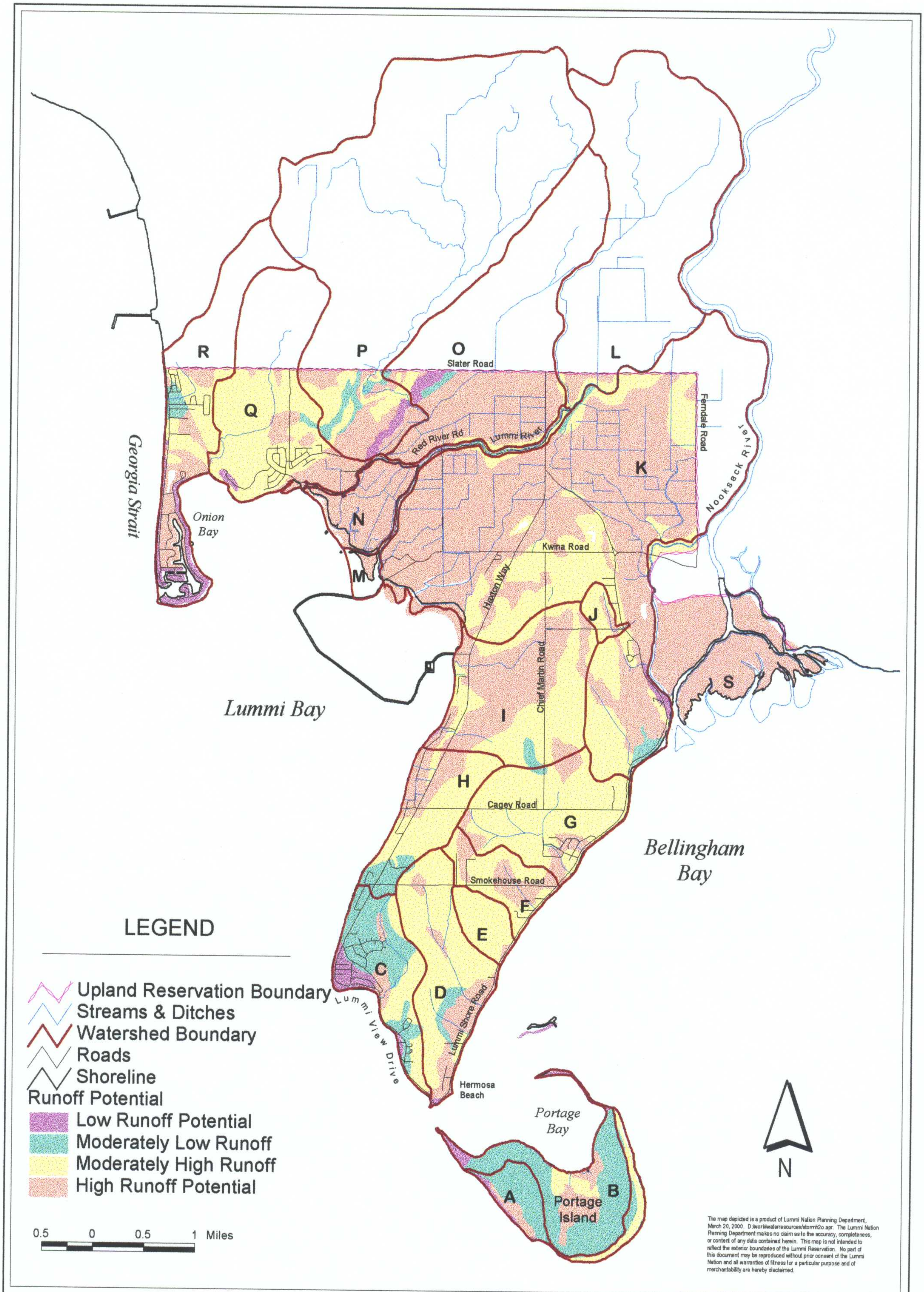


Figure 3. Soil Hydrologic Groups on the Lummi Reservation

area of Group B soils along the west side of Chief Martin Road near the abandoned landfill. The Group C and D soils are found along the glaciomarine drift plains in the upland areas and the flood plains of the Lummi and Nooksack rivers. Most of the northern and southern upland areas on the Reservation have a moderately high or high runoff potential. A review of the soil map units in the areas north of the Reservation suggests that most of these soils also have a moderately high or high runoff potential.

2.6 LAND USE

Like most places, land use changes on the Reservation have generally been associated with changes in vegetation types, decreases in the areas covered by vegetation, changes in natural drainage patterns, and increases in impervious surfaces. With the arrival of Euro-americans, forested land was logged, cleared, and drained for agricultural development, buildings, and eventually parking lots and other paved surfaces. Roads were cut through slopes and low spots filled. Many of these low spots were wetland areas. Natural drainage patterns on the Reservation were substantially altered by the road system and agricultural drainage and diking.

Historic, current, and projected future land uses on the Reservation watersheds are described below. Much of the information about historic land uses comes from the *Lummi Nation Comprehensive Environmental Land Use Plan: Background Document* (LIBC 1996).

2.6.1 Historic Land Use

Prior to the arrival of Euro-americans, the Lummi people were, and to an extent remain, a fishing, hunting, and gathering society. Based on the accounts of Lummi Elders, early European explorers, and early photographs of the region, prior to 1850 the Lummi Reservation was dominated by old growth forests of massive Douglas fir, Western hemlock, Sitka spruce, and Western red cedar. Deciduous trees such as Big leaf maple, Black cottonwood, Red alder, and Paper birch were also likely present along the rivers, streams, and open areas. Understory vegetation probably included Vine maple, Oregon grape, several different willows, Ocean spray, Salmonberry, Thimbleberry, and many others. Wetlands, streams, and rivers supported a unique array of plants adapted to wet environments. The marine shoreline was also a unique environment where only plants adapted to a saltwater influenced environment thrived.

The dominant disturbances that shaped vegetation patterns in the northwest prior to the arrival of Euro-americans were fires, wind storms, ice storms, and floods. Traditional uses of vegetation included the gathering of medicinal plants, use of willows and other shrubs for fishing, and extensive use of Western red cedar for many things including clothing, baskets, buildings, and canoes. Many plants were also used as food to complement the traditional diet of fish, shellfish, elk, and deer. Some of these foods, such as ferns, camas, and wapato, were cultivated in natural prairies along the Nooksack River.

Like most areas in the Nooksack River watershed downstream from Everson, conversion of forest land to agricultural land occurred on the Lummi Reservation following the arrival of Euro-americans. In 1896 there were reported to be approximately 1,222 acres under cultivation on the Reservation. Along with clearing the forested land for agriculture, the landscape was ditched, wetland areas were drained, log jams were cleared, the Nooksack River was diverted to drain into Bellingham Bay, and the Lummi River delta cut off from the Nooksack River by a dike. All of these changes in the natural hydrology of the Lummi Reservation changed the distribution and patterns of wetland and riparian associated plant communities.

One or more large fires swept through the Lummi Reservation sometime between 1850 and 1900. These fires destroyed nearly all of the remaining old growth forests. Logging of timber on the Lummi Reservation began after the fires. Much of the cedar was cut into shingle bolts and shipped to local shingle mills. The old growth trees on Portage Island were cut down to fuel steamboats on the Nooksack River. Reforestation was not practiced during the early logging period and pioneer tree species such as alder, willow, and cottonwood soon replaced the conifer forests and dominated the landscape. Although there are cedar groves and Douglas fir plantations, the present day forests on the Reservation are largely comprised of deciduous trees.

2.6.2 Current Land Use

As part of the Lummi Indian Reservation Storm Water Management Program, a LANDSAT satellite image from August 15, 1991 was used to estimate the extent of various land uses in the watersheds that drain to the Reservation tidelands (LIBC 1998a). The Whatcom County Planning and Development Services had classified the image into different land cover types. The land uses in the Nooksack River basin were characterized based on information presented in the Whatcom County Comprehensive Plan (Whatcom County 1997). Excluding both tribal tidelands and land cover/land use types in the Nooksack River watershed off-Reservation, approximately 91 percent of the Reservation upland area is either agricultural, forested, or wetlands.

2.6.3 Future Land Use

The Lummi Planning Department used demographic profile data from the 1990 Census and projected that between 3,800 and 4,350 housing units will be needed on the Reservation by the year 2010 (LIBC 1996). These population projections, planned economic and institutional growth on the Reservation, and the small percentage of tribal land that has been developed suggest that portions of existing forested lands on the Reservation will be converted to residential and commercial uses in the coming years.

Similarly, the future land use in the Nooksack River watershed is projected to include more residential, commercial, and urban development to accommodate projected population increases (Whatcom County 1997).

2.7 SURFACE WATER RESOURCES

Surface waters in the study area include the Nooksack River, the Lummi River, sloughs, small streams, roadside and agricultural ditches, springs, wetlands, estuaries, and marine waters. The locations of some of these features are shown in Figure 4.

2.7.1 Rivers, Sloughs, Streams, and Ditches

The Nooksack River drains much of western Whatcom County and currently discharges to Reservation waters and the marine water of Bellingham Bay near the eastern extent of the Reservation. Prior to 1860, the Nooksack River discharged primarily into Lummi Bay by way of the channel presently used by the Lummi River (WSDC 1960, Deardorff 1992). In 1860 a logjam blocked the Nooksack River and diverted it to a small stream that flowed into Bellingham Bay (WSDC 1960). Since that year, due to the increased commercial value of the river that resulted from its proximity to sawmills along Bellingham Bay, considerable effort has been expended to keep the Nooksack River discharging into Bellingham Bay (Deardorff 1992). The Nooksack River was also the primary transportation corridor for Ferndale, Deming, and Lynden residents to travel to Bellingham until the early 1900s. The stream remaining in the Nooksack River's old channel has been called the Lummi or Red River (WSDC 1960).

In the 1920s, a reclamation project was initiated to both construct a dike to keep back the sea along the shore of Lummi Bay, and to construct a levee along the west side of the Nooksack River (Deardorff 1992). This project, which was started in 1926 and completed in 1934, initially resulted in the near complete separation of the Lummi River from the Nooksack River. However, when salt water intrusion onto the newly reclaimed farmlands and damage to the dam at the head of the Lummi River occurred during flooding, the dam was replaced with a dam and spillway structure (Deardorff 1992). This spillway structure was also damaged over the years during high flow conditions and was most recently replaced by a culvert structure that allows flow into the Lummi River only during high flow conditions. Levees were also constructed along the Lummi River to prevent salt-water intrusion onto adjacent farmlands.

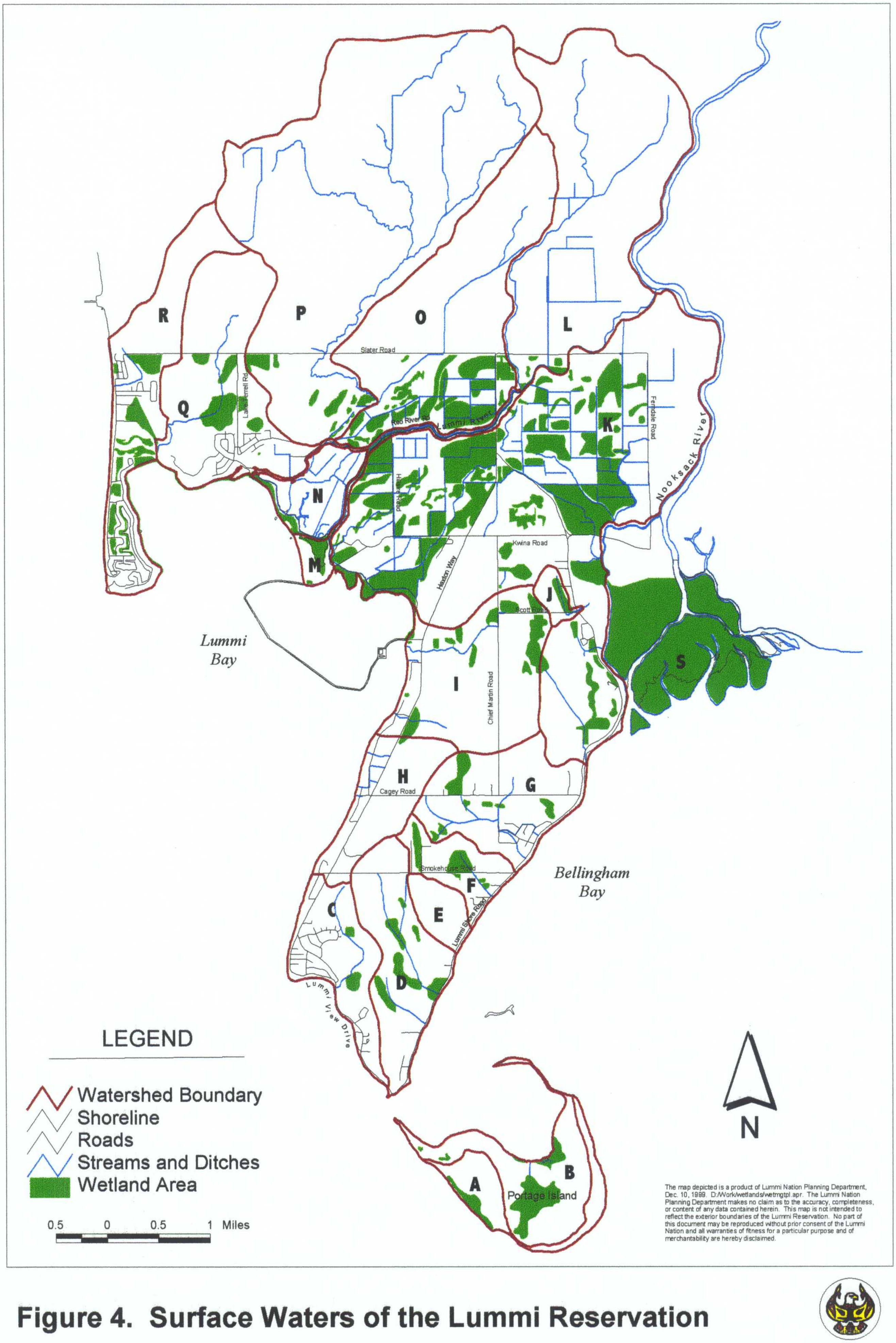


Figure 4. Surface Waters of the Lummi Reservation

The dike and levee construction activity was accompanied by agricultural ditching to drain fields and wetland areas. Based on 1887-88 topographic surveys, Bortleson et al. (1980) estimated that wetlands located landward of the general saltwater shoreline (subaerial wetlands) in the lower Lummi River watershed have decreased from approximately 2.0 square miles (mi^2) to 0.1 mi^2 (approximately 95 percent).

In general, the Lummi River currently carries storm water runoff from the Ferndale upland as well as the drainage from a complex network of agricultural ditches in the floodplain. Tidal waters enter the Lummi River from Lummi Bay twice daily, and during the late dry season, saline water extends as far upstream as Slater Road at extreme tides. Although currently there is Nooksack River water flowing in the Lummi River channel only during high flow events, available data indicate that the flow in the Lummi River was around 200 cfs as recently as 1955 (WSDC 1964) when a dam/spillway structure was in place along the Nooksack River.

The Nooksack River reach located on the Lummi Reservation is tidally influenced. Streamside levees are in place to protect agricultural lands from flooding and saline water. Several named sloughs, which are the remains of former river channels, have been incorporated into the agricultural drainage network built on the floodplain of the Lummi and Nooksack rivers. Kwina Slough, a distributary channel of the lower Nooksack River, is the water source for the Sea Ponds salmon hatchery and the Mamoya salmon rearing ponds.

There are several mapped and previously unmapped streams on the Reservation. Most of the unmapped streams have poorly defined channels and contain surface flow only during the October through July period. The approximate locations of these streams were identified as part of the storm water facilities inventory. No flow was observed in any of the streams during a field survey of all Reservation streams in late August 1996.

2.7.2 Springs and Wetlands

Upland springs, which are commonly ground water discharge zones for shallow perched aquifers, are found throughout the Reservation. When water moves downward in permeable sand or sand and gravel lenses and encounters relatively impermeable silt or clay, it moves laterally along the top of the impermeable layer until the layer either intercepts the land surface or a more permeable layer. A seep or spring occurs if the interception point is the land surface and wetlands may occur there if the interception point is a topographic depression in the land surface or clayey soils with a shallow slope. In addition to upland springs, springs occur along the shoreline below the ordinary high water line at numerous locations throughout the Reservation.

Historically, springs emerging along the slopes of the uplands served as a water supply for the Lummi people. In many cases they are part of a wetland system where the water infiltrates along the lower terraces to return to ground water. The springs are important for wildlife habitat and for aquifer recharge and protection. Upland aquifers, which provide the primary Reservation drinking water supply as well as salmon egg incubation and rearing water for the hatchery program, have experienced depletion and salt water intrusion. Where it occurs, the infiltration of fresh water along shorelines provides a buffer against salt-water intrusion.

The wetlands in the upland areas are palustrine (i.e., marshes, wet meadows, swamps, small shallow ponds), generally forested wetlands that are often seasonally rather than permanently wet. Most Reservation wetlands formed on silty loams deposited by glacial outwash such as Alluvium, Bellingham Drift, and sands and gravels overlying Bellingham Drift (Whatcom County 1992, Caplow and Plake 1992). Since then, logging and road construction have altered the hydrologic processes of many of these wetlands by either draining them or impounding more water. Historic fires, logging activities, and conversion to agriculture have transformed Reservation wetlands to their current vegetative composition.

Most of the once extensive wetlands of the Lummi and Nooksack rivers floodplain have been diked, drained, filled, and cultivated since the late 1800s. Low areas near some of the sloughs still reflect the rich and complex wetland habitat that covered most of the lower floodplain before human alteration. Small estuarine wetlands lie in sheltered, low energy areas at Onion Bay, Neptune Beach, Portage Island, Lummi River floodplain, the Nooksack River delta, and adjacent to the Aquaculture dike.

Road construction and agricultural activity have altered the wetlands north of Marine Drive adjacent to the Nooksack River. South of Marine Drive, many of the Nooksack River delta wetlands have been physically altered by the accumulation of sediment at a high rate. The Nooksack River delta was identified as the fastest growing delta for the basin size in Puget Sound, with a progradation of approximately 1 mile over the 1888 - 1973 period (Bortleson et al. 1980). In addition to the delta progradation, the wetlands of the Nooksack River delta are likely affected by the low instream flows and poor water quality that characterizes the river during some summer months.

On the west bank of Kwina Slough, areas that were marine beaches in 1900 have developed into wetland areas as the Nooksack River delta has prograded seaward. Former beach sands and gravels have been mined in a few locations. Beaver activity is common in this area of the Reservation.

These palustrine/estuarine emergent wetlands of the lowlands/floodplains are significant for water quality enhancement, flood reduction, storm water attenuation, fish habitat, wildlife habitat, and for plants with traditional cultural importance. The estuarine wetlands provide critical juvenile rearing habitat for migrating salmon, herring, smelt, and other finfish and shellfish.

The significance of these wetlands is increasing as wetlands upstream from the Reservation are altered and destroyed. These Reservation wetlands reduce the water quality impacts of off-Reservation urban development and agricultural land uses on Lummi commercial and subsistence shellfish beds in Portage and Lummi bays.

Protecting and enhancing floodplain and estuarine wetlands is essential to preserving and/or restoring the interdependent fish, shellfish, and wildlife habitat.

Remnants of what were once extensive high value wetlands are located on the Sandy Point peninsula between Sucia Drive and the private Sandy Point marina. Road construction and drainage facilities now limit tidal inundation, but wildlife and wetland vegetation is abundant. Plants of traditional cultural significance have been identified in this area. Further north on Sucia Drive, formerly dry and seasonally wet areas are now permanently flooded as a result of road construction that blocked natural drainage.

2.7.3 Estuarine and Marine Waters

Brackish estuarine waters grade to marine waters of the Reservation in Lummi Bay, Portage Bay, portions of Bellingham Bay and Hale Passage, and the shoreline along Georgia Strait. Saline water moves across tideflats and into the Lummi and Nooksack river channels twice daily with the tidal cycle. The salt water underlies the less dense fresh water and moves as a wedge upstream. Tidal effects in the Nooksack and Lummi rivers have been observed as far upstream as Slater Road.

Estuarine waters of the Nooksack and Lummi river deltas form the interface between marine and fresh water. Estuarine waters are important habitat for juvenile and adult salmon as they acclimate to either saline or fresh waters during their seaward and landward migrations respectively.

Estuarine wetland ecosystems in general are considered to produce more biomass for their area than any other natural ecosystem on earth. The complex and rich aquatic resources that provide feeding grounds for fish also attract a large variety of wildlife. The estuaries of the Lummi and Nooksack rivers are a part of a major pacific coast flyway for ducks, geese, swans, and shorebirds. These estuaries are also habitat for the threatened and endangered Bald eagle and Peregrine falcon.

Small, estuarine marshes in Lummi Bay occur in sheltered fringes of diked areas. Lummi Bay tideflats are extensive and rich in resources for tribal subsistence and as wildlife feeding areas. Less extensive tideflats at Gooseberry Point, Stommish, and Portage Bay are also important to the tribal economy and culture.

2.8 BIOLOGICAL DIVERSITY

The Lummi Reservation is home to diverse biological (biotic) communities including low salinity estuaries, high salinity estuaries, a variety of upland forest communities, active and fallow agricultural lands, sandy spits, tidelands, streams, ponds, and numerous diverse freshwater wetlands. Each of the communities contain a variety of species of flora and fauna that move within and between communities. At a watershed or ecosystem level, wetlands help maintain and enhance biological diversity on the Reservation.

2.8.1 Plant Diversity

Upland plant communities are typically forested except on the floodplain where agricultural land uses predominate. The numerous diked backwater channels throughout the floodplain contain corridors of trees, shrubs, or herbaceous cover. Estuarine plant communities contain salt tolerant plant species.

Upland forests vary between conifer forests, monoculture or mixed conifer plantations, mixed hardwood/conifer forests, and hardwood forests. Douglas fir dominates the conifer forests on Portage Island (Caldwell 1983). Conifer plantations on the Reservation are young stands of Douglas fir and/or Western red cedar with limited understory (LIBC 1999). As these plantations age, they will generally be harvested before canopy stratification and the development of understory diversity.

The mixed hardwood/conifer forests consist of numerous tree species. Red alder, Big-leaf maple, Black cottonwood, and Paper birch comprise the hardwood component, while Douglas fir, Grand fir, Sitka spruce, and Western red cedar comprise the conifer component (Caldwell 1983, LIBC 1999, Harper 1999). These mixed forests contain a few remnant trees that survived fire and timber harvesting. Mixed forests naturally have canopy stratification and a variety of understory shrubs and herbs. Soils, hydrologic processes, and temperature influence plant species presence/absence in an area and often control the type of plant community that develops (USDA 1992).

Either Big-leaf maple or Red alder typically dominates hardwood forests (LIBC 1999). Present with these dominant species can be Black cottonwood, and/or Paper birch. Hardwood forests contain a variety of understory shrubs and herbs such as Red elderberry, Salmonberry, Vine maple, and Hardhack.

The floodplain has been farmed for nearly a century. Some areas are too wet or have excess salt concentrations to continue farming and have been left to become degraded wetlands. Some areas are left fallow or are no longer farmed. These areas consist of grasses such as Reed canary grass that preclude colonization by other plant species.

Backwater channels in the floodplain vary between fresh water and brackish water throughout the year. During the rainy season (October through April), overland flow and ground water discharge to backwater channels. During the dry summer months, tides can push saltwater upstream creating brackish conditions. Salinity in the water and soil influences the plant species that can grow within and along the shorelines of the surface water. Along the shoreline, Himilayan blackberry, Reed canary grass, Tansy and other non-native weeds often dominate the uplands adjacent to the backwater channels. In areas closer to Lummi Bay, backwater channels have no adjacent dike and sea water can flood adjacent agricultural lands during high tides.

Reservation estuaries along Bellingham Bay and Lummi Bay are different due largely to the hydrologic processes that affect them. The Bellingham Bay estuary receives flow directly from the Nooksack River, which results in low salinity water flooding the associated saltmarshes. These low salinity saltmarshes are dominated by bulrush species at lower elevations and Lyngby sedge at higher elevations, with the Lyngby sedge community having a greater overall diversity and distribution of plant species (Disraeli 1997). The Lummi Bay estuary has limited freshwater influence and maintains higher salinity levels in both water and soils. This high salinity environment excludes many plant species. Pickleweed and Saltgrass with Pigweed present dominate the high salinity saltmarsh at low elevations. At higher elevations, plant diversity and distribution is variable with areas dominated by Tufted hairgrass, Gumweed, or Meadow barley. Below mean low tide, Eelgrass dominate the intertidal zone (Evans-Hamilton, Inc. and D.R. Systems, Inc. 1987).

2.8.2 Animal Diversity

The diversity of plant communities and the proximity to both fresh and salt water create habitat for numerous animal species. Amphibians, reptiles, birds, and mammals live in the terrestrial habitat of the Reservation uplands. Some of these animals move between the terrestrial environment and the adjacent sea. The tidelands are home to a variety of birds, fish, and shellfish (Eissinger and Drummond 1994).

Forested wetlands on the Reservation provide habitat for a variety of amphibians. Numerous salamanders and the Pacific tree frog require moist forests or forested wetlands for all or part of their life cycles similar to the Western toad and Red legged frog (Eissinger and Drummond 1994). The drier areas of the Reservation provide habitat for the Terrestrial garter snake.

Avian diversity is high within Reservation boundaries (Eissinger and Drummond 1994). Winter and permanent ponds on the Reservation provide habitat for migratory waterfowl like Trumpeter swans, Canadian geese, and a variety of ducks. Lummi and Bellingham bays are winter homes to numerous species of loon, grebe, and other pelagic birds (Eissinger and Drummond 1994). Shorebirds, like Killdeer, plovers, and sandpipers occupy the Reservation tidelands. Gulls, terns, and crows live off of the abundance of food sources found throughout the Reservation. A variety of raptors inhabit the Reservation either seasonally or year-round. Red-tailed hawks, falcons, owls, and Marsh hawks have been observed on Reservation agricultural lands (Eissinger and Drummond 1994). Some Bald eagles overwinter along the lower Nooksack River, while others have made the Reservation their permanent home (Eissinger and Drummond 1994). Passerines (e.g., sparrows, finches, etc.) can be heard throughout the Reservation.

Although seldom seen or heard, a variety of mammals live on the Reservation. Shrews, moles, rabbits, Black-tailed deer and a variety of other mammals are a food source for local predators. Beaver build homes and dams along the wetlands of the floodplain and lower Nooksack River. Coyote, Mink, Striped skunk, and Mountain lion hunt throughout the Reservation (Eissinger and Drummond 1994).

Reservation estuaries provide an abundant food resource to both the Lummi People and local wildlife. Small fish such as surfsmelt, herring, and sandlance are food for salmon, perch, and rockfish. Dungeness crab migrate throughout the estuary depending on the stage of their life cycle. Various species of clam (e.g., horse, butter) dig into the tideflats while oysters attach to old shells, rock, or other hard intertidal substrates.

3. WETLAND FUNCTIONS AND CLASSIFICATIONS

In this section, after defining wetlands and wetland functions and values, different approaches for classifying wetlands and methods for assessing wetland functions are described. Wetlands can be simple ponds surrounded by upland plant communities or they can be complex plant communities interspersed over an impermeable soil/hardpan (Bill et al. 1999, McMillan 1998). Wetlands provide society with a variety of functions and values (McMillan 1998). Wetland functions are specific actions that the wetland performs such as peak flow attenuation and sediment removal (Granger et al. 1996, Gersib 1997). Wetland values are the worth that society places on specific wetland types or functions. Wetland classification is the grouping of wetlands based on similarities such as the dominant vegetative community or water source.

3.1 WETLANDS

Wetlands are defined as "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, bogs, and similar areas" (Corps 1987).

Two types of wetland determinations are ecological determinations and jurisdictional delineations (Bill et al. 1999, McMillan 1998, Tiner 1991b). An ecological determination includes the entire area influenced by the hydrologic cycle over time (not just one season). Wetland determinations based on the ecological approach are not always apparent due to variations in seasonal weather patterns. A jurisdictional delineation is defined based on the U.S. Army Corps of Engineers Wetlands Delineation Manual (Corps 1987). A jurisdictional delineation defines a wetland as an area with all three wetland parameters (hydrology, hydric soils, and hydrophytic vegetation) present for five to twelve percent of the growing season during the time that the wetland delineation is being conducted (Corps 1987). Appendix B provides the criteria for each of the parameters required for a jurisdictional wetland delineation. During drier seasons or years, jurisdictional wetland boundaries can be underestimated.

3.1.1 Hydrology

The source of water influences the type and location of wetlands and varies depending on location throughout the Reservation. Initially precipitation in the form of rain, sleet, snow, hail, and fogdrip is the source of essentially all freshwater on the Reservation. This water flows into wetlands directly through precipitation, headwater and backwater flooding, overland flow, and ground water seepage (Corps 1987). Precipitation events in the Nooksack River watershed influence the water level of the Nooksack River, often flooding wetlands along the lower Nooksack River. Major flood events of the Nooksack River can break through or overflow the levees along the lower reaches of the river and flood the Nooksack River floodplain. Uplands located adjacent to the marine shoreline and areas in the floodplains of the Lummi and Nooksack rivers can be inundated by saltwater from the surrounding marine waters. Hydrologic processes are the single most important factor in developing wetland characteristics (Corps 1987, Bill et al. 1999).

Indicators that wetland hydrologic processes occur in a wetland include: drainage patterns, strand lines, sediment deposition, watermarks, stream gage data and flood elevation predictions, historic records, visual observation of saturated soils, and visual observation of inundation (Corps 1987).

3.1.2 Hydric Soils

There are 28 different soil series within 39 soil map units found within the boundaries of the Reservation (USDA 1992). Fifteen of the 28 soil series are considered "hydric soils" (USDA 1999 – see Appendix C).

It is noted that inclusions of "hydric soils" occur within soil series that are non-hydric (USDA 1992). Soil series inclusions are areas within a mapped soil series or map unit that have different properties than the dominant mapped unit. The spatial distribution of soil map units characterized as hydric soils is shown on Figure 5. Hydric soils cover approximately 46 percent of the upland Reservation area.

Hydric soils are "soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic (no oxygen) conditions in the upper part" (USDA 1998). The biochemical processes resulting from anaerobic activity by microbial organisms in saturated soils creates distinct, observable indicators. These indicators include hydrogen sulfide gas (rotten egg smell), the accumulation of iron or manganese concentrations (mottling), the loss of iron or manganese from soil particles (gleying), and the deep dark colors of accumulated carbon (organics) (Corps 1987).

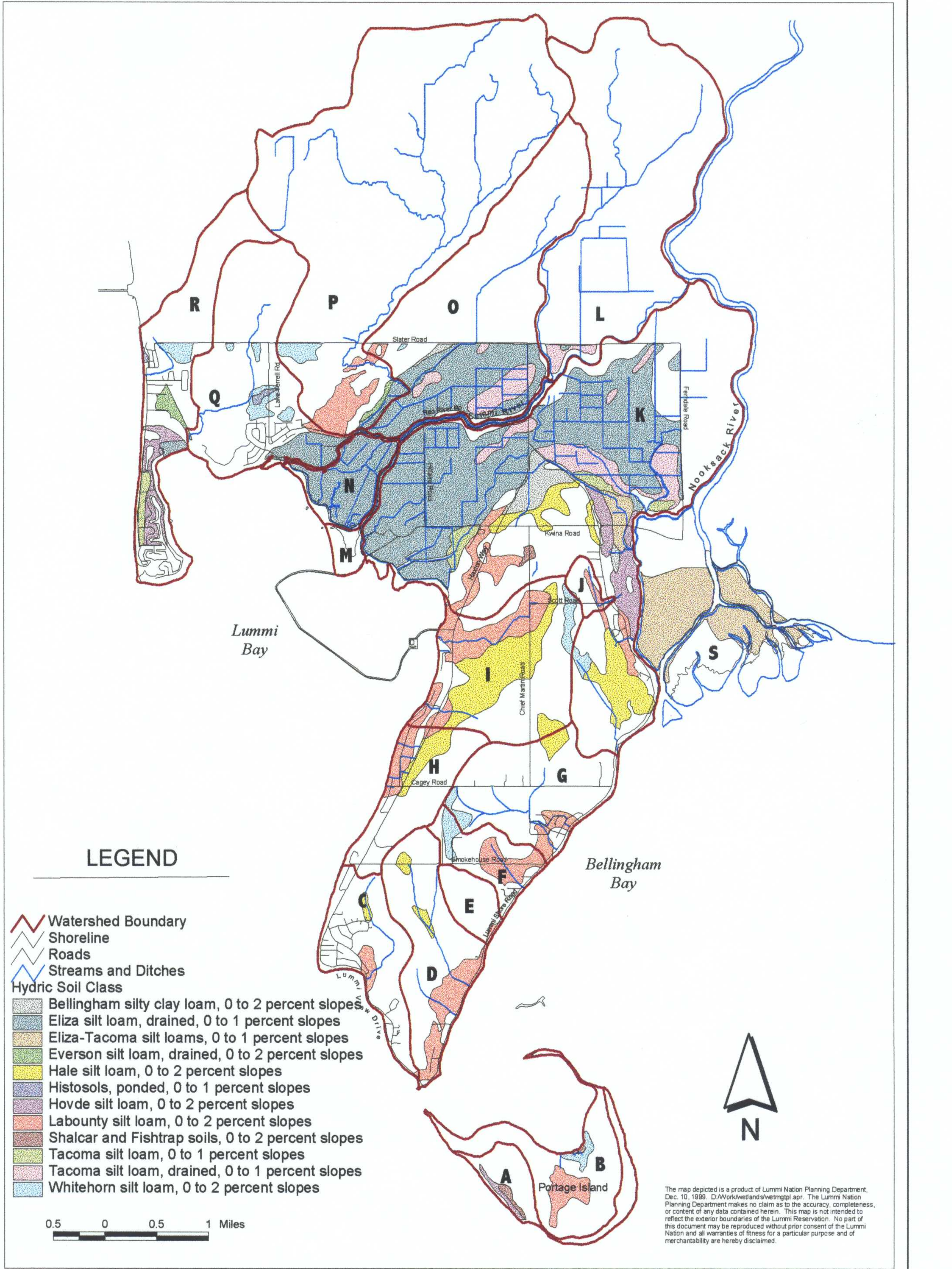


Figure 5. Location of Hydric Soils on the Lummi Reservation

3.1.3 Hydrophytic Vegetation

The term hydrophyte means, "water loving." Hydrophytic vegetation are plants that have adapted to survival in anaerobic soils. The USFWS has developed a national list of plant species that occur in wetlands in the northwest for use when conducting jurisdictional wetland delineations (Reed 1988). However, species that are considered upland species can, and often do, exhibit adaptations for surviving in anaerobic soils (Tiner 1991). This adaptability of some plant species has led to court challenges, confusion, and changes in the indicator status of some plant species (Reed 1993).

For jurisdictional wetland delineations, the national list of plant species that occur in wetlands (Reed 1988) identifies the indicator status for each plant species likely to be encountered in northwest plant communities. As shown in Table 1, plant species are classified into one of five indicator categories that range from obligate wetland species to obligate upland species.

Table 1. Indicator categories for plant species for conducting wetland determinations.

Indicator Category[1]	Indicator Symbol	Definition
Obligate Wetland Plants	OBL	Plants that occur almost always (estimated probability >90 percent) in wetlands under natural conditions, but which may also occur rarely (estimated probability <1 percent) in nonwetlands.
Facultative Wetland Plants	FACW	Plants that occur usually (estimated probability >67 to 99 percent) in wetlands, but also occur (estimated probability 1 percent to 33 percent in nonwetlands).
Facultative Plants	FAC	Plants with a similar likelihood (estimated probability 33 percent to 67 percent) of occurring in both wetlands and nonwetlands.
Facultative Upland Plants	FACU	Plants that occur sometimes (estimated probability 1 percent to <33 percent) in wetlands, but occur more often (estimated probability >67 percent to 99 percent) in nonwetlands.
Obligate Upland Plants	UPL	Plants that occur rarely (estimated probability <1 percent) in wetlands, but occur almost always (estimated probability >99 percent) in nonwetlands under natural conditions.

[1] The three facultative categories are further subdivided by (+) and (-) modifiers.

3.2 WETLAND FUNCTIONS AND VALUES

The value of wetland functions depends on the perspective of the individual or group of individuals. Wetlands can provide value without providing any identified function (Smardon 1978, Gersib 1997). The following discussion separates wetland functions into three categories (hydrology, water quality, and habitat) and includes a discussion on social values.

3.2.1 Hydrologic Functions

There are four basic hydrologic functions that wetlands provide: ground water recharge/discharge, flood flow storage and associated reduction in peak discharge, maintaining base stream flow, and shoreline stabilization. Each of these functions are described below.

Wetlands are important for maintaining the quality and quantity of ground water in an aquifer. Water that pools in a wetland can infiltrate into the soil and continue to move downward to recharge an aquifer. However, the amount of water that infiltrates into the soil is dependent upon the characteristics of the soil underlying the wetland (Sather and Smith 1984). Highly impermeable soils can provide limited to no ground water recharge.

Wetlands can also affect storm water runoff by intercepting overland flow and storing the water. This storage function of wetlands reduces the peak flow and can help reduce downstream property damage and flooding. The storage of storm water in wetlands can also provide other functions such as ground water recharge and amphibian habitat.

The storage of storm water in a wetland and the desynchronization of outflow from a wetland can also provide the function of maintaining base stream flow levels in adjacent water bodies. This base flow can be either surface or subsurface flow. During the dry season, water stored in or below a wetland can discharge to adjacent surface waters and provide water for instream flows.

Wetlands can help stabilize shorelines in a couple of ways. When wetlands store and then slowly release storm water runoff, they reduce downstream peak flows. This reduction in downstream peak flows reduces stream bank scouring and can allow for native vegetation to establish and further maintain stream bank stability (Adamus et al. 1991). Wetlands also provide the water and substrate necessary for hydrophytic vegetation to establish, which enhances shoreline stabilization.

3.2.2 Water Quality Functions

Wetlands are important for their role in maintaining water quality by providing temperature control; microbial control; and removal of sediment, nutrient, and toxicants from the water column.

Forested, scrub-shrub, and emergent wetlands provide shading of pooled water that helps to maintain cool water temperatures. As the water is discharged to streams, it can help provide a thermal environment conducive to fish health (Cedarholm 1994). Vegetated wetlands also provide a mechanism to capture, retain, and destroy simple biological organisms such as fecal coliform and *E. coli* (Hammer 1992, Hammer 1994).

By slowing the downstream flow of water, vegetated wetlands allow sediments, toxicants, and nutrients to be removed from the water column (Adamus et al. 1991). Toxicants are removed from the water column in a variety of ways including through adsorption onto suspended solids that settle out of the water column. Biochemical activities break some toxicants down into non-toxic forms and plants can uptake some toxicants and assimilate them into plant tissue (Adamus et al. 1991). Nutrient removal in a wetland also occurs in a variety of ways including adsorption onto suspended solids, microbial transformation, and plant uptake (Adamus et al. 1991).

3.2.3 Habitat Functions

Wetlands provide habitat for most terrestrial and fresh water aquatic organisms (Brown 1985). These organisms include fish, birds, amphibians, mammals, reptiles, plants, and arthropods. Wetlands can be critical in the long-term survival of threatened, endangered, and sensitive (TES) species (Williams and Dodd 1978). Wetlands are required for some of these species, such as Chinook salmon, to successfully complete one or more life stages (Levy and Northcote 1982, Healy 1980, Fisher and Pearcy 1989).

Wetlands with permanent open water, especially when associated with rivers and lakes, are important habitat for the maintenance of the diversity and abundance of finfish. In addition to open water, plants provide food for the food chain, cover to maintain cool water temperatures, and filtration to maintain water quality (Larson et al. 1989, Adamus et al. 1991).

Wetlands can provide excellent habitat for migratory waterfowl. The Puget Sound region contains primary winter habitat for waterfowl that nest and reproduce in the interior aquatic systems throughout North America. Some of these local aquatic systems are wetlands with permanent open water. The factors affecting migratory waterfowl habitat include the size of the wetland, availability of cover, isolation from disturbance, the absence of contaminants, and the spatial and temporal arrangement of these factors (Adamus et al. 1991).

Wetlands are home to a variety of species besides fish and birds and are an important part of the terrestrial and aquatic food chain. Wetlands and their associated riparian corridors often provide habitat for mammals, amphibians, reptiles, arthropods, and plants. The biological, chemical, and physical properties of a wetland affect its capability to provide food and shelter for the various life cycles of these organisms (Adamus et al. 1991). Available water and nutrients provide the opportunity for increased plant growth, which in turn provides a food source for higher trophic levels (Sather and Smith 1984). In addition, wetlands that drain to downstream systems export materials for consumption by organisms downstream.

3.2.4 Social Values

Wetlands were previously widely viewed as low value lands. However, this view is changing as a greater understanding of natural processes and the importance of wetlands emerges. Wetlands provide a variety of social values to the human communities around them. These values include areas of cultural significance, recreation, and opportunities for outdoor education (Smardon 1978). The factors affecting the social values of a wetland include the distance from the population center, water quality, access, and the interest of local residents (Gersib 1997).

The cultural significance and value of a wetland can range from the preservation of rare or endemic plant communities, aesthetics, open space, or to the protection of archaeologic, geologic, or historic sites (Adamus et al. 1991).

Recreation activities can be separated into consumptive and non-consumptive activities (Adamus et al. 1991). Consumptive activities include fishing, food gathering, and hunting. Non-consumptive activities include swimming, boating, and birdwatching.

Wetlands are also excellent areas to conduct outdoor learning experiences. Outdoor education can take the form of basic nature studies by elementary and secondary education classes or advanced scientific research on ecosystem functions and processes within and/or surrounding wetlands.

3.3 WETLAND CLASSIFICATION SYSTEMS

Wetlands are typically classified according to specific characteristics and there is some overlap between classification and function assessment methods. Four wetland classification systems are:

1. Cowardin Classification System,
2. Washington State Wetland Rating System
3. Washington Department of Natural Resources Wetland Classification System, and
4. Hydrogeomorphic Classification System.

The Cowardin Classification System is based on the physical characteristics of the source of water to the wetland, the type of substrate under the water, and the dominant vegetative community. The Washington State Wetland Rating System categorizes wetlands based on a combination of functions and values. The Washington State Department of Natural Resources Wetland Classification System is based on basic wetland characteristics. The Hydrogeomorphic Classification System is based on the landform where the wetland occurs and the source of water to the wetland.

3.3.1 Cowardin Classification

In 1979, the U.S. Fish and Wildlife Service adopted the Cowardin Classification System for wetlands and deepwater habitats in the United States (Figure 6). The Cowardin System is based on the shared characteristics of vegetation and water regime divided into systems, subsystems, classes, subclasses, and dominance types (Cowardin et al., 1979).

Systems are a complex of wetlands that share the influence of similar hydrologic, geomorphic, chemical, or biological factors. Systems describe where the wetland is found within the terrestrial community. A system can be marine (found in saline waters), estuarine (found in brackish waters), riverine (found associated with rivers and streams), lacustrine (found associated with lakes), or palustrine (does not fit any of the above descriptions). All systems except palustrine include a set of subsystems that further distinguish physical characteristics. The subsystems for marine and estuarine systems are subtidal and intertidal. There are four subsystems for riverine systems: tidal, lower perennial, upper perennial, and intermittent. There are two subsystems for lacustrine systems, limnetic and littoral.

All systems and subsystems include a variety of classes. Classes describe the general appearance of the habitat in terms of either the dominant life form of the vegetation or the physiography and composition of the substrate. Subclasses further separate wetlands based on the recognition of finer differences in life forms. Finally, the dominance type defines the taxonomic category based on the dominant plant species, dominant sedentary or sessile animal species, or the dominant plant and animal species.

Lakes are areas of permanent open water greater than 20 acres in area (Cowardin et al. 1979, Ecology 1998a, Ecology 1998b). Since there are no permanent freshwater open water areas greater than 20 acres on the Reservation, the Lacustrine system is not applicable on the Reservation.

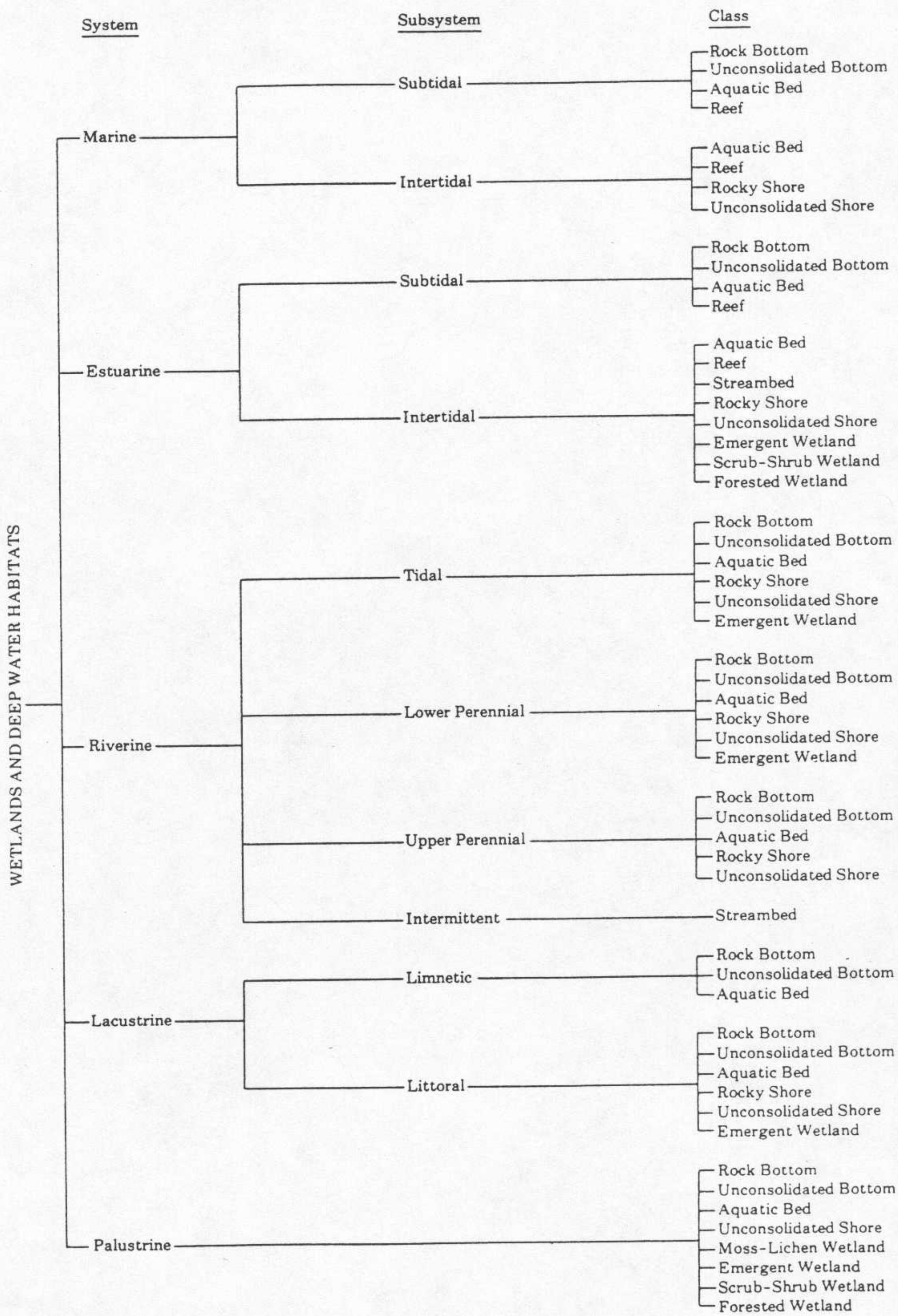


Figure 6. Classification hierarchy of wetlands and deepwater habitats, showing Systems, Subsystems, and Classes. The Palustrine System does not include deepwater habitats (Cowardin et al., 1979).

3.3.2 Washington State Department of Natural Resources Wetland Classification System

The Washington State Department of Natural Resources (DNR) is charged with implementing and regulating forest practices in Washington State. The DNR classifies wetlands according to their size, canopy closure, and the presence of open water (Table 2). Type A and B wetlands are protected through the use of Wetland Management Zones. Wetland Management Zones are buffers adjacent to wetlands that are intended to protect the wetland from adverse impacts from forest practices.

Table 2. Washington Department of Natural Resources Wetland Classification System

Wetland	Type	Characteristics
Nonforested		Any wetland or portion thereof that has, or if the trees were mature would have, a crown closure of less than 30 percent.
Nonforested	Type A	(i) Are greater than 0.5 acre in size, including any acreage of open water where the water is completely surrounded by the wetland; and (ii) Are associated with at least 0.5 acre of ponded or standing open water. The open water must be present on the site for at least 7 consecutive days between April 1 and October 1 to be considered for the purposes of these rules.
Nonforested	Type B	All other nonforested wetlands (except for bogs) greater than 0.25 acre.
Forested		Any wetland or portion thereof that has, or if the trees were mature would have, a crown closure of 30 percent or more.
Forested and Nonforested	Type A	Bogs greater than 0.25 acres

3.3.3 Washington State Wetland Rating System

The Washington State Wetland Rating System uses four basic criteria (rarity, irreplaceability, sensitivity to disturbance, and habitat functions) to classify a wetland into one of four categories. As summarize in Table 3, Whatcom County has adopted this system.

Table 3. Whatcom County wetland categories based on Washington State Wetland Rating System (Whatcom County, 1992).

Category	Criteria	Features
I	Wetlands or ponds that have exceptional resource value based on unique qualities, presence of rare wetland communities, and sensitivity to disturbance	Wetlands or ponds with one or more of the following: 1. Documented habitat for endangered or threatened fish, or animal species or potentially extirpated plant species recognized by State or Federal agencies; or 2. Wetland communities which qualify as quality Natural Heritage wetlands; or 3. High quality wetlands with irreplaceable ecological functions, including peat wetlands, estuarine wetlands, or mature forested wetlands; or 4. Wetlands of exceptional local significance. The criteria for such a designation includes, but is not limited to rarity, ground water recharge areas, significant habitats, unique educational sites, or other specific functional values within a watershed.
II	Wetlands or ponds that do not contain features outlined in Category I	Wetlands or ponds with one or more of the following: 1. Documented habitats for sensitive plant, fish or animal species recognized by Federal or State agencies; or 2. Wetlands with significant functions, including peat wetlands, estuarine wetlands, or mature forested wetlands, which are not high quality but which can not be adequately replicated through creation or restoration; or 3. Wetlands with significant water quality functions, and habitat value determined through a score of at least 35 points in the section Q5 of the Whatcom County Wetlands Rating System; or 4. Regulated wetlands, which provide documented habitat for salmonids.
III	Wetlands or ponds that do not contain the features outlined in Category I and II criteria.	Wetlands or ponds with one or more of the following: 1. Wetlands that are contiguous to other wetlands constituting a total of five acres or larger; 2. Wetlands over 10,000 square feet that are contiguous with a stream, river, pond, lake or marine water; 3. Isolated wetlands that are 5 acres or larger; 4. Wetlands (isolated or contiguous) over 10,000 square feet that provide a significant aquifer recharge function; 5. Isolated wetlands over 0.5 acres that have a less than 80% cover of hardhack, soft rush, or alder over 20 years of age 6. Isolated wetlands over 0.5 acres that have less than an 80% cover of non-native species including but not limited to Reed canarygrass and common pasture grasses.
IV	Wetlands one acre or greater that are not included in Categories I, II, or III	

3.3.4 Hydrogeomorphic Classification System

The Hydrogeomorphic (HGM) Classification System (Brinson, 1993b) classifies wetlands based on the hydrologic processes and geomorphologic characteristics of the wetland. Wetland hydrologic processes include the mechanisms by which water moves into, through, and out of wetlands. The geomorphologic characteristics include the landform of a wetland and its topographic position in the landscape. As summarized in Table 4, the major divisions of the HGM approach are riverine, depressional, tidal fringe, slope, mineral or organic soil flats, and lacustrine fringe. The primary reason for developing the HGM classification system was to develop a function assessment methodology.

Table 4. The Hydrogeomorphic Classification System Divisions

Classification	Definition
Riverine	Wetlands in topographic valleys
Depressional	Wetlands in topographic depressions
Slope	Wetlands on topographic slopes
Mineral soil flats	Wetlands on topographically flat areas with mineral soils
Organic soil flats	Wetland on topographically flat areas with organic soils
Estuarine fringe	Wetlands on the edges of marine waters
Lacustrine fringe	Wetlands on the edges of lakes

3.4 WETLAND FUNCTION ASSESSMENTS

Wetland function assessments typically group wetland functions into three general categories: water quality improvement, hydrologic effects, and habitat. Water quality improvement functions include nutrient removal, toxicant removal, and sediment removal. Hydrologic functions include water storage, velocity reduction, baseflow maintenance, and aquifer recharge. Habitat functions include plant diversity, invertebrate diversity, fish habitat, mammal habitat, bird habitat, reptile and amphibian habitat, general habitat, and food chain support. Various methodologies exist for assessing the ability of a wetland to perform these functions.

Originally wetland functions were evaluated based on the "best professional judgment" of experienced wetland professionals (Granger et al., 1996). Disadvantages of "best professional judgement" determinations of wetland functions include a lack of consistency, predictability, and reliability between individuals conducting assessments. In recognition of these disadvantages, numerous efforts have been made to develop a wetland function assessment methodology that can be used by different individuals to produce similar results.

Wetland function assessment methodologies use indicators to provide information about the ability of a wetland to perform a given function (Granger et al. 1996). Indicators are characteristics or conditions of the wetland that, when present, indicate a certain function is being performed. Indicators can be surveyed for presence or absence or can be numerically scaled to express the degree to which a function is being performed. Assessment methods that only use presence/absence can show neither trends nor impacts due to land use activities or climatic changes. Numerical evaluations of indicators allow for models that provide a performance score to be developed for each function present.

The information provided by functional assessments allows resource managers to understand the functions a wetland performs, to determine how the impacts from a proposed project will affect those functions, and to evaluate whether the impacts can be permitted. In instances where impacts are unavoidable, knowing what functions will be lost allows managers and regulators to plan compensatory mitigation projects that replace the lost functions.

Because of the recognized importance of wetland functions and the costs associated with wetland losses and mitigation, governments require a consistent approach to determine the presence and functions of wetlands. Because wetlands in different regions of the country perform functions differently, regional methodologies are needed. Washington State has adapted the Hydrogeomorphic (HGM) Approach to Assessing Wetland Functions. However, the Washington State HGM model currently assesses only depressional and riverine wetlands. A function assessment tool available for tidally influenced wetlands is the Indicator Value Assessment (IVA) method developed and utilized by Snohomish County. Snohomish County's IVA method will require some modifications to more accurately assess Reservation estuarine wetlands.

In the remainder of this section of the report, various approaches and methods for assessing wetland functions are summarized.

3.4.1 Wetland Evaluation Technique

The Wetland Evaluation Technique (WET) was originally developed by the U.S. Army Corps of Engineers to evaluate wetlands at a national level. The WET approach rates the probability that a wetland performs a given function as High, Medium, or Low (Granger et al. 1996). The WET approach does not allow local planners to differentiate between similar wetlands at a local level (McMillan 1998). The method has been modified by various states to better represent local conditions.

3.4.2 Reppert Method

One of the first methods for assessing wetland functions was the Reppert Method. The Reppert Method assigns numerical values to indicators present in a wetland. Indicator values for a given wetland are averaged to produce an overall assessment of wetland function. The results from the Reppert Method are considered too broad and general for local site-specific evaluations (McMillan 1998, Granger et al. 1996).

3.4.3 Oregon Method

The Oregon Freshwater Wetland Assessment Methodology (Oregon Method) was developed to provide qualitative descriptions of multiple wetlands within a given watershed (Roth et al. 1993). The Oregon Method assesses six wetland functions: wildlife habitat, fish habitat, water quality, hydrologic control, education, and recreation. Function assessments using the Oregon Method are cursory assessments that only provide information about whether the wetland: 1) provides, 2) has the potential to provide, or 3) does not provide the function assessed. This information can assist planners, citizens, and governmental staff in understanding wetlands and their functions within a watershed.

3.4.4 Semi-Quantitative Assessment Methodology

The Wetland and Buffer Functions Semi-Quantitative Assessment Methodology (SAM) was developed by Cooke Scientific Services (Cooke 1996). The SAM approach is essentially the Reppert method modified to northwest wetland ecosystems. The SAM approach assists wetland professionals with the identification and quantification of potential wetland functions by providing information about the presence and relative importance of wetland functions. The SAM approach is quick and easy for both wetland professionals and novices, but does not provide the comprehensive information about wetland functions provided by the Hydrogeomorphic methodology (Granger et al. 1996).

3.4.5 Lummi Wetland Function Classification Methodology

The Lummi Nation developed a Wetland Classification System to understand the functions of Reservation wetlands (Caplow 1994). When this system was developed, there was no functional assessment methodology that provided consistently reproducible results. This classification method uses indicator values for each function analyzed and was used during the mid-90s wetland inventory on the Reservation to rate the functions of wetlands (Arnett 1994).

3.4.6 Habitat Evaluation Procedures

The USFWS developed the Habitat Evaluation Procedure (HEP) to standardize methods for evaluating project impacts on both terrestrial and inland aquatic habitats and to allow comparison of alternative plans or projects (USFWS 1980). The HEP method is limited to assessing the habitat values for individual species or guilds of species (Granger et al. 1996). Although the HEP evaluates terrestrial and inland aquatic habitats, it does not evaluate hydrologic processes and wetland functions related to water quality (Granger et al. 1996).

3.4.7 Indicator Value Assessment

The Indicator Value Assessment (IVA) was developed as an extension of the HEP method (Hruby 1997). The IVA method assigns a numerical value to an indicator. The indicator values are input as variables into simple algebraic equations, one equation for each wetland function. The IVA method provides a level of performance for each wetland function assessed and the perceived benefits of each function (McMillan 1998). A drawback to the IVA method is that current models are site specific (Granger et al. 1996). However, the Snohomish Estuary Wetland Integration Plan provides a method that can be modified to assess the estuarine wetlands on the Reservation (MacWhinney and Thomas 1996).

3.4.8 Hydrogeomorphic Approach to Assessing Wetland Functions

The U.S. Army Corps of Engineers Waterways Experiment Station developed the Hydrogeomorphic Approach to Assessing Wetland Functions (HGM approach) in an attempt to better measure the capacity of a wetland to perform functions (Brinson, 1993b). The HGM approach can be described as consisting of three inter-related but distinct steps. First, wetlands in an area are classified based on differences in hydrologic processes and geomorphologic characteristics. As described in Table 4, seven major hydrogeomorphic wetland classes have been developed: riverine, depressional, slope, mineral soil flats, organic soil flats, estuarine fringe, and lacustrine fringe. Once a wetland is classified, the function of each of these classes in the study area is defined. Finally, a reference wetland for each class is identified and used to establish the range of functions for the wetlands in the study area. Three fundamental factors that define how wetlands function in a watershed are the position/location of the wetland in the watershed, water source, and the flow and fluctuation of water within and through the wetland (Brinson et al. 1993b).

The HGM approach was developed to increase the accuracy of wetland function assessments and the replicability of assessments by different individuals, while decreasing the amount of time needed to conduct the assessment (McMillan 1998, Granger et al. 1996). Washington State has developed an HGM approach specific to western Washington for riverine and depressional wetlands (Ecology 1998a, Ecology 1998b). Washington State reportedly intends to continue to develop methods to assess slope, flats, lacustrine fringe, and estuarine fringe wetlands. The Washington State HGM approach was applied on the Reservation as part of the comprehensive wetland inventory (Appendix A).

4. WETLAND MITIGATION AND RESTORATION

Wetland mitigation and wetland restoration are used for the long-term protection of wetlands. Wetland mitigation is used to lessen the impacts from land use activities that adversely impact wetlands. Wetland restoration is used to redevelop degraded or lost aquatic systems that historically provided wetland functions necessary for the life cycles of local animal and plant species or communities. Wetland restoration can be a form of wetland mitigation.

4.1 WETLAND MITIGATION

Wetland mitigation is defined by the Council of Environmental Quality as "avoiding impacts, minimizing impacts, rectifying impacts, reducing impacts over time, and compensating for impacts" (40 CRF 1508.20). In essence, there are three general types of wetland mitigation: avoidance, minimization, and compensatory mitigation. Avoidance means to not impact a wetland. For example, with avoidance mitigation, no fill could be discharged into the wetland if there is a practical alternative available that will result is less adverse impacts to the aquatic resource. Minimization occurs when wetland impacts cannot be avoided by a proposed project. In these instances, the project is modified and conditions that control the project implementation are put in place to ensure that unavoidable adverse impacts are minimized. Compensatory mitigation occurs when impacts are unavoidable and will result in a loss of "waters of the United States." Compensatory mitigation means that the applicant must preserve a high quality wetland, enhance an existing functional wetland, restore an existing degraded wetland, or create a new man-made wetland. Preferably the compensatory mitigation will occur at the same location or watershed where the wetland impacts will occur (McMillan 1998). However, if a new wetland cannot be built on-site, the off-site location should be in the same geographic area.

The functional characteristics of the lost wetland must be considered when assessing mitigation actions (McMillan 1998). Creating wetlands for compensatory mitigation and habitat restoration follow the same procedures. Project planning and design should include an analysis of soils, grading contours, water source and hydroperiod, native plant species, planting densities, species groupings, and size of planting zones (Castelle et al. 1992a, McMillan 1998).

The goal of compensatory mitigation is no net loss of wetland function or acreage (Walker 1999, McMillan 1998). As shown in Table 5, the U.S. Army Corps of Engineers uses a range of ratios as guidelines. The ratios for compensatory mitigation depend on the type of mitigation. However, all ratios are greater than 1:1 due to (Castelle et al. 1992a):

- The lag time for complete habitat replacement,
- The difficulty/uncertainty of determining a critical size to replace habitat,
- The feasibility of fully restoring habitat, and
- The difficulty of predicting success of a given project.

Table 5. Approximate replacement ratios for wetland impacts using compensatory mitigation (Walker, 1999).

Compensation Type	Ratio
Creation	2 or 3 : 1
Enhancement	6 : 1
Restoration	1.5 : 1
Preservation	10 : 1

The ratios shown in Table 5 were developed based on the following considerations (Walker 1999):

- Wetland creation occurs on non-hydric soils that are the most difficult environment to build a wetland due to soil characteristics.
- Wetland enhancement requires a large ratio because there is an overall loss of acreage.
- Wetland restoration requires building a wetland on a hydric soil. The ratio is correspondingly low since it is assumed that once wetland hydrologic processes are returned, wetland plants and functions will return.
- Wetland preservation requires no net loss of function and acreage. This approach often requires some other form of compensatory mitigation to ensure no net loss.

4.2 WETLAND RESTORATION

Wetland restoration involves reestablishing wetland functions in areas that were once wetlands (Hruby 1997). Although wetland restoration can be used for compensatory mitigation, wetland restoration activities can also occur independently and can be stand-alone projects. For example, on the Lummi Indian Reservation the Nooksack River Estuary Recovery Project is potentially a very large-scale wetland restoration project (LIBC 1998b). The project is currently in the planning/study phase to determine the options available for restoration, the economic benefits and costs of returning agricultural land to aquatic ecosystems, and the costs associated with conducting the Environmental Impact Statement and implementing the preferred alternative.

There are a number of options for restoring wetlands on the Lummi and Nooksack River floodplain. For example, removing the seawall along portions of Lummi Bay will expand the intertidal zone and adjacent saltmarsh communities. Restoring freshwater flow from the Nooksack River into the Lummi River will reopen an anadromous fish migration channel. Restoring degraded wetlands associated with the Lummi River and other freshwater channels on the floodplain will provide filtration systems to improve water quality and habitat for a variety of plants and animals.

5. EXISTING WETLAND PROTECTION PROGRAMS

Effective wetland protection programs generally combine regulatory and non-regulatory approaches. Regulatory approaches on the Lummi Reservation are currently derived from Executive Orders and federal laws such as the Clean Water Act, the Rivers and Harbors Act, and the Coastal Zone Management Act. Non-regulatory approaches could include tax incentives for conservation easements, grant funding for wetland restoration activities, public education efforts to increase awareness of the importance of wetland functions, and approaches to preserving high quality wetlands such as land acquisition.

5.1 FEDERAL REGULATIONS

In 1997, the LIBC adopted Resolution 97-104 to formally create a Technical Review Committee (TRC). The TRC is responsible for reviewing applications for land use activities on the Reservation to ensure that the applicant complies with applicable tribal and federal laws and to ensure that impacts on neighboring property owners are minimized. In formally creating the TRC, the LIBC also reaffirmed its commitment to provisions of the Clean Water Act, Rivers and Harbors Act, and other federal laws that protect Lummi resources such as wetlands.

5.1.1 Executive Order 11990 Protection of Wetlands

Executive Order 11990 of May 24, 1977 defined wetlands and recognized the significant values provided by wetlands. The Executive Order directed each federal agency to provide leadership and to take actions to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities. To the extent permitted by law, each federal agency is to avoid undertaking or providing assistance for new construction located in wetlands unless the head of the agency finds, 1) that there is no practicable alternative to such construction, and 2) that the proposed action includes all practicable measures to minimize harm to wetlands which may result from such use. Each agency was also directed to provide opportunity for early public review of any plans or proposals for new construction in wetlands.

The key requirement of Executive Order 11990 is determining whether a practicable alternative to locating an action in wetlands exists. This determination requires the identification and evaluation of alternatives that could be located outside of wetlands (alternative sites); other means that would accomplish the same purpose as the proposed action (alternative actions); and no action. If there is no practicable alternative to locating an action in wetlands, the Executive Order requires that the action include all practical measures to minimize harm to the wetlands and preserve and enhance the natural and beneficial values.

5.1.2. Executive Order 11988 Floodplain Management

Executive Order 11988 of May 24, 1977 requires federal agencies to recognize the significant value of floodplains and to consider the public benefits that would be realized from restoring and preserving floodplains. The objective of Executive Order 11988 is avoidance, to the extent possible, of long- and short-term adverse impacts associated with occupancy and modification of the base floodplain (100-year floodplain) and the avoidance of direct and indirect support of development in the base floodplain wherever there is a practicable alternative. Federal agencies are directed to take action to:

1. Avoid development in the base floodplain unless it is the only practicable alternative;
2. Reduce the hazard and risk associated with floods;
3. Minimize the impact of floods on human safety, health, and welfare; and
4. Restore and preserve the natural and beneficial values of the base floodplain.

5.1.3 Clean Water Act

The objective of the federal Clean Water Act (CWA) is to restore and maintain the chemical, physical, and biological integrity of the "waters of the United States" (33 U.S.C 1251 et seq.). The CWA protects wetlands by regulating the dredging or filling of wetlands. Under Section 404 of the CWA, the U.S. Army Corps of Engineers issues permits for dredging and filling activities that impact wetlands. Under Section 401 of the CWA, currently the Environmental Protection Agency (EPA) must certify that proposed projects will not cause exceedence of water quality standards. When the Lummi Indian Nation is authorized to administer Section 401 of the CWA and adopts water quality standards, the Lummi Natural Resources Department will be responsible for certifying that proposed projects will not cause exeedences of water quality standards.

5.1.3.1 Section 404

The U.S. Army Corps of Engineers has developed a permitting system for regulating wetlands that are considered "waters of the United States." The three types of permits used by the Corps under Section 404 are: Individual Permits, Regional Permits, and Nationwide Permits.

Individual Permits for a project are issued after a full public interest review of an application for a Section 404 permit. A public notice is distributed to all known interested persons including the USFWS, the National Marine Fisheries Service (NMFS), the EPA, and state and local government agencies. The general public is notified through local newspapers. Individual permits are for specific, individual projects that are too large or do not meet the criteria of Regional or Nationwide permits.

Regional Permits are used for general category activities that are similar in nature and cause minimal environmental impact (both individually and cumulatively). The Regional Permit reduces duplication of regulatory control.

Nationwide Permits cover a category of activities throughout the United States. If the proposed activity does not meet any of the available categories, a regional or individual permit is required. Some Nationwide Permits require a public input phase while others only require a permit application and notification after project completion.

All of the Corps permits for work on the Reservation are obtained by submitting a Joint Aquatic Resource Permits Application (JARPA). In cooperation with the Corps, the Lummi Nation developed a JARPA specific to the Reservation (Appendix D).

5.1.3.2 Section 401

When a JARPA is submitted to the Corps, the Corps currently notifies the EPA. A Section 401 Water Quality Certification may be necessary to ensure that the proposed project meets aquatic protection regulations. The certifying agency must approve, condition, or waive the Section 401 permit before the applicant can begin work on the proposed project. Section 401 conditions become conditions of the Section 404 permit.

5.1.4 Rivers and Harbors Act

All work conducted in or over navigable waters of the United States requires a Federal River and Harbors Act Section 10 permit. Activities requiring a Section 10 permit include the construction of bulkheads, dolphins, floats, piers, and wharves. A permit is required for any activity that affects the course, location, condition, or capacity of "waters of the United States" (Corps 1998).

5.1.5 Food Security Act

The Natural Resources Conservation Service (NRCS) is charged with delineating wetlands on agricultural lands throughout the United States (EPA, 1998b). The NRCS is responsible for determining whether an area is a wetland, farmed wetland, prior converted cropland, or a non-wetland area before the landowner can receive consideration for funding under the Food Security Act (7 CFR 650). Wetlands and farmed wetlands do not qualify for funding under the Food Security Act.

Section 404 of the CWA applies to all wetlands and farmed wetlands on agricultural lands. On agricultural lands, discharges are allowed when "associated with normal farming, ranching, and forestry activities such as plowing, cultivating, minor drainage, and harvesting for the production of food, fiber, and forest products, or upland soil and water conservation practices" (33 USC 1251 et seq.). To be exempt, these activities must be part of an established ongoing operation. Grading and filling activities that convert a wetland to upland are not exempt and require a Corps permit.

5.2 NON-REGULATORY PROTECTION MEASURES

With the need to protect wetlands and property rights, a number of non-regulatory wetland stewardship approaches have been developed. Land trusts and other local organizations protect wetlands through purchases, donations, and conservation easements (Rubey and O'Connor 1996). Often this type of protection will include non-compensatory enhancement, restoration, or creation of wetlands in attempts to restore watershed functions and processes (McMillan 1998). Another approach involves improved land management through the use of best management practices (BMPs), management plans, or agreements and partnership contracts. Finally, governments can develop tax incentives for not developing land, the transfer of development rights, inclusion of buffer strips, greenbelts, or open space requirements in development projects. Public education efforts that provide information on the important functions of wetlands can also increase voluntary wetland protection activities.

6. CRITERIA FOR WETLAND PROTECTION

Identifying and protecting wetlands ensures the long-term integrity of these important aquatic resources. In this section of the report, inventories of Reservation wetlands are described and wetland protection approaches are identified.

6.1 COMPREHENSIVE WETLANDS INVENTORY

In the early 1970s, Reservation wetlands were inventoried as part of the USFWS National Wetland Inventory. This inventory was conducted using aerial photograph interpretation with little to no ground truthing. As a result, numerous wetlands were either not identified or the extent of the wetlands not accurately represented. More recently, some of the Reservation wetlands have been inventoried or delineated for various projects. As detailed in Appendix A, a comprehensive wetland inventory was conducted throughout the Lummi Reservation during 1999. Figure 7 shows one of the results of the inventory.

The 1999 comprehensive inventory of wetlands on the Lummi Reservation indicated that approximately 43 percent of the Reservation upland areas are either wetlands or wetland complexes. Of these Reservation wetlands, about 60 percent are located in the flood plains of the Lummi and Nooksack rivers. Wetland complexes are areas where wetlands formed a highly interspersed mosaic with upland hummocks. During the wetland inventory, boundaries were drawn around the outer edges of the mosaic and the entire area labeled a "wetland complex". As a result, the estimated wetland area identified in the inventory represents more wetland area than actually exists.

The comprehensive wetland inventory (Harper, 1999) utilized both the Cowardin System and the HGM Classification System to categorize Reservation wetlands. Some of the wetlands identified and mapped during the inventory are wetland complexes that include uplands interspersed with wetlands and intermittent non-fish bearing streams. Many of the wetlands mapped as part of the inventory are intact wetlands that can include a single plant community or a complex of variable plant communities. All wetland boundaries mapped during the comprehensive wetland inventory are general boundaries based on interpretation of color and infrared aerial photographs with some field verification. Specific wetland boundaries will be delineated on the ground as needed for specific activities.

As part of the inventory, function assessments were conducted on twelve wetlands using the Washington State HGM Approach to Assessing Wetland Functions (Ecology 1998a, Ecology 1998b). The wetlands assessed included small forested wetlands, large forested/scrub-shrub/emergent wetlands, and both degraded and recovering wetlands in the floodplain.

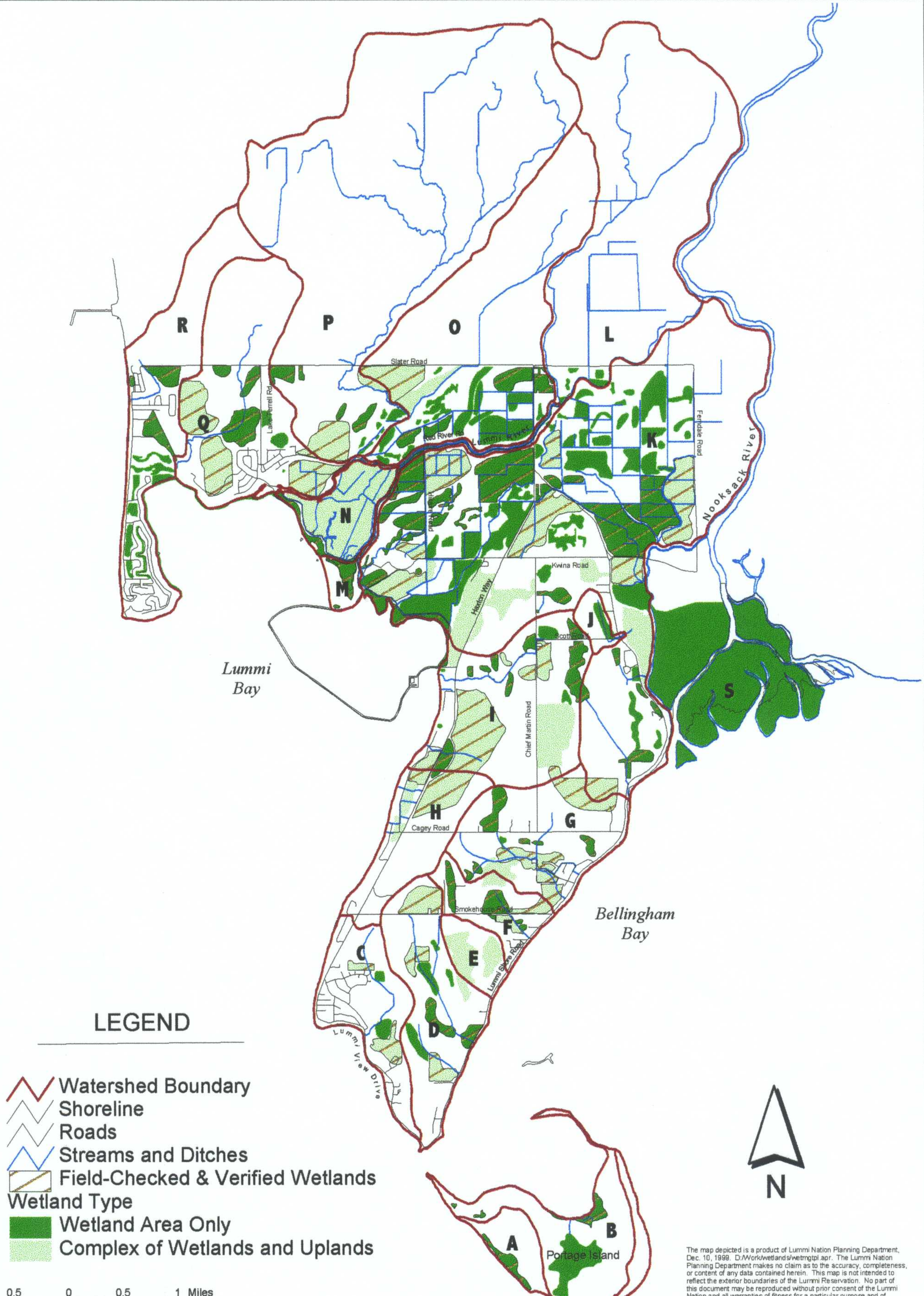


Figure 7. Location of Wetlands on the Lummi Reservation

6.2 WETLAND PROTECTION

Wetland protection methods include wetland preservation, the use of buffers, and the development of mitigation banks.

6.2.1 Wetland Preservation

Preserving wetlands protects aquatic resources for future generations by keeping or maintaining existing wetlands intact. Preserving wetlands maintains wetland functions such as biotic diversity, aquifer recharge, and peak flow attenuation (McMillan 1998). Wetland preservation efforts entail determining which wetlands require preservation and how to ensure preservation of wetland functions.

The best candidates for wetland preservation are those which include threatened or endangered species; high quality native wetland communities; significant finfish, waterfowl, or shorebird concentration areas; and irreplaceable ecological functions (Rubey and O'Connor 1996, McMillan 1998). Good candidates for wetland preservation include rare wetland types, wetlands that provide recreation and open space, and those considered ecologically irreplaceable (Rubey and O'Connor 1996, McMillan 1998).

One approach to preserving Reservation wetlands is for the LIBC to designate critical wetlands as conservation areas and work with affected landowners to protect both the wetlands and the property owners interests. For example, the LIBC could trade or purchase the portion of land containing the wetland from the owner.

6.2.2 Wetland Buffers

Wetland buffers are important for protecting the physical, chemical, and biological integrity of wetlands (McMillan 1998, Castelle et al. 1992b). Wetland buffers function similarly to wetlands in that they act as filtration systems for sediment and nutrients, hydrologic controls for overland flow, and wildlife habitat for wetland dependent species. Darling et al. (1982) found that the most stable buffers function the best and high percentages of vegetative cover and dense stands of trees enhance buffer stability.

Buffers reduce the adverse impacts of adjacent land uses by: stabilizing soil and preventing erosion; filtering suspended solids, nutrients, and toxic substances; moderating impacts of storm water runoff (i.e., water level fluctuations); and reducing noise, light, intrusion, and other human disturbances (McMillan 1998, Brown and Schaefer 1987, Shisler et al. 1987, Castelle et al. 1992b). Buffers provide important habitat for wildlife, which utilize the wetland and the buffer area for essential feeding, nesting, breeding, rearing, and resting (Eissinger and Drummond 1994). For example, some waterfowl feed in the wetlands and nest in adjacent uplands while many amphibians spend the majority of their lives in forested areas and breed in wetlands. Without protecting adjacent upland areas, wetlands could not support these wetland dependent species.

There has been extensive research on the minimum size a buffer should be to successfully perform a given function. The Washington State Department of Ecology (Ecology) has developed a range of buffers to protect wetlands based on the wetland classification scheme described in Table 3. Table 6 presents the suggested buffer widths for each of the four wetland categories.

Table 6. Suggested buffer widths for wetlands as classified using Washington State Wetland Rating System (McMillan 1998).

Classification	Buffer Size
Category I	200-300 feet
Category II	100-200 feet
Category III	50-100 feet
Category IV	25-50 feet

The appropriate width for a wetland buffer depends on both the functions performed by the wetland and the functions provided by the buffer. Ecology staff use the following guidelines to determine the buffer width within the ranges identified in Table 6 (McMillan, 1998):

- Buffer effectiveness increases with buffer width;
- Buffers of less than 50 feet in width are generally ineffective in protecting wetlands;
- Buffer widths effective in preventing significant water quality impacts to wetlands are generally 100 feet or greater;
- Buffers from 50 to 150 feet are necessary to protect a wetland from direct human disturbance in the form of human encroachment (e.g., trampling, debris); and
- In western Washington, wetlands with important wildlife functions should have 200 to 300 foot buffers depending on land use. In eastern Washington wetlands with important wildlife functions should have 100 to 200 foot buffers depending on land use.

Preventing sediment from entering wetlands is an important buffer function that both prevents the in-filling of wetlands due to sedimentation and the contamination of wetlands from nutrients adsorbed to sediment. Research has shown that the appropriate buffer width for sediment removal depends on the average particle size of the sediment, the slope adjacent to the wetland, the roughness of vegetated cover, and the runoff characteristics through the proposed buffer (Wong and McCuen 1982, Broderson 1973). In general, small buffers remove a small percentage of sediment. Disproportionately larger buffer widths are required for small increases in sediment filtering (Castelle et al. 1992b, Cedarholm 1994). Buffers have a reduced ability to filter sediment if the storm water flows into a wetland in defined channels. Buffers are only effective in sediment removal if they can resist channelization and can spread the runoff out as sheetflow (Broderson 1973).

Reducing or preventing nutrients from entering wetlands is another important function of buffers and can help protect wetlands from eutrophication. Leaving or replanting vegetated buffers around wetlands can effectively reduce nutrient loads in storm water runoff from agricultural lands (EPA 1998a). Doyle et al. (1977) found that both forested and grass buffers are effective at reducing nitrogen, phosphorus, potassium, and fecal coliform bacteria in storm water runoff (Murdoch and Capobianco 1979). Grass buffers were found to also reduce nitrates and sodium levels (Doyle et al. 1977). Buffers between urban development areas and estuarine wetlands must be large enough to prevent increases in both eutrophic nutrients and biochemical oxygen demanding substances (Phillips 1989). Reducing the amount of nutrient loading into a wetland can reduce stress and degradation to the wetland.

Forested wetland buffers moderate temperatures in wetlands by providing cover to portions or all of a wetland and thereby reduce the amount of sunlight reaching the water surface (Karr 1978, Cedarholm 1994). The buffer attenuates temperature fluctuations both on a daily and seasonal basis. Reduced sunlight also lowers the risk of algal blooms from occurring due to less photosynthesis.

Wetland buffers also protect wetlands from human impacts by limiting access and reducing or blocking the transmittal of noise into the wetland area. Human impacts resulting from easy access to wetlands typically involves the dumping of refuse from construction operations and neighborhood landscaping activities. Another aspect of human access is the trampling of vegetation and/or the compaction of soils. Trampled vegetation and compacted soils reduce the vigor of many desired wetland plant species allowing for more invasive, often exotic, plant species to establish. Noise pollution can directly affect wetland animals, particularly during their reproductive season.

Shisler et al. (1987) found that low intensity land uses (e.g., low density residential, recreation) have a lower impact on adjacent wetlands and therefore require a smaller wetland buffer than high intensity land uses (e.g., high density residential and commercial/industrial). Buffer vegetative cover type and buffer area ownership are also important factors for determining the long-term effectiveness of a buffer to protect against direct human impacts.

As previously described, wetland buffers provide wildlife with both wetland and adjacent upland habitat. Milligan (1985) found that wetland buffer size is correlated with bird species diversity, richness, relative abundance, and breeding numbers. Similar to the human impact deterrence, wetlands adjacent to high intensity land uses require larger buffers to protect for species diversity. When considering buffer sizes for obligate wetland animal species, the life history and spatial requirements for successful reproduction must be considered to effectively protect wetlands from becoming uninhabitable to these wetland animals.

The above discussion suggests that no specific buffer size is sufficient for all wetlands. The predominant approaches to determining wetland buffer sizes use vegetative cover, soil characteristics, and percent slope to determine the effectiveness of different buffer sizes based on the functions to be protected (McMillan 1998, Castelle et al. 1992b).

Buffers should be at least 200 to 300 feet from the wetland edge for wildlife habitat protection (McMillan 1998, Cedarholm 1994).

6.2.3 Mitigation Banking

Wetland mitigation banks are sites where wetlands or other aquatic resources are restored, created, enhanced, or preserved to provide compensatory mitigation in advance of authorized impacts (63CFR 36045). Mitigation banking is a method of preparing for current and future impacts to existing wetlands (McMillan 1998). Mitigation banking involves constructing a compensatory wetland and allowing it to develop to a functioning system (60 CFR 58605-58614). Future wetland impacts are debited against the available mitigation bank credit line.

Mitigation banking requires long term planning. The location of the mitigation bank should be in the same watershed as the wetlands being adversely impacted. With the development and implementation of the Nooksack River Estuary Recovery Project, opportunities may arise for building a wetland mitigation banking system. If a banking system is developed, wetlands within the Reservation can be impacted with minimal costs to property owners.

7. WETLAND MANAGEMENT PROGRAM ACTION PLAN

Future actions to develop and implement the Lummi Nation Wetland Management Program include coordinating the program with other Tribal land use and resource plans, development of a Lummi Nation wetland management ordinance, public participation and education, and ensuring that adequate staff and funding are available for the program.

7.1 COORDINATION WITH TRIBAL LAND USE AND RESOURCE PLANS

As described previously, the Lummi Wetland Management Program is part of the Comprehensive Water Resources Management Program (CWRMP) being developed and implemented by the Water Resources Division. The CWRMP also includes wellhead protection, storm water management, water quality standards, administrative procedures and the revision of the Lummi Nation Water Code. The Lummi Indian Reservation Wetland Management Program will support the Lummi Nation's watershed-based approach to protect natural resources and promote larger efforts to build self-government capabilities.

The CWRMP is part of larger plans to manage and protect Lummi Natural Resources while planning for long term development. The CWRMP will be used by the Lummi Planning Department for the development of a Comprehensive Land Use Plan. The Water Code will also provide the Technical Review Committee with greater direction and authority for regulating land use activities.

7.2 WETLAND MANAGEMENT ORDINANCE DEVELOPMENT

Similar to other elements of the CWRMP, a wetland management ordinance is being developed in stages. This technical background document is the technical foundation for the program. Following completion of this document, a review will be conducted of wetland management ordinances developed by other tribal, federal, state, and local governments. Based on this literature review and the technical background document, a wetland management ordinance will be drafted. Pursuant to the Lummi Nation Code of Laws, public hearings will be held on the proposed ordinance and the draft ordinance revised as necessary before it is approved and enacted.

7.3 PUBLIC EDUCATION

Public participation and education are important tools for protecting Lummi Nation resources. Once a draft wetland management ordinance is developed, it will be presented to the Lummi Natural Resources, Lummi Planning, Lummi Economic Development, and other related commissions for review. If the commissions and the Lummi Indian Business Council approve the draft ordinance, public outreach will expand so that the community has an opportunity to review and revise the ordinance prior to voting on its adoption.

The public education element of the wetland management program will entail a slide presentation, fact sheets, articles in the Lummi newspaper (*Squol Quol*), public meetings, and family meetings associated with the ordinance approval process. Articles about the CWRMP and the wetland management program have already appeared in the *Squol Quol*.

7.4 STAFF, TRAINING, AND BUDGET NEEDS

The wetland management ordinance approval process will require a 0.25 Full Time Equivalent (FTE). Staff should have a background in environmental education and water policy with an emphasis on wetland ecology. Training needs will be determined according to the background of the staff hired for this task. Wetlands training will include the ability to identify hydrophytic plants, hydric soils, and the patterns of hydrologic activity found throughout the Reservation wetlands.

Estimates of annual budget needs for the Wetland Management Program ordinance approval process and implementation are listed in Table 7.

Table 7. Estimated annual funding requirements for the Lummi Nation Wetland Management Program

Item	Cost
1. Personnel	
Salary Water Resources Planner ($15.00/hr @ 520 hours)	$7,800
Fringe Benefits Water Resources Planner ($15.00 @ 20%)	$1,560
2. Photo Copy and Postage ($200/month @ 12 months)	$2,400
3. Telephone and Fax ($50/month @ 12 months)	$600
4.Office Supplies ($50/month @ 12 months)	$600
5.Vehicle ($50/month @ 12 months)	$600
Total Direct Costs	$13,560
Total Indirect Costs (@ 43.9%	$5,953
Total Costs	$19,513

8. CONCLUSION

Management of Reservation wetlands is important for maintaining the long-term integrity of aquatic resources. The Lummi Nation Wetland Management Program includes the development of this technical background document; a literature review of wetland management ordinances developed by other tribal, federal, state, and local governments; and the development, adoption and implementation of a Wetlands Management Ordinance. Public education and participation are necessary to ensure that the Reservation community helps protect aquatic resources on the Reservation. A comprehensive land use plan supported by technically sound resource management programs will allow tribal members and the LIBC to develop the Reservation while preserving, creating, and restoring wetlands. The results of the wetland inventory and a determination of what constitutes a wetland worth preserving will help protect critical aquatic resources on the Lummi Reservation.

9. REFERENCES

Adamus, P. R., ARA, Inc., E. Clairain, Jr., R. Smith, and R. Young. 1991. Wetland Evaluation Technique (WET); Volume I: Literature review and evaluation rationale. US Army Corps of Engineers, Vicksburg, MS.

Arnett, J. 1994. Lummi Reservation wetlands study field inventory - Final Report.

Bauer, H.H. and M.C. Mastin. 1997. Recharge from precipitation in three small glacial-till-mantled catchments in the Puget Sound Lowland, Washington. U.S. Geological Survey Water Resources Investigation. Report 96-4219.

Bill, P., D. Sheldon, and K. Harper. 1999. Lummi Nation Wetland Training. Sheldon and Associates, Seattle, Washington.

Bortleson, G.C., M.J. Chrzastowski, and A.K. Helgerson. 1980. Historical changes of shoreline and wetland at eleven major deltas in the Puget Sound Region, Washington. U.S. Geological Survey. Hydrologic Investigations Atlas HA-617.

Broderson, J.M. 1973. Sizing buffer strips to maintain water quality. M.S. Thesis, University of Washington, Seattle.

Brown, E.R. (ed). 1985. Riparian zones and freshwater wetlands. In: Management of wildlife and fish habitats in forests of western Oregon and Washington, Part I – Chapter Narratives. pp. 57-80

Brown, M.T. and J.M. Schaefer. 1987. Buffer zones for water, wetland, and wildlife. A final report on the evaluation of the applicability of upland buffers for the wetlands of the Wekiva Basin. Prepared for the St. Johns River Water Management District by the Center for Wetlands, University of Florida, Gainesville, Florida.

Brinson, M.M. 1993a. Changes in the functioning of wetlands along environmental gradients. Wetlands 13: 65-74.

Brinson, M.M. 1993b. A hydrogeomorphic classification for wetlands. Technical Report WRP-DE-4 U.S. Army Corps of Engineers Waterways Experimental Station, Vicksburg, MS.

Caldwell, J.E. 1983. Portage Island ecological survey. Lummi Indian Business Council.

Canning, D.J. and M. Stevens. 1990. Wetlands of Washington: a resource characterization. Shorelines and Coastal Zone Management Program, Washington State Department of Ecology, Olympia, Washington.

Caplow, F. 1994. Lummi Nation Wetlands Classification System. Florence Caplow, Wetlands Consultant, Bellingham, Washington.

Caplow, F. and T. Plake. 1992. Nooksack River management planning: wetlands study. Whatcom County Planning Department, Whatcom County, Washington.

Castelle, A.J., C. Conolly, M. Emers, E.D. Metz, S. Meyer, M. Witter, S. Maurmann, M. Bentley, D. Sheldon, and D. Dole. 1992a. Wetland mitigation replacement ratios: defining equivalency. Washington State Department of Ecology, Shorelands and Environmental Assistance Program, Olympia, Washington. Publication No. 92-08.

Castelle, A.J., C. Conolly, M. Emers, E.D. Metz, S.Meyer, M. Witter, S. Mauermann, T, Erickson, and S.S. Cooke. 1992b. Wetland buffers: use and effectiveness. Washington State Department of Ecology, Shorelands and Coastal Zone Management Program, Olympia, Washington. Publication No. 92-10.

Cedarholm, C.J. 1994. A suggested landscape approach for salmon and wildlife habitat protection in western Washington riparian ecosystems. In: Washington Forest Landscape Management Project - Progress Report. A.B. Carey and C. Elliot compilers. Washington State Department of Natural Resources, Washington Forest Landscape Project. Report No. 1.

Cline, D.R. 1974. A ground water investigation of the Lummi Indian Reservation area, Washington. Tacoma, U.S. Geological Survey. Open-File Report.

Cooke, S.S. 1996. Wetland and buffer functions semi-quantitative assessment methodology. Cooke Scientific Services, Seattle, Washington.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Government Printing Office, Washington, D. C. Publication No. FWS/OBS-79/31.

Darling, N., L. Stonecipher, D. Couch, and J. Thomas. 1982. Buffer strip survival survey. Hoodsport Ranger District, Olympic National Forest, Washington.

Deardorff, L. 1992. A brief history of the Nooksack River's delta distributaries. Lummi Nation Fisheries Department.

Disraeli, D.J. 1977. Gradient analysis of the vegetation in a brackish marsh, Bellingham Bay, Washington. Masters Thesis, Western Washington State College, Bellingham, Washington.

Doyle, R.C., G.C. Stanton, and D.C. Wolf. 1977. Effectiveness of forest and grass buffer strips in improving the water quality of manure polluted runoff. American Society of Agricultural Engineers. Paper No. 77-2501.

Easterbrook, D.J. 1973. Environmental geology of western Whatcom County, Washington. Western Washington University, Bellingham, Washington.

Easterbrook, D.J. 1976. Geologic map of western Whatcom County, Washington. U.S. Geologic Survey Map I-854-B, 1:62,500.

Eissinger, A.M. and D.P. Drummond. 1994. The wildlife and habitat of the Lummi Reservation, Lummi Forestry Environmental Assessment: Wildlife Element.

Evans-Hamilton, Inc. and D.R. Systems, Inc. 1987. Puget Sound Environmental Atlas: Vol. 1. Prepared for the U.S. Environmental Protection Agency, Puget Sound Water Quality Authority, and the U.S. Army corps of Engineers.

Fisher, J.P. and W.G. Pearcy. 1989. Distribution and residence times of juvenile fall and spring Chinook salmon in Coos Bay, Oregon. Fishery Bulletin 88:51-58.

Gersib, D. 1997. Restoring wetlands at a river basin scale – a guide for Washington's Puget Sound. Washington State Department of Ecology, Shorelands and Water Resources Program, Olympia, Washington. Publication No. 97-099.

Granger T., T. Hruby, and A. McMillan. 1996. Washington State wetland function assessment project: an approach to developing methods to assess the performance of Washington's wetlands. Washington State Department of Ecology, Shorelands and Water Resources Program, Olympia, Washington. Publication No. 96-110.

Hammer, D.A. 1992. Designing constructed wetlands systems to treat agricultural nonpoint source pollution. Elsevier Science Publishers. pp. 49-82.

Hammer, D.A. 1994. Guidelines for design, construction and operation of constructed wetlands for livestock wastewater treatment. In: Proceedings: Constructed Wetlands for Animal Waste Management, Lafayette, IN. pp. 155-181.

Harper, K. 1999. Comprehensive Wetland Inventory of the Lummi Reservation. Sheldon and Associates, Inc. Seattle Washington.

Healy, M.C. 1980. Utilization of the Nanaimo River estuary by Juvenile Chinook salmon, *Oncorhunchus tshawytscha.* Fishery Bulletin 77(3): 653-668.

Hruby, T. 1997. Planning for wetland restoration and enhancement in the context of regional wetland management plans. In Wetland and Riparian Restoration: Taking a Broader Look. Eds. K.B. Macdonald and F. Weinmann. U.S. Environmental Protection Agency, Seattle, Washington. Publication No. EPA910-R-97-007. pp 15-21.

Karr, J.R. and J. Schlosser. 1978. Water resources and the land-water interface. Science 201(4253): 229-234.

Larson, J.S., P. Adumus, and E. Clairain, Jr. 1989. Functional assessment of freshwater wetlands: a manual and training outline. Univ. of Mass. Publ. No. 89-6.

Levy, D.A. and T.G. Northcote. 1982. Juvenile salmon residency in a marsh area of the Fraser River estuary. Can. J. Fish. Aquat. Sci. 39:270-276.

Lummi Indian Business Council (LIBC). 1996. Lummi Nation comprehensive environmental land use plan: background document. Bellingham, Washington.

Lummi Indian Business Council (LIBC). 1998a. Lummi Reservation storm water management program technical background document. Bellingham, Washington.

Lummi Indian Business Council (LIBC). 1998b. Nooksack Estuary Recovery Project: Conceptual Plan. Bellingham, Washington.

Lummi Indian Business Council (LIBC). 1999. Draft Environmental Assessment for the Lummi Indian Nation Forest Management Plan. Bellingham, Washington.

MacWhinney, E.J. and J.G. Thomas. 1996. Phase II: Skagit Wetlands and Industry Negotiation (WIN) - Indicator Value Assessment (IVA) of Wetland Functions at the Port of Skagit County, Located in the Padilla Bay/Bayview Watershed, Washington. Port of Skagit County, Mt. Vernon, WA.

McMillan, A. 1998. How Ecology Regulates Wetlands. Washington State Department of Ecology, Shorelines and Environmental Assistance Program, Olympia, Washington. Publication No. 97-112.

Milligan, D.A. 1985. The ecology of avian use of urban freshwater wetlands in King County, Washington. M.S. Thesis, University of Washington, Seattle.

Murdock, A. and J.A. Capobianco. 1979. Effluent on a natural marsh.. Journal of the Water Pollution Control Feder. 51: 2243-2256.

Phillips, E.L. 1966. Washington climate for these counties: Clallam, Jefferson, Island, San Juan, Skagit, Snohomish, Whatcom. Washington State Cooperative Extension Service, Washington State University.

Phillips, J.D. 1989. Evaluation of North Carolina's estuarine shoreline area of environmental concern from a water quality perspective. Coastal Management 17: 103-117.

Reed, P.B. 1988. National list of plant species that occur in wetlands : northwest (Region 9). For the U.S. Fish and Wildlife Service (USFWS). Biological Report 88(26.9).

Reed, P.B. 1993. 1993 Supplement to list of plant species that occur in wetlands: northwest (Region 9). For the U.S. Fish and Wildlife Service (USFWS).

Roth, E., R. Olsen, P. Snow, and R. Sumner. 1993. Oregon freshwater wetland assessment methodology. Oregon Division of State Lands, Salem, Oregon.

Rubey, J. and S. O'Connor. 1996. Exploring wetland stewardship: a reference guide for assisting Washington landowners. Washington State Department of Ecology, Shorelands and Water Resources Program. Publication No. 96-120.,

Sather, J.H., and R. Smith. 1984. An overview of major wetland functions. U.S. Fish and Wildlife Service. Report No. FWS/OBS-84/18.

Shisler, J.K., R.A. Jordan, and R.N. Wargo. 1987. Coastal wetland buffer delineation. New Jersey Department of Environmental Protection, Division of Coastal Resources, Trenton, New Jersey.

Smardon, R.C. 1978. Visual-cultural values of wetlands. In: Wetland Functions and Values: the state of our understanding. P.E. Greeson, J.R. Clark, and J.E. Clark (eds) American Water Resources Association. pp. 535-544.

Tiner, R.W. 1991a. The concept of a hydrophyte. BioScience 41: 236-247.

Tiner, R.W. 1991b. How wet is a wetland? Great Lakes Wetlands 2(3): 1-7.

U.S. Army Corps of Engineers (Corps). 1987. Corps of Engineers Wetlands Delineation Manual. Washington, D.C.

U.S. Army Corps of Engineers (Corps). 1992. Memorandum for See Distribution: Clarification and Interpretation of the 1987 Manual.

U.S. Army Corps of Engineers (Corps). 1993. Special Public Notice: 1993 Supplement to national list of plant species that occur in wetlands: Northwest (Region 9).

U.S. Army Corps of Engineers (Corps). 1997. Detailed Project Report, Lummi Shore Protection Project, Lummi Indian Reservation, Whatcom County, Washington.

U.S. Army Corps of Engineers (Corps). 1998. The regulatory permit program: a brief guide from the Sacramento district. http://wetland.seace.mil/RPP-bro.html

U.S. Department of Agriculture (USDA) - Soil Conservation Service. 1992. Soil Survey of Whatcom County Area, Washington.

U.S. Department of Agriculture (USDA) – National Resources Conservation Service. 1998. Field indicators of hydric soils in the United States: a guide for identifying and delineating hydric soils, Version 4.0.

U.S. Environmental Protection Agency (EPA). 1995. Federal guidance for the establishment, use and operation of mitigation banks. Office of Wetlands, Oceans and Watersheds, Washington, D.C.

U.S. Environmental Protection Agency (EPA). 1998a. Design manual: constructed wetlands and aquatic plant systems for municipal wastewater treatment. Office of Research and Development, Washington, D.C. Report No. EPA-625/1-88-022.

U.S. Environmental Protection Agency (EPA). 1998b. Memoranda of Agreement concerning the delineation of wetlands for purposes of Section 404 of the Clean Water Act and Subtitle B of the Food Security Act. MOA between EPA, USDA Soil Conservation Service, Corps and the U.S. Fish and Wildlife Service.

U.S. Fish and Wildlife Service (USFWS). 1987. National Wetlands Inventory. Washington, D.C.

U.S. Fish and Wildlife Service (USFWS). 1980. Habitat Evaluation Procedures. Washington, D.C.

Walbridge, M.R. 1993. Functions and values of forested wetlands in the southern United States. Journal of Forestry 91: 15-19.

Walker, M. 1999. Personal Communication. Biologist/Project Manager. Regulatory Branch, U.S. Army Corps of Engineers.

Washburn, R.L. 1957. Ground water in the Lummi Indian Reservation, Whatcom County, Washington. Tacoma, U.S. Geological Survey, Open-File Report.

Washington State Department of Conservation (WSDC). 1960. Water Resources of the Nooksack River Basin and certain adjacent streams: Water Supply Bulletin No. 12.

Washington State Department of Conservation (WSDC). 1964. Miscellaneous stream-flow measurements in the State of Washington 1890 to January 1961: Water Supply Bulletin No. 23.

Washington State Department of Ecology (Ecology). 1998a. Methods for assessing wetland functions, volume I: riverine and depressional wetlands in the lowlands of western Washington. Shorelands and Environmental Assistance Program. Publication No. 98-106.

Washington State Department of Ecology (Ecology). 1998b. Methods for assessing wetland functions, volume II: procedures for collecting data in the lowlands of western Washington. Shorelands and Environmental Assistance Program. Publication No. 98-107.

Whatcom County, Washington. 1992. Category I wetlands. Whatcom County Planning Department, Bellingham, Washington.

Whatcom County. 1997. Whatcom County Comprehensive Plan. Whatcom County, Washington.

Williams, J.D. and C.K. Dodd. 1978. Importance of wetlands to Endangered and Threatened species. In: Wetland Functions and Values: the State of our Understanding. P.E. Greeson, J.R. Clark, and J.E. Clark (eds) American Water Resources Association. pp. 565-575.

Wong, S.L. and R.H. McCuen. 1982. The design of vegetative buffer strips for runoff and sediment control. A technical paper developed as part of a study of stormwater management in coastal areas funded by Maryland Coastal Zone Management Program.

Appendix A: Lummi Nation Wetland Inventory Technical Report

LUMMI NATION WETLAND INVENTORY TECHNICAL REPORT

Prepared For:

Lummi Indian Business Council
2616 Kwina Road
Bellingham, Washington 98226

Prepared By:

Kim Harper
Sheldon & Associates, Inc.
5031 University Way NE
Seattle, Washington 98105-4341

December 21, 1999

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

EXECUTIVE SUMMARY

The Lummi Nation initiated a comprehensive wetland inventory of the Lummi Indian Reservation (Reservation) in 1999. The purpose of the study is to identify wetland locations on the Reservation and to collect data on the characteristics and functions of the wetlands. This information will be used in making future management decisions regarding wetlands and land use. The study was conducted by staff of the Lummi Natural Resources Department (LNR), with training and oversight provided by staff of Sheldon & Associates. Data were collected and analyzed in the spring and summer of 1999. This report summarizes the results of the inventory and function assessments.

Wetland boundaries were determined in the field using the criteria and methodology of the *Washington State Wetlands Identification and Delineation Manual* (Washington Department of Ecology 1997) and the *Corps of Engineers Wetlands Delineation Manual* (Corps of Engineers 1987). Wetlands were located and mapped using a combination of aerial photo and map review with verification in the field. Final maps were produced using a geographic information system database. Selected wetlands were assessed for function using the methods developed for the Washington State Wetland Function Assessment Project (Hruby et al. 1998). Quality control checks of the data collection and mapping effort were conducted throughout the inventory process.

A total of 214 wetlands and wetland complexes were identified on the Lummi Reservation. These wetland areas total 5,432 acres, or roughly 43 percent of the land area of the Reservation, excluding tidelands. Individual wetlands and wetland complexes range in size from 0.2 acre to 469 acres. About 50 percent of the wetlands are over 10 acres in size, and 13 percent over 50 acres. About 6 percent of wetlands are less than one acre in size.

The majority of wetland on the Reservation was classified as palustrine, in terms of both area (79 percent) and number of wetlands (88 percent). Palustrine wetlands include nontidal wetlands dominated by trees, shrubs, herbaceous plants, mosses or lichens, and all such wetlands that occur in tidal areas where salinity from marine waters is below 0.5‰. Estuarine and riverine wetlands are few, although riverine wetlands occupy extensive area. Approximately 67 percent of the wetlands on the Reservation have only one Cowardin class, 22 percent have two classes, and 11 percent have three or more. About 50 percent of the total number of wetlands have a palustrine emergent class, 45 percent have a palustrine forested class, and 23 percent have a palustrine scrub-shrub class. The majority of the estuarine wetlands are open water or emergent, as would be expected in salt marsh habitats. The riverine wetlands are predominantly forested or scrub-shrub. Referring exclusively to vegetation community or habitat type, approximately 58 percent of all wetlands have an emergent class, and 50 percent have a forested class.

Wetlands occur in all of the 19 watersheds on the Reservation. Watershed K (the flood plains of the Lummi and Nooksack rivers) has the greatest number of wetlands as well as the greatest acreage. Wetlands cover roughly 40 percent of the mapped area of this watershed. Watersheds M and N also have high percentages of area occupied by wetland. Watersheds K, M, and N also show high levels of

connectivity among water bodies, with 63 percent of the 82 wetlands in Watershed K having a hydrologic connection to another surface water body.

Most of the forested wetlands on the Reservation have a canopy dominated by red alder and a salmonberry shrub layer. The most frequently occurring forested communities in the wetlands include alder, alder/salmonberry, alder/cottonwood/salmonberry, and alder/red cedar. The scrub-shrub wetland areas are dominated by willow species, salmonberry, red osier dogwood, Nootka rose, and hardhack. The most frequently occurring cover in emergent wetlands is cultivated crop or pasture species, indicating the extent to which flood plain areas have been converted to agricultural uses. After crops and pastures, the most common communities in the freshwater emergent wetlands include reed canarygrass/soft rush, cattail/bulrush, and water parsley/slough sedge. In the brackish marsh or salt marsh areas, the most frequently occurring communities are seashore saltgrass/sickleweed and Pacific silverweed/rush.

The most common type of disturbance to vegetation is tilling of wetlands and planting crops. This was observed in at least some portion of 24 percent of all wetlands on the Reservation. Of the 149 wetlands for which information was collected on invasive species, reed canarygrass, Himalayan blackberry, and creeping buttercup were most frequently noted.

Of the 214 wetlands mapped on the Reservation, 20 (9 percent) were determined to be tidal. This includes both brackish and freshwater wetlands with hydrologic patterns that are tidally influenced. A total of 52 wetlands (24 percent) are directly associated with streams or rivers. While extensive areas of the flood plain wetlands are hydrologically influenced by streams and rivers, the large number of wetlands that occur on flat forested plains of the Lummi Peninsula are primarily suppied water by precipitation and overland sheetflow.

Disturbances to wetland hydrology have been primarily associated with conversion of low-lying, wet areas to agricultural uses. Draining by constructing ditches or berms is the most prevalent conversion that can be visually observed; historic installation of tile drains is probable but difficult to determine. Diking of wetlands from rivers or streams, and diversion of flows due to road construction are also common alterations to wetland hydrology on the Reservation.

A total of 28 soil series are divided into 39 soil map units on the Reservation (USDA 1992). Of the 39 soil map units, 15 are hydric soils (USDA 1999). Most of the soils mapped in the wetlands are silt loams with poor drainage, slow permeability, and a seasonally high water table. Eliza and Birch Bay soils occupy the greatest area in the wetlands. The soils have been tilled in 62 percent of the 106 wetlands for which soil observations were recorded.

The Washington State Function Assessment Method was applied to 12 assessment units (AUs) in nine selected wetlands. Wetlands were chosen based on expectations of imminent development in the vicinity and are not intended to be representative of wetlands occurring on the Reservation. Assessment results are described for the three categories into which the 12 wetland units were divided: riverine flow-through, depressional closed, and depressional outflow. Function index scores vary widely within the groups and within each wetland.

The use of the Washington State Function Assessment Method as part of this project was essentially a pilot study for the Lummi Reservation. Only a very small percentage of the total wetlands on the Reservation was assessed. However, this method could be very useful in the future to help inform wetland management decisions. Potential applications for the method are proposed in this report.

1. INTRODUCTION

The Lummi Indian Business council (LIBC) initiated a study of wetlands on the Lummi Indian Reservation (Reservation) in January 1999. The study was conducted by staff of the Lummi Natural Resources Department (LNR), with training and oversight provided by staff of Sheldon & Associates. Data were collected and analyzed in the spring and summer of 1999. This report summarizes the results.

1.1 PURPOSE AND NEED FOR STUDY

Management of wetland resources on the Reservation is the responsibility of the LNR, Lummi Planning Department, and individual landowners. During the fall of 2000, LNR will issue draft wetland regulations and provide management guidelines for development in and adjacent to wetlands. The LNR determined that an inventory of the wetlands on the Reservation was needed to provide baseline data on wetland location and characteristics in order to better inform wetland policy and future development planning. This report provides technical information that will be used by LNR in making planning and management decisions to help protect and enhance the wetlands that are a commonly held resource of the Lummi Nation.

The purpose of this wetland study was to complete a comprehensive inventory and characterization of wetlands occurring on the Reservation. The primary goal of the inventory was to locate every wetland on the Reservation, by either remote photo and map review and/or direct field reconnaissance, and to collect basic data on wetland vegetation, hydrology, classification, and other features. The secondary goal was to conduct a detailed, quantitative function assessment for selected wetlands that are located in known areas of proposed development. As part of the study, LNR staff received training in wetland determination and function assessment, skills that will be used over the long-term in managing wetlands on the Reservation.

The resulting products of the wetland inventory study include this report, a training manual on wetland inventory and function assessment developed specifically for LNR staff, a geographic information system (GIS) data layer with wetland locations for the entire Reservation, a database with basic characteristics of each wetland, and a second database with function assessment data for selected wetlands. Wetland base maps were produced from the GIS data layer and are included in this report.

1.2 STUDY AREA DESCRIPTION

The study area includes the mainland of the Lummi Reservation and Portage Island, totaling approximately 12,500 acres of land. Excluded from the study area are the roughly 8,000 acres of marine tidelands. The land forms, drainage patterns, soils, vegetation, and land use trends of the Reservation are described in this section in terms of their relevance to the occurrence of wetlands.

1.2.1 Land Forms

The land forms of the Lummi Reservation were primarily determined by glacial processes and by more recent actions associated with river flood plains and deltas. The Vashon Stade of the Fraser Glaciation is the most recent glacial event to influence this area, having retreated from the Pacific Northwest about

10,000 years ago. The general shape of the Lummi Peninsula and the marine shoreline were formed by this massive glacier, although the smaller land forms and the general topography of the Reservation were influenced by riverine and coastal processes.

This area is a low-lying landscape with few steep slopes and little topographic relief. Elevations on the Reservation uplands range from sea level to about 220 feet above mean sea level. The higher elevations occur mostly on the Lummi Peninsula and in the northwest portions of the Reservation. These two large upland areas are separated by the low-lying flood plain of the Lummi River. The Nooksack River flood plain lies along the eastern portions of the Reservation. These flood plain areas support large, interconnected wetland systems. Additionally, there is extensive wetland area occurring on the forested plateaus of the Lummi Peninsula and on Portage Island.

1.2.2 Drainage Patterns

Drainage patterns on the Reservation are primarily determined by the Nooksack and Lummi River systems, and by the constructed storm water system. Historically, the Nooksack River drained into Lummi Bay. In the mid-1800s, commercial logging interests diverted the river to flow into Bellingham Bay, and built a dike to keep it from reverting to its original path. The channel that once carried the waters of the Nooksack to Lummi Bay is now called the Lummi River, and, with the reduction in flow, is now significantly smaller than the historic channel. Several small unnamed streams cross the north portions of the Reservation, flowing south into the Lummi River or directly into Lummi Bay. On the Lummi Peninsula, there are a number of very short drainages that flow directly to marine waters. Storm water is managed on the Reservation with an extensive system of roadside ditches, agricultural ditches, tide gates, catch basins, and culverts.

The Reservation is divided into 19 watersheds, ranging in size from 198 acres to 4,696 acres (LIBC 1998). The watersheds of the Reservation are shown in Figure 1. Watershed boundaries had been determined previously by Lummi staff, but several boundaries were modified based on field observations made during this study. Due to the extensive flat areas on the Reservation, both on the flood plains and on the Lummi Peninsula, watershed boundaries have been very difficult to precisely determine. Boundaries have been altered simply by the construction of a new roadside ditch. While it is unusual for a continuous wetland system to extend into more than one watershed, that is the case in a number of instances on the Reservation. This most commonly occurs in those watersheds where the headwater regions of watersheds are extensive, virtually flat plateaus that support complex wetland systems, or in areas where watershed boundaries have been formed by constructed drainage ditches.

Most of the wetland area on the Reservation is associated with the rivers, streams, and drainage ditches, being either directly adjacent to a surface water feature, or located in a flood plain. Therefore, historic alterations to surface water features and natural drainage patterns have likely resulted in alterations to wetlands. It is apparent from soil investigations in the area of the historic flood plain of the Nooksack River that wetlands were once much more extensive, and that diversion of the main flow of the Nooksack River to Bellingham Bay, as well as agricultural drainage ditches, have resulted in wetland loss in this area. The network of storm water drainage ditches has also resulted in alterations to wetlands, intercepting sheetflow in some areas, and creating new wetland outlets in others. Diking of streams and estuarine areas has also resulted in wetland losses in flood plain areas.

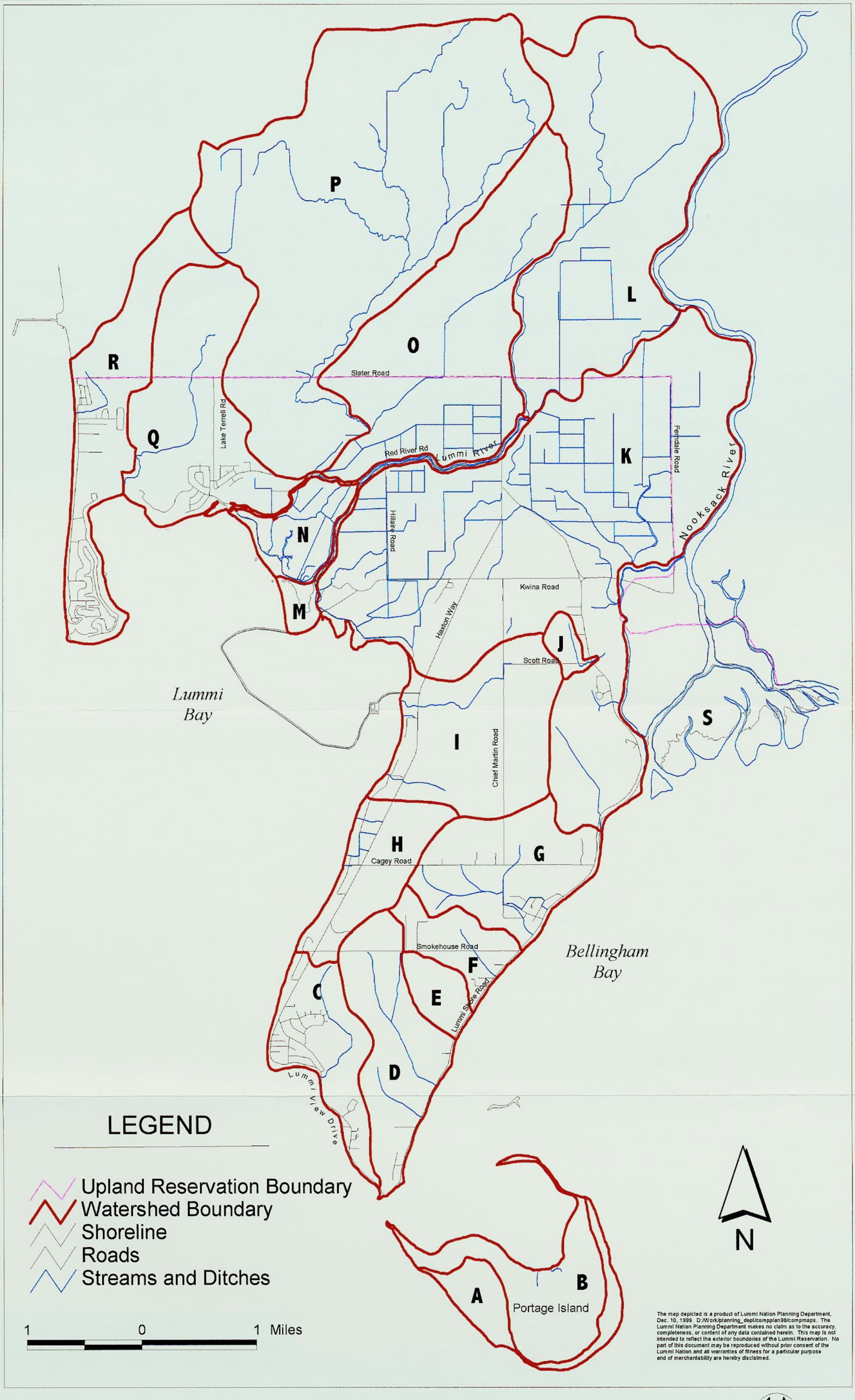


Figure 1. Lummi Reservation Watersheds

1.2.3 Soils

The soils on the Reservation generally have slow to very slow infiltration rates (USDA 1992). Where soils with slow infiltration rates are located in depressions, flood plains, or broad plateaus, prolonged ponding and saturation typically occurs, thus providing conditions ideal for wetland formation. This is the case on the Lummi Reservation where most of the land lies in broad glaciomarine drift plains or river flood plains. Exceptions to this are isolated areas with more rapid infiltration, which occur on Portage Island, the southwest portion of the Lummi Peninsula, and in several other scattered areas.

Of the 39 different soil types that are mapped as occurring on the Lummi Reservation, 15 are listed as hydric soils, or soils that commonly occur in wetland areas (USDA 1992, USDA 1999). Hydric soils occupy roughly 46 percent of the Reservation. Areas that are mapped as having hydric soils are typically wetland, unless they have been effectively drained or the hydrology otherwise altered. However, many wetlands occur in areas mapped as non-hydric soils. Hydric inclusions that are too small to warrant separate mapping, or were simply overlooked during the mapping process of the soil survey, are common in non-hydric soils. However, the distribution of hydric soils in an area is generally a rough approximation of wetland locations. Table 1 summarizes the characteristics of hydric soils that are mapped on the Reservation, and Figure 2 shows hydric soil locations.

1.2.4 Vegetation

The Lummi Reservation is well-vegetated, with developed impervious surfaces covering less than 3 percent of the land (LIBC 1998). The dominant cover types include grassland/agricultural field, which covers over 50 percent of the Reservation, primarily in the north half, and deciduous forest, which covers at least 25 percent, primarily on the Lummi Peninsula (LIBC 1998). Coniferous and mixed forests and scrub-shrub communities are minor components of the vegetation on the Reservation. The species composition of a particular area varies of course with local conditions. This section is intended to be a brief overview of the general vegetation types common to the Reservation. Wetland vegetation is described in detail in Section 3.3.

Grasslands and fallow pastures are dominated by non-native grasses species such as velvetgrass (*Holcus lanatus*), bentgrass (*Agrostis* spp.), orchard grass (*Dactylis glomerata*), fescue (*Festuca* spp.), wheatgrass (*Agropyron* spp.), timothy (*Phleum* spp.), and in wetter areas, reed canarygrass (*Phalaris arundinacea*). Weedy herbaceous species are also common in these areas, including plantain (*Plantago* spp.), dock (*Rumex* spp.), Canada thistle (*Cirsium arvense*), and in wetter areas, buttercup (*Ranunculus* spp.). Actively farmed areas support a variety of vegetable crops such as corn and cultivated poplars.

Deciduous forests in this area are dominated by red alder (*Alnus rubra*), with some areas having a significant component of black cottonwood (*Populus trichocarpa*). The shrub layer in these deciduous forests is dominated by varying combinations of salmonberry (*Rubus spectabilis*), red osier dogwood (*Cornus stolonifera*), Nootka rose (*Rosa nutkana*), snowberry (*Symphoricarpos albus*), and hardhack (*Spiraea douglasii*), depending on the moisture regime. Common groundcover species include sword fern (*Polystichum munitum*), dewberry (*Rubus ursinus*), false lily-of-the-valley (*Maianthemum dilatatum*), and a number of other species. Some wet areas are dominated by willows (*Salix* spp.) with a shrub layer of salmonberry.

Table 1. Hydric Soil Characteristics and Extent on Lummi Reservation (USDA 1992, USDA 1999)

Map Unit Name	Map Unit No.	Acres on Reservation	Hydrologic Group[1]	Flooding Frequency[2]	Permeability	High Water Table	
						Depth (ft)	Months
Bellingham silty clay loam	11	126	D	None	slow	0-1.0	Nov-Apr
Clipper silt loam, drained	31	17	C	None	moderate	2.0-4.0	Nov-Apr
Eliza silt loam, drained	46	2,578	D	Frequent	moderate	0-2.5	Nov-Apr
Eliza-Tacoma silt loams	47	588	D	Frequent	moderately slow	0-1.0	Nov-Apr
Everson silt loam	53	45	D	None	slow in upper part, rapid in lower	1.0-3.0	Nov-Apr
Hale silt loam	61	712	D	None	moderate in upper part, very rapid in lower	0.5-2.0	Nov-Apr
Histosols, ponded	72	12	D	None	moderately slow to moderate	+1 to surface	Nov-Aug
Hovde silt loam	73	261	D	Frequent	very rapid	0-0.5	Nov-Apr
Hydraquents, tidal	75	171	D	Frequent	moderate	+1 to surface	Jan-Dec
Labounty silt loam	93	1,064	D	None	moderately slow	0-3.0	Nov-May
Shalcar and Fishtrap soils	144	26	D	None	moderate	+1 to -1.5	Oct-May
Tacoma silt loam	163	110	D	Frequent	moderately slow	+1 to surface	Nov-Apr
Tacoma silt loam, drained	164	407	D	Frequent	moderately slow	1.0-2.5	Nov-Apr
Typic Psammaquents, tidal	170	127	D	Frequent	very rapid	+1 to surface	Jan-Dec
Whitehorn silt loam	184	266	D	None	slow	+1 to -1.0	Nov-May

[1] Hydrologic Groups are defined by rate of infiltration, rate of water transmission, and measure of runoff potential. Soils in the C group have slow infiltration rates, slow water transmission rates, and moderately high runoff potential. Soils in the D group have very slow infiltration rates, very slow water transmission rates, and high runoff potential.

[2] Flooding frequency refers to flooding from rivers and streams, and does not account for inundation or ponding from storm water.

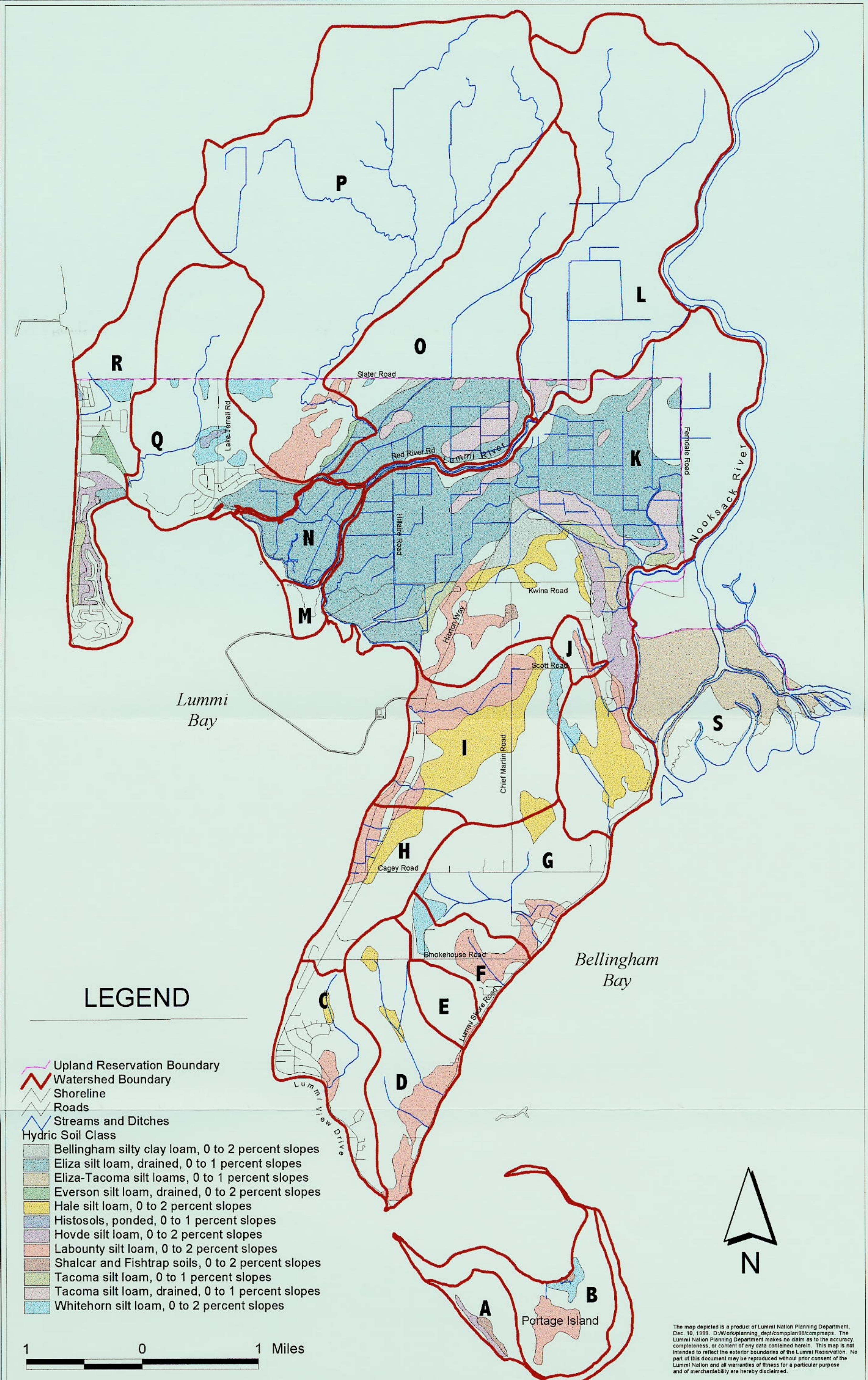


Figure 2. Location of Hydric Soils on the Lummi Reservation

Coniferous forests are generally dominated by Douglas fir (*Pseudotsuga menziesii*) with some areas of western red cedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*), and Sitka spruce (*Picea sitchensis*). Mixed forests are dominated by Douglas fir and red alder, with some lesser components of cedar, hemlock, and spruce. The shrub communities on the Reservation typically support monotypic stands of salmonberry, Himalayan blackberry (*Rubus procerus*), or hardhack. Some areas that have been recently logged are comprised of alder saplings, salmonberry, and Himalayan blackberry, with planted conifers interspersed. Himalayan blackberry is common around the edges of forested areas and in disturbed sites. Shrub communities occur both in and outside of wetlands on the Reservation.

1.2.5 Land Use and Historic Wetland Alteration

Existing land uses on the Reservation have been mapped and quantified using satellite images (LIBC 1998). The land area that is covered in residential, urban, or industrial uses totals less than 3 percent of the Reservation. Given the low percentage of land converted to developed uses, it is reasonable to assume that there has been little direct fill of wetlands on the Reservation. Despite what has been a low rate of urbanization, significant alterations have been made to the wetlands. Over 50 percent of the Reservation has been cleared of forest and converted to agricultural use or grasslands. In much of this area, it is apparent that extensive efforts were made to drain wetlands by installation of ditches, dikes, and possibly drain tiles.

However, it was the diversion of the Nooksack River to Bellingham Bay in the mid-1800s and the reclamation of the historic flood plain for farming in the 1920s that are the most significant alterations to wetlands that have occurred on the Reservation. These actions resulted in draining extensive wetland area in the historic Nooksack River flood plain. There are still large wetlands in this area, but soil probes sampled during this study indicate relict hydric soil characteristics in extensive areas in the historic flood plain that no longer meet wetland criteria. At the same time, the diversion also created some of the largest wetland complexes in the area by the formation of a flood plain and delta in the current location of the Nooksack River.

The current trend in development on the Reservation is to clear forested areas to create needed housing units. It is certain that this activity will result in filling and the permanent loss of portions of wetlands, primarily in areas that are currently forested.

2. METHODS

The wetland inventory study was conducted by Lummi Natural Resources Department staff who were trained in the methods described below by staff of Sheldon & Associates. Training sessions were conducted in February and April of 1999, and data were collected throughout the spring and early summer. Quality control checks were completed periodically throughout the data collection period by both LNR and Sheldon & Associates staff. Four methods are described in this section: method for wetland boundary determination, method for wetland inventory, method for function assessment, and method for quality control.

2.1 METHOD FOR WETLAND BOUNDARY DETERMINATION

Wetland boundaries were determined in the field using the criteria and methodology of the *Washington State Wetlands Identification and Delineation Manual* (Washington Department of Ecology 1997) and the *Corps of Engineers Wetlands Delineation Manual* (COE 1987). These manuals require examination of three parameters: vegetation, soils, and hydrology. For an area to be classified as wetland, hydrophytic vegetation, hydric soils, and wetland hydrology must be exhibited. The specified criteria are mandatory and must all be met, except under circumstances when a wetland is considered a disturbed area or problem wetland.

2.1.1 Hydrophytic Vegetation

Hydrophytic vegetation is defined as macrophytic (large enough to be visible without a microscope) plant life growing in water, soil, or substrate that is periodically deficient in oxygen (Reed 1988). The hydrophytic vegetation criterion is met when more than 50 percent of the dominant species are hydrophytic, based on the wetland plant species indicator status listed in the U.S. Fish and Wildlife Service publication *National List of Plant Species That Occur in Wetlands: Northwest, Region 9* (Reed 1988, revised in 1993). Plants are considered hydrophytic if they are listed as obligate wetland species, facultative wetland species, or facultative species. These terms are defined in Table 2.

Table 2. Definitions of Plant Indicator Status (Reed 1988)

Plant Indicator Status	Definition
Obligate Wetland Plants (OBL)	Plants that occur almost always in wetlands: estimated probability in wetlands greater than 99% under natural conditions.
Facultative Wetland Plants (FACW)	Plants that have an estimated probability of 67% - 99% to be found in wetlands.
Facultative Plants (FAC)	Plants that are equally likely to occur in wetlands or non-wetlands: estimated probability of 34% - 66% to be found in wetlands.
Facultative Upland Plants (FACU)	Plants that usually occur in non-wetlands, estimated probability of 1% - 33% to be found in wetlands.
Obligate Upland (UPL)	Plants that occur almost always in non-wetlands under natural conditions, estimated probability greater than 99%.

During inventory fieldwork, dominant plants were identified to species whenever possible. All plant species that are noted in this report are listed in Appendix A with their designated indicator status. Field teams were composed of at least one LNR staff member with previous botanical experience. The primary plant identification sources used were Hitchcock and Cronquist (1973) and Cooke (1997). Some outdated plant names were used in recording the data, and these are maintained in the text of this report, as well as the database to minimize confusion. Updated taxonomic synonyms are presented in Appendix A.

2.1.2 Wetland Hydrology

Indicators of wetland hydrologic processes (wetland hydrology) confirm the occurrence of saturation or inundation of an area for periods of the growing season and may be present throughout the year. However, it is preferable to conduct fieldwork during the growing season in order to actually observe the hydrologic patterns. Therefore, the majority of fieldwork for this study was conducted during the growing season. Indicators for hydrology that are designated in the wetland manuals (Ecology 1997, COE 1987) include recorded data and field data such as visual observation of inundation or saturation, watermarks, drift lines, sediment deposits, drainage patterns, oxidized rhizospheres (root tunnels), local soil survey data, water-stained leaves, and the FAC neutral test (using the dominant plant species to infer presence of wetland hydrology).

Areas that have inundation and/or soil saturation for a consecutive number of days equal to or exceeding 12.5 percent of the growing season are considered wetlands if the vegetation and soil criteria are met. Areas with inundation or soil saturation for 5 to 12.5 percent of the growing season may be considered wetlands, but generally require more intense study to make a determination. The growing season is defined as that portion of the year when soil temperatures at 19.7 inches below the soil surface are higher than biological zero, or 41 degrees Fahrenheit (°F). Rather than measuring soil temperatures, we typically approximate the growing season by the number of frost-free days. This is generally taken to be the period from the last date in spring that the air temperature drops to 28 °F to the first date in fall that it drops to that temperature. According to temperature records for the Bellingham area, approximately 7 miles east of the Reservation, the median length of the growing season is about 227 days and extends from approximately April 8 to October 30 (USDA 1992). Therefore, the wetlands in the vicinity of the Lummi Reservation must have a minimum of 28 days of continuous saturation or inundation within the growing season of average rainfall years to definitively meet the criteria for wetland hydrology.

For purposes of this inventory, areas that were found to be saturated to the soil surface in the early part of the growing season were assumed to meet the hydrology criteria. However, they were only determined to be wetland areas if the hydric soil and hydrophytic vegetation criteria were also met. Agricultural areas that had relict hydric soil indicators but showed no saturation in the soils in the early growing season were determined to be effectively drained and were designated as non-wetland.

2.1.3 Hydric Soils

A soil that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper part is considered a hydric soil. Examples of hydric field indicators include the presence of organic soils, or mottling and/or gleyed mineral soils. All organic soils (histosols) that occur in Washington State are considered hydric soils, as histosols typically form only in areas that pond for significant periods. Mineral soils must show indicators of prolonged saturation or inundation to be considered hydric. Mottles are spots or blotches of contrasting color occurring within the soil matrix. Gleyed soils are predominantly neutral gray in color. Soil chroma, or color, is determined by comparing soil samples to color chips using a Munsell color chart (Kollmorgen Corporation 1975). Mineral soils that have chromas of 1 or less, or chromas of 2 combined with mottles, are considered to be hydric. The color is checked in the B-horizon (the layer just below the surface horizon), or at 10 inches below the surface, whichever is shallower.

For purposes of this inventory, soil characteristics were noted to aid in determining approximate wetland boundaries. However, data on soils were not recorded for every wetland that was field visited as soil pits were not always dug in areas where hydrophytic vegetation and wetland hydrology were clearly demonstrated.

2.2 METHOD FOR WETLAND INVENTORY

The wetlands on the Reservation were located and mapped using a combination of aerial photo and map review with verification in the field. The following documents were reviewed to obtain information on potential wetlands in the study area:

- color aerial photographs, scale 1" = 2000', dated August 1997;
- color infrared aerial photographs, scale 1" = 2000', dated August 1998;
- Soil Survey of Whatcom County Area, Washington (USDA 1992);
- USGS topographic maps: Eliza Island, Ferndale, Lummi Bay, Lummi Island quadrangles, scale 1:24,000;
- National Wetlands Inventory Maps (USFWS 1987): Eliza Island, Ferndale, Lummi Bay, Lummi Island quadrangles, scale 1:24,000; and
- files on previous wetland inventories or delineations conducted on the Reservation.

Prior to fieldwork, preliminary wetland boundaries were marked on mylar overlays of the aerial photos. These preliminary boundaries were based mainly on topography and changes in vegetation and hydrology observed in the photos. Areas that received particular focus included those that had previously been mapped as having hydric soils or as being wetland on the National Wetlands Inventory maps (USFWS 1987). For only a subset of these wetlands (roughly 50 percent), boundaries were confirmed on the ground during fieldwork, and the mylar overlays corrected as needed. In areas where wetlands formed a highly interspersed mosaic with upland hummocks, boundaries were drawn around the outer edges of the mosaic, and the entire area labeled a "wetland complex". This term was also designated for several forested areas that clearly contained large wetland complexes, but were too extensive to thoroughly field verify and too densely forested to accurately map by photo review.

The boundaries for all identified wetlands were transferred from the mylar overlays to base maps at a scale of 1" = 200', which had been generated by Lummi staff using a geographic information system (GIS). A GIS technician then digitized the hand-drawn wetland boundaries off of the base maps.

Wetlands were assigned unique numbers based on the township, range, and section in which each occurred. For each wetland that was identified during aerial photo and map review, basic data were recorded in the office, based on those photo or map sources. For those wetlands that were field checked, additional more specific information was collected on wetland characteristics. These data were recorded on field forms and were later entered into a computer database. An example of the data form is included in Appendix B; the types of information that were collected are summarized in Table 3. A condensed version of the database is included in Appendix C.

Table 3. Summary of Types of Wetland Data Collected

Data from Remote Sources:	• wetland location description • photo and map numbers/names • records of previous inventories • watershed name and size • wetland size • Cowardin classes present (photo observation) • association with streams or river • soil units mapped in wetland
Data Collected in the Field:	• water sources, water outlet description • depth of ponding or saturation • evidence of other hydrology indicators • tidal/nontidal regime • hydrogeomorphic classification • Cowardin classes/major plant associations • degree of interspersion of Cowardin classes • average tree size • extent of invasive species • buffer vegetation description • soil profile • general wetland description • observed alterations to wetland features

Dominant plant communities were identified when possible, either by direct field observation, or by estimation from aerial photo review. After field verification of some areas, patterns on the aerial photos could be linked to certain common plant communities that occur on the Reservation. Mapping of plant communities could then be extended to areas that had not been field verified because the patterns, or 'signature', of these communities could be recognized on the photos. Whether or not an inventoried wetland was field verified is defined in the database. In addition, as listed in Table 3, more detailed information on the plant communities was collected for those wetlands that were field visited.

2.3 METHOD FOR FUNCTION ASSESSMENT

The methods developed by the Washington State Wetland Function Assessment Project (Hruby et al. 1999) were used to assess functions of selected wetlands on the Lummi Reservation. This method was recently developed under the lead of the Washington State Department of Ecology (Ecology) with technical input from ecologists and hydrologists from numerous agencies and private consulting firms.

This is the first regional effort in the State of Washington to create a method for quantifying the performance of a function by a wetland relative to the function performance level of local reference wetlands.

The method was selected for use because it is based on the nationally recognized hydrogeomorphic (HGM) approach (Brinson 1993), which classifies wetlands based on landscape position and water regime, and provides guidance on arriving at technical assumptions on which assessments of performance of functions are based. The HGM method proposes the following classes of wetlands: depression, fringe, slope, riverine, and flats. The Washington State technical committee has thus far developed methods only for depressional and riverine wetlands. Most of the wetlands on the Lummi Reservation fall into these two categories, although estuarine fringe and flats are also clearly present. The five HGM classes are defined in Table 4, with relevant subclasses defined only for depressional and riverine wetlands.

The Washington State approach (Hruby et al. 1999) relies on indicators of functions to assess potential performance, rather than direct measurements. Indicators are usually physical characteristics of the wetland or its surrounding area that can be correlated to a specific function. For example, rather than trying to directly sample aquatic mammals, the presence of steep banks in the wetland can be used as an indicator of the suitability of the wetland habitat for aquatic mammals. After collecting detailed data on indicators, mechanistic models (mathematical equations) are applied to the data to arrive at a numeric indexed score. This step is based on the assumption that the relationship between indicators and the actual performance level for a function can be defined by a simple mathematical expression. Different models were developed for each subclass of wetland and for each function category.

The models that were developed for each function are calibrated on reference wetlands. Reference wetlands for western Washington were selected by the technical committee developing the method, with the intention that the broad range in performance of functions that can be found in local wetlands would be represented. A minimum of 20 sites were chosen as reference wetlands for each wetland subclass. For each function assessed, the reference wetlands range from not performing the function at all, to providing among the highest level of function observed in this region. By running the data for an assessment wetland through the models, a score or index is arrived at for each of the assessed functions. This score directly compares the assessment wetland to the pool of reference wetlands.

Wetlands are divided into assessment units (AUs) for the purposes of this method, based on differences in water regime. The AU boundaries occur where the volume, flow, or velocity of the water changes rapidly, whether created by natural or artificial features. An entire wetland may be uniform in its water regime and would therefore be comprised of one AU.

A total of 15 categories of functions are assessed in the Washington State method; these are defined in Table 5. Specific indicators or measures are entered into each model as the basic data collected in the assessment. Lists of the measures or indicators for each model are presented in Appendix D. A numeric value for each indicator is measured, estimated, or assigned based on observations from background documents or fieldwork. The numeric values are entered into separate models for each function, resulting in a quantitative index for each function.

Table 4. Definitions of Wetland Classes and Subclasses Using the Hydrogeomorphic Method of Classification (Hruby et. al. 1999)

Wetland Class	Definition	
Depressional	Depressional wetlands occur in topographic lows, such that the elevations of the surrounding landscape are higher. Possible sources of water include precipitation, surface water (sheetflow or channelized), subsurface water moving through an unsaturated or saturated zone, or any combination of these. These wetlands generally have low hydrologic energy. If located in or near a flood plain, these wetlands receive flood waters less frequently than every two years.	
	Wetland Subclasses	
	Outflow	Depressional Outflow wetlands are depressions that have surface water outflow.
	Closed	Depressional Closed wetlands are depressions that have no surface water outflow.
Riverine	**Definition**	
	Riverine wetlands occurs in topographic valleys adjacent to stream channels ranging from perennial higher order streams to intermittent headwaters. Possible sources of water can be precipitation, overbank flooding from adjacent stream channels, subsurface water, or any combination. These wetlands are generally high energy relative to Depressional Wetlands. These wetlands occur in the flood plain and receive flood water at least every two years.	
	Wetland Subclasses	
	Flow-through	Riverine Flow-through wetlands do not retain flood waters.
	Impounding	Riverine Impounding wetlands retain flood waters due to a constricted outlet such as a beaver dam.
Slope	Slope wetlands occur on hill or valley slopes. Elevation gradients may range from steep hillsides to slight slopes. Principal water sources are usually ground water seepage and precipitation. Slope wetlands may occur in nearly flat landscapes if ground water discharge is a dominant source of water and there is flow in one direction. The movement of surface and shallow subsurface water is perpendicular to topographic contour lines. Slope wetlands are distinguished from the riverine wetland class by the lack of a defined topographic valley with observable features of bed and bank. Slope wetlands may develop channels but the channels serve only to convey water away from the slope wetland.	
Estuarine Fringe	Estuarine fringe wetlands are found along the coasts and in river mouths to the extent of tidal influence. The dominant source of water is from the ocean or river. The one unifying characteristic of this class is hydrodynamic. All estuarine fringe wetlands have water flows dominated by tidal influences, and water depths are controlled by the tidal cycles. These wetlands can be salt or freshwater.	
Flats	Flats wetlands occur in topographically flat areas that are hydrologically isolated from surrounding ground or surface water. The main source of water in these wetlands is precipitation. They receive virtually no ground water discharge. This characteristic distinguishes them from depressional and slope wetlands.	

Table 5. Functions Assessed Under the Washington State Method

Function	Function Definition[1]
Water Quality Functions	
Potential for Removing Sediment	The wetland processes that retain sediment within a wetland, and keep them from going to downstream waters in the watershed.
Potential for Removing Nutrients	The wetland processes that remove nutrients (particularly phosphorus and nitrogen) from incoming water, and keep them from going to downstream waters in the watershed.
Potential for Removing Heavy Metals and Toxic Organics	The wetland processes that retain metals and toxic organic compounds, and keep them from going to downstream waters in the watershed.
Water Quantity Functions	
Potential for Reducing Peak Flows	The wetland processes or characteristics by which the peak flow in a watershed can be reduced during major storm events that cause flooding.
Potential for Reducing Downstream Erosion	The wetland processes that detain high flows during storms and reduce the duration of erosive flows, thus decreasing downstream erosion of stream.
Potential for Recharging Ground water	The wetland processes by which surface water coming into a wetland is transported into subsurface water that flows either into unconfined aquifers, or interflow, that support flows in streams during the dry season.
Habitat Suitability Functions	
General Habitat Suitability	The characteristics or processes present in a wetland that indicate a general suitability as habitat for a broad range of animal species. It also includes processes or characteristics within a wetland that help maintain ecosystem resilience (characteristics that are important in maintaining the ecosystem when it is of different habitats).
Habitat Suitability for Invertebrates	The wetland processes and characteristics that help maintain a high number of invertebrate species in the wetland.
Habitat Suitability for Amphibians	The wetland processes and characteristics that contribute to the feeding, breeding, or refuge needs of amphibian species using wetlands of the regional subclass.
Habitat Suitability for Anadromous Fish	The environmental characteristics that contribute to the feeding, breeding, or refuge needs of anadromous fish species that are using wetlands.
Habitat Suitability for Resident Fish	The wetland processes and characteristics that contribute to the feeding, breeding, or refuge needs of resident native fish.
Habitat Suitability for Aquatic Birds	The processes and environmental conditions in a wetland that provide habitats or life resources for species of wetland-dependent birds.
Habitat Suitability for Aquatic Mammals	Wetland features and processes that support one or more life requirements of economically important aquatic or semi-aquatic mammals. i.e. beaver, muskrat, river otter, and mink
Habitat for Native Plant Communities	The wetland processes and characteristics that help maintain a high number of native plant species as well as providing specialized habitats for less common species.
Primary Production and Export	Wetland processes that result in the production of plant material and its subsequent export to surface waters.

[1] Definitions are quoted directly from *Methods for Assessing Wetland Functions Volume I: Riverine and Depressional Wetlands in the Lowlands of Western Washington* (Hruby et al. 1999).

As part of the Lummi Wetland Inventory Study, specific wetlands were selected for assessment with this method because of pending plans for development on nearby lands. Field data were collected for a total of twelve assessment units, occurring in nine wetlands. An example of the data form is included in Appendix E. Following fieldwork, the collected data were entered into Excel® spreadsheets which calculated the index for each function in each assessment unit.

2.4 METHOD FOR QUALITY CONTROL

Quality control checks of the data collection and mapping effort were conducted throughout the inventory process by both LNR and Sheldon & Associates staff. Inventory data forms were reviewed by Sheldon & Associates staff during training, and during subsequent visits to the Reservation as the forms were completed by LNR staff. Forms were checked for thoroughness, consistency, and when possible, accuracy. Wetlands that were identified by LNR staff as difficult boundary determinations were visited by Sheldon & Associates staff to confirm the boundaries. For those wetlands, a direct check of the accuracy of the data form was completed. Entry of the data into an Access® database was completed by LNR staff. Approximately 33 percent of the hand-written data forms were later checked against the Access® database to confirm the accuracy of data entry.

Wetland boundaries drawn on aerial photo overlays were spot-checked in the office by Sheldon & Associates staff for accuracy. The transfer of wetland boundaries from aerial photo overlays to the base maps was checked to identify any systematic errors in scale, or specific errors in shape or location. It was confirmed that each data form had a corresponding wetland drawn on the base maps. Once the base maps were digitized, a list was generated from the GIS of the wetland identification numbers. This list was cross-checked with the Access® database to confirm that all identified wetlands were mapped in the GIS database. The wetland boundaries on the hand-drawn base maps were compared to GIS-generated maps and checked for accuracy.

For the functional assessment process, Sheldon & Associates staff supervised data collection in 9 of the 12 assessment units that were completed. All data forms were checked for thoroughness, consistency, and accuracy. The Excel® spreadsheet for each assessment unit was checked for accuracy of data entry.

3. RESULTS OF WETLAND INVENTORY

This section reports the results from the wetland inventory, and includes sections on wetland size and classification, wetland distribution by watershed, wetland plan communities, wetland hydrology, and wetland soils. Because of the large number of wetlands identified in the inventory, only summaries of the data are presented in the body of this report. A binder containing the completed data forms for each wetland on the Reservation and the complete database is on file with the LNR Water Resources Division. A condensed version of the database for the inventory is included in Appendix C, with data listed for each identified wetland.

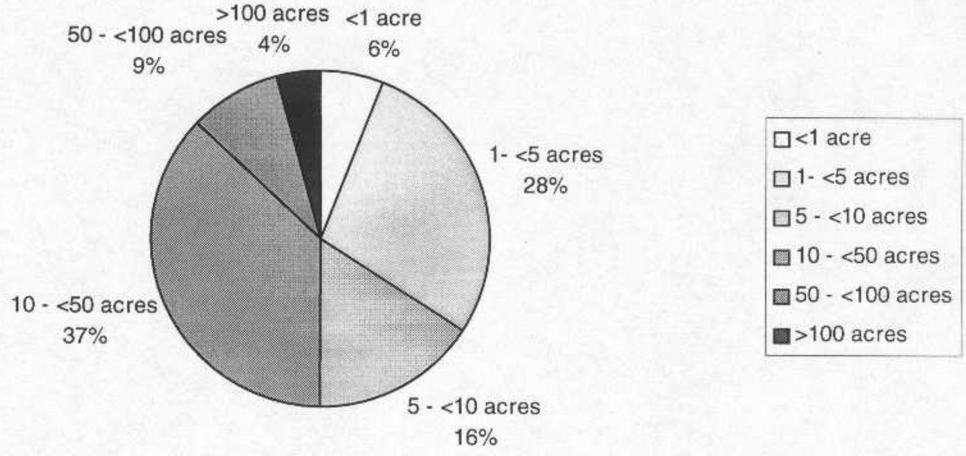
3.1 WETLAND SIZE AND CLASSIFICATION

A total of 214 wetlands and wetland complexes were identified as occurring on the Lummi Reservation. Wetland area totals 5,432 acres, or roughly 43 percent of the 12,500 acres of land area of the Reservation, excluding tidelands. Individual wetlands and wetland complexes range in size from 0.2 acre to 469 acres. The distribution of wetland sizes is summarized in Table 6 and shown graphically in Figure 3.

Table 6. Wetland Size Distribution

Size Range (ac)	**<1**	**1 - <5**	**5 - <10**	**10 - <50**	**50 - <100**	**>100**
No. of Wetlands	13	60	34	79	19	9

Figure 3 - Percent of Wetlands in Selected Size Ranges



The fact that 50 percent of the wetlands on the Reservation are over 10 acres in size (13 percent over 50 acres) indicates the relatively minor extent to which development has occurred. Urbanization typically divides larger wetland complexes so that the trend is towards smaller, more hydrologically isolated wetlands. Based on our experience in assessing wetlands in lowland coastal areas, the Lummi Reservation holds some of the largest, intact forested wetlands remaining in the Puget Lowlands. The unusually small number of wetlands of less than one acre may indicate that smaller wetlands were overlooked in the inventory process. While it seems apparent that there are fewer small wetlands on the Reservation than one would see in a typical wetland inventory for a small town, it is also likely that some of the smaller wetlands were missed given the scale of the aerial photos that were used for the initial review process.

The system most commonly used to classify wetlands is the one developed by the U.S. Fish and Wildlife Service for the National Wetlands Inventory (Cowardin et al. 1979). Known as the Cowardin system, after its senior author, it categorizes wetlands based on their association with water bodies, their position in the landscape, their predominant habitat or vegetation community type, their hydrologic regime, and their substrate type. This is done using a hierarchical organization that starts with broad categories, known as systems, and moves through increasingly specific levels such as subsystems, classes, hydrologic modifier, and so on. For the purposes of the Lummi Wetland Inventory Study, wetlands were categorized only down to the class level. Appendix F fully describes the Cowardin classification system.

All wetlands are placed in one of five systems, which include estuarine, lacustrine, marine, palustrine, and riverine. In this way, wetlands are classified in relation to their association with estuaries, lakes, marine environments, freshwater inland sites, and rivers or streams. Palustrine wetlands includes nontidal wetlands dominated by trees, shrubs, herbaceous plants, mosses or lichens, and all such wetlands that occur in tidal areas where salinity from marine waters is below 0.5‰. Palustrine wetlands may include ponds, marshes, wooded wetlands, wet meadows, or bogs. The class defines the dominant vegetation community or habitat type, such as forested, scrub-shrub, or open water. A wetland may have more than one class.

Inventory results indicate that the majority of wetland on the Reservation was classified as palustrine, in terms of both area (79 percent) and number of wetlands (88 percent). The number of wetlands that were classified as estuarine or riverine is low, 4.5 and 6 percent of all wetlands, respectively. However, the total area of riverine wetland (17 percent) indicates that, although they are fewer in number, riverine wetlands on the Reservation are particularly large in size. This reflects the extensive in-channel wetlands of the Nooksack and Lummi Rivers. There were no lacustrine or marine wetlands inventoried on the Reservation, although eelgrass beds are known to occur in intertidal areas of the Reservation. Table 7 shows the distribution by wetland area among the three systems represented on the Reservation.

Table 7. Distribution of Wetland Area by Cowardin System

System	Palustrine	Riverine	Estuarine
Wetland Area (ac)	4,289	952	191
Percent of Total Wetland Area	79	17	4

Approximately 67 percent of the wetlands identified on the Reservation have only one Cowardin class, 22 percent have two classes, and 11 percent have three or more. About 50 percent of the total number of wetlands have a palustrine emergent class, 45 percent have a palustrine forested class, and 23 percent have a palustrine scrub-shrub class (total is greater than 100 percent because of the number of wetlands with more than one class). The majority of the estuarine wetlands are open water or emergent, as would be expected in salt marsh habitats. The riverine wetlands are predominantly forested or scrub-shrub.

Referring exclusively to vegetation community or habitat type, approximately 58 percent of all wetlands have an emergent class, 50 percent have a forested class, 27 percent have a scrub-shrub class, 8 percent have an open water class, and 1.5 percent have an aquatic bed class. These numbers are compiled from Table 8, which summarizes the distribution of wetlands by Cowardin class. The number and percent of wetlands that fit each combination of classes is shown. A similar analysis in terms of wetland area could not be completed because estimates of percent cover of each Cowardin class were not made for a number of wetlands that were not field visited.

Table 8. Wetland Distribution by Cowardin Class Combination

Classes Present in Wetland [1]	No. of Wetlands	Percent of Wetlands
Palustrine		
PEM	70	44
PFO	50	23
PFO, PSS	19	9
PFO, PEM	10	5
PSS	9	4
PFO, PSS, PEM	9	4
PSS, PEM	5	2
PFO, POW	3	1
PSS, PEM, POW	3	1
POW	2	1
PEM, POW	2	1
PFO, PSS, PEM, PAB	2	1
PFO, PSS, PEM, POW	1	<1
PFO, PSS, PEM, PAB, POW	1	<1
Riverine		
RFO	3	1
RFO, RSS, REM	3	1
RFO, RSS	2	1
RFO, RSS, REM, ROW	2	1
REM	1	<1
RSS	1	<1
REM, ROW	1	<1
Estuarine		
EEM	8	4
EEM, EOW	1	<1
EFO, ESS, EEM	1	<1
Combinations (more than one system in a wetland)		
PFO, PSS, PEM, RFO	1	<1
PEM, REM	1	<1
PEM, EEM	2	1
PEM, POW, EEM	1	<1

1 PEM - palustrine emergent, PFO - palustrine forested, PSS - palustrine scrub-shrub, POW - palustrine open water, PAB - palustrine aquatic bed, RFO - riverine forested, RSS - riverine scrub-shrub, REM - riverine emergent, ROW - riverine open water, EEM - estuarine emergent, EFO - estuarine forested, EOW - estuarine open water

3.2 WETLAND DISTRIBUTION BY WATERSHED

As part of the Lummi Indian Reservation Storm Water Management Program (LIBC 1998), the Lummi Reservation was divided into 19 watersheds. Wetlands occur in all of the watersheds. Watershed K, the largest watershed, has both the greatest number of wetlands and the greatest amount of wetland acreage. This watershed extends outside the Reservation, so not all wetlands occurring in the watershed were necessarily mapped as part of this study. Even so, wetlands cover roughly 40 percent of the mapped area of this watershed. Watersheds M and N also have high percentages of area occupied by wetland. This is expected since these three watersheds comprise much of the Lummi River flood plain. Watersheds K, M, and N also show high levels of connectivity among water bodies, with 63 percent of the 82 wetlands in Watershed K having a hydrologic connection to another surface water body. Watershed S has a significant amount of wetland areas as it contains the mainstem of the Nooksack River. Watershed I also contains extensive wetland area; it is on the plateau of the Lummi Peninsula and has several very large forested wetland complexes. Watersheds A, J, L, and M all have less than 50 acres of wetland within their boundaries. These are either very small watersheds, or only small portions of the watersheds lie within the Reservation and so were not fully surveyed for wetlands. Figure 4 compares total wetland acreage by watershed, and Table 9 shows the actual distribution of wetlands by watershed. Refer to Figure 5 for locations of wetlands in specific watersheds.

Figure 4 - Total Wetland Acreage by Watershed

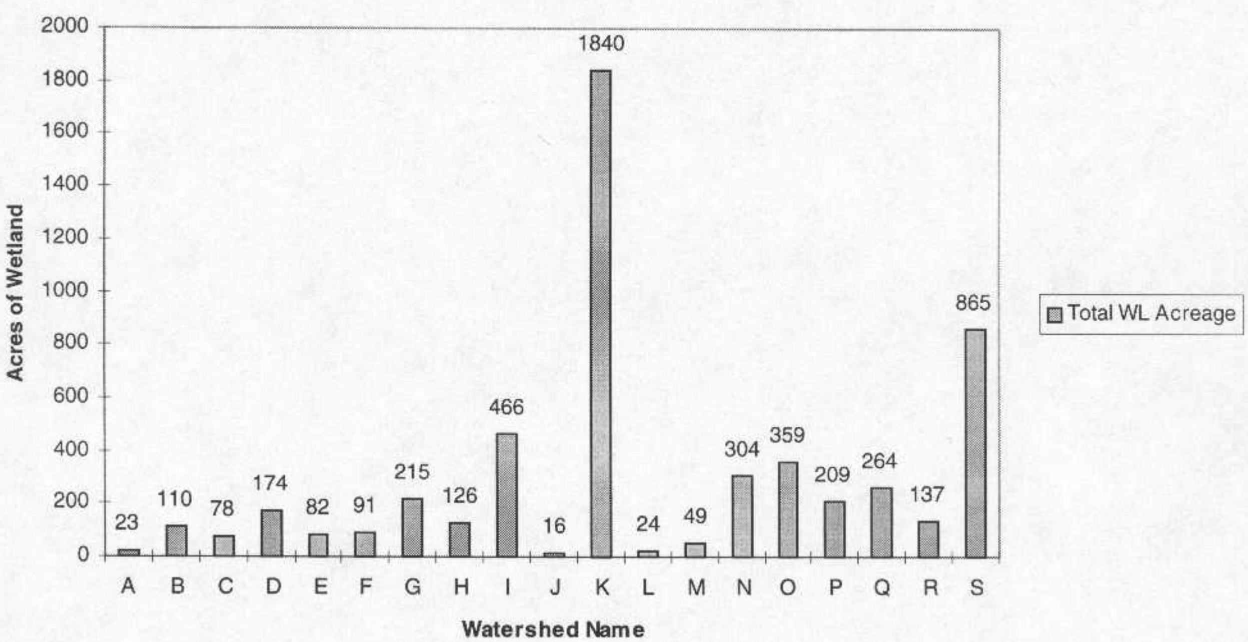


Table 9. Lummi Reservation Wetlands Summarized by Watershed

Watershed Name	Watershed Size (acres on Reservation only)	No. of Wetlands	Total Area of Wetlands (ac)	Cowardin Classes Present	No. of Tidal Wetlands	No. of Hydrologic Connected Wetlands
A	306	1	23	POW, PEM, PSS	1	0
B	634	5	110	EOW, EEM, POW, PEM, PSS, PFO	3	3
C	583	5	78	PEM, PSS, PFO	0	0
D	797	9	174	PSS, PFO, RSS, RFO	0	2
E	183	2	82	PSS, PFO	0	0
F	326	7	91	POW, PEM, PSS, PFO	0	2
G	836	12	215	PEM, PSS, PFO, ROW, REM, RSS	0	6
H	537	2	126	PFO	0	0
I	1,142	19	466	POW, PEM, PSS, PFO, RSS, RFO	0	0
J	87	1	16	PFO	0	0
K	4,696	82	1,840	EEM, POW, PAB, PEM, PSS, PFO, ROW, REM, RFO	2	52
L	2,384	7	24	EEM, ESS, EFO, PEM	1	4
M	198	3	49	EEM	3	3
N	333	2	304	EEM, PEM, REM	1	2
O	1,964	20	359	PEM, PSS, PFO	0	9
P	4,228	12	209	PEM, PSS, PFO	0	2
Q	1,292	9	264	PEM, PSS, PFO, RFO	0	4
R	1,024	12	137	EEM, POW, PEM, PSS, PFO	5	8
S	not available*	4	865	ROW, REM, RSS, RFO	4	4
Totals	**21,550**	**214**	**5,432**		**20**	**110**

• Watershed S extends off-reservation and is the entire Nooksack River watershed.

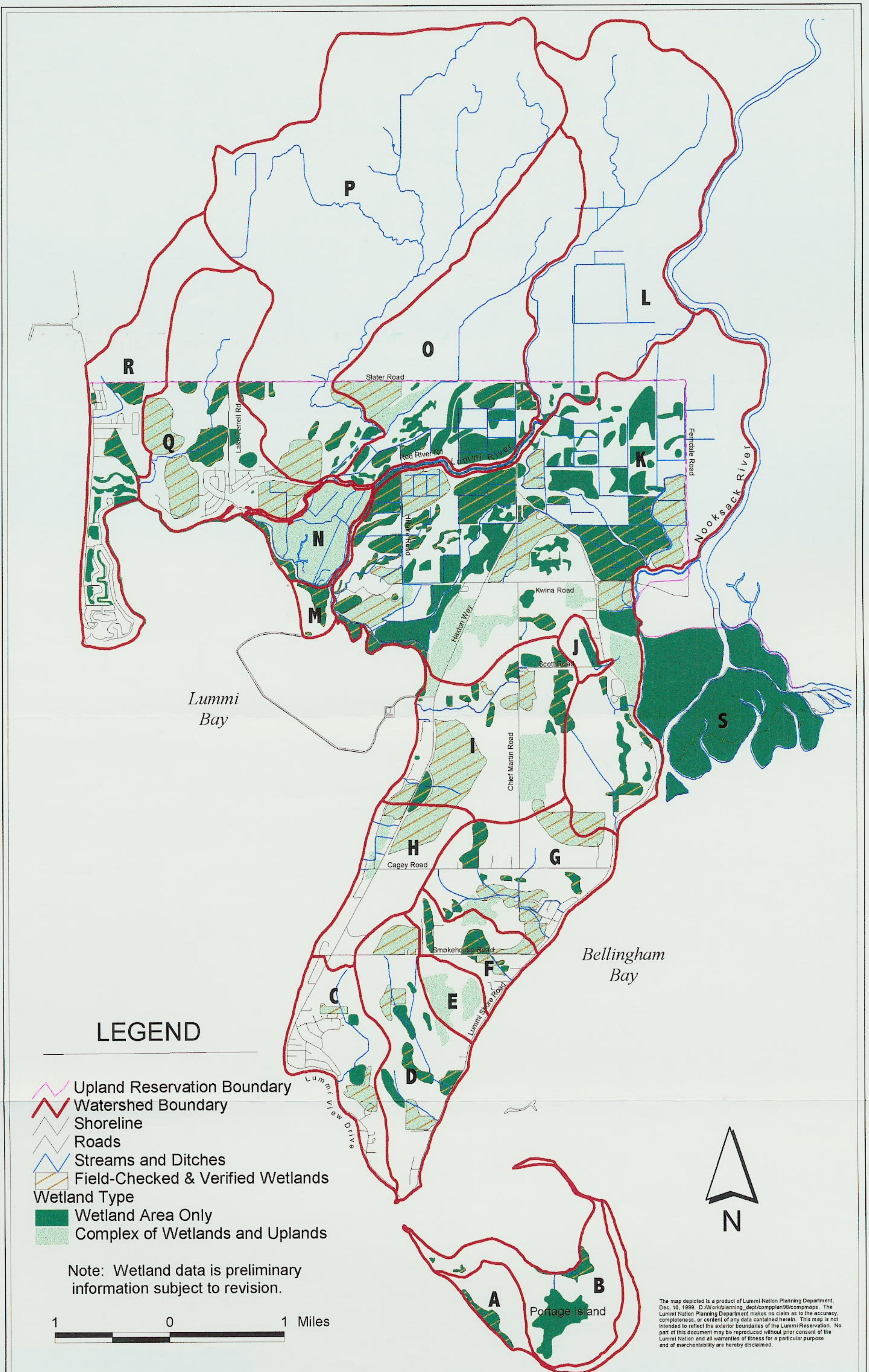


Figure 5. Location of Wetlands on the Lummi Reservation

3.3 WETLAND PLANT COMMUNITIES

Most of the forested wetlands on the Reservation have a canopy dominated by red alder and a salmonberry shrub layer. About 54 percent of the total number of wetlands inventoried have alder as a dominant species. The most frequently occurring forested communities in the wetlands include alder, alder/salmonberry, alder/cottonwood/salmonberry, and alder/red cedar. Red osier dogwood (*Cornus stolonifera*) was often a co-dominant with the salmonberry (*Rubus spectabilis*) in the shrub layer. Common groundcover species in these forested communities include false lily-of-the-valley (*Maianthemum dilatatum*), slough sedge (*Carex obnupta*), and water parsley (*Oenanthe sarmentosa*). Pacific willow (*Salix lucida*), Sitka willow (*Salix sitchensis*) and crabapple (*Malus fusca*) are common in some forested wetlands. The cottonwood or hybrid poplar plantations on the flood plains are grouped with forested wetlands because they function as very simplified forested stands.

The scrub-shrub wetland areas are dominated by willow species, salmonberry, red osier dogwood, Nootka rose, and hardhack (*Spiraea douglasii*). Willow-dominated shrub communities occur in almost 10 percent of all wetlands inventoried. Salmonberry communities are also common, typically with an understory of slough sedge and water parsley.

The most frequently occurring cover in emergent wetlands is cultivated crop or pasture species, indicating the extent to which flood plain areas have been converted to agricultural uses. After crops and pastures, the most common communities in the freshwater emergent wetlands include reed canarygrass/soft rush, cattail/bulrush, and water parsley/slough sedge. Reed canarygrass, a non-native invasive species, is dominant in about 14 percent of the freshwater emergent wetlands. In the brackish marsh or salt marsh areas, the most frequently occurring communities are seashore saltgrass/pickleweed and Pacific silverweed/rush. Table 10 summarizes the frequency with which the various communities occur in wetlands on the Reservation. The communities have been somewhat simplified in this table.

The extent and type of disturbance to wetland vegetation was also noted during fieldwork. The most common type of disturbance is tilling wetlands and planting crops, observed in at least some portion of 24 percent of all wetlands on the Reservation. A number of wetlands had been clear-cut recently (4 percent of total), and some logged 10 - 20 years ago and subsequently replanted (3 percent of total). Blow-down was observed in six wetlands, particularly along the edges of clear-cuts. Active grazing by cows was observed in five wetlands. Aside from historic logging, the forested wetlands on the Reservation are largely undisturbed. Disturbance of wetland vegetation is obviously most prevalent in developing areas and in farmed areas.

Disturbance of wetland vegetation is typically associated with an increase in non-native or invasive plant species. As previously noted, reed canarygrass frequently occurs as a dominant species in the emergent communities on the Reservation. This species moves into open, wet areas that have been disturbed and forms a monotypic stand, out-competing native species and decreasing biological diversity. Himalayan blackberry is also a problematic invasive in wetlands in this area. This species does not generally thrive in very wet soils, but it readily creeps into wetland edges by fast-growing rhizomes and tip propagation (new plants establish where vine tips arch down to the soil). Though blackberry does not cover as much wetland areas as reed canarygrass on the Reservation, it occurs in a higher number of wetlands and could easily spread much further than its current extent. This species is highly aggressive in disturbed areas, readily growing over and shading out native species. As more residences are built on the Reservation, disturbed edges of wetlands will be increasingly vulnerable to the spread of blackberry. Of the 149 wetlands for which information was collected on non-native invasive species, reed canarygrass, Himalayan blackberry, and creeping buttercup were most frequently noted, and pose the greatest threat to native species.

Table 10. Wetland Plant Communities in Lummi Reservation Wetlands

Plant Community	Dominant Plants	Other Species That May be Present	Number of Wetlands Occurs in
Forested Communities			
ALRU	*Alnus rubra*	*grasses, Lysichiton americanum, Rubus discolor*	7
ALRU/COST	*Alnus rubra, Cornus stolonifera*	*Rubus spectabilis, Maianthemum dilatatum*	4
ALRU/RUSP	*Alnus rubra, Rubus spectabilis*	*Betula papyrifera, Cornus stolonifera, Maianthemum dilatatum, Carex obnupta, Rubus discolor, Lysichiton americanum*	71
ALRU/CAOB/OESA	*Alnus rubra, Carex obnupta, Oenanthe sarmentosa*	*Lysichiton americanum, Scirpus spp.,*	3
ALRU/THPL	*Alnus rubra, Thuja plicata*	*Rubus spectabilis, Myrica gale, Carex obnupta, Oenanthe sarmentosa, Tsuga heterophylla, Betula papyrifera, Malus fusca, Rosa nutkana, Rubus discolor, Maianthemum dilatatum*	13
ALRU/RUSP/SPDO/ RONU	*Alnus rubra, Populus trichocarpa, Rubus spectabilis*	*Malus fusca, Oenanthe sarmentosa, Betula papyrifera, Cornus stolonifera, Salix spp.*	11
ALRU/POTR/THPL	*Alnus rubra, Populus trichocarpa, Thuja plicata*	*Rubus spectabilis, Cornus stolonifera, Oenanthe sarmentosa, Carex obnupta*	1
ALRU/SALIX	*Alnus rubra, Salix spp.*	*Cornus stolonifera*	3
MAFU	*Malus fusca*	*Spiraea douglasii, Rosa nutkana, Oenanthe sarmentosa, Lonicera involucrata*	4
POTR	*Populus trichocarpa plantations*	*Phalaris arundinacea*	7
POTR/RUSP	*Populus trichocarpa, Rubus spectabilis*	*Cornus stolonifera, Oenanthe sarmentosa*	3
SALU	*Salix lucida*	*Malus fusca, Salix sitchensis, Crataegus douglasii, Cornus stolonifera, Carex obnupta*	2
CONIFER PLANTATION	*Tsuga heterophylla, Thuja plicata*	*Alnus rubra*	5
Scrub-Shrub Communities			
COST/SPDO	*Cornus stolonifera, Spiraea douglasii*	*Rosa nutkana, Oenanthe sarmentosa, Carex obnupta, Ranunculus repens*	5

Table 10. Wetland Plant Communities in Lummi Reservation Wetlands

Plant Community	Dominant Plants	Other Species That May be Present	Number of Wetlands Occurs in
RONU	*Rosa nutkana*	*Salix spp., Oenanthe sarmentosa, Spiraea douglasii*	2
RUSP	*Rubus spectabilis*	*Oenanthe sarmentosa, Carex obnupta, Ranunculus repens, Tolmiea menziesii*	8
RUSP/COST	*Rubus spectabilis, Cornus stolonifera*	*Oenanthe sarmentosa, Carex obnupta, Ranunculus repens*	1
SALIX	*Salix spp.*	*Cornus stolonifera, Spiraea douglasii, Rosa nutkana, Carex obnupta, Oenanthe sarmentosa, Betula papyrifera*	21
Emergent Communities			
AGAL/JUNCUS	*Agrostis alba, Juncus spp.*	*Holcus lanatus, Festuca rubra*	2
CALY	*Carex lyngbyei*	*Distichlis spicata, Potentilla pacifica*	1
CAOB/JUNCUS	*Carex obnupta, Juncus spp.*	*Typha latifolia, Holcus lanatus*	2
CROP/PASTURE	*Planted crop such as corn, pasture herbs and grasses*		65
DECE/GRIN	*Deschampsia cespitosa, Grindelia integrifolia*		1
DISP/SAVI	*Distichlis spicata, Salicornia virginica*	*Atriplex patula, Juncus spp., Potentilla palustris, Elymus mollis, Scirpus spp.*	12
OESA/CAOB	*Oenanthe sarmentosa, Carex obnupta*	*Athyrium filix-femina, Stachys cooleyae, Scirpus spp., Potentilla pacifica, Lysichiton americanum, Ranunculus repens*	10
PHAR/THLA	*Phalaris arundinacea, Typha latifolia*	*Juncus effusus, Carex spp., Carex obnupta, Lysichiton americanum, Atriplex patula*	6
PHAR/JUNCUS	*Phalaris arundinacea, Juncus spp.*	*Juncus effusus, pasture species, Cirsium arvense, Ranunculus repens, Solanum dulcamara*	21
POPA/JUNCUS	*Potentilla palustris, Juncus spp.*	*Agrostis alba, Hordeum brachyantherum, Atriplex patula, Phalaris arundinacea, Carex obnupta, grasses*	11
TYLA/SCIRPUS	*Typha latifolia, Scirpus spp.*	*Carex spp., Juncus spp., Phalaris arundinacea, Carex lyngbyei, Atriplex patula, Salicornia virginica*	9
TYLA/OESA	*Typha latifolia, Oenanthe sarmentosa*	*Glyceria elata*	2
Aquatic Bed Communities			
NUPO	*Nuphar polysepalum*	*Potamogeton spp.*	4

3.4 WETLAND HYDROLOGY

Of the 214 wetlands mapped on the Reservation, 20 (9 percent) were determined to be tidal. This includes both brackish and freshwater wetlands with hydrologic patterns that are tidally influenced. A total of 52 wetlands (24 percent) are directly associated with streams or rivers. This number does not include those wetlands that are associated with drainage ditches that eventually flow into streams or rivers. While extensive areas of the flood plain wetlands are hydrologically influenced by streams and rivers, the large number of wetlands that occur on flat forested plains of the Lummi Peninsula are primarily supplied water by precipitation and overland sheetflow. Discharge from the seasonally shallow ground water is also common in wetlands in this area. Table 11 summarizes the primary sources of water for wetlands on the Reservation.

Table 11. Primary Sources of Water for Wetlands

Water Source	No. of Wetlands for Which Primary Source
Precipitation	207
Overland Sheetflow	104
Seep/Ground Water	71
Culverted Stream/ Adjacent to Stream	52
Flood Plain Inundation	14
Tidal Flooding	4
Culverted Storm Water	3
Ditch Flow	1

Disturbances to wetland hydrology have been primarily associated with conversion of low-lying, wet areas to agricultural uses. Draining by constructing ditches or berms is the most prevalent conversion that can be visually observed; historic installation of tile drains is probably but difficult to determine. Diking of wetlands from rivers, streams, or marine waters is the second-most frequently observed alteration, and diversion of flow due to road construction is also common. Alterations to wetland hydrology are summarized in Table 12.

Table 12. Observed Alterations to Wetland Hydrology

Type of Alteration	No. of Wetlands in Which Observed
Historic conversion to agriculture (possible tiling)	85
Ditched and drained	51
Diked from river or stream	29
Flow blocked by roads/ outlet blocked	23
Diked from sea/ tide gate	8
Old skid trails channel flow	7
Filling	4
Excavated and ponded	4
Diversions to wetland from stream/drainage ditches/ reservoir	3

3.5 WETLAND SOILS

A total of 28 soil series are mapped within the wetlands on the Reservation (USDA 1992). Of these, 14 are listed as hydric soils on the Whatcom County list (USDA 1999). It is common that non-hydric soils are mapped as occurring in wetlands; typical soil surveys lack extensive field verification and many non-hydric soils contain unmapped inclusions of hydric soils. Most of the soils mapped in the wetlands are silt loam with poor drainage, slow permeability, and a seasonally high water table. Eliza soil is mapped over about 26 percent of the total wetland area, with Birch Bay second in wetland area occupied at 15 percent. Eliza silt loam is a very poorly drained soil that occurs on flood plains and deltas. It has typically been artificially drained, usually for agricultural purposes. Eliza will support red alder forest in its undrained state, but it is typically vegetated with crops or pasture species. The normally high water table appears to be lowered during the growing season by drainage ditches and possibly by drain tiles. Table 13 summarizes the distribution of soils in the wetlands on the Reservation.

Of the 106 wetlands for which soil observations were recorded, the soils have been tilled in 62 percent. Other types of soil disturbance, such as compaction and ditching, were noted in only a handful of wetlands.

Table 13. Extent of Mapped Soil Series in Wetlands

Soil Series	Map Unit No.	Hydric	Percent Total Wetland Area	Soil Series	Map Unit No.	Hydric	Percent Total Wetland Area
Bellingham	11	Y	2	Lynden	99	N	<1
Birch Bay	12-14	N	15	Lynnwood	102, 103	N	<1
Clipper	31	Y	<1	Mt. Vernon	107	N	<1
Eliza	46	Y	26	Neptune	111	N	<1
Eliza-Tacoma	47	Y	10	Pits	120	N	<1
Everson	53	Y	<1	Puyallup	124	N	<1
Hale	61	Y	6	Shalcar-Fishtrap	144	Y	<1
Histosols	72	Y	<1	Skipopa	148	N	<1
Hovde	73	Y	3	Tacoma	163, 164	Y	4
Hydraquents	75	Y	3	Typic Psammaquents	170	Y	1
Kickerville	80, 81	N	1	Whatcom	179-181	N	1
Labounty	93	Y	10	Whitehorn	184	Y	3
Laxton	96-98	N	1	Yelm	191	N	1

4. RESULTS OF FUNCTION ASSESSMENT

The Washington State Function Assessment Method was applied to 12 assessment units (AUs) in nine selected wetlands on the Reservation. Table 14 presents the indexes for each AU for the 15 functions that were assessed as part of the study and Figure 6 shows the locations of these wetlands. This assessment method does not allow for calculating an overall function index for the wetland. As can be seen from the table, a particular AU may vary significantly in its relative performance of one function to another. For example, the first riverine AU listed in the table received a 4 out of a possible 10 for removing sediment and a 9 for general habitat suitability. These are very different types of functions, and as such it is not appropriate to add together or average them to arrive at an overall score for an AU. Therefore, the AUs are not compared using an overall index, rather the potential performance levels (the index) for each function are compared among AUs of the same HGM category. As different models were developed for each subclass, it is not meaningful to compare across categories: riverine flow-through cannot be reasonably compared to depressional outflow. Each function index, of course, serves as a comparison of the assessed wetland to a large pool or reference wetlands.

The wetlands that were selected for function assessment as part of this inventory study were chosen based on expectations of imminent development in the vicinity. They are not intended to be representative of wetlands occurring on the Reservation, but they are also not particularly exceptional or unusual.

4.1 ASSESSMENT OF RIVERINE FLOW-THROUGH WETLANDS

Relative to the reference wetlands that were assessed in developing the function assessment method, one of the riverine flow-through wetlands (38N1E04-01A) that was assessed for this study rated above average (index of 7 or higher for a function) for 12 of the 15 functions, with only the following functions scoring average (index of 4-6): removing sediment, removing nutrients, and ground water recharge. The wetland scored quite high for the habitat suitability functions, reflecting the presence of a variety of components that contribute to high quality habitats for all of the assessed wildlife guilds. These include a permanently flowing stream, dense coniferous and evergreen forest components, very high plant species richness, well-vegetated stream banks, a number of snags in varying states of decay, high quality buffer, an intact riparian corridor, and a significant amount of large woody debris. The amphibian index is especially high due to the good condition of the buffer, the abundance of woody debris for cover, the presence of a permanent flowing stream, and the lack of surrounding development. The bird index is also quite high due to the buffer, presence of snags, proximity of agricultural fields, and the complexity of the vegetative structure of the forest.

For the water quality functions, the wetland scored above average for removing metals and toxics and average for removing sediment and nutrients. This is primarily because the removal of sediment and nutrients is largely dependent on the settling that occurs in slow-moving flows, where wetlands have a longer retention time of water. Removal of toxics and organics is more dependent on a dense cover of emergent species providing filtration of the water flowing through. While this wetland is densely vegetated with emergent species, it is a flow-through wetland that does not have the long retention time

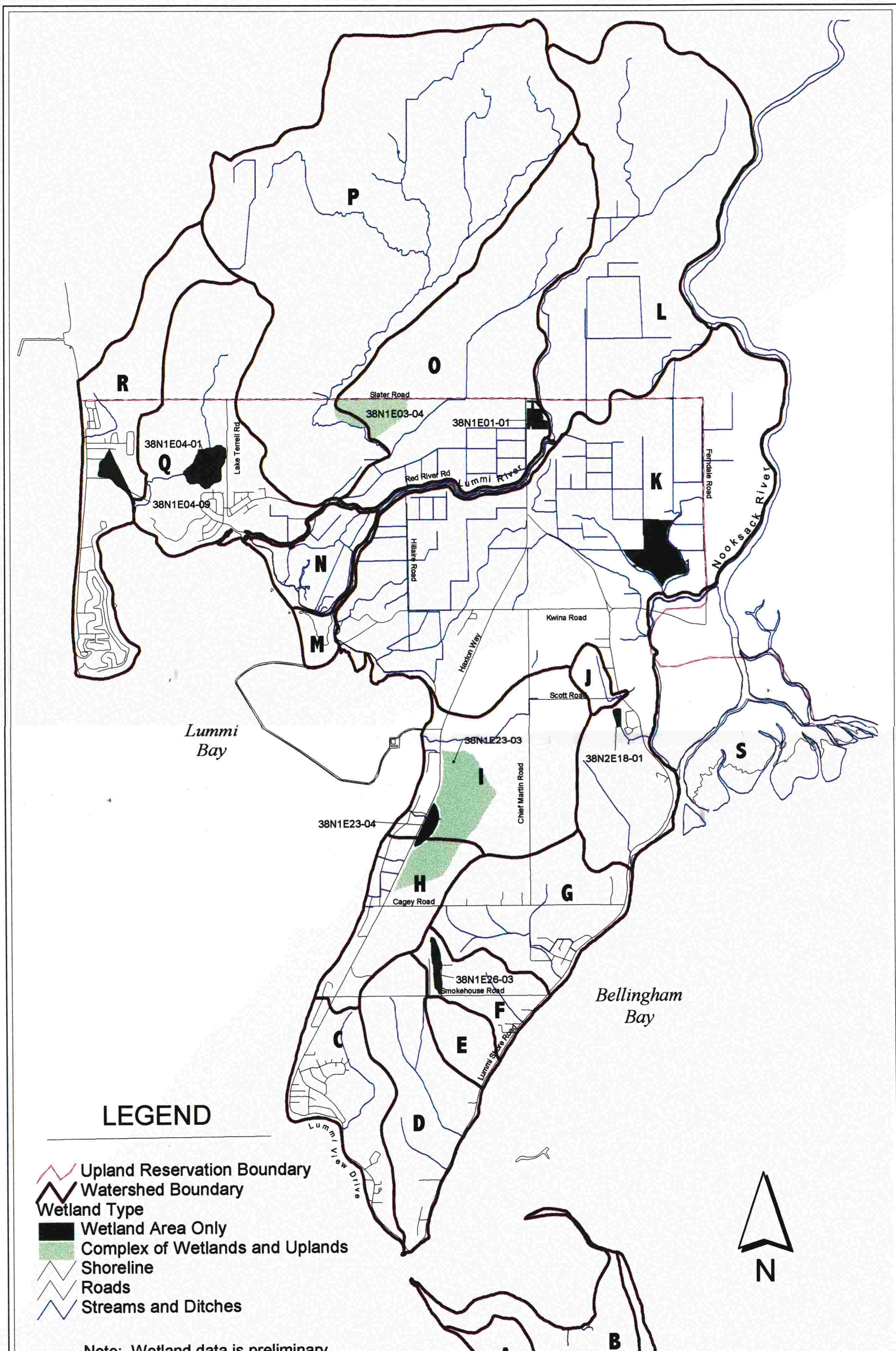


Figure 6. Location of Wetlands Assessed for Function

Table 14. Summary of Function Assessments by HGM Category

Wetland Identification/Assessment Unit Number	HGM Category: Riverine Flow-through		Depressional Closed		Depressional Outflow							
	38N1E04-01A	38N1E23-03B	38N1E03-04	38N1E26-03	38N1E01-01A	38N1E04-01B	38N1E04-01C	38N1E04-09	38N1E23-03A	38N1E23-04	38N2E07-01	38N2E18-01
Water Quality Functions												
Removing Sediment	4	5	M	M	7	6	5	5	5	5	6	5
Removing Nutrients	4	5	5	5	9	3	3	4	2	3	6	3
Removing Heavy Metals & Toxic Organics	7	6	6	6	8	6	6	3	7	6	9	5
Water Quantity Functions												
Reducing Peak Flows	7	5	M	M	7	3	2	6	4	3	5	4
Reducing Downstream Erosion	9	8	M	M	7	6	4	9	7	6	5	7
Recharging Ground Water	4	1	5	3	5	6	5	3	4	8	6	10
Habitat Suitability Functions												
General Habitat Suitability	9	5	6	7	2	8	8	6	5	6	5	8
Suitability for Invertebrates	8	3	4	6	2	8	7	4	4	4	6	7
Suitability for Amphibians	12	4	2	6	3	7	7	6	2	3	4	8
Suitability for Anadromous Fish	9	2	N/A	N/A	0	7	4	0	2	4	5	5
Suitability for Resident Fish	10	3	N/A	N/A	1	7	6	2	2	4	6	6
Suitability for Aquatic Birds	12	4	4	5	3	5	7	4	3	3	7	5
Suitability for Aquatic Mammals	7	3	3	4	2	6	5	2	3	2	4	4
Habitat for Native Plant Communities	9	8	6	8	0	8	6	6	7	7	2	7
Primary Production and Export	8	9	N/A	N/A	7	8	8	7	9	11	8	10

N/A - not applicable to that HGM category of wetland
M - Moderate (Function does not have quantitative model for that subclass)

of a more constricted flow. The wetland scored high for reducing peak flows and downstream erosion because the stream floods overbank into the densely forested wetland where the water is stored for short-term periods and the trees and shrubs have an opportunity to uptake some of the water. This gets water out of the channel, thus de-synchronizing the storm-related peaks and minimizing downstream flooding.

In comparison, the other wetland in this category (38N1E23-03B) scored above average for only the following three functions: reducing downstream erosion, native plant richness, and primary production and export. The wetland scored high for reducing downstream erosion because of the high coverage of trees and shrubs and the potential for water uptake in the stream flood plain. Native plant richness scored high due to the presence of mature trees, the moderate number of native plants and plant associations, and the low coverage of non-native species. Primary production and export is expected to be high for this wetland due to the high proportion of deciduous species, the high cover of herbaceous understory, and the presence of the stream which readily exports the decaying organic matter. Habitat suitability is generally average to below average for this wetland due to the scarcity of habitat features such as snags, downed logs, permanently flowing stream, edge complexity, and so on.

4.2 ASSESSMENT OF DEPRESSIONAL CLOSED WETLANDS

The two wetlands in this category (38N1E03-04 and 38N1E26-03A) that were assessed as part of the study scored similarly for most functions. Both wetlands scored moderate for removing sediment, reducing peak flows, and decreasing downstream erosion. This is primarily because they are both closed wetlands of good size, they are densely forested, and they have a high proportion of area that is inundated relative to the size of the contributing basin (i.e. they store a significant amount of the storm water flows that move through their basins). However, they do not rate high for these functions due to the low level of upgradient development in the watersheds. Wetland 38N1E26-03A scored high for general habitat suitability, reflecting the density and complexity of the forest structure, the variety of water regimes that occur, the moderate variety of snags, the high number of native plant species, the presence of mature trees, and the good buffer condition. The high rating for native plant communities also reflects the high number and complexity of plant associations and the relatively low cover of non-native species. This wetland rated below average only for its ground water recharge potential primarily due to the expected slow soil permeability. Both wetlands did not receive ratings for the fish functions or the primary production and export functions because closed depressions lack outlets or flow-through streams.

Besides the three functions noted previously, Wetland 38N1E03-04 rated average for all other functions except habitat suitability for amphibians and wetland-associated mammals. The primary contributor to the low score for amphibian suitability is the lack of permanently inundated or open water areas. For aquatic mammals, the shallowness of the seasonal inundation and the lack of open water, denning banks, and woody vegetation that might be used by beaver all contribute to the low score for this function.

4.3 ASSESSMENT OF DEPRESSIONAL OUTFLOW WETLANDS

Among the depressional outflow wetlands, the only one that consistently scored high for the water quality functions is Wetland 38N1E01-01. The wetland has a high potential for removing sediment, nutrients, metals, and toxic organics because it has a severely constricted outlet that backs up water, thus facilitating settling of particles, and dense emergent vegetation, which acts to catch and filter out particles suspended in the water column. The only other high scores for water quality functions in this group of wetlands were for Wetlands 38N1E23-03A and 38N2E07-01 for their potential for removing heavy metals and toxic organics. These two wetlands both have a particularly high percent cover of emergent species or herbaceous understory of the forest component. The remaining wetlands scored average or below average for all water quality functions for varying reasons.

Among the water quantity functions, one wetland (38N1E01-01) scored high for both reducing peak flows and decreasing downstream erosion. This wetland has a severely constricted outlet and a large area of inundation relative to the size of the contributing basin. Three other wetlands also scored high for decreasing downstream erosion: 38N1E04-09A, 38N2E18-01, and 38N1E23-03A. These three have in common a very high coverage of dense forest (high potential for water uptake and storage) and large areas of inundation relative to the size of the contributing basin. The remaining wetlands in this group have unconstricted outlets and low cover of forest, resulting in average to low ratings for this function. Only two wetlands rated high for the potential for ground water recharge: 38N1E23-04C and 38N2E18-01. These wetlands both have moderate ratings for soil permeability.

For the habitat suitability functions, three wetlands received more than one high rating: 38N1E04-01B, 38N1E04-01C, and 38N2E18-01. These wetlands all have moderate to very high plant species richness, some amount of permanent inundation, a variety of vegetation classes, moderate to high interspersion among vegetation classes, a broad representation of snag and large woody debris types, good buffer condition, and extensive riparian corridors. Wetland 38N2E07-01 received a high rating only for habitat suitability for wetland-associated birds, primarily due to the high interspersion among vegetation classes, the high rating for edge complexity, and the more open forest canopy that allows for greater bird access.

Four wetlands scored high for habitat for native plant communities: 38N1E04-01B, 38N1E23-03A, 38N1E23-04C, and 38N2E18-01. Contributing factors these wetlands have in common include very high native species counts (up to 45 species in one wetland), moderate to high number of plant associations, high number of strata in plant associations (high complexity), the presence of mature trees, and the relatively low percent cover of non-native plant species. All eight depressional outflow wetlands scored high for primary production and export. Having outlets, they all obviously have the capacity for export, and all are densely vegetated with deciduous forest or emergent species, thus having high productivity of organic matter.

4.4 IMPLICATIONS FOR ONGOING USE OF THE METHOD

The use of the Washington State Function Assessment Method as part of this project was essentially a pilot study for the Lummi Reservation. Staff received training and the tools necessary to continue use of this method if desired. They have now had sufficient exposure to the method to determine some of its strengths and weaknesses and to assess the feasibility of applying it at a greater scale to the wetlands of the Reservation.

Only a very small percentage of the total wetlands on the Reservation was assessed. However, from this assessment it is clear that wetlands provide functions for the ecosystem and for humans living in their vicinity at differing levels. some wetlands that have high potential for water quality improvement have low ratings for habitat suitability. Other may have particularly high suitability for wetland-associated birds and low ratings for amphibian suitability. Clearly all wetlands do not provide all functions at the same level. It is the cumulation of wetland functions provided by numerous wetlands on the landscape that is essential to maintaining healthy ecosystems on the Reservation.

The Lummi Reservation is gradually moving from an agricultural base and a low-density residential land use to a higher density residential use. Historical and ongoing practices associated with logging and agricultural uses have impacted wetlands through clearing of vegetation and draining by installation of ditches, dikes, and possibly drain tiles. Effects that can be expected from increased buildout for residential use include increased impervious surface area, decreased vegetated areas, increased storm-related peaks in streams, increased contamination of surface area, decreased vegetated areas, increased storm-related peaks in streams, increased contamination of surface water bodies, increased human disturbance of wildlife and habitats, and others. All of these factors are likely to directly affect the wetlands on the Reservation. Some wetland functions will be affected to a greater extent than others, depending on the wetland and the type of impact. It is possible in relatively undeveloped areas such as this to guide development to protect the more sensitive wetlands or vulnerable wetland functions, or to try and protect a wide range in function types and levels. However, the best way to protect wetland functions is to maintain as much undisturbed wetland as possible.

As development pressures on the Lummi Reservation increase, difficult decisions will need to be made as to which wetlands to fill, which to protect, and how best to protect them. The Washington State Function Assessment Method can help in these decisions in the following ways:

1. Wetlands of the same HGM category can be ranked relative to each function. Those wetlands in each category with consistently higher functions would receive the highest priority for protection. This might include those wetlands that consistently score 6 or greater for all functions.

2. Particular functions could be selected for prioritization in selected regions of the Reservation and those wetlands scoring highest for those functions would receive the highest priority for protection. For example, in flood-prone regions, wetlands that have high potential for reducing peak flows and downstream erosion may be prioritized to reduce the flood risk.

3. Selected wetlands that are believed to be particularly vulnerable to development-related impacts could be monitored for function level using the Washington State method. If functions were

observed to be decreasing in these more sensitive wetlands, actions could be taken to prevent further degradation in wetlands in that particular region of the Reservation.

4. The method could be used to predict changes in function levels relative to a specific proposed development action. This is done by assessing a specific wetland under existing conditions, and then completing a second assessment based on expected changes that could be caused by the proposed development. This involves filling out a data form and trying to predict changes that might occur. This may include decreased wetland area due to fill, decreased buffer rating due to the new development, increased area of inundation in the wetland due to increased storm water, and so on. The two sets of function indexes are then compared to get an idea of the extent to which the development might impact the wetland. This information could then be used as an argument for relocating the development. This is a controversial idea among local wetland professionals because the method was not specifically intended as a predictive tool and has not yet been proven effective for this type of use. However, it is likely that wetland managers at the local level will try and use the method for the purpose on an experimental basis, as there are no other good alternatives for quantitative predictions of wetland function loss due to development.

5. REFERENCES

Brinson, M.M. 1993. A Hydrogeomorphic Classification for Wetlands. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS. Wetlands Research Program Technical Report WRP-DE-4.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. La Roe. 1979. Classification of wetlands and deepwater habitats of the United States. Office of Biological Services, Fish and Wildlife Service, U.S. Department of the Interior, FWS 1035-79/81. 103 pp.

Hitchcock, C.L. and A. Cronquist. 1973. Flora of the Pacific Northwest. University of Washington Press. 730 pp.

Hruby, T., T. Granger, K. Brunner, S. Cooke, K. Dublonica, R. Gersib, L. Reinelt, K. Richter, D. Sheldon, A. Wald, and F. Weinmann. 1999. Methods for Assessing Wetland Functions Volume I: Riverine and Depressional Wetlands in the Lowlands of Western Washington. WA State Department of Ecology Publication #99-115 & 99-116.

Kollmorgen Corporation. 1975. Munsell soil color chart. Macbeth Division of Kollmorgen Corporation. Baltimore, Maryland.

Lummi Indian Business Council (LIBC). 1998. Lummi Reservation Storm Water Management Program. Technical Background Document. Prepared for Lummi Indian Business Council, Bellingham, WA. December.

Reed, P.B., Jr. 1988. National list of plant species that occur in wetlands: Northwest (Region 9). U.S. Fish and Wildlife Service Biological Report. 88 (26.9). 89 pp.

U.S. Army Corps of Engineers (COE). 1987. Corps of Engineers Wetlands Delineation Manual. Technical Report Y-87-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

U.S. Department of Agriculture, Natural Resource Conservation Service (USDA). 1999. Whatcom County hydric soil list.

U.S. Department of Agriculture, Natural Resource Conservation Service (USDA). 1992. Soil Survey of Whatcom County Area, Washington.

U.S. Fish and Wildlife Service. 1987. National Wetland Inventory maps.

Washington State Department of Ecology (Ecology). 1997. Washington State wetlands identification and delineation manual. Washington State Department of Ecology Publication #96-94.

APPENDIX A

List of Dominant Plants in Lummi Reservation Wetlands

Appendix A
List of Dominant Plants Observed in Wetlands on Lummi Reservation

Scientific Name[1]	Plant Code	Common Name	Indicator Status
Trees			
Alnus rubra	ALRU	red alder	FAC
Betula papyrifera	BEPA	paper birch	FAC
Malus fusca	MAFU	crab apple	FACW
Populus trichocarpa (balsamifera)	POTR	black cottonwood	FAC
Salix lucida	SALU	Pacific willow	FACW+
Salix spp.	SALIX	willow	varies
Thuja plicata	THPL	western red cedar	FAC
Tsuga heterophylla	TSHE	western hemlock	FACU-
Shrubs			
Cornus stolonifera (sericea)	COST	red osier dogwood	FACW
Crataegus douglasii	CRDO	Douglas hawthorn	FAC
Lonicera involucrata	LOIN	twinflower	FAC+
Myrica gale	MYGA	sweet gale	OBL
Rosa nutkana	RONU	Nootka rose	FAC
Rubus discolor	RUDI	Himalayan blackberry	FACU
Rubus spectabilis	RUSP	salmonberry	FAC+
Salix sitchensis	SASI	Sitka willow	FACW
Spiraea douglasii	SPDO	hardhack	FACW
Typha latifolia	TYLA	common cattail	OBL
Herbs			
Atriplex patula	ATPI	fat-hen saltbush	FACW
Cirsium arvense	CIAR	Canada thistle	FACU+
Grindelia integrifolia	GRIN	Puget Sound gumweed	FACW
Hordeum brachyantherum	HOBR	meadow barley	FACW-
Lysichiton americanum	LYAM	skunk cabbage	OBL
Maianthemum dilatatum	MADI	false lily-of-the-valley	FAC

Scientific Name[1]	Plant Code	Common Name	Indicator Status
Nuphar polysepalum (luteum)	NUPO	yellow pond-lily	OBL
Oenanthe sarmentosa	OESA	water parsley	OBL
Potentilla palustris	POPA	marsh cinquefoil	OBL
Ranunculus repens	RARE	creeping buttercup	FACW
Solanum dulcumara	SODU	bitter nightshade	FAC+
Stachys cooleyae	STCO	great betony	FACW
Tolmiea menziesii	TOME	youth-on-age	FAC
Grasses/ Sedges/ Rushes/ Ferns			
Agrostis alba	AGAL	redtop	FAC
Alopecurus spp.	ALOPECURUS	foxtails	varies
Athyrium filix-femina	ATFI	lady fern	FAC
Carex lyngbyei	CALY	Lyngby sedge	OBL
Carex obnupta	CAOB	slough sedge	OBL
Carex spp.	CAREX	sedges	varies
Deschampsia cespitosa	DECE	tufted hairgrass	FACW
Distichlis spicata	DISP	seashore saltgrass	FAC+
Festuca rubra	FERU	red fescue	FAC+
Glyceria elata	GLEL	tall mannagrass	FACW+
Holcus lanatus	HOLA	velvet grass	FAC
Juncus effusus	JUEF	soft rush	FACW
Juncus spp.	JUNCUS	rushes	varies
Phalaris arundinacea	PHAR	reed canarygrass	FACW
Poa spp.	POA	bluegrasses	varies
Polystichum munitum	POMU	sword fern	FACU
Salicornia virginica	SAVI	pickleweed	OBL
Scirpus spp.	SCIRPUS	bull rushes	varies

[1] Species names in parentheses represent updated taxa

APPENDIX B

Example Inventory Data Form

LUMMI RESERVATION
WETLAND INVENTORY DATA FORM

JD 7/8/99

plex

A

OFFICE DATA

WETLAND NO. 38N1E36-02 TOWNSHIP/RANGE/SECTION 38N1E36

LOCATION DESCRIPTION Along South side of Smokehouse Rd west of Stream "F1"

REVIEWER INITIALS JD DATE OF REVIEW 3/17/99

AERIAL PHOTO NO.: NORMAL COLOR 15-15 COLOR INFRARED 69-42

USGS QUAD NAME Lummi Island WL ON NWI MAP? Y (N)

WL PREVIOUSLY INVENTORIED/DELINEATED BY LUMMI STAFF/CONTRACTOR? Y (N)

DATE OF WORK ______ WETLAND NO. USED PREVIOUSLY ______

WATERSHED F APPROX. SIZE OF WATERSHED 340 acres

APPROX. SIZE OF WL ______

COWARDIN CLASSES PRESENT IN WL PFO

IS WL ASSOCIATED W/ STREAM OR RIVER? Y (N) STREAM NAME ______

SOIL UNITS MAPPED IN WL (circle hydric soils) (Labounty)

FIELD DATA

TEAM INITIALS JD, KT DATE FIELD CHECKED 3-17-99

BASE MAP NO. 38-1-36 (SITE ACCESS) / WINDSHIELD ACCESS / NO VISUAL ACCESS

GPS USED TO FIELD LOCATE WL? YES (NO) GPS FILE NAME ______

WETLAND HYDROLOGY

WATER SOURCES: STREAM / CLVRTED STRMWTR / SHEET FLOW / FLDPLAIN / (SEEP) / (PRECIP)

DESCRIBE WL OUTLET (width, structure, flowing?) No out let

OUTLET CONSTRICTION: (NO OUTLET) / SEVERE / MODERATE / SLIGHT TO NONE

WL IS: PONDED (Depth) 1"-2" / (SATURATED)

WL HAS: WATERMARKS ON VEG. / DRIFT LINES / DRAINAGE PATTERNS / SEDIMENT DEPOSITS

WL HAS: TIDAL / (NONTIDAL) / UNKNOWN HYDROLOGIC REGIME

EVIDENCE FOR TIDAL REGIME ______

WA STATE WETLAND FUNCTION CLASSIFICATION (use key) Depressional closed

OBSERVED ALTERATIONS TO HYDROLOGY & OTHER RELEVANT INFORMATION: Possibly disconnected from adjacent Wetlands because of Lane driveway + Smokehouse Rd.

JD 7/18/99

KH ✓ 5/4/99

WETLAND VEGETATION

COWARDIN CLASS	MAJOR PLANT ASSOCIATIONS	% TOTAL WL AREA BY CLASS
PFO	ALRu/RUSP	70
PFO	AlRu/RuSP/CAOB	25
PFO	AlRu/RUDI	5

(Should total 100%)

DEGREE OF INTERSPERSION OF CLASSES: HIGH / MODERATE / LOW / (NONE)

IF FORESTED, AVERAGE SIZE OF DOM. TREE SPECIES: HEIGHT 50 ft. DBH 6 in.

INVASIVE SPECIES PRESENT IN WL & APPROX. % COVER OF TOTAL WL

RUDI ~15% RARE ~10% Possible loosestrife

OBSERVED DISTURBANCES TO VEGETATION:

N/A

BUFFER DESCRIPTION:

N - Smokehouse Rd
W - V. Lane driveway S and E - Forested

WETLAND SOILS (Observed only if necessary to confirm wetland presence)

SOIL PROFILE:

Mottling

OBSERVED DISTURBANCES TO SOILS:

None

GENERAL WETLAND DESCRIPTION:

Forested complex w/hummocks, low wetland or higher upland; possible loosestrife

MANAGEMENT RECOMMENDATIONS:

FF 7/13/99

APPENDIX C

Condensed Inventory Database

Wetland No.	Complex	Watershed	Wetland Size	Base Map No.	Eval. method	Water Sources	Cowardin Class PFO	PSS	PEM	POW	PAB	EFO	ESS	EEM	EOW	RFO	RSS	REM	ROW/	Dominant Plant Communities	Invasive Species	% Cover
37N1E02-01		D	15.20	37-1-2	Site access	P, STR										70	30			ALRU/POTR/MAFU/OESA, MAFU/OESA	N/O	
37N1E02-02		D	23.19	37-1-2, 38-1-35	Site access	P, SP		100												THPL/ALRU/RUSP/OESA, THPL/MAFU/OESA	RUDI	<10
37N1E02-03	X	C	33.28	37-1-2	Site access	P	10	90												THPL/ALRU/RONU/RUDI/OESA, POTR/RUSP	RUDI	15
37N1E02-04	X	D	27.18	37-1-2	Windshield	P	100													ALRU/RUSP	RUDI	
37N1E02-05		C	13.09	37-1-2	Aerial photo	P, SP	90		10											ALRU/COST, GLEL/OESA/TYLA	RULA, RUDI, RARE	
37N1E02-06		C	17.03	37-1-2	Aerial photo	P, SP			90	10										POTR/ALRU/COST/OESA	RARE, SODU	
37N1E11-01		B	2.15	Portage	Windshield	P, SP			90	10										JUNCUS/AGAL/POPA	None	
37N1E11-02		B	0.64	Portage	Site access	P, SP, T			100											JUNCUS/AGAL/POPA	None	
37N1E12-01		B	83.14	Portage	Aerial photo	P, SP	UK	UK	UK											POTR/ALRU/RUSP, SALIX, CAREX/JUNCUS/TYLA	N/O	
37N1E12-02		B	2.20	Portage	Site access	T								100						DISP/SAVI/ATPA, DISP/JUNCUS, HOBR/POPA	RUCR	5
37N1E12-03		B	21.30	Portage	Site access	P, SP, T								90	10					DISP/SAVI, JUNCUS/POPA, AGAL/JUNCUS	RARE	20
37N1E13-01		A	22.95	Portage	Site access	P, SP, T		16	79	5										SCIRPUS/TYLA, JUNCUS/AGAL/POPA, CAREX, RONU, MAFU/LOIN	None	
38N1E01-01		O	17.60	38-1-1	Site access	P, SH, ST			100											PHAR/RARE	PHAR/RARE	
38N1E01-02		K	110.76	38-1-1, 38-1-12	Site access	P, D		12	88											PHAR, TYLA, POTAMAGETON, SPDO/RONU/MAFU	PHAR	70
38N1E01-03		M	22.96	38-1-1	Site access	P, FP, STR, T								100						SAVI/DISP/ATPA, CALY, HOBR/POPA, TYLA/SCIRPUS/ATPA/SAVI	None	
38N1E01-04		L	10.52	38-1-1	Windshield	P, FP, STR, T						5	5	90						CALY/SCIRPUS/TYLA, PHAR/TYLA/ATPA, SALIX, ALRU	PHAR, RUCR	10
38N1E01-05		L	1.56	38-1-1	Site access	P, SH, STR			100											PHAR/JUNCUS	PHAR	80
38N1E01-06		O	32.55	38-1-1	Windshield	P, SH			100											Crop	None	
38N1E01-07		O	16.29	38-1-1	Aerial photo	P, SH			100											Crop	None	
38N1E01-08		O	61.81	38-1-1	Aerial photo	P, SH			100											Crop	None	
38N1E01-09	X	K	30.85	38-1-1	Site access	P			100											PHAR	PHAR	98
38N1E01-10		K	4.54	38-1-1	Aerial photo	P, SH, STR			100											PHAR/JUNCUS, Crop	PHAR	100
38N1E01-11		K	2.25	38-1-1	Aerial photo	P, FP			100											Pasture	PHAR	
38N1E01-12		K	1.46	38-1-1	Aerial photo	P, SH			100											Pasture	PHAR	
38N1E01-13		L	1.82	38-1-1	Aerial photo	P, SH			100											Crop	None	
38N1E01-14		K	5.56	38-1-1	Aerial photo	P, SH			100											Crop	None	
38N1E01-15		K	11.73	38-1-1	Aerial photo	P, SH			100											Crop	None	
38N1E01-16		K	5.86	38-1-1	Aerial photo	P, SH			100											Crop	None	
38N1E01-17		K	7.88	38-1-1	Aerial photo	P, SH			100											Crop	None	
38N1E01-18		L	1.97	38-1-1	Aerial photo	P, SH			100											Crop	None	
38N1E01-19		O	3.76	38-1-1	Aerial photo	P, SH			100											Crop	None	
38N1E01-20		L	1.65	38-1-1	Aerial photo	P, SH			100											Crop	None	
38N1E02-01		O	13.78	38-1-2	Site access	P, SH			100											Crop	None	
38N1E02-02		O	13.32	38-1-2	Site access	P			100											Pasture	None	
38N1E02-03		O	5.97	38-1-1	Aerial photo	P, SH			100											Crop	None	
38N1E02-04		O	10.89	38-1-1	Aerial photo	P, SH			100											Crop	None	
38N1E02-05		O	29.15	38-1-1, 38-1-2	Aerial photo	P, SH			100											Crop	None	
38N1E02-06		O	1.51	38-1-2	Aerial photo	P, SH	10	90												SALIX, ALRU/RUSP	N/O	
38N1E02-07	X	O	39.40	38-1-2	Aerial photo	P, SP, SH			100											Crop, Pasture	None	
38N1E02-08		P	7.22	38-1-2	Aerial photo	P, SH			100											Crop, Pasture	None	
38N1E02-09		P	2.06	38-1-2	Aerial photo	P, SP, SH	100													ALRU/RUSP	N/O	
38N1E02-10		P	1.22	38-1-2	Aerial photo	P, SP, SH	100													ALRU/RUSP	N/O	
38N1E02-11		P	0.39	38-1-2	Aerial photo	P, SH			100											Pasture	None	
38N1E02-12		P	0.41	38-1-2	Aerial photo	P, SH			100											Pasture	None	
38N1E02-13		O	9.53	38-1-2	Aerial photo	P, SH			100											Crop	None	
38N1E02-14		O	3.16	38-1-2	Aerial photo	P, SH			100											Crop	None	
38N1E02-15		O	3.75	38-1-[illegible]	Aerial photo	P, SH			100											Crop	None	
38N1E02-16		O	3.24	38-1-2	Aerial photo	P, SH			100											Crop	None	
38N1E02-17		O	18.76	38-1-2	Aerial photo	P, SH			100											Crop	None	

Wetland No.	Complex	Watershed	Wetland Size	Base Map No.	Eval. method	Water Sources	Cowardin Class PFO	PSS	PEM	POW	PAB	EFO	ESS	EEM	EOW	RFO	RSS	REM	ROW	Dominant Plant Communities	Invasive Species	% Cover
38N1E02-18		O	0.91	38-1-2	Aerial photo	P, SH			100											Crop	None	
38N1E02-19		O	0.63	38-1-2	Aerial photo	P, SH			100											Crop	None	
38N1E03-01	X	P	77.68	38-1-2	Site access	P, SP, STR	100													POTR/COST/OESA, ALRU/RUSP	None	
38N1E03-02		P	14.37	38-1-2	Site access	P, SP	100													ALRU/Grasses, ALRU/RUSP	RUDI, RARE	35
38N1E03-03		P	4.81	38-1-2	Site access	P, SP	70	30												ALRU/RUSP	RUDI, RARE	<15
38N1E03-04	X	O	87.83	38-1-2	Site access	P, STR	80	20												POTR/ALRU/RUSP, ALRU/RUSP/OESA, ALRU/THPL/MADI, SALIX/SPDO	RUDI, RARE	15
38N1E03-05		Q	6.59	38-1-4	Aerial photo	P, SP, SH	25	75												ALRU/RUSP, Conifer plantation	N/O	
38N1E03-06		P	19.71	38-1-4	Site access	P	100													ALRU/RUSP	RUDI, SODU	
38N1E03-07		Q	3.32	38-1-2	Site access	P	80		20											ALRU/RUSP, OESA/STCO	RUDI	
38N1E03-08		Q	9.94	38-1-4	Aerial photo	P, SP	100													ALRU/RUSP	N/O	
38N1E03-09		Q	0.25	38-1-10	Aerial photo	P, SP	100													Grasses	None	
38N1E03-11		P	1.81	38-1-2	Aerial photo	P, SP, SH	15		85											ALRU, Pasture	None	
38N1E03-12		P	1.45	38-1-2	Aerial photo	P, SH	100													Pasture	None	
38N1E04-01		Q	53.86	38-1-4	Site access	P, SP, STR	UK	UK	UK							UK				ALRU/RUSP, ALRU/COST, SPDO/SALIX, LYAM/CAOB/OESA/RARE	RUDI, RARE	
38N1E04-02		Q	15.62	38-1-4	Site access	P, STR	UK	UK												ALRU/COST/RUSP, ALRU/LYAM, COST/RUSP	N/O	
38N1E04-03		Q	8.55	38-1-4	Site access	P	100													ALRU/CAOB, ALRU/BEPA/RUSP, ALRU/RUSP/MADI	RARE	<5
38N1E04-04		R	26.64	38-1-4	Site access	P	100													ALRU/RUSP, ALRU/CAOB	RULA, RARE	10
38N1E04-05	X	Q	79.88	38-1-4	Site access	P, SP	90	10												ALRU/POTR/RUSP, SALIX	RUDI	<10
38N1E04-06	X	Q	80.86	38-1-4, 38-1-8	Site access	P	100													POTR/RUSP, POTR/ALRU/THPL	N/O	
38N1E04-07		R	10.70	38-1-4	Aerial photo	P, SP, STR	20		80											ALRU/RUSP/SPDO/RONU, TYLA, CAOB/OESA/POPA	RARE, RUDI, PHAR	
38N1E04-08		R	7.49	38-1-4	Aerial photo	P, SP		5	95											CAOB/POPA, SALIX/RONU/SPDO	SODU, PHAR, IRPS	
38N1E04-09		R	26.75	38-1-4	Site access	P, SP	100													ALRU/RUSP	N/O	
38N1E05-01		R	7.90	38-1-4	Aerial photo	P, SP, SH	60	10	30											COST/MAFU/SALU, THPL/TSHE/ALRU/BEPA, TYLA/CAOB/PHAR/LYAM	SODU, RULA, RUDI	
38N1E05-02		R	2.18	38-1-4	Windshield	P, SP, ST		10	80	10										TYLA/SCIRPUS, RONU, SALIX	PHAR	
38N1E08-01		R	5.21	38-1-8	Aerial photo	P, SP				100											N/O	
38N1E08-02		R	5.82	38-1-8B	Aerial photo	P, STR, T			50	10				40						PHAR, DISP	PHAR, SODU	60
38N1E08-03		R	9.42	38-1-8B	Aerial photo	P, STR, T			UK					UK						PHAR, DISP/SAVI	PHAR, SODU	
38N1E08-04		R	3.85	38-1-8B	Aerial photo	P, STR, T			UK					UK						PHAR/SODU, SCIRPUS/SAVI/DISP	PHAR, SODU	
38N1E08-05		R	7.61	38-1-8B	Aerial photo	P, SH, FP, T								100						DISP	N/O	
38N1E09-01		R	23.86	38-1-8B	Aerial photo	FP, SH, T								100						DISP	N/O	
38N1E10-01	X	P	67.61	1-10, 38-1-2, 38-	Site access	P	5		95											PHAR/JUEF, POTR/RUSP/ALRU	PHAR	80
38N1E10-02	X	N	278.08	38-1-10, 38-1-2	Aerial photo	P, STR			100											Crop, Pasture	None	
38N1E10-03		M	25.09	38-1-10	Site access	FP, STR, T								100						SAVI/DISP/ATPA, DECE/GRIN	N/O	
38N1E10-04		N	26.19	38-1-10	Site access	SH, T								100						DISP/SAVI	None	
38N1E10-05		K	1.87	38-1-10	Windshield	P, STR												80	20	JUNCUS/Grasses	N/O	
38N1E11-01		K	14.34	38-1-10	Site access	P, STR												100		JUNCUS/Grasses/ATPA	None	
38N1E11-02	X	K	51.55	38-1-10, 38-1-14	Site access	P, STR			100											PHAR/CIAR, Pasture, POPA/Grasses	PHAR, CIAR	
38N1E11-03		K	1.56	38-1-10	Site access	P, SP		5	60	35										TYLA/PHAR, SALIX/SPDO	SODU, RARE, RUDI	20
38N1E11-04		K	18.46	38-1-10	Site access	P			100											Pasture	None	
38N1E11-05		K	49.76	38-1-10, 38-1-2	Site access	P			100											JUNCUS/PHAR	PHAR	70
38N1E11-06		K	7.67	38-1-12	Windshield	P			100											PHAR/Pasture	PHAR	20
38N1E11-07		K	17.36	38-1-12	Windshield	P, STR			100											PHAR/Pasture	PHAR	20
38N1E11-08		K	6.42	38-1-12	Windshield	P, STR			100											PHAR/Pasture	PHAR	20
38N1E11-09		K	1.72	38-1-12	Windshield	P, STR			100											PHAR/Pasture	PHAR	20
38N1E11-10	X	K	82.07	1-2, 38-1-10, 38	Site access	P, STR			100											POPA/Grasses/PHAR/JUNCUS	PHAR	
38N1E11-11	X	K	19.05	38-1-10	Site access	P, STR			100											JUNCUS/HOLA/AGAL/FERU, PHAR, ALOPECURUS/POPA	CIAR, PHAR	50
38N1E11-12		K	2.35	38-1-10	Windshield	P, STR			40	60										TYLA/PHAR	PHAR	10

Wetland No.	Complex	Watershed	Wetland Size	Base Map No.	Eval. method	Water Sources	Cowardin Class PFO	PSS	PEM	POW	PAB	EFO	ESS	EEM	EOW	RFO	RSS	REM	ROW/	Dominant Plant Communities	Invasive Species	% Cover
38N1E11-13		K	10.68	38-1-10	Windshield	P, STR		100												POTR plantation	None	
38N1E11-14		K	24.16	38-1-10	Windshield	P, STR		100												POTR plantation	None	
38N1E11-15		K	15.97	38-1-12	Aerial photo	P, STR			100											Crop	None	
38N1E11-16		K	8.67	38-1-12	Aerial photo	P, SH			100											Crop	None	
38N1E11-17		K	4.59	38-1-12	Aerial photo	P, SH			100											Crop	None	
38N1E11-18		K	24.36	38-1-12	Aerial photo	P, SH			100											Crop	None	
38N1E11-19		K	15.76	38-1-12, 38-1-14	Aerial photo	P, SP, SH	10		90											Pasture	None	
38N1E11-20	X	K	7.62	38-1-12	Aerial photo	P, SH			100											Crop/Pasture	PHAR	<30
38N1E11-21	X	K	99.69	38-1-12, 38-1-14	Aerial photo	P, SH	100													ALRU/RUSP	N/O	
38N1E12-02		K	2.61	38-1-12	Site access	P, STR		15	85											PHAR/JUNCUS, SALIX/SPDO/COST	PHAR	75
38N1E12-03		K	4.37	38-1-12	Site access	P, STR		30	70											TYLA, SALIX/SPDO	RUDI	10
38N1E12-04		K	7.54	38-1-12	Site access	P, SH			100											Crop	None	
38N1E12-05		K	6.89	38-1-12	Site access	P, SH			100											Pasture	None	
38N1E12-06		K	56.21	38-1-12	Aerial photo	P, STR	20	10	60		10									PHAR/TYLA/JUEF/CAREX, SALU/SASI/CRDO, NULU, POspp., ALRU/POTR/BAPO/SALIX	PHAR, SODU, CIAR, RUDI	
38N1E12-07		K	15.86	38-1-12	Aerial photo	P, STR	95	5												ALRU/RUSP, SPDO/COST	RARE, SODU, PHAR, RUDI	
38N1E12-08		K	0.20	38-1-12	Aerial photo	P	100													ALRU/RUSP	N/O	
38N1E12-09	X	K	97.88	38-1-12	Site access	P, STR	70		30											CAOB/HOLA/JUNCUS, JUNCUS/Pasture, ALRU/COST/MADI, ALRU/RUSP/CAOB	RUDI, RARE	<20
38N1E12-10		K	11.40	38-1-12	Aerial photo	P, SH	100													ALRU/RUSP	N/O	
38N1E12-11		K	1.89	38-1-12	Aerial photo	N/O	10			90										ALRU/RUSP	N/O	
38N1E12-12		K	7.73	38-1-12	Aerial photo	P, SH			100											Pasture	None	
38N1E12-13		K	10.40	38-1-12	Aerial photo	P, SH			100											Pasture	None	
38N1E12-14		K	0.59	38-1-12	Aerial photo	P, SH			100											Pasture	None	
38N1E12-15		K	9.09	38-1-12	Aerial photo	P, SP	100													Conifer plantation	N/O	
38N1E13-01		I	2.10	38-1-13	Site access	P, STR										100				ALRU/RUSP/OESA/CAOB	RUDI	<5
38N1E13-02		I	8.14	38-1-13	Site access	P, SP, STR										70	30			ALRU/RUSP/OESA, RUSP/OESA	N/O	
38N1E13-03	X	I	4.10	38-1-13	Site access	P, SP	85	15												ALRU/RUSP/OESA, RUSP/OESA	N/O	
38N1E13-04		I	5.31	38-1-14	Site access	P	100													ALRU/RUSP/OESA	RUDI	10
38N1E13-05		I	6.68	38-1-13	Site access	P, STR										100				ALRU/THPL/OESA, ALRU/OESA	N/O	
38N1E13-06		I	45.06	38-1-13	Site access	P, SP, SH	75	25												ALRU/THPL/OESA/CAOB, THPL/RUSP, COST/OESA/CAOB, SPDO/OESA/CAOB	N/O	
38N1E13-07		I	10.07	38-1-13	Windshield	P, SP	100													SALIX/COST	N/O	
38N1E13-08	X	I	10.83	38-1-13	Site access	P, SP	100													ALRU/RUSP	N/O	
38N1E13-09	X	I	26.96	38-1-13	Site access	P, SP	100													ALRU/RUSP/OESA/LYAM	RUDI	<5
38N1E13-10		K	15.69	38-1-13	Site access	P, SP, STR	100													ALRU/THPL/RUSP	RUDI	<10
38N1E13-11		I	4.42	38-1-13	Aerial photo	P, SP, SH	100													ALRU/RUSP	N/O	
38N1E13-12		K	0.39	38-1-13	Site access	P				100											None	
38N1E13-13	X	K	41.43	38-1-13	Aerial photo	P	UK	UK	UK											ALRU/RUSP	N/O	
38N1E13-14		I	11.16	38-1-13	Aerial photo	P, SP, SH	100													ALRU/RUSP	N/O	
38N1E14-01		I	2.74	38-1-14	Site access	P	100													ALRU/RUSP/OESA	RUDI	<5
38N1E14-02		I	2.89	38-1-14	Site access	P	100													ALRU/RUSP/OESA	N/O	
38N1E14-03		I	0.47	38-1-14	Aerial photo	P, SP, SH	20			80										ALRU/RUSP	N/O	
38N1E14-04		K	55.73	38-1-14	Aerial photo	P			100											Crop	None	
38N1E14-05		K	48.44	38-1-14	Site access	T								100						DISP/SAVI/LYMO/ATPA	N/O	
38N1E14-06	X	K	9.42	38-1-14	Aerial photo	P, SH	100													ALRU/RUSP, Conifer plantation	N/O	
38N1E15-01		M	0.89	38-1-10	Site access	FP, SH, STR, T								100						SAVI/DISP	None	
38N1E23-03	X	I	249.63	38-1-24	Site access	P, SP	70	30												ALRU/RUSP/OESA/CAOB	N/O	
38N1E23-04		I	19.45	38-1-24	Site access	P, SP	100													ALRU/RUSP/OESA	RUDI, RARE	<6
38N1E23-05	X	I	28.18	38-1-24	Site access	P, SP	100													ALRU/RUSP/OESA/CAOB	RUDI	<10
38N1E23-06		I	0.78	38-1 [illegible]	Aerial photo	P, SH	UK		UK											ALRU/RUSP	N/O	
38N1E24-01	X	I	107.80	38-1-24, 38-2-19	Aerial photo	P, SP, SH	100													Conifer plantation, ALRU/RUSP	N/O	
38N1E24-02	X	G	101.57	38-2-19	Site access	P	100													ALRU/RUSP	RUDI	<5

Wetland No.	Complex	Watershed	Wetland Size	Base Map No.	Eval. method	Water Sources	Cowardin Class PFO	PSS	PEM	POW	PAB	EFO	ESS	EEM	EOW	RFO	RSS	REM	ROW	Dominant Plant Communities	Invasive Species	% Cover
38N1E25-01	X	G	46.37	38-1-25	Site access	P, SP, SH	30	60	10											ALRU/RUSP/CAOB/OESA, CAOB/OESA, OESA/ATFI, RUSP/OESA	RARE, RUDI	5
38N1E25-02		G	9.34	38-1-25	Site access	P, SH	100													ALRU/RUSP	RUDI	
38N1E25-03		F	26.41	38-1-25	Site access	P, SP		100												ALRU/THPL/MYGA/RUSP/CAOB/OESA	RUDI, RARE	25
38N1E25-04		G	30.34	38-1-25, 38-1-24	Site access	P, SP	85	15												ALRU/RUSP, THPL/ALRU, COST/RARE/CAOB	RARE, RUDI	<10
38N1E25-05	X	G	35.91	38-1-25	Site access	P, STR	100													ALRU/RUSP, ALRU/RUSP/CAOB, ALRU/RUSP/OESA	RUDI, RARE	<15
38N1E25-06	X	G	10.97	38-1-25	Site access	P, STR	100													ALRU/RUSP, ALRU/RUSP/CAOB	RUDI, RARE	<10
38N1E25-07		G	2.30	38-1-25	Aerial photo	P, SP, STR	100													ALRU/RUSP/LYAM/OESA	N/O	
38N1E25-08	X	G	36.76	38-1-25	Aerial photo	P, SH	UK		UK												N/O	
38N1E25-10		G	1.86	38-1-25	Site access	P		50	50											OESA, RUSP/TOME	None	
38N1E25-11		G	2.63	38-1-25	Site access	P, STR											100			ALRU/RUSP	RUDI	<5
38N1E26-01		G	4.19	38-1-26	Site access	P, SP, SH										10	40	35	15	SCIRPUS/CAOB/OESA, ALRU/RUSP, RUSP/CAOB	RUDI	10
38N1E26-02		G	2.98	38-1-26	Site access	P, SP	100													POTR/BEPA/ALRU/RUSP	RUDI	>10
38N1E26-03		F	18.00	38-1-26	Site access	P, SP	70	5	25											ALRU/RUSP/OESA, OESA/CAOB, Pasture, SPDO	RUDI, RARE	10
38N1E26-04	X	D	50.49	38-1-26	Site access	P, SP	100													ALRU/THPL/RUSP	RARE, RUDI	<10
38N1E26-05	X	H	10.96	38-1-26	Aerial photo	P, SH, SP, STR	100													ALRU/RUSP	N/O	
38N1E26-06	X	H	17.76	38-1-26, 38-1-24	Aerial photo	P, SH, STR	100													ALRU/RUSP	N/O	
38N1E34-01	X	C	9.91	38-1-35	Site access	P	100													ALRU/THPL/RUSP	RARE	10
38N1E35-01	X	D	12.82	38-1-35	Site access	P, SP	100													SALIX/BEPA/SPDO/CAOB/OESA	RUDI	>10
38N1E35-02	X	D	10.54	38-1-35	Site access	P, SP	100													ALRU/RUSP	N/O	
38N1E35-03		D	2.58	38-1-35	Aerial photo	P, SH	100													ALRU/RUSP	N/O	
38N1E35-04	X	E	65.14	38-1-35	Aerial photo	P, SP, SH	UK	UK												ALRU/RUSP	N/O	
38N1E35-05		C	4.87	38-1-35	Aerial photo	P, SP, SH	20	80													N/O	
38N1E35-06		D	16.09	38-1-35	Aerial photo	P, SH, STR	100													ALRU/RUSP	N/O	
38N1E35-07		D	3.87	38-1-35	Aerial photo	P, SP, SH	100													ALRU/RUSP	N/O	
38N1E36-01		F	1.14	38-1-36	Site access	P, ST, SP, SH	25	75												ALRU/POTR/RUSP, RUSP/RARE/OESA, MAFU	RARE, RUDI, PHAR	98
38N1E36-02	X	F	11.09	38-1-36	Site access	P, SP	100													ALRU/RUSP, ALRU/RUSP/CAOB, ALRU/RUDI	RUDI, RARE	25
38N1E36-03		F	1.88	38-1-36	Site access	P	100													ALRU/RUSP	RUDI, RARE	<20
38N1E36-04		F	1.42	38-1-36	Site access	P	100													ALRU/RUSP	RARE	40
38N1E36-05		F	0.16	38-1-36	Site access	P	20			80										ALRU/RUSP	RARE	<10
38N1E36-06	X	E	29.57	38-1-36	Aerial photo	P, SP, SH	100													ALRU/RUSP	N/O	
38N2E06-01		L	3.23	38-1-1	Aerial photo	P, SH			100											Crop	None	
38N2E06-02		L	4.43	38-1-1	Aerial photo	P, SH			100											Crop	None	
38N2E06-03		K	45.89	38-1-1, 38-2-7	Aerial photo	P, SH			100											Crop	None	
38N2E06-04		K	4.11	38-1-1	Aerial photo	P, SH			100											Crop	None	
38N2E06-05		K	8.33	38-1-1	Aerial photo	P, SH			100											Crop	None	
38N2E06-06		K	1.78	38-1-1	Aerial photo	P, SH			100											Crop	None	
38N2E06-07		K	2.49	38-1-1	Aerial photo	P, SH			100											Crop	None	
38N2E06-08		K	2.27	38-1-1	Aerial photo	P, SH			100											Crop	None	
38N2E06-09		K	5.33	38-1-1	Aerial photo	P, SH			100											Crop	None	
38N2E06-10		K	6.79	38-1-1	Aerial photo	P, SH			100											Crop	None	
38N2E06-11		K	46.81	38-2-7	Aerial photo	P, SH		100												POTR plantation	None	
38N2E06-12		K	17.05	38-2-7	Aerial photo	P, SH			10											Crop	None	
38N2E06-13		K	15.95	38-2-7	Aerial photo	P, SH		100												POTR plantation	None	
38N2E06-14		K	3.82	38-2-7	Aerial photo	P, SH										100				ALRU/POTR	N/O	
38N2E06-15		K	12.98	38-2-7	Aerial photo	P, SH		100												POTR plantation	None	
38N2E06-16		K	2.20	38-2-7	Aerial photo	P, SH		100												POTR plantation	None	
38N2E06-17		K	4.65	38-2-7	Aerial photo	P, SH			100											Crop	None	
38N2E06-18		K	2.27	38-2-7	Aerial photo	P, SH			100											Crop	None	
38N2E06-19		K	9.81	38-2-7	Aerial photo	P, SH			100											Crop	None	

Wetland No.	Complex	Watershed	Wetland Size	Base Map No.	Eval. method	Water Sources	Cowardin Class PFO	PSS	PEM	POW	PAB	EFO	ESS	EEM	EOW	RFO	RSS	REM	ROW	Dominant Plant Communities	Invasive Species	% Cover
38N2E07-01		K	89.52	38-2-7	Site access	P, FP, STR	5	10	85											SALIX/SPDO, PHAR, PHAR/JUNCUS, SCIRPUS/TYLA, OESA/ALRU/PHAR, ALRU/POTR	PHAR, RARE	50
38N2E07-02	X	K	22.58	38-2-7, 38-1-12	Aerial photo	P, SP	UK	UK													N/O	
38N2E07-03		K	118.45	38-2-7	Windshield	P, SP, SH	10	8	80		2									TYLA/SCIRPUS, ALRU/COST/RUSP, SALIX, NUPO	N/O	
38N2E07-04	X	K	43.43	38-2-17C	Windshield	P, SP, STR	UK	UK	UK		UK									TYLA/SCIRPUS, NUPO, SALIX, ALRU	PHAR	
38N2E07-05	X	K	100.73	38-2-7	Windshield	P, SH	UK	UK	UK											SCIRPUS, JUNCUS/Grasses, PHAR, ALRU/SALIX, SALIX/SPDO, POTR Plantation	PHAR	
38N2E17-01		S	469.05	38-2-17B	Aerial photo	P, FP, SH, T										UK	UK	UK			N/O	
38N2E17-02		S	91.45	38-2-17B	Aerial photo	P, FP, SH, T										UK	UK	UK			N/O	
38N2E18-01		K	5.16	38-1-13	Site access	P, SP	100													ALRU/CAREX/OESA/THPL	None	
38N2E18-03		J	16.38	38-1-13	Aerial photo	P, SP, STR	100													Conifer plantation	N/O	
38N2E18-04		S	287.89	38-2-17b	Aerial photo	P, FP, SH, STR, T										UK	UK	UK	UK	ALRU	N/O	
38N2E18-05		K	38.57	38-2-17C	Aerial photo	P, FP, FP, STR	UK	UK	UK												N/O	
38N2E18-06	X	K	79.12	38-2-17D	Aerial photo	P, FP, SP, STR,	UK	UK	UK	UK											N/O	
38N2E18-07		K	4.96	38-2-7	Aerial photo	P, SP, SH	UK	UK	UK											ALRU/RUSP, RUSP/COST, RARE/OESA/CAOB	RARE	
38N2E19-01		K	20.24	38-2-19	Site access	P, SP, STR	100													ALRU/RUSP, ALRU/RUSP/OESA	RUDI	<10
38N2E19-02		K	3.99	38-2-19	Windshield	P, SP, SH	30	70												ALRU/SALIX, SALIX/COST	PHAR	<10
38N2E19-03		K	3.18	38-2-19	Windshield	P, SP, SH	70	30												ALRU/SALIX, SALIX	PHAR	10
38N2E19-04		K	4.66	38-2-19	Aerial photo	P, SH	UK		UK												N/O	
38N2E19-05		K	18.31	38-2-19	Aerial photo	P, SH	20	80												SALIX/COST, ALRU/RUSP	N/O	
38N2E19-06		S	16.33	38-2-17	Aerial photo	P, FP, SH, STR, T										UK	UK	UK			N/O	

Key to Water Source: P - precipitation, SH - sheetflow, STR - stream, SP - seep, T - tidal flooding, ST - stormwater, FP - flood plain, D - ditch

APPENDIX D

Function Assessment Model Details

Appendix D
Function Assessment Model Details

The following tables summarize the indicators or measures that considered for each function. The function indexes are based directly on these measures. The tables summarize the model inputs for riverine flow-through, depressional closed, and depressional outflow wetlands. Though similar in the factors that are measured, there are important differences among the models.

Table D-1. Riverine Flow-through Model - Indicators or Measures

Function	Indicators or Measures
Water Quality Functions	
Potential for Removing Sediment	• ratio of width of AU to width of stream • weighted scaling of forest, shrub, and emergent cover • % cover of herbaceous understory Reducers: • AU constained by dikes
Potential for Removing Nutrients	• index for sediment removal
Potential for Removing Heavy Metals and Toxic Organics	• index for sediment removal • pH of interstitial water • % cover of emergent vegetation
Water Quantity Functions	
Potential for Reducing Peak Flows	• ratio of width of AU to width of stream • ratio of area of inundation to contributing basin
Potential for Reducing Downstream Erosion	• elevation difference between bottom of outlet and flood marks • coverage of forest and shrubs • index for reducing peak flows • channel or stream contained within dikes
Potential for Recharging Groundwater	• rating permeability of soils • ratio of width of AU and stream
Habitat Suitability Functions	
General Habitat Suitability	• condition of buffer around AU in terms of plant structure and level of disturbance • % canopy closure over AU • maximum number of strata in any one plant association • categories of snags present • interspersion between vegetation classes • categories of large woody debris present • number of water regimes present in AU • number of plant species present in AU • presence/absence of mature trees • characteristics of AU edge Reducer: • land uses within 1 km. of AU

Table D-1. Riverine Flow-through Model - Indicators or Measures

Function	Indicators or Measures
Habitat Suitability for Invertebrates	• presence of channels or streams in AU with permanently flowing water • types of surface substrates present • characteristics of open water interspersion with vegetated areas • categories of large woody debris present • maximum number of strata in any one plant association • interspersion between vegetation classes • number of plant associations in AU
Habitat Suitability for Amphibians	• condition of buffer around AU in terms of plant structure and level of disturbance • types of surface substrates present • presence of permanently flowing stream • presence of micro-depressions in stream bed • categories of large woody debris present Reducers: • pH of surface water • types of land uses within 1 km of AU
Habitat Suitability for Anadromous Fish	• characteristics of open water interspersion with vegetated areas • number and type of refuge present in water • % of stream with canopy closure >75% • gravel or cobbles present in stream
Habitat Suitability for Resident Fish	• presence of permanently flowing channel • number and type of refuge present in water • % of stream with canopy closure >75% • gravel or cobble present in stream • composition of substrate or surface layer • index for invertebrate habitat suitability
Habitat Suitability for Aquatic Birds	• condition of buffer around AU in terms of plant structure and level of disturbance • categories of snags present • interspersion between vegetation classes • presence of special habitat features (e.g. adjacent agricultural land use, islands, etc.) • % of AU that has a permanent stream • index for invertebrate habitat suitability • index for amphibian habitat suitability • index for anadromous or resident fish habitat suitability (the higher of the two) Reducers: • % canopy closure over AU • AU is above 300 meters in elevation
Habitat Suitability for Aquatic Mammals	• condition of buffer around AU in terms of plant structure and level of disturbance • the number of water depth classes present in AU • condition of corridors to and from AU • area of woody vegetation for beaver • has minimum of .25 hectare of emergent vegetation • presence of steep banks comprised of fine material for denning • AU has channel with permanent flowing water • index for anadromous or resident fish habitat suitability (the higher of the two) Reducers: • types of land uses present within 1 km of AU
Habitat for Native Plant Communities	• number of strata present in any plant association • number of plant associations • presence/absence of mature trees • number of native plant specie Reducers: • % of AU covered by non-native plant species
Primary Production and Export	• % of AU with vegetation cover • % cover of all non-evergreen vegetation • % cover of herbaceous understory

Table D-2. Depressional Closed Model - Indicators or Measures

Function	Indicators or Measures
	Water Quality Functions
Potential for Removing Sediment	qualitatively assessed based on opportunity to remove sediment (level of potential for sediment to enter wetland) - depressional closed wetlands have the potential to remove sediment at the highest levels because they have no outlet
Potential for Removing Nutrients	• amount of clay in soil • amount of organics in soil • total area of vegetation in AU
Potential for Removing Heavy Metals and Toxic Organics	• amount of clay in soil • amount of organics in soil • pH of interstitial water • % cover of emergent vegetation • % of AU that is seasonally inundated
	Water Quantity Functions
Potential for Reducing Peak Flows	qualitatively rated based on opportunity - related to extent of upgradient watershed development
Potential for Reducing Downstream Erosion	qualitatively rated based on opportunity - related to extent of upgradient watershed development
Potential for Recharging Groundwater	• rating permeability of soils • area of seasonal inundation minus permanent open water
	Habitat Suitability Functions
General Habitat Suitability	• condition of buffer around AU in terms of plant structure and level of disturbance • % canopy closure over AU • maximum number of strata in any one plant association • categories of snags present • interspersion between vegetation classes • categories of large woody debris present • number of water regimes present in AU • number of water depth categories in AU • characteristics of open water interspersion with vegetated areas • number of plant species present in AU • presence/absence of mature trees • characteristics of AU edge
Habitat Suitability for Invertebrates	• types of surface substrates present • characteristics of open water interspersion with vegetated areas • categories of large woody debris present • maximum number of strata in any one plant association • interspersion between vegetation classes • number of plant associations in AU • number of water regimes present in AU • categories of different aquatic bed structures Reducers[2]: • qualitative estimate of presence/absence of tannins
Habitat Suitability for Amphibians	• condition of buffer around AU in terms of plant structure and level of disturbance • types of surface substrates present • characteristics of open water interspersion with vegetated areas • categories of large woody debris present • % of AU with permanent water, or permanent water under forest or scrub-shrub areas • physical structures present under the water surface for egg laying Reducers: • pH of surface water • types of land uses within 1 km of AU

Table D-2. Depressional Closed Model - Indicators or Measures

Function	Indicators or Measures
Habitat Suitability for Anadromous Fish	N/A
Habitat Suitability for Resident Fish	N/A
Habitat Suitability for Aquatic Birds	• condition of buffer around AU in terms of plant structure and level of disturbance • categories of snags present • interspersion between vegetation classes • characteristics of AU edge • presence of special habitat features (e.g. adjacent agricultural land use, islands, etc.) • % permanent open water • index for invertebrate habitat suitability • index for amphibian habitat suitability Reducers: • % canopy closure over AU • AU is above 300 meters in elevation
Habitat Suitability for Aquatic Mammals	• condition of buffer around AU in terms of plant structure and level of disturbance • the water depth classes present in AU • condition of corridors to and from AU • area of woody vegetation for beaver • has minimum of .25 hectare of emergent vegetation • characteristics of open water interspersion with vegetated areas, if AU is at least .25 hectare • % of AU in permanent open water and aquatic bed • presence of steep banks comprised of fine material for denning Reducers: • types of land uses present within 1 km of AU
Habitat for Native Plant Communities	• number of strata present in any plant association • number of plant associations • presence/absence of mature trees • number of native plant species • % of AU covered by sphagnum bog Reducers: • % of AU covered by non-native plant species
Primary Production and Export	N/A

Table D-3. Depressional Outflow Model - Indicators or Measures

Function	Indicators or Measures
	Water Quality Functions
Potential for Removing Sediment	• corrected depth of permanent open water and seasonal inundation • qualitative descriptors of outlet constriction, water marks, moss lines, evidence of deposition • % of wetland that is seasonally inundated • weighted scaling of forest, shrub, and emergent cover • % cover of herbaceous understory
Potential for Removing Nutrients	• index for sediment removal • amount of clay in soil • amount of organics in soil • evidence (e.g. high water marks) indicating aerial extent of AU that undergoes changes between oxic and anoxic conditions • qualitative description of outlet characteristics
Potential for Removing Heavy Metals and Toxic Organics	• index for sediment removal • amount of clay in soil • amount of organics in soil • pH of interstitial water • % cover of emergent vegetation • % of AU that is seasonally inundated
	Water Quantity Functions
Potential for Reducing Peak Flows	• elevation difference between bottom of outlet and flood marks • qualitative descriptors of outlet constriction • ratio of area of inundation to contributing basin
Potential for Reducing Downstream Erosion	• elevation difference between bottom of outlet and flood marks • qualitative descriptors of outlet constriction • coverage of forest and shrubs • ratio of area of inundation to contributing basin
Potential for Recharging Groundwater	• rating permeability of soils • area of seasonal inundation minus permanent open water
	Habitat Suitability Functions
General Habitat Suitability	• condition of buffer around AU in terms of plant structure and level of disturbance • % canopy closure over AU • maximum number of strata in any one plant association • categories of snags present • interspersion between vegetation classes • categories of large woody debris present • number of water regimes present in AU • number of water depth categories in AU • characteristics of open water interspersion with vegetated areas • number of plant species present in AU • presence/absence of mature trees • characteristics of AU edge

Table D-3. Depressional Outflow Model - Indicators or Measures

Function	Indicators or Measures
Habitat Suitability for Invertebrates	• presence of channels or streams in AU with permanently flowing water • types of surface substrates present • characteristics of open water interspersion with vegetated areas • categories of large woody debris present • maximum number of strata in any one plant association • interspersion between vegetation classes • number of plant associations in AU • number of water regimes present in AU • categories of different aquatic bed structures Reducers[2]: • qualitative estimate of presence/absence of tannins
Habitat Suitability for Amphibians	• condition of buffer around AU in terms of plant structure and level of disturbance • types of surface substrates present • characteristics of open water interspersion with vegetated areas • categories of large woody debris present • % of AU with permanent water, or permanent water under forest or scrub-shrub areas • physical structures present under the water surface for egg laying Reducers: • pH of surface water • types of land uses within 1 km of AU
Habitat Suitability for Anadromous Fish	• characteristics of open water interspersion with vegetated areas • the water depth classes present in AU • number and type of refuge present in water • % of AU in permanent open water • index for invertebrate habitat suitability Reducers: • percent are of AU covered by sphagnum bog
Habitat Suitability for Resident Fish	• characteristics of open water interspersion with vegetated areas • the water depth classes present in AU • number and type of refuge present in water • % of AU in permanent open water • presence/absence of permanently flowing water in channel • composition of substrate or surface layer • index for invertebrate habitat suitability
Habitat Suitability for Aquatic Birds	• condition of buffer around AU in terms of plant structure and level of disturbance • categories of snags present • interspersion between vegetation classes • characteristics of AU edge • presence of special habitat features (e.g. adjacent agricultural land use, islands, etc.) • % permanent open water • index for invertebrate habitat suitability • index for amphibian habitat suitability • index for anadromous or resident fish habitat suitability (the higher of the two) Reducers: • % canopy closure over AU • AU is above 300 meters in elevation

Table D-3. Depressional Outflow Model - Indicators or Measures

Function	Indicators or Measures
Habitat Suitability for Aquatic Mammals	• condition of buffer around AU in terms of plant structure and level of disturbance • the water depth classes present in AU • condition of corridors to and from AU • area of woody vegetation for beaver • has minimum of .25 hectare of emergent vegetation • characteristics of open water interspersion with vegetated areas, if AU is at least .25 hectare • % of AU in permanent open water and aquatic bed • presence of steep banks comprised of fine material for denning • AU has channel with permanent flowing water • index for anadromous or resident fish habitat suitability (the higher of the two) Reducers: • types of land uses present within 1 km of AU
Habitat for Native Plant Communities	• number of strata present in any plant association • number of plant associations • presence/absence of mature trees • number of native plant species • % of AU covered by sphagnum bog Reducers: • % of AU covered by non-native plant species
Primary Production and Export	• % of AU with vegetation cover • % cover of all non-evergreen vegetation • % cover of herbaceous understory • extent of organic soils in AU • % of wetland that is seasonally inundated Reducers: • % area of AU covered by sphagnum bog

APPENDIX E

Example Data Form for Function Assessment

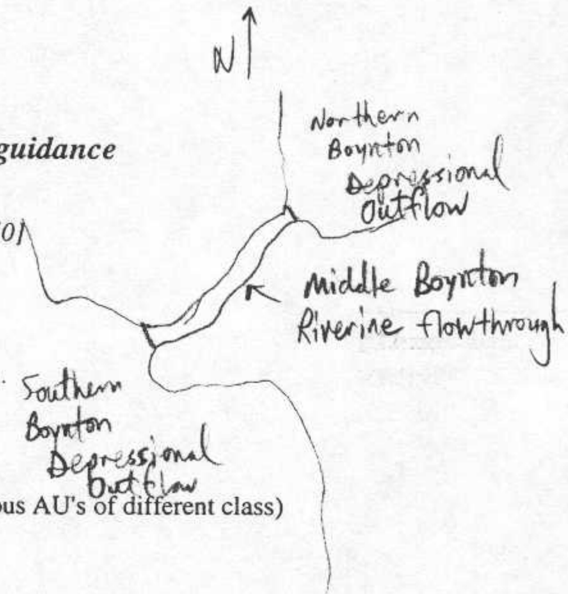
38N1E23-03

4/28/99

WETLAND NAME Middle Boynton 5/3/99 **ID # AU-** B

Data collected by: KH, MS, GD

Riverine Flow-through - Lowlands of Western Washington



Data Sheet is to be used in conjunction with written guidance

AU = Assessment Unit: the area of wetland being assessed

Record only numbers, yes/no answers are recorded as a [1] or [0]

Estimate/ Score/ Rating

LANDSCAPE DATA

0.14 ha D1 Area of AU ~50' x 300' = 15,000 ft² or 0.34 ac.

156 ha D2 Area of contributing basin (upgradient watershed) CA = 1,560,894 m²

D3 Land use (as % of total area) within 1km of AU (include contiguous AU's of different class)

58 % D3.1 Undeveloped Forest

0 % D3.2 Agriculture (field and pasture)

5 % D3.3 Clear cut logging (<5yrs since clearing)

0 % D3.4 Urban/commercial

2 % D3.5 High density residential (> 1residence/acre)

0 % D3.6 Low density residential (<= 1 residence/acre)

35 % D3.7 Undeveloped areas, shrubland, other wetlands, and open water (SL water)

WATER REGIME

1 0/1 D4 Channels or streams in AU with identifiable banks

0 0/1 D4.1 Channels or streams in AU have permanently flowing water *(you see water flowing)*

0 0/1 D4.2 Channel or stream is contained by dikes

~~40~~ 12 m D5 Average width of stream in or adjacent to AU (bank to bank)

~~50~~ 15 m D6 Average width of AU perpedicular to stream or river

1:1 ratio D7 Ratio of length of channel to length of AU

use channel with greatest water volume, or if dry, largest cross section

D8 Inundation

D8.1

D8.2

D8.3

0 % D8.4 Percent of AU with unvegetated bars or mudflats

0 0/1 D8.5 Unvegetated bars or mudflats at least 100 square meters in size

D9 Inundation regimes with area >0.1 ha (1/4 acre) or > 10% of AU if AU smaller than 1ha (2.5 acres)

D9.1

D9.2

Chose all that apply

1 0/1 D9.3 Occasionally Flooded (<= 1 month)

0 0/1 D9.4 Saturated but seldom inundated

0 0/1 D9.5 Pernanently flowing stream *(if meets size criteria)*

1 0/1 D9.6 Intermittently flowing stream *(if meets size criteria)*

D10

WETLAND NAME________________________________ **Riverine Flow-through** **ID # AU-**

D11 ________________________
D11.1
D11.2
D11.3

D12 Categories of water depths present in stream of AU (**score only if D4 = 1**)

record a 1 for each category present if >0.1 hec (1/4 acre) or 10% of stream in AU

1	0/1	D12.1	0-20cm (<8in)
1	0/1	D12.2	20-100cm(8-40in)
0	0/1	D12.3	>100cm (>40in)

D13
D13.1
D13.2
D13.3
D13.4

VEGETATION

D14 Cowardin Classes (as % area of AU)

Include forest only if trees are rooted in AU. If forest is a mix of deciduous and evergreen estimate the relative % cover of each and divide percentage between the two categories. If vegetation classes are patchy, add the patches together for each class to get a total. To count, a class must cover at least 0.1 hectares or be more than 10% of the total area of the AU

0	%	D14.1	Forest - evergreen
100	%	D14.2	Forest -deciduous
0	%	D14.3	Scrub-shrub - evergreen
0	%	D14.4	Scrub Shrub - deciduous
0	%	D14.5	Emergent
0	%	D14.6	Aquatic Bed

1 0/1 D15 Does D8.3 + D8.4+ sum (D14.1 to D14.6) = 100 ? **If not, give reason.**

60 % D16 % area of herbaceous understory **in forest and shrub areas** (not % area in entire AU)

80 % D17 % area of AU with >75% closure of canopy *(SS,FO classes > 1m high)*

D18 % length of stream with a 75% canopy closure

ALRU ATFI RONU
RUSP LYAM Angelica?
OESA CAOB RARE*
RONA* SPDO
COSE URDI
MADI

D19 Plant Richness

12 # D19.1 record number of native plant species found in AU

2 # D19.2 record number of non- native plant species found in AU

2 # D20 Number of plant assemblages in the AU with area > 0.1hec (1/4 acre) or >10% if AU <1hect. If more than 12 record a 12. (Record a name for each assemblage below)

ALRU/RUSP/COSE/OESA
ALRU/CAOB

3 [1-6] D21 The maximum number of strata present in any plant assemblage

A stratum has to have 20% cover in assemblage to count

0 0/1 D21.1 Is "vine" stratum dominated by non-native Blackberries yes=1, no=0

VETLAND NAME____________________________________**Riverine Flow-through** **ID # AU-**

1 0/1 D22 Mature trees present in AU

Average DBH of 3 out of 5 largest trees has to exceed size criteria

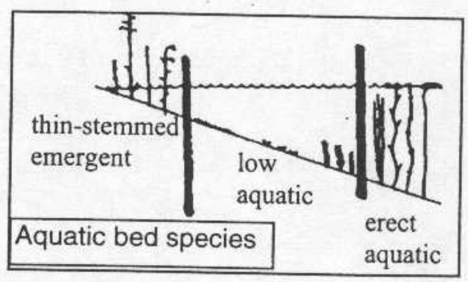
Tsuga heterophylla (western hemlock) > 45 cm (18")
Thuja plicata (western red cedar) > 45 cm (18")
Pseudotsuga menziesii (douglas fir) > 45 cm (18")
Picea sitchensis (sitka spruce) > 45 cm (18")
Populus balsamifera (black cottonwood) > 45 cm (18")
Acer macrophyllum (big-leaf maple) > 45 cm (18")
Alnus rubra (red alder) >30cm (12")
Fraxinus latifolia (Oregon ash) >30cm (12")
Pinus contorta (lodgepole pine) >30cm (12")
Salix lucida (Pacific willow) >30cm (12")

D23
D23.1
D23.2
D23.3
D23.4
D23.5

D24 Dominance by non-native plant species
0 0/1 D24.1 % area of non-native species >75%
0 0/1 D24.2 % area of non-native species 50-75%
0 0/1 D24.3 %area of non-native species 25-49%
1 0/1 D24.4 % area of non-native species 1-24%
0 0/1 D24.5 NO cover of non-natives in the AU

HABITAT CHARACTERISTICS

0 [0-3] D25 Number of structure categories in aquatic bed vegetation
Applies only to aquatic bed species DO NOT count emergents

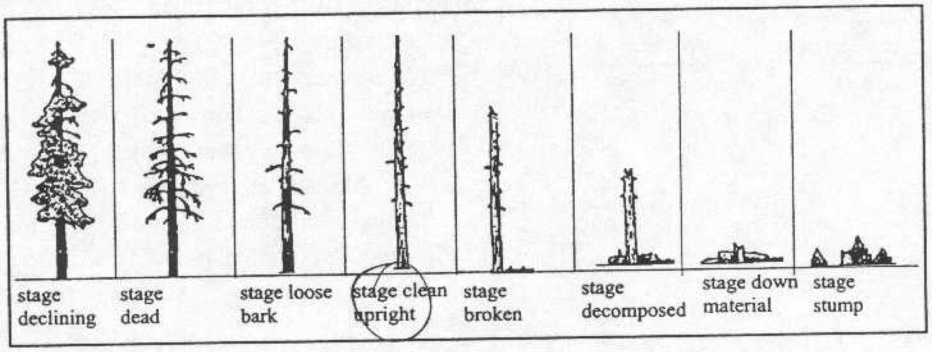


D26 pH
4.7 [4-9] D26.1 pH of interstitial water *(measure immediately after digging hole in non inundated areas)*
5.0 [4-9] D26.2 pH of open or standing water *(record the lowest pH, if you cannot measure record a [7])*

1 0/1 D27 AU is within 8 km (5mi) of a brackish or salt water estuary
0 0/1 D28 AU is within 1.6km (1 mi) of a lake > 8 hectares (20 acres)
1 0/1 D29 AU is within 5km (3 mi) of an open field (ag or pasture) > 16 hectares (40 acres)
0 0/1 D30 AU has more than 1 hectare (2.5 ac) of preferred woody vegetation for beaver in and within 100m of AU

WETLAND NAME________________________________ **Riverine Flow-through** **ID # AU-**

1 [0-8] D31 snags (record # of stages present,)
circle the categories present; min DBH of snag=10 cm,(4")



0 0/1 D31.1 At least one of the snags above has a DBH greater than 30cm (12").

0 0/1 D32 Overhanging vegetation (1 m wide) for at least 10m (33ft) over stream or open water.
0 0/1 D33 AU has upland islands of at least 10 square meters (100 square ft.) within its boundaries
islands need to be surrounded by at least 30m (100 ft) of open water deeper than 1m (3ft)
0 0/1 D34 Undercut banks present for at least 2m (6.6ft).

D35

0 0/1 D36 Tannins present in surface waters >10% of water surface
0 0/1 D37 Steep banks suitable for denning (>30deg. slope, fine material, >10m long, >0.6m high) *may be a dike*

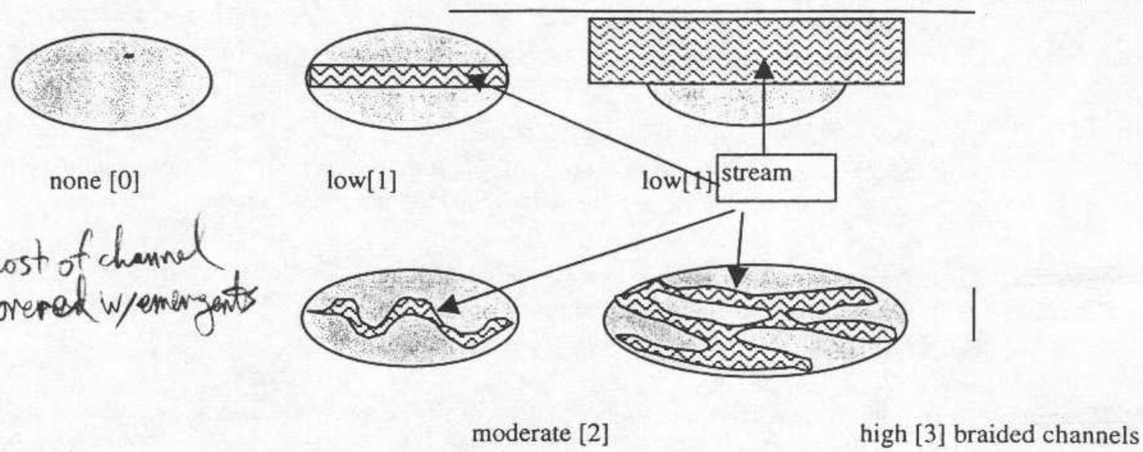
4/28/99

'ETLAND NAME______________________________**Riverine Flow-through** **ID # AU-**

1 [0-3] D38 Interspersion between erect vegetation and streams of AU

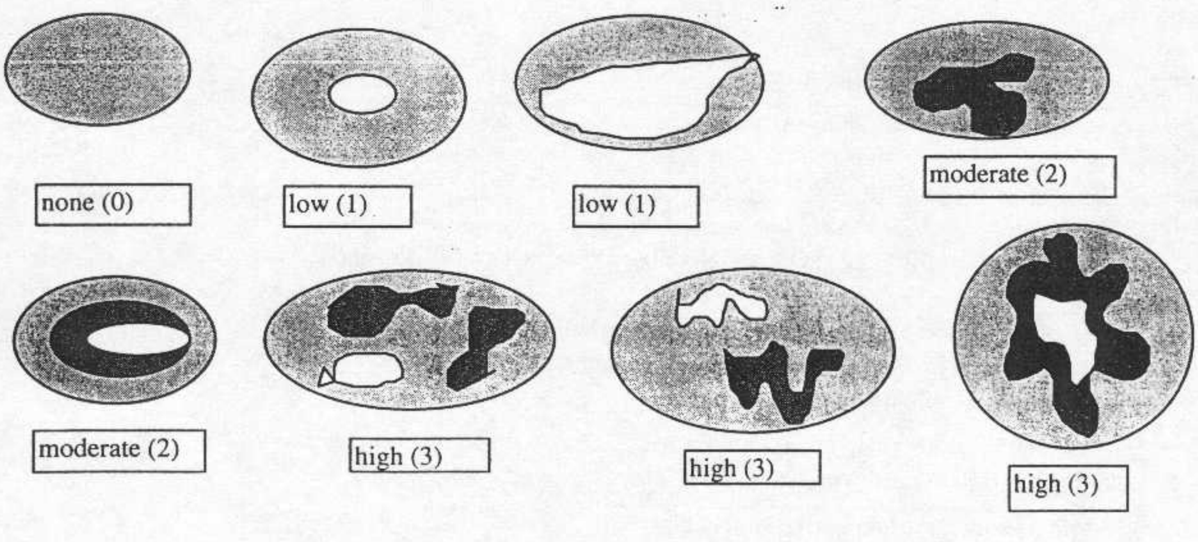
Choose the diagram that best fits field conditions

Most of channel covered w/emergents



0 [0-3] D39 Interspersion between Cowardin vegetation classes

**AU's with only 2 classes can only score a moderate[2] or lower*
**AU's with 4 vegetation classes score a high [3]*
** AU's with 3 classes can score a moderate (2) or a high (3)*



0 0/1 D40 Structures in AU that create flow eddies (bars, large logs, large rocks (in channels or flood path)

WETLAND NAME______________________________**Riverine Flow-through** **ID # AU-**

0 [0-3] D41 EDGE of AU: The characteristics of the edge between AU and uplands or adjacent wetlands. *Choose the description that best fits the characteristics of the AU edge.*

0 There are **no differences in level** of vegetation height as reflected by vegetation classes on each side of the AU for more than 50% of the circumference, record a [0] **regardless of the sinuosity**. Examples: emergent (or herbaceous) to emergent (or herbaceous), shrub to shrub, forest to forest.

1 There is a **difference of one level** in vegetation height as reflected by vegetation classes on each side of the AU and the **edge is straigh**t side for more than 50% of the circumference, record a [1]. Example: emergent (or herbaceous) to shrub, shrub to forest

2 There is a **difference of one level** in vegetation height as reflected by vegetation classes on each side of the AU and the **edge is sinuous** for more than 50% of the circumference, record [2]. Examples: emergent (or herbaceous) to shrub, shrub to forest.

2 There is a **difference of more than one level** of vegetation height as reflected by vegetation classes on each side of the AU and the **edge is straight**. Examples: Emergent (or herbaceous) to forest, bryophytes to scrub/shrub or forest.

3 There is a **difference of more than one level** of vegetation height as reflected by vegetation classes on each side of the AU and the **edge is sinuous**. Example: Emergent (or herbaceous) to forest, bryophytes to scrub/shrub or forest.

2 If **no single category** above extends for more than 50% of the circumference, and the **edge is straight**.

3 • If **no single category** above extends for more than 50% of the circumference, and the **edge is sinuous**.

4 [0-5] D42 BUFFER of AU: Choose the description that best represents condition of AU buffer

> ** Open water or adjacent wetlands are considered part of the buffer*
> **Infrequently used gravel or paved roads or vegetated dikes in a relatively undisturbed buffer can be ignored as a "disturbance"*

5 100 m (330ft) of forest, scrub, relatively undisturbed grassland or open water >95% of circumference. Clear cut > 5yrs ago is OK. No developed areas within undisturbed part of buffer

(4) 100 m (330 ft) of forest, scrub, relatively undisturbed grassland or open water > 50% circumference OR 50 m (170ft) of forest scrub, grassland or open water >95% circumference. No developed areas within undisturbed part of buffer

3 100 m (330ft) of forest, scrub, grassland or open water > 25% circumference, OR 50 m (170ft) of forest, scrub, grassland or open water > 50% circumference

If AU does not meet any criteria above

2 No paved areas or buildings within 25 m (80ft) of wetland > 95% circumference. Pasture or lawns are OK. OR no paved areas or buildings within 50m of wetland >50% curcumference

0 Vegetated buffers are <2m wide (6.6ft) for more than 95% of the circumference

1 Does not meet any of the criteria above

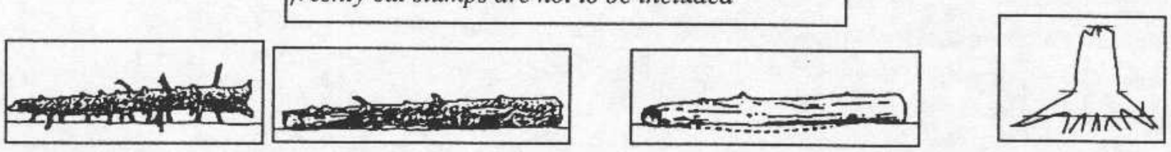
WETLAND NAME____________________________________**Riverine Flow-through** **ID # AU-**

1 [0-3] D43 CORRIDORS of AU: Rate corridors using following key *(record rating of 0,1,2,or 3)*

1. Is the AU part of a riparian corridor *(see text for definitions)*
   NO go to 5 **YES go to 2**
2. Is the wetland part of riparian corridor >50m wideconnecting 2 or more wetlands within 1km with at least 30% shrub or forest cover in the corridor ?
   NO go to 3 **YES = [3]**
3. Is the AU part of a riparian corridor 25-50m wide connecting to other wetlands with at least 30% shrub or forest cover in the corridor?
   NO go to 4 **YES = [2]**
4. Is the AU part of any riparian corridor >5m wide with relatively undisturbed vegetation ?
   NO go to 5 **YES = [1]**
5. Is there a corridor >50m wide with good (>30%) cover of forest or shrub (>2m high) to natural upland or open water >100ha?
   NO go to 6 **YES = [3]**
6. Is there a 10-50m wide forest or shrub corridor to an undisturbed upland or open water >10 hectares?
   NO go to 7 **YES = [2]**
7. Is there a corridor of relatively undisturbed vegetation >50m wide to an undisturbed upland or open water >10 hectares?
   NO go to 8 **YES = [2]**
8. Is there any vegetated corridor 5-50 m wide between the AU and any relatively undisturbed area or open water >2.5 hectares?
   NO = [0] **YES = [1]**

3 1-12 D44 # of categories of large woody debris in AU **outside of permanent stream**

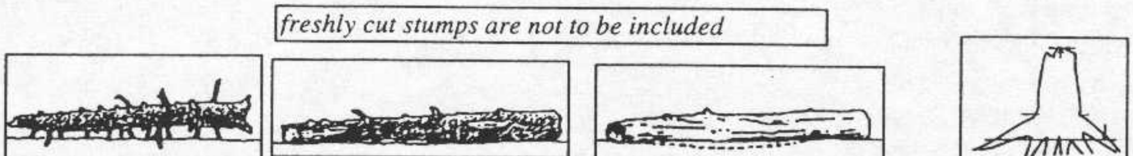
freshly cut stumps are not to be included



Diameter	log class 1	log class 2	log class 3	stump
10-20cm (4-8")	✓			
21-50cm (8-20")		✓	✓	
>50cm (>20")				

0 1-12 D45 # of categories of large woody debris **in permanent stream** of AU

freshly cut stumps are not to be included



Diameter	log class 1	log class 2	log class 3	stump
10-20cm (4-8")				
21-50cm (8-20")				
>50cm (>20")				

WETLAND NAME______________________ **Riverine Flow-through** **ID # AU-**

SOILS and SUBSTRATES

D46 Composition of surface layer (above soil)

1 0/1 D46.1 deciduous leaf litter
1 0/1 D46.2 other plant litter
1 0/1 D46.3 decomposed organic
0 0/1 D46.4 exposed cobbles
0 0/1 D46.5 exposed gravel
0 0/1 D46.6 exposed sand
1 0/1 D46.7 exposed silt
0 0/1 D46.8 exposed clay

record a 1 for each category present if its area is> 10 square meters. Note: bare earth from animal tunnels does NOT count

D47 Soil Types (record [1] if 1-49% area of AU, [2] if 50-95%, [3] if >95%)

0 [0-3] D47.1 Peat
0 [0-3] D47.2 Muck
3 [0-3] D47.3 Mineral with clay fraction <30%
0 [0-3] D47.4 Clay (clay fraction >30%)

Record the soil type nearest the surface and below the top surface layer

D48 Infiltration rate of soils in seasonally inundated areas

0 0/1 D48.1 Fast >50% gravel and cobble and the rest a sand, loamy sand, or sandy loam
0 0/1 D48.2 Moderate > 50% sand and rest cobble, gravel, loamy sand, or sandy loam
1 0/1 D48.3 Slow - muck, peat, or loams (except sandy loam), silts, and clays

Record the least permeable layer if there are several down to 60cm. Record permeability of soils with greatest areal extent.

D49 Substrate of streams

0 0/1 D49.1 Substrate **of permanent stream** or river in AU has at least 1 square meter of gravel
0 0/1 D49.2 Substrate **of permanent stream** or river in AU has at least 1 square meter of cobbles
1 0/1 D49.3 Microdepressions in stream channel

Judgments of Opportunity (Ratings of High, Medium, Low)

Rating	FUNCTIONS
L	Removing Sediments
L	Removing Nutrients
L	Removing Toxic Metals and Organics
L	Reducing Peak Flows
M	Reducing Downstream Erosion
L	Recharging Groundwater
M	General Habitat
L	Anadromous Fish Habitat

APPENDIX F

Cowardin Classification System

APPENDIX F

Cowardin System of Wetland Classification

(Cowardin et. al. 1979)

The Cowardin system of classifying wetlands and deepwater habitats was developed by the U.S. Fish and Wildlife Service. It is used primarily on National Wetlands Inventory maps, and in local inventories. This is a hierarchical approach that divides wetlands and deepwater habitats into the following, increasingly specific categories:

System - a complex of wetlands that share the influence of hydrologic, geomorphologic, chemical, or biological factors. The five major systems are marine, estuarine, riverine, lacustrine, and palustrine.

Subsystem - subsystems specify a particular area or condition of the system such as intertidal vs. subtidal in the marine system, or lower perennial vs. intermittent in the riverine system.

Class - the class refers to the substrate (e.g., unconsolidate bottom) or to the dominant type of vegetation growing in a wetland (e.g., scrub-shrub).

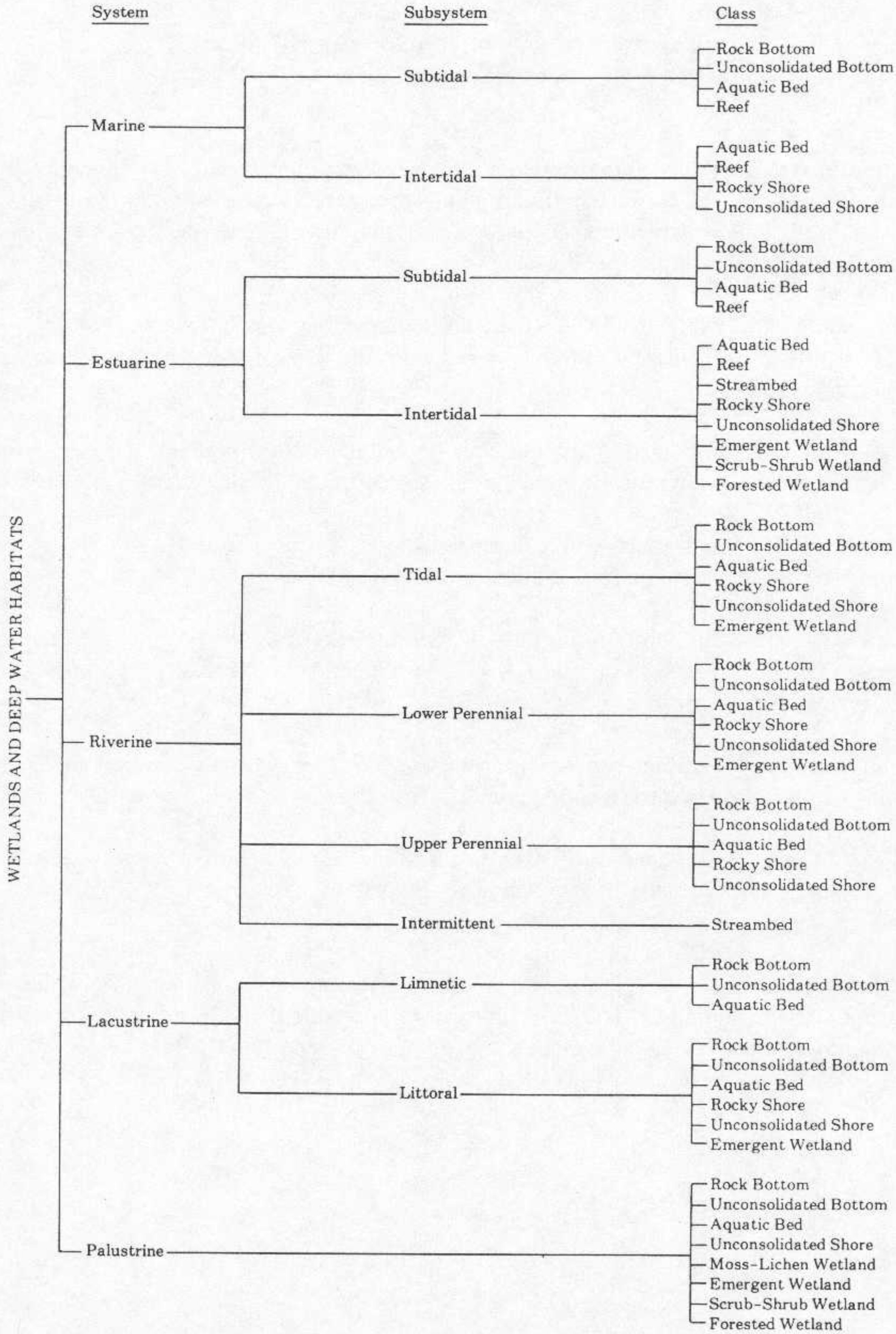
Subclass - the subclass further modifies the substrate or vegetation type. Unconsolidated bottom might be further defined as sand or mud. A scrub-shrub class could be broad-leaved deciduous, needle-leaved evergreen, or other category.

Water Regime - these modifiers provide information on the approximate duration and frequency of flooding or saturation in a wetland (e.g., temporarily flooded or seasonal tidal).

Special Conditions - additional modifiers may indicate historical disturbances (e.g., excavated) or specifics on the water chemistry of a wetland (e.g., hyperhaline).

For the purposes of the Lummi Reservation Wetland Inventory, most wetlands were classified only down to system and class. This is a common way of using the Cowardin system when conducting inventories in areas that include a large number of wetlands. The following figure shows the classification hierarchy for systems, subsystems, and classes.

Classification Hierarchy for Cowardin System



Appendix B: Clarification and Interpretation of the 1987 Wetlands Delineation Manual

DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:

CECW-OR

6 MAR 1992

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Clarification and Interpretation of the 1987 Manual

1. The purpose of this memorandum is to provide additional clarification and guidance concerning the application of the Corps of Engineers Wetlands Delineation Manual, Technical Report Y-87-1, January 1987, Final Report (1987 Manual). As discussed in my 20 February 1992 memorandum, procedures for the identification and delineation of wetlands must be fully consistent with both the 1987 Manual and the Questions and Answers issued 7 October 1991. The technical and procedural guidance contained in paragraphs 2 thru 6 below has been prepared by the Waterways Experiment Station (WES) and is provided as further guidance. The following guidance is considered to be consistent with the 1987 Manual and the 7 October Questions and Answers. Further, this guidance will be presented in the upcoming Regulatory IV wetlands delineation training sessions in FY 92. The alternative technical methods of data gathering discussed below are acceptable as long as the basic decision rules (i.e., criteria and indicators) established in the 1987 Manual are applied. Also enclosed is a revised data form which may be used in lieu of the routine data sheet provided with the 1987 Manual, if desired. As discussed in my 20 February 1992 memorandum to the field, regional approaches and/or alternative data sheets must be reviewed and approved by HQUSACE (CECW-OR) prior to regional implementation. Notwithstanding this requirement, we encourage interagency coordination and cooperation on implementation of the 1987 Manual. Such cooperation can facilitate the continued success of our use of the 1987 Manual.

2. Vegetation:

a. Basic rule: More than 50 percent of dominant species from all strata are OBL, FACW, or FAC (excluding FAC-) on the appropriate Fish and Wildlife Service regional list of plant species that occur in wetlands.

b. The 1987 Manual provides that the 3 most dominant species be selected from each stratum (select 5 from each stratum if only 1-2 strata are present). However, alternative ecologically based methods for selecting dominant species from each stratum are also acceptable. The dominance method described in the 1989 interagency manual is an appropriate alternative method. (1989 Manual, p. 9, para. 3.3)

c. The 4 vegetation strata (tree, sapling/shrub, herb, and woody vine) described in the 1987 Manual are appropriate. However, a 5-stratum approach (tree, sapling, shrub, herb, and woody vine) is an acceptable alternative.

d. The 1987 Manual states on page 79 that hydrophytic vegetation is present if 2 or more dominant species exhibit morphological adaptations or have known physiological adaptations for wetlands. This rule should be used only after the basic rule is applied; use caution with adaptations (e.g., shallow roots) that can develop for reasons other than wetness. Furthermore, the morphological adaptations must be observed on most individuals of the dominant species.

e. In areas where the available evidence of wetlands hydrology or hydric soil is weak (e.g., no primary indicators of hydrology), the Facultative Neutral (FAC neutral) option may be used to help clarify a wetland delineation. Use of the FAC neutral option is explained in paragraph 35(a), page 23, of the 1987 Manual. Use of the FAC neutral option is at the discretion of the District. Further, the FAC neutral option cannot be used to exclude areas that meet the "basic vegetation rule" <u>and</u> the hydrology and hydric soil requirements.

3. Hydrology:

a. Areas which are seasonally inundated and/or saturated to the surface for a consecutive number of days for more than 12.5 percent of the growing season are wetlands, provided the soil and vegetation parameters are met. Areas wet between 5 percent and 12.5 percent of the growing season in most years (see Table 5, page 36 of the 1987 Manual) may or may not be wetlands. Areas saturated to the surface for less than 5 percent of the growing season are non-wetlands. Wetland hydrology exists if field indicators are present as described herein and in the enclosed data sheet.

b. To evaluate hydrologic data (e.g., from stream gages or groundwater wells) growing season dates are required. Soil temperature regime (i.e., period of the year when soil temperature at 20 inches below the surface is above 5 C) is the primary definition of growing season, but data are rarely available for individual sites. Broad regions based on soil temperature regime (e.g., mesic, thermic) are not sufficiently site-specific. For wetland determinations, growing season can be estimated from climatological data given in most SCS county soil surveys (usually in Table 2 or 3 of modern soil surveys). Growing season starting and ending dates will generally be determined based on the "28 degrees F or lower" temperature threshold at a frequency of "5 years in 10." In the south, at the discretion of the district, it may be more appropriate to use the 32 degree F threshold.

c. In groundwater-driven systems, which lack surface indicators of wetland hydrology, it is acceptable to use local Soil Conservation Service (SCS) soil survey information to evaluate the hydrology parameter (p. 37 in the Manual) in conjunction with other information, such as the FAC neutral test. Use caution in areas that may have been recently drained.

d. Oxidized rhizospheres surrounding living roots are acceptable hydrology indicators on a case-by-case basis and may be useful in groundwater systems. Use caution that rhizospheres are not relicts of past hydrology. Rhizospheres should also be reasonably abundant and within the upper 12 inches of the soil profile. Oxidized rhizospheres must be supported by other indicators of hydrology such as the FAC neutral option if hydrology evidence is weak.

4. Soil:

a. The most recent version of National Technical Committee for Hydric Soils hydric soil criteria will be used. At this writing, criteria published in the June 1991 Hydric Soils of the United States are current. These criteria specify at least 15 consecutive days of saturation or 7 days of inundation during the growing season in most years.

b. Local Lists of Hydric Soil Mapping Units recently developed by SCS and available from county or State SCS offices give local information about presence of hydric soils on a site. When available, these local lists take precedence over the national list for hydric soil determinations.

c. SCS is currently developing regional indicators of significant soil saturation. Until finalized and adopted, these indicators may not be used for hydrology or hydric soil determinations.

d. The statement (p. 31 of the 1987 Manual) that gleyed and low-chroma colors must be observed "immediately below the A-horizon or 10 inches (whichever is shallower)" is intended as general guidance. Certain problem soils may differ.

5. Methods:

a. As stated in the 1987 Manual (footnote, p. 76), alternative plot sizes and dominance measures are acceptable.

b. For comprehensive determinations involving a patchy or diverse herb layer, a single, centrally located 3.28 x 3.28-foot quadrat may not give a representative sample. As an alternative, the multiple-quadrat procedure presented in the 1989 Manual (p. 42) is recommended.

6. Problem Areas

a. Page 93, paragraph 78 of the 1987 Manual states that similar problem situations may occur in other wetland types; therefore, problem areas are not limited to this list.

b. Problem soil situations mentioned elsewhere in the Manual include soils derived from red parent materials, some Entisols, Mollisols, and Spodosols.

7. Questions concerning this information should be directed to Ms. Karen A. Kochenbach, HQUSACE (CECW-OR), at (202) 272-1784, or Mr. James S. Wakeley, WES, at (601) 634-3702.

Encl

ARTHUR E. WILLIAMS
Major General, USA
Directorate of Civil Works

DISTRIBUTION:
(SEE PAGE 2 & 3)

Appendix C: Hydric Soil List, Whatcom County Area, Washington

HYDRIC SOILS LIST
WHATCOM COUNTY AREA, WASHINGTON: Detailed Soil Map Legend

Map symbol and map unit name	Component	Hydric	Local landform	Hydric soils criteria: Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria	Acres
1: ANDIC CRYOCHREPTS, 60 TO 90 PERCENT SLOPES	ANDIC CRYOCHREPTS	No	---	---	---	---	---	2,890
2: ANDIC CRYOCHREPTS-ROCK OUTCROP COMPLEX, 60 TO 90 PERCENT SLOPES	ANDIC CRYOCHREPTS	No	---	---	---	---	---	1,386
	ROCK OUTCROP	No	---	---	---	---	---	396
3: ANDIC XEROCHREPTS, 60 TO 90 PERCENT SLOPES	ANDIC XEROCHREPTS	No	---	---	---	---	---	14,900
4: ANDIC XEROCHREPTS-ROCK OUTCROP COMPLEX, 60 TO 90 PERCENT SLOPES	ANDIC XEROCHREPTS	No	---	---	---	---	---	7,538
	ROCK OUTCROP	No	---	---	---	---	---	1,508
	Wet spots	Yes	alluvial cone	---	---	---	---	---
5: ANDIC XEROCHREPTS, COOL-ROCK OUTCROP COMPLEX, 60 TO 90 PERCENT SLOPES	ANDIC XEROCHREPTS	No	---	---	---	---	---	4,500
	ROCK OUTCROP	No	---	---	---	---	---	900
6: BARNESTON GRAVELLY LOAM, 0 TO 8 PERCENT SLOPES	BARNESTON	No	---	---	---	---	---	5,060
	Unnamed	Yes	alluvial cone	---	---	---	---	---
	Wet spots	Yes	alluvial cone	---	---	---	---	---
7: BARNESTON VERY GRAVELLY LOAM, 8 TO 15 PERCENT SLOPES	BARNESTON	No	---	---	---	---	---	2,470
8: BARNESTON VERY GRAVELLY LOAM, 15 TO 30 PERCENT SLOPES	BARNESTON	No	---	---	---	---	---	1,800
9: BARNESTON VERY GRAVELLY LOAM, 30 TO 60 PERCENT SLOPES	BARNESTON	No	---	---	---	---	---	1,735
	Wet spots	Yes	alluvial cone	---	---	---	---	---

HYDRIC SOILS LIST--Continued
WHATCOM COUNTY AREA, WASHINGTON: Detailed Soil Map Legend

Map symbol and map unit name	Component	Hydric	Local landform	Hydric soils criteria: Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria	Acres
10: BARNHARDT GRAVELLY LOAM, 0 TO 5 PERCENT SLOPES	BARNHARDT	No	---	---	---	---	---	2,124
	Clipper	Yes	terrace	2A	YES	NO	NO	24
11: BELLINGHAM SILTY CLAY LOAM, 0 TO 2 PERCENT SLOPES	BELLINGHAM	Yes	depression	2B3	YES	NO	NO	3,655
	Bellingham	Yes	depression	2B3	YES	NO	NO	129
	Everson	Yes	terrace	2B3	YES	NO	NO	129
	Shalcar	Yes	flood plain	3,1	NO	NO	YES	129
	Skipopa	No	---	---	---	---	---	---
12: BIRCHBAY SILT LOAM, 0 TO 3 PERCENT SLOPES	BIRCHBAY	No	---	---	---	---	---	3,834
	Clipper	Yes	terrace	2A	YES	NO	NO	90
	Hale	Yes	terrace	2A	YES	NO	NO	90
	Labounty	Yes	depression	2B3	YES	NO	NO	90
	Whitehorn	Yes	depression	2B3	YES	NO	NO	90
	Wet spots	Yes	alluvial cone	---	---	---	---	---
13: BIRCHBAY SILT LOAM, 3 TO 8 PERCENT SLOPES	BIRCHBAY	No	---	---	---	---	---	2,176
	Clipper	Yes	terrace	2A	YES	NO	NO	51
	Hale	Yes	terrace	2A	YES	NO	NO	51
	Labounty	Yes	depression	2B3	YES	NO	NO	51
	Whitehorn	Yes	depression	2B3	YES	NO	NO	51
	Wet spots	Yes	alluvial cone	---	---	---	---	---
14: BIRCHBAY SILT LOAM, 8 TO 15 PERCENT SLOPES	BIRCHBAY	No	---	---	---	---	---	378
	Clipper	Yes	terrace	2A	YES	NO	NO	9
	Whitehorn	Yes	depression	2B3	YES	NO	NO	9
15: BLAINEGATE SILTY CLAY, 0 TO 1 PERCENT SLOPES	BLAINEGATE	Yes	terrace	2B3	YES	NO	NO	518

HYDRIC SOILS LIST--Continued
WHATCOM COUNTY AREA, WASHINGTON: Detailed Soil Map Legend

Map symbol and map unit name	Component	Hydric	Local landform	Hydric soils criteria: Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria	Acres
	Blaingate	Yes	terrace	2B3	YES	NO	NO	12
	Shalcar	Yes	flood plain	1,3	NO	NO	YES	12
	Whitehorn	Yes	depression	3,2B3	YES	NO	YES	12
	Yelm	No	---	---	---	---	---	---
16: BLAINEGATE-URBAN LAND COMPLEX, 0 TO 1 PERCENT SLOPES	BLAINEGATE	Yes	terrace	2B3	YES	NO	NO	150
	URBAN LAND	No	---	---	---	---	---	90
	Whitehorn	Yes	depression	2B3,3	YES	NO	YES	15
	Yelm	No	---	---	---	---	---	---
17: BLETHEN GRAVELLY LOAM, 5 TO 15 PERCENT SLOPES	BLETHEN	No	---	---	---	---	---	2,720
	Unnamed	Yes	alluvial cone	---	---	---	---	---
18: BLETHEN GRAVELLY LOAM, 15 TO 30 PERCENT SLOPES	BLETHEN	No	---	---	---	---	---	5,510
19: BLETHEN GRAVELLY LOAM, 30 TO 60 PERCENT SLOPES	BLETHEN	No	---	---	---	---	---	2,800
20: BLETHEN VERY BOULDERY LOAM, 5 TO 40 PERCENT SLOPES	BLETHEN	No	---	---	---	---	---	1,070
21: BOROSAPRISTS, 0 TO 2 PERCENT SLOPES	BOROSAPRISTS	Yes	depression	1	NO	NO	NO	325
22: BRISCOT SILT LOAM, DRAINED, 0 TO 2 PERCENT SLOPES	BRISCOT	Yes	flood plain	2B3	YES	NO	NO	5,967
	Briscot, undrained	Yes	flood plain	2B3	YES	NO	NO	140
	Shalcar	Yes	flood plain	1,3	NO	NO	YES	140
	Puyallup	No	---	---	---	---	---	---

HYDRIC SOILS LIST--Continued
WHATCOM COUNTY AREA, WASHINGTON: Detailed Soil Map Legend

Map symbol and map unit name	Component	Hydric	Local landform	Hydric soils criteria				Acres
				Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria	
23: BRISCOT, ORIDIA AND SUMAS SOILS, 0 TO 2 PERCENT SLOPES	BRISCOT	Yes	flood plain	2B3	YES	NO	NO	215
	ORIDIA	Yes	flood plain	2B3	YES	NO	NO	86
	SUMAS	Yes	flood plain	2B3	YES	NO	NO	64
	Briscot, drained	Yes	flood plain	2B3	YES	NO	NO	13
	Oridia, drained	Yes	flood plain	2B3	YES	NO	NO	13
	Sumas, drained	Yes	flood plain	2B3	YES	NO	NO	13
	Unnamed	No	---	---	---	---	---	---
24: CHUCKANUT LOAM, 3 TO 8 PERCENT SLOPES	CHUCKANUT	No	---	---	---	---	---	514
	Briscot	Yes	flood plain	2B3	YES	NO	NO	18
25: CHUCKANUT LOAM, BEDROCK SUBSTRATUM, 5 TO 15 PERCENT SLOPES	CHUCKANUT	No	---	---	---	---	---	1,547
	Bellingham	Yes	depression	2B3	YES	NO	NO	55
	Wet spots	Yes	alluvial cone	---	---	---	---	---
26: CHUCKANUT LOAM, BEDROCK SUBSTRATUM, 15 TO 30 PERCENT SLOPES	CHUCKANUT	No	---	---	---	---	---	4,675
	Bellingham	Yes	depression	2B3	YES	NO	NO	165
	Wet spots	Yes	alluvial cone	---	---	---	---	---
27: CHUCKANUT LOAM, BEDROCK SUBSTRATUM, 30 TO 60 PERCENT SLOPES	CHUCKANUT	No	---	---	---	---	---	3,868
	Bellingham	Yes	depression	2B3	YES	NO	NO	136
28: CHUCKANUT-SHALCAR COMPLEX, 0 TO 15 PERCENT SLOPES	CHUCKANUT	No	---	---	---	---	---	885
	SHALCAR	Yes	depression	1,3	NO	NO	YES	118

HYDRIC SOILS LIST--Continued
WHATCOM COUNTY AREA, WASHINGTON: Detailed Soil Map Legend

Map symbol and map unit name	Component	Hydric	Local landform	Hydric soils criteria: Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria	Acres
	Bellingham	Yes	depression	2B3	YES	NO	NO	35
29: CHUCKANUT-URBAN LAND COMPLEX, 5 TO 20 PERCENT SLOPES	CHUCKANUT	No	---	---	---	---	---	575
	URBAN LAND	No	---	---	---	---	---	402
	Bellingham	Yes	depression	2B3	YES	NO	NO	23
	Labounty	Yes	depression	2B3	YES	NO	NO	23
30: CLENDENEN GRAVELLY SILT LOAM, 5 TO 30 PERCENT SLOPES	CLENDENEN	No	---	---	---	---	---	470
	Unnamed	Yes	alluvial cone	---	---	---	---	---
	Wet spots	Yes	alluvial cone	---	---	---	---	---
31: CLIPPER SILT LOAM, DRAINED, 0 TO 2 PERCENT SLOPES	CLIPPER	Yes	terrace	2A	YES	NO	NO	3,442
	Clipper, undrained	Yes	terrace	2A	YES	NO	NO	122
	Whitehorn	Yes	depression	2B3,3	YES	NO	YES	122
	Birchbay	No	---	---	---	---	---	---
32: COMAR SILT LOAM, 5 TO 15 PERCENT SLOPES	COMAR	No	---	---	---	---	---	251
	Bellingham	Yes	depression	2B3	YES	NO	NO	6
33: COMAR SILT LOAM, 15 TO 30 PERCENT SLOPES	COMAR	No	---	---	---	---	---	620
	Bellingham	Yes	depression	2B3	YES	NO	NO	15
34: COMAR SILT LOAM, 30 TO 60 PERCENT SLOPES	COMAR	No	---	---	---	---	---	1,232
	Bellingham	Yes	depression	2B3	YES	NO	NO	29
35: CRINKER VERY CHANNERY SILT LOAM, 30 TO 60 PERCENT SLOPES	CRINKER	No	---	---	---	---	---	2,500

HYDRIC SOILS LIST--Continued
WHATCOM COUNTY AREA, WASHINGTON: Detailed Soil Map Legend

Map symbol and map unit name	Component	Hydric	Local landform	Hydric soils criteria: Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria	Acres
36: CUPPLES GRAVELLY LOAM, 5 TO 30 PERCENT SLOPES	CUPPLES	No	---	---	---	---	---	2,020
	Unnamed	Yes	alluvial cone	---	---	---	---	---
	Wet spots	Yes	alluvial cone	---	---	---	---	---
37: CUPPLES GRAVELLY LOAM, 30 TO 60 PERCENT SLOPES	CUPPLES	No	---	---	---	---	---	655
38: DEKAPEN LOAM, 8 TO 25 PERCENT SLOPES	DEKAPEN	No	---	---	---	---	---	1,550
	Unnamed	Yes	alluvial cone	---	---	---	---	---
39: DEMING GRAVELLY SILT LOAM, 5 TO 30 PERCENT SLOPES	DEMING	No	---	---	---	---	---	510
	Unnamed	Yes	alluvial cone	---	---	---	---	---
40: DEMING GRAVELLY SILT LOAM, 30 TO 60 PERCENT SLOPES	DEMING	No	---	---	---	---	---	2,460
	Unnamed	Yes	alluvial cone	---	---	---	---	---
41: DIOBSUD GRAVELLY SILT LOAM, 30 TO 60 PERCENT SLOPES	DIOBSUD	No	---	---	---	---	---	1,700
42: EDFRO VERY GRAVELLY SILT LOAM, 8 TO 30 PERCENT SLOPES	EDFRO	No	---	---	---	---	---	1,175
	Unnamed	Yes	alluvial cone	---	---	---	---	---
43: EDFRO VERY GRAVELLY SILT LOAM, 30 TO 60 PERCENT SLOPES	EDFRO	No	---	---	---	---	---	865
44: EDFRO VERY STONY SILT LOAM, 30 TO 60 PERCENT SLOPES	EDFRO	No	---	---	---	---	---	425
45: EDMONDS-WOODLYN LOAMS, 0 TO 2 PERCENT SLOPES	EDMONDS	No	---	---	---	---	---	6,300

HYDRIC SOILS LIST--Continued
WHATCOM COUNTY AREA, WASHINGTON: Detailed Soil Map Legend

Map symbol and map unit name	Component	Hydric	Local landform	Hydric soils criteria: Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria	Acres
	WOODLYN	Yes	depression	2B3	YES	NO	NO	2,625
	Edmonds, undrained	No	depression	---	---	---	---	315
	Fishtrap	Yes	depression	1	NO	NO	NO	315
	Hale	Yes	terrace	2A	YES	NO	NO	315
	Woodlyn, undrained	Yes	depression	2B3	YES	NO	NO	315
	Tromp	No	---	---	---	---	---	---
46: ELIZA SILT LOAM, DRAINED, 0 TO 1 PERCENT SLOPES	ELIZA	Yes	delta	2B3	YES	NO	NO	2,754
	Eliza, undrained	Yes	delta	2B3,4	YES	YES	NO	130
	Mt. Vernon	No	---	---	---	---	---	---
47: ELIZA-TACOMA SILT LOAMS, 0 TO 1 PERCENT SLOPES	ELIZA	Yes	delta	2B3,4	YES	YES	NO	356
	TACOMA	Yes	delta	4,2B3	YES	YES	NO	276
	Shalcar	Yes	flood plain	1,3	NO	NO	YES	40
	Snohomish	Yes	flood plain	2B3	YES	NO	NO	40
	Mt. Vernon	No	---	---	---	---	---	---
48: EVERETT GRAVELLY SANDY LOAM, HARD SUBSTRATUM, 2 TO 8 PERCENT SLOPES	EVERETT	No	---	---	---	---	---	1,912
	Clipper	Yes	terrace	2A	YES	NO	NO	68
	Labounty	Yes	depression	2B3	YES	NO	NO	68
49: EVERETT VERY GRAVELLY SANDY LOAM, 8 TO 15 PERCENT SLOPES	EVERETT	No	---	---	---	---	---	850
	Clipper	Yes	terrace	2A	YES	NO	NO	30
50: EVERETT VERY GRAVELLY SANDY LOAM, 15 TO 35 PERCENT SLOPES	EVERETT	No	---	---	---	---	---	230
	Clipper	Yes	terrace	2A	YES	NO	NO	8

HYDRIC SOILS LIST--Continued
WHATCOM COUNTY AREA, WASHINGTON: Detailed Soil Map Legend

Map symbol and map unit name	Component	Hydric	Local landform	Hydric soils criteria: Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria	Acres
51: EVERETT COMPLEX, 2 TO 8 PERCENT SLOPES	EVERETT	No	---	---	---	---	---	2,365
	EVERETT	No	---	---	---	---	---	1,656
	Clipper	Yes	terrace	2A	YES	NO	NO	142
	Labounty	Yes	depression	2B3	YES	NO	NO	142
	Wet spots	Yes	alluvial cone	---	---	---	---	---
52: EVERETT-URBAN LAND COMPLEX, 5 TO 20 PERCENT SLOPES	EVERETT	No	---	---	---	---	---	400
	URBAN LAND	No	---	---	---	---	---	240
	Labounty	Yes	depression	2B3	YES	NO	NO	24
53: EVERSON SILT LOAM, DRAINED, 0 TO 2 PERCENT SLOPES	EVERSON	Yes	terrace	2B3	YES	NO	NO	604
	Edmonds	No	depression	---	---	---	---	21
	Everson, undrained	Yes	terrace	2B3	YES	NO	NO	21
	Hale	Yes	terrace	2A	YES	NO	NO	21
	Labounty	Yes	depression	2B3	YES	NO	NO	21
	Whitehorn	Yes	depression	2B3,3	YES	NO	YES	21
	Unnamed	No	---	---	---	---	---	---
54: FISHTRAP MUCK, DRAINED, 0 TO 2 PERCENT SLOPES	FISHTRAP	Yes	depression	1	NO	NO	NO	1,819
	Fishtrap, undrained	Yes	depression	1	NO	NO	NO	43
	Hale	Yes	terrace	2A	YES	NO	NO	43
	Tromp	No	---	---	---	---	---	---
55: GALLUP SILT LOAM, 30 TO 60 PERCENT SLOPES	GALLUP	No	---	---	---	---	---	1,760
56: GALLUP SILT LOAM, 60 TO 80 PERCENT SLOPES	GALLUP	No	---	---	---	---	---	595

HYDRIC SOILS LIST--Continued
WHATCOM COUNTY AREA, WASHINGTON: Detailed Soil Map Legend

Map symbol and map unit name	Component	Hydric	Local landform	Hydric soils criteria: Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria	Acres
57: GALLUP SILT LOAM, COLD, 30 TO 60 PERCENT SLOPES	GALLUP	No	---	---	---	---	---	560
58: GALLUP SILT LOAM, COLD, 60 TO 80 PERCENT SLOPES	GALLUP	No	---	---	---	---	---	1,250
59: GETCHELL LOAM, 3 TO 30 PERCENT SLOPES	GETCHELL	No	---	---	---	---	---	5,000
	Unnamed	Yes	alluvial cone	---	---	---	---	---
	Wet spots	Yes	alluvial cone	---	---	---	---	---
60: GETCHELL LOAM, 30 TO 60 PERCENT SLOPES	GETCHELL	No	---	---	---	---	---	1,890
	Unnamed	Yes	alluvial cone	---	---	---	---	---
61: HALE SILT LOAM, 0 TO 2 PERCENT SLOPES	HALE	Yes	terrace	2A	YES	NO	NO	816
	Edmonds	No	depression	---	---	---	---	19
	Everson	Yes	terrace	2B3	YES	NO	NO	19
	Labounty	Yes	depression	2B3	YES	NO	NO	19
	Shalcar	Yes	flood plain	1,3	NO	NO	YES	19
	Whitehorn	Yes	depression	2B3,3	YES	NO	YES	19
	Lynden	No	---	---	---	---	---	---
62: HALE SILT LOAM, DRAINED, 0 TO 2 PERCENT SLOPES	HALE	Yes	terrace	2A	YES	NO	NO	8,500
	Edmonds	No	depression	---	---	---	---	200
	Everson	Yes	terrace	2B3	YES	NO	NO	200
	Fishtrap	Yes	flood plain	1,3	NO	NO	YES	200
	Labounty	Yes	depression	2B3	YES	NO	NO	200
	Whitehorn	Yes	depression	3,2B3	YES	NO	YES	200
	Lynden	No	---	---	---	---	---	---
63: HALLENTON SILT LOAM, 0 TO 1 PERCENT SLOPES	HALLENTON	Yes	depression	3,2B3	YES	NO	YES	340

HYDRIC SOILS LIST--Continued
WHATCOM COUNTY AREA, WASHINGTON: Detailed Soil Map Legend

Map symbol and map unit name	Component	Hydric	Local landform	Hydric soils criteria: Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria	Acres
	Labounty	Yes	depression	2B3	YES	NO	NO	22
	Shalcar	Yes	flood plain	3,1	NO	NO	YES	22
	Unnamed	No	---	---	---	---	---	---
64: HANNEGAN VERY GRAVELLY LOAM, 15 TO 40 PERCENT SLOPES	HANNEGAN	No	---	---	---	---	---	500
65: HARTNIT SILT LOAM, COLD, 5 TO 30 PERCENT SLOPES	HARTNIT	No	---	---	---	---	---	1,060
	Unnamed	Yes	alluvial cone	---	---	---	---	---
	Wet spots	Yes	alluvial cone	---	---	---	---	---
66: HARTNIT SILT LOAM, COLD, 30 TO 60 PERCENT SLOPES	HARTNIT	No	---	---	---	---	---	1,325
	Unnamed	Yes	alluvial cone	---	---	---	---	---
67: HARTNIT-GALLUP-ROCK OUTCROP COMPLEX, 50 TO 80 PERCENT SLOPES	HARTNIT	No	---	---	---	---	---	1,200
	GALLUP	No	---	---	---	---	---	900
	ROCK OUTCROP	No	---	---	---	---	---	450
68: HEISLER VERY GRAVELLY SILT LOAM, 8 TO 30 PERCENT SLOPES	HEISLER	No	---	---	---	---	---	1,030
69: HEISLER VERY GRAVELLY SILT LOAM, 30 TO 60 PERCENT SLOPES	HEISLER	No	---	---	---	---	---	580
70: HINKER VERY CHANNERY SILT LOAM, 5 TO 30 PERCENT SLOPES	HINKER	No	---	---	---	---	---	570
71: HINKER VERY CHANNERY SILT LOAM, 30 TO 60 PERCENT SLOPES	HINKER	No	---	---	---	---	---	2,750
	Wet spots	Yes	alluvial cone	---	---	---	---	---

HYDRIC SOILS LIST--Continued
WHATCOM COUNTY AREA, WASHINGTON: Detailed Soil Map Legend

Map symbol and map unit name	Component	Hydric	Local landform	Hydric soils criteria: Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria	Acres
72: HISTOSOLS, PONDED, 0 TO 1 PERCENT SLOPES	HISTOSOLS	Yes	depression	1,3	NO	NO	YES	442
	Bellingham	Yes	depression	2B3	YES	NO	NO	26
	Pangborn	Yes	depression	1	NO	NO	NO	26
73: HOVDE SILT LOAM, 0 TO 2 PERCENT SLOPES	HOVDE	Yes	terrace	2B3	YES	NO	NO	306
	Eliza	Yes	delta	2B3,4	YES	YES	NO	18
	Tacoma	Yes	delta	2B3,4	YES	YES	NO	18
	Unnamed	No	---	---	---	---	---	---
74: HOZOMEEN GRAVELLY LOAM, 20 TO 45 PERCENT SLOPES	HOZOMEEN	No	---	---	---	---	---	1,240
75: HYDRAQUENTS, TIDAL, 0 TO 1 PERCENT SLOPES	HYDRAQUENTS	Yes	alluvial cone	3,2B3	YES	NO	YES	1,750
76: JACKMAN GRAVELLY SILT LOAM, 30 TO 60 PERCENT SLOPES	JACKMAN	No	---	---	---	---	---	1,320
77: JORGENSON GRAVELLY SILT LOAM, 3 TO 15 PERCENT SLOPES	JORGENSON	No	---	---	---	---	---	1,145
78: JUG VERY GRAVELLY LOAM, 3 TO 15 PERCENT SLOPES	JUG	No	---	---	---	---	---	985
79: KICKERVILLE SILT LOAM, 0 TO 3 PERCENT SLOPES	KICKERVILLE	No	---	---	---	---	---	4,836
	Clipper	Yes	terrace	2A	YES	NO	NO	57
	Fishtrap	Yes	flood plain	1,3	NO	NO	YES	57
	Shalcar	Yes	flood plain	3,1	NO	NO	YES	57
80: KICKERVILLE SILT LOAM, 3 TO 8 PERCENT SLOPES	KICKERVILLE	No	---	---	---	---	---	4,131
	Clipper	Yes	terrace	2A	YES	NO	NO	49
	Fishtrap	Yes	flood plain	1,3	NO	NO	YES	49

HYDRIC SOILS LIST--Continued
WHATCOM COUNTY AREA, WASHINGTON: Detailed Soil Map Legend

Map symbol and map unit name	Component	Hydric	Local landform	Hydric soils criteria: Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria	Acres
	Shalcar	Yes	flood plain	1,3	NO	NO	YES	49
	Wet spots	Yes	alluvial cone	---	---	---	---	---
81: KICKERVILLE SILT LOAM, 8 TO 15 PERCENT SLOPES	KICKERVILLE	No	---	---	---	---	---	1,530
82: KICKERVILLE-URBAN LAND COMPLEX, 0 TO 3 PERCENT SLOPES	KICKERVILLE	No	---	---	---	---	---	420
	URBAN LAND	No	---	---	---	---	---	252
	Clipper	Yes	terrace	2A	YES	NO	NO	25
83: KINDY GRAVELLY SILT LOAM, 8 TO 30 PERCENT SLOPES	KINDY	No	---	---	---	---	---	1,970
	Unnamed	Yes	alluvial cone	---	---	---	---	---
84: KINDY GRAVELLY SILT LOAM, 30 TO 60 PERCENT SLOPES	KINDY	No	---	---	---	---	---	3,125
85: KINDY-OSO COMPLEX, 5 TO 40 PERCENT SLOPES	KINDY	No	---	---	---	---	---	1,738
	OSO	No	---	---	---	---	---	1,216
	Unnamed	Yes	alluvial cone	---	---	---	---	---
86: KLAWATTI VERY GRAVELLY LOAM, 30 TO 60 PERCENT SLOPES	KLAWATTI	No	---	---	---	---	---	635
87: KLAWATTI VERY GRAVELLY LOAM, SERPENTINE, 10 TO 30 PERCENT SLOPES	KLAWATTI	No	---	---	---	---	---	275
88: KLAWATTI VERY GRAVELLY LOAM, SERPENTINE, 30 TO 60 PERCENT SLOPES	KLAWATTI	No	---	---	---	---	---	1,070
89: KLAWATTI-ROCK OUTCROP COMPLEX, 60 TO 80 PERCENT SLOPES	KLAWATTI	No	---	---	---	---	---	440
	ROCK OUTCROP	No	---	---	---	---	---	200

HYDRIC SOILS LIST--Continued
WHATCOM COUNTY AREA, WASHINGTON: Detailed Soil Map Legend

Map symbol and map unit name	Component	Hydric	Local landform	Hydric soils criteria				Acres
				Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria	
90: KLINE GRAVELLY SANDY LOAM, 2 TO 8 PERCENT SLOPES	KLINE	No	---	---	---	---	---	1,037
	Briscot	Yes	flood plain	2B3	YES	NO	NO	49
91: KULSHAN LOAM, 5 TO 30 PERCENT SLOPES	KULSHAN	No	---	---	---	---	---	765
	Unnamed	Yes	alluvial cone	---	---	---	---	---
92: KULSHAN LOAM, 30 TO 60 PERCENT SLOPES	KULSHAN	No	---	---	---	---	---	940
	Unnamed	Yes	alluvial cone	---	---	---	---	---
93: LABOUNTY SILT LOAM, 0 TO 2 PERCENT SLOPES	LABOUNTY	Yes	depression	2B3	YES	NO	NO	1,530
	Hale	Yes	terrace	2A	YES	NO	NO	90
	Labounty, art. drained	Yes	depression	2B3	YES	NO	NO	90
	Unnamed	No	---	---	---	---	---	---
94: LABOUNTY SILT LOAM, DRAINED, 0 TO 2 PERCENT SLOPES	LABOUNTY	Yes	depression	2B3	YES	NO	NO	4,488
	Bellingham	Yes	depression	2B3	YES	NO	NO	106
	Hale	Yes	terrace	2A	YES	NO	NO	106
	Labounty, undrained	Yes	depression	2B3	YES	NO	NO	106
	Shalcar	Yes	flood plain	3,1	NO	NO	YES	106
	Unnamed	No	---	---	---	---	---	---
95: LARUSH SILT LOAM, 0 TO 2 PERCENT SLOPES	LARUSH	No	---	---	---	---	---	536
	Bellingham	Yes	depression	2B3	YES	NO	NO	13
	Briscot	Yes	flood plain	2B3	YES	NO	NO	13
	Oridia	Yes	flood plain	2B3	YES	NO	NO	13
	Riverwash	Yes	flood plain	4	NO	YES	NO	13
	Shalcar	Yes	flood plain	3,1	NO	NO	YES	13

HYDRIC SOILS LIST--Continued
WHATCOM COUNTY AREA, WASHINGTON: Detailed Soil Map Legend

Map symbol and map unit name	Component	Hydric	Local landform	Hydric soils criteria				Acres
				Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria	
96: LAXTON LOAM, 0 TO 3 PERCENT SLOPES	LAXTON	No	---	---	---	---	---	3,476
	Hale	Yes	terrace	2A	YES	NO	NO	123
	Wet spots	Yes	alluvial cone	---	---	---	---	---
97: LAXTON LOAM, 3 TO 8 PERCENT SLOPES	LAXTON	No	---	---	---	---	---	314
	Hale	Yes	terrace	2A	YES	NO	NO	11
98: LAXTON LOAM, 8 TO 15 PERCENT SLOPES	LAXTON	No	---	---	---	---	---	635
99: LYNDEN SANDY LOAM, 0 TO 3 PERCENT SLOPES	LYNDEN	No	---	---	---	---	---	8,317
	Hale	Yes	terrace	2A	YES	NO	NO	196
	Wet spots	Yes	alluvial cone	---	---	---	---	---
100: LYNDEN SANDY LOAM, 3 TO 8 PERCENT SLOPES	LYNDEN	No	---	---	---	---	---	1,624
	Hale	Yes	terrace	2A	YES	NO	NO	57
101: LYNDEN-URBAN LAND COMPLEX, 0 TO 3 PERCENT SLOPES	LYNDEN	No	---	---	---	---	---	327
	URBAN LAND	No	---	---	---	---	---	208
	Hale	Yes	terrace	2A	YES	NO	NO	18
102: LYNNWOOD SANDY LOAM, 0 TO 5 PERCENT SLOPES	LYNNWOOD	No	---	---	---	---	---	765
	Hale	Yes	terrace	2A	YES	NO	NO	18
	Wet spots	Yes	alluvial cone	---	---	---	---	---
103: LYNNWOOD SANDY LOAM, 5 TO 20 PERCENT SLOPES	LYNNWOOD	No	---	---	---	---	---	1,377
	Hale	Yes	terrace	2A	YES	NO	NO	32
104: MONTBORNE GRAVELLY LOAM, 5 TO 30 PERCENT SLOPES	MONTBORNE	No	---	---	---	---	---	3,250

HYDRIC SOILS LIST--Continued
WHATCOM COUNTY AREA, WASHINGTON: Detailed Soil Map Legend

Map symbol and map unit name	Component	Hydric	Local landform	Hydric soils criteria: Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria	Acres
	Unnamed	Yes	alluvial cone	---	---	---	---	---
105: MONTBORNE GRAVELLY LOAM, 30 TO 60 PERCENT SLOPES	MONTBORNE	No	---	---	---	---	---	1,515
106: MONTBORNE-RINKER COMPLEX, 30 TO 60 PERCENT SLOPES	MONTBORNE	No	---	---	---	---	---	2,316
	RINKER	No	---	---	---	---	---	965
107: MT. VERNON FINE SANDY LOAM, 0 TO 2 PERCENT SLOPES	MT. VERNON	No	---	---	---	---	---	8,942
	Briscot	Yes	flood plain	2B3	YES	NO	NO	210
	Eliza	Yes	delta	2B3,4	YES	YES	NO	210
	Oridia	Yes	flood plain	2B3	YES	NO	NO	210
	Riverwash	Yes	flood plain	4	NO	YES	NO	210
	Shalcar	Yes	flood plain	1,3	NO	NO	YES	210
108: NATI LOAM, 5 TO 15 PERCENT SLOPES	NATI	No	---	---	---	---	---	2,388
	Bellingham	Yes	depression	2B3	YES	NO	NO	28
	Shalcar	Yes	flood plain	1,3	NO	NO	YES	28
	Wet spots	Yes	alluvial cone	---	---	---	---	---
109: NATI LOAM, 15 TO 30 PERCENT SLOPES	NATI	No	---	---	---	---	---	4,097
	Bellingham	Yes	depression	2B3	YES	NO	NO	48
	Shalcar	Yes	flood plain	1,3	NO	NO	YES	48
110: NATI LOAM, 30 TO 60 PERCENT SLOPES	NATI	No	---	---	---	---	---	5,074
	Bellingham	Yes	depression	2B3	YES	NO	NO	60
	Shalcar	Yes	flood plain	1,3	NO	NO	YES	60
111: NEPTUNE VERY GRAVELLY SANDY LOAM, 0 TO 3 PERCENT SLOPES	NEPTUNE	No	---	---	---	---	---	829

HYDRIC SOILS LIST--Continued
WHATCOM COUNTY AREA, WASHINGTON: Detailed Soil Map Legend

Map symbol and map unit name	Component	Hydric	Local landform	Hydric soils criteria: Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria	Acres
	Hovde	Yes	terrace	2B3	YES	NO	NO	29
112: OAKES VERY GRAVELLY LOAM, 8 TO 30 PERCENT SLOPES	OAKES	No	---	---	---	---	---	4,770
	Unnamed	Yes	alluvial cone	---	---	---	---	---
113: OAKES VERY GRAVELLY LOAM, 30 TO 60 PERCENT SLOPES	OAKES	No	---	---	---	---	---	11,700
114: OAKES VERY GRAVELLY LOAM, 60 TO 80 PERCENT SLOPES	OAKES	No	---	---	---	---	---	2,100
115: ORIDIA SILT LOAM, DRAINED, 0 TO 2 PERCENT SLOPES	ORIDIA	Yes	flood plain	2B3	YES	NO	NO	4,072
	Oridia, undrained	Yes	flood plain	2B3	YES	NO	NO	96
	Shalcar	Yes	flood plain	3,1	NO	NO	YES	96
	Mt. Vernon	No	---	---	---	---	---	---
116: PANGBORN MUCK, DRAINED, 0 TO 2 PERCENT SLOPES	PANGBORN	Yes	depression	1	NO	NO	NO	6,868
	Bellingham	Yes	depression	2B3	YES	NO	NO	81
	Fishtrap	Yes	flood plain	1,3	NO	NO	YES	81
	Puget	Yes	flood plain	2B3	YES	NO	NO	81
	Shalcar	Yes	flood plain	3,1	NO	NO	YES	81
	Snohomish	Yes	flood plain	2B3	YES	NO	NO	81
117: PICKETT-ROCK OUTCROP COMPLEX, 5 TO 30 PERCENT SLOPES	PICKETT	No	---	---	---	---	---	569
	ROCK OUTCROP	No	---	---	---	---	---	175
	Unnamed	Yes	alluvial cone	---	---	---	---	---
118: PICKETT-ROCK OUTCROP COMPLEX, 30 TO 60 PERCENT SLOPES	PICKETT	No	---	---	---	---	---	903

HYDRIC SOILS LIST--Continued
WHATCOM COUNTY AREA, WASHINGTON: Detailed Soil Map Legend

Map symbol and map unit name	Component	Hydric	Local landform	Hydric soils criteria: Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria	Acres
	ROCK OUTCROP	No	---	---	---	---	---	376
	Unnamed	Yes	alluvial cone	---	---	---	---	---
119: PILCHUCK LOAMY FINE SAND, 0 TO 3 PERCENT SLOPES	PILCHUCK	No	---	---	---	---	---	2,095
	Briscot	Yes	flood plain	2B3	YES	NO	NO	49
	Riverwash	Yes	flood plain	4	NO	YES	NO	49
120: PITS, GRAVEL	PITS	No	---	---	---	---	---	620
121: POTCHUB LOAM, 8 TO 30 PERCENT SLOPES	POTCHUB	No	---	---	---	---	---	2,435
	Unnamed	Yes	alluvial cone	---	---	---	---	---
	Wet spots	Yes	alluvial cone	---	---	---	---	---
122: POTCHUB LOAM, 30 TO 60 PERCENT SLOPES	POTCHUB	No	---	---	---	---	---	2,235
123: PUGET SILT LOAM, DRAINED, 0 TO 2 PERCENT SLOPES	PUGET	Yes	flood plain	2B3	YES	NO	NO	2,261
	Puget, undrained	Yes	flood plain	2B3	YES	NO	NO	80
	Shalcar	Yes	flood plain	3,1	NO	NO	YES	80
	Mt. Vernon	No	---	---	---	---	---	---
124: PUYALLUP FINE SANDY LOAM, 0 TO 2 PERCENT SLOPES	PUYALLUP	No	---	---	---	---	---	4,743
	Bellingham	Yes	depression	2B3	YES	NO	NO	112
	Briscot	Yes	flood plain	2B3	YES	NO	NO	112
	Fishtrap	Yes	flood plain	3,1	NO	NO	YES	112
	Oridia	Yes	flood plain	2B3	YES	NO	NO	112
	Shalcar	Yes	flood plain	3,1	NO	NO	YES	112
125: REVEL LOAM, 5 TO 30 PERCENT SLOPES	REVEL	No	---	---	---	---	---	1,480
	Unnamed	Yes	alluvial cone	---	---	---	---	---

HYDRIC SOILS LIST--Continued
WHATCOM COUNTY AREA, WASHINGTON: Detailed Soil Map Legend

Map symbol and map unit name	Component	Hydric	Local landform	Hydric soils criteria				Acres
				Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria	
126: REVEL LOAM, 30 TO 60 PERCENT SLOPES	REVEL	No	---	---	---	---	---	3,620
	Unnamed	Yes	alluvial cone	---	---	---	---	---
127: REVEL-WELCOME-ROCK OUTCROP COMPLEX, 30 TO 60 PERCENT SLOPES	REVEL	No	---	---	---	---	---	1,022
	WELCOME	No	---	---	---	---	---	681
	ROCK OUTCROP	No	---	---	---	---	---	227
128: RINKER VERY CHANNERY SILT LOAM, 8 TO 30 PERCENT SLOPES	RINKER	No	---	---	---	---	---	450
129: RINKER VERY CHANNERY SILT LOAM, 30 TO 60 PERCENT SLOPES	RINKER	No	---	---	---	---	---	2,310
130: RIVERWASH	RIVERWASH	Yes	terrace	4	NO	YES	NO	2,490
131: ROCK OUTCROP	ROCK OUTCROP	No	---	---	---	---	---	2,160
132: ROCK OUTCROP-KULSHAN COMPLEX, 60 TO 90 PERCENT SLOPES	ROCK OUTCROP	No	---	---	---	---	---	748
	KULSHAN	No	---	---	---	---	---	340
	Unnamed	Yes	alluvial cone	---	---	---	---	---
133: RUBBLELAND	RUBBLELAND	No	---	---	---	---	---	940
134: SAAR GRAVELLY SILT LOAM, 5 TO 30 PERCENT SLOPES	SAAR	No	---	---	---	---	---	965
	Unnamed	Yes	alluvial cone	---	---	---	---	---
135: SAAR GRAVELLY SILT LOAM, 30 TO 60 PERCENT SLOPES	SAAR	No	---	---	---	---	---	2,660
	Unnamed	Yes	alluvial cone	---	---	---	---	---

HYDRIC SOILS LIST--Continued
WHATCOM COUNTY AREA, WASHINGTON: Detailed Soil Map Legend

Map symbol and map unit name	Component	Hydric	Local landform	Hydric soils criteria: Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria	Acres
136: SAAR-HARTNIT COMPLEX, 5 TO 40 PERCENT SLOPES	SAAR	No	---	---	---	---	---	492
	HARTNIT	No	---	---	---	---	---	345
	Unnamed	Yes	alluvial cone	---	---	---	---	---
137: SANDUN VERY GRAVELLY SANDY LOAM, 5 TO 30 PERCENT SLOPES	SANDUN	No	---	---	---	---	---	875
138: SANDUN VERY GRAVELLY SANDY LOAM, 30 TO 60 PERCENT SLOPES	SANDUN	No	---	---	---	---	---	1,135
139: SEHOME LOAM, 2 TO 8 PERCENT SLOPES	SEHOME	No	---	---	---	---	---	1,985
	Bellingham	Yes	depression	2B3	YES	NO	NO	47
	Wet spots	Yes	alluvial cone	---	---	---	---	---
140: SEHOME LOAM, 8 TO 15 PERCENT SLOPES	SEHOME	No	---	---	---	---	---	1,674
	Bellingham	Yes	depression	2B3	YES	NO	NO	39
	Wet spots	Yes	alluvial cone	---	---	---	---	---
141: SEHOME GRAVELLY LOAM, 15 TO 30 PERCENT SLOPES	SEHOME	No	---	---	---	---	---	840
142: SEHOME GRAVELLY LOAM, 30 TO 60 PERCENT SLOPES	SEHOME	No	---	---	---	---	---	1,380
143: SHALCAR MUCK, DRAINED, 0 TO 2 PERCENT	SHALCAR	Yes	depression	1	NO	NO	NO	1,640
	Bellingham	Yes	depression	2B3	YES	NO	NO	19
	Fishtrap	Yes	depression	1	NO	NO	NO	19
	Puget	Yes	flood plain	2B3	YES	NO	NO	19
	Snohomish	Yes	flood plain	2B3	YES	NO	NO	19
	Sumas	Yes	flood plain	2B3	YES	NO	NO	19

HYDRIC SOILS LIST--Continued
WHATCOM COUNTY AREA, WASHINGTON: Detailed Soil Map Legend

Map symbol and map unit name	Component	Hydric	Local landform	Hydric soils criteria: Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria	Acres
144: SHALCAR AND FISHTRAP SOILS, 0 TO 2 PERCENT SLOPES	SHALCAR	Yes	flood plain	1,3	NO	NO	YES	402
	FISHTRAP	Yes	flood plain	1,3	NO	NO	YES	362
	Pangborn	Yes	depression	1	NO	NO	NO	24
145: SHUKSAN GRAVELLY SILT LOAM, 5 TO 30 PERCENT SLOPES	SHUKSAN	No	---	---	---	---	---	1,460
	Unnamed	Yes	alluvial cone	---	---	---	---	---
	Wet spots	Yes	alluvial cone	---	---	---	---	---
146: SHUKSAN GRAVELLY SILT LOAM, 30 TO 60 PERCENT SLOPES	SHUKSAN	No	---	---	---	---	---	1,940
	Unnamed	Yes	alluvial cone	---	---	---	---	---
	Wet spots	Yes	alluvial cone	---	---	---	---	---
147: SHUKSAN-KULSHAN-ROCK OUTCROP COMPLEX, 50 TO 80 PERCENT SLOPES	SHUKSAN	No	---	---	---	---	---	3,045
	KULSHAN	No	---	---	---	---	---	2,175
	ROCK OUTCROP	No	---	---	---	---	---	1,740
	Unnamed	Yes	alluvial cone	---	---	---	---	---
148: SKIPOPA SILT LOAM, 0 TO 8 PERCENT SLOPES	SKIPOPA	No	---	---	---	---	---	3,358
	Bellingham	Yes	depression	2B3	YES	NO	NO	158
	Labounty	Yes	depression	2B3	YES	NO	NO	158
	Shalcar	Yes	depression	1	NO	NO	NO	158
149: SKIPOPA-BLAINEGATE COMPLEX, 0 TO 8 PERCENT SLOPES	SKIPOPA	No	---	---	---	---	---	1,402
	BLAINEGATE	Yes	terrace	2B3	YES	NO	NO	982
	Edmonds	No	depression	---	---	---	---	112
	Shalcar	Yes	flood plain	3,1	NO	NO	YES	112
	Wet spots	Yes	alluvial cone	---	---	---	---	---

HYDRIC SOILS LIST--Continued
WHATCOM COUNTY AREA, WASHINGTON: Detailed Soil Map Legend

Map symbol and map unit name	Component	Hydric	Local landform	Hydric soils criteria: Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria	Acres
150: SKYKOMISH VERY GRAVELLY LOAM, 3 TO 30 PERCENT SLOPES	SKYKOMISH	No	---	---	---	---	---	495
151: SNOHOMISH SILT LOAM, DRAINED, 0 TO 2 PERCENT SLOPES	SNOHOMISH	Yes	flood plain	2B3	YES	NO	NO	788
	Oridia	Yes	flood plain	2B3	YES	NO	NO	39
	Pangborn	Yes	depression	1	NO	NO	NO	39
	Puget	Yes	flood plain	2B3	YES	NO	NO	39
	Snohomish, undrained	Yes	flood plain	2B3	YES	NO	NO	39
	Unnamed	No	---	---	---	---	---	---
152: SNOQUALMIE GRAVELLY LOAMY SAND, 0 TO 3 PERCENT SLOPES	SNOQUALMIE	No	---	---	---	---	---	561
	Riverwash	Yes	flood plain	4	NO	YES	NO	20
	Unnamed	Yes	alluvial cone	---	---	---	---	---
153: SORENSEN VERY GRAVELLY SILT LOAM, 8 TO 30 PERCENT SLOPES	SORENSEN	No	---	---	---	---	---	490
154: SORENSEN VERY GRAVELLY SILT LOAM, 30 TO 60 PERCENT SLOPES	SORENSEN	No	---	---	---	---	---	1,565
155: SPRINGSTEEN VERY GRAVELLY LOAM, 30 TO 60 PERCENT SLOPES	SPRINGSTEEN	No	---	---	---	---	---	2,015
156: SQUALICUM GRAVELLY LOAM, 5 TO 15 PERCENT SLOPES	SQUALICUM	No	---	---	---	---	---	9,274
	Bellingham	Yes	depression	2B3	YES	NO	NO	109
	Labounty	Yes	depression	2B3	YES	NO	NO	109
	Wet spots	Yes	alluvial cone	---	---	---	---	---

HYDRIC SOILS LIST--Continued
WHATCOM COUNTY AREA, WASHINGTON: Detailed Soil Map Legend

Map symbol and map unit name	Component	Hydric	Local landform	Hydric soils criteria: Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria	Acres
157: SQUALICUM GRAVELLY LOAM, 15 TO 30 PERCENT SLOPES	SQUALICUM	No	---	---	---	---	---	6,282
	Labounty	Yes	depression	2B3	YES	NO	NO	148
158: SQUALICUM GRAVELLY LOAM, 30 TO 60 PERCENT SLOPES	SQUALICUM	No	---	---	---	---	---	1,394
	Labounty	Yes	depression	2B3	YES	NO	NO	33
159: SQUALICUM-URBAN LAND COMPLEX, 5 TO 20 PERCENT SLOPES	SQUALICUM	No	---	---	---	---	---	1,040
	URBAN LAND	No	---	---	---	---	---	624
	Labounty	Yes	depression	2B3	YES	NO	NO	62
160: SQUIRES VERY CHANNERY LOAM, 5 TO 30 PERCENT SLOPES	SQUIRES	No	---	---	---	---	---	705
161: SQUIRES VERY CHANNERY LOAM, 30 TO 60 PERCENT SLOPES	SQUIRES	No	---	---	---	---	---	4,105
162: SUMAS SILT LOAM, DRAINED, 0 TO 2 PERCENT SLOPES	SUMAS	Yes	flood plain	2B3	YES	NO	NO	2,104
	Briscot	Yes	flood plain	2B3	YES	NO	NO	74
	Puget	Yes	flood plain	2B3	YES	NO	NO	74
	Shalcar	Yes	flood plain	3,1	NO	NO	YES	74
	Sumas, undrained	Yes	alluvial cone	---	---	---	---	74
	Unnamed	No	---	---	---	---	---	---
163: TACOMA SILT LOAM, 0 TO 1 PERCENT SLOPES	TACOMA	Yes	delta	2B3,4	YES	YES	NO	595
	Tacoma, drained	Yes	delta	2B3	YES	NO	NO	21
	Unnamed	No	---	---	---	---	---	---

HYDRIC SOILS LIST--Continued
WHATCOM COUNTY AREA, WASHINGTON: Detailed Soil Map Legend

Map symbol and map unit name	Component	Hydric	Local landform	Hydric soils criteria: Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria	Acres
164: TACOMA SILT LOAM, DRAINED, 0 TO 1 PERCENT SLOPES	TACOMA	Yes	delta	2B3	YES	NO	NO	280
	Shalcar	Yes	flood plain	3,1	NO	NO	YES	10
	Tacoma, undrained	Yes	alluvial cone	---	---	---	---	10
	Unnamed	No	---	---	---	---	---	---
165: TROMP LOAM, 0 TO 2 PERCENT SLOPES	TROMP	No	---	---	---	---	---	7,769
	Edmonds	No	depression	---	---	---	---	183
	Hale	Yes	terrace	2A	YES	NO	NO	183
166: TWINSI VERY GRAVELLY LOAM, 30 TO 60 PERCENT SLOPES	TWINSI	No	---	---	---	---	---	885
167: TWINSI VERY STONY LOAM, 30 TO 60 PERCENT SLOPES	TWINSI	No	---	---	---	---	---	985
168: TYPIC CRYORTHODS, 60 TO 90 PERCENT SLOPES	TYPIC CRYORTHODS	No	---	---	---	---	---	4,980
169: TYPIC CRYORTHODS-ROCK OUTCROP, 60 TO 90 PERCENT SLOPES	TYPIC CRYORTHODS	No	---	---	---	---	---	3,406
	ROCK OUTCROP	No	---	---	---	---	---	1,048
170: TYPIC PSAMMAQUENTS, TIDAL, 0 TO 1 PERCENT SLOPES	TYPIC PSAMMAQUENTS	Yes	alluvial cone	3,2B2,4	YES	YES	YES	1,700
	Hydraquents	Yes	tidal flat	2B3,3	YES	NO	YES	100
171: URBAN LAND	URBAN LAND	No	---	---	---	---	---	1,232
	Labounty	Yes	depression	2B3	YES	NO	NO	14
	Whitehorn	Yes	depression	2B3,3	YES	NO	YES	14
172: URBAN LAND-WHATCOM-LABOUNTY COMPLEX, 0 TO 8 PERCENT SLOPES	URBAN LAND	No	---	---	---	---	---	1,692

HYDRIC SOILS LIST--Continued
WHATCOM COUNTY AREA, WASHINGTON: Detailed Soil Map Legend

Map symbol and map unit name	Component	Hydric	Local landform	Hydric soils criteria: Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria	Acres
	WHATCOM	No	---	---	---	---	---	1,269
	LABOUNTY	Yes	depression	2B3	YES	NO	NO	846
	Bellingham	Yes	depression	2B3	YES	NO	NO	85
173: VANZANDT VERY GRAVELLY LOAM, 5 TO 15 PERCENT SLOPES	VANZANDT	No	---	---	---	---	---	1,390
	Bellingham	Yes	depression	2B3	YES	NO	NO	33
	Shalcar	Yes	flood plain	1,3	NO	NO	YES	33
	Wet spots	Yes	alluvial cone	---	---	---	---	---
174: VANZANDT VERY GRAVELLY LOAM, 15 TO 30 PERCENT SLOPES	VANZANDT	No	---	---	---	---	---	2,524
	Bellingham	Yes	depression	2B3	YES	NO	NO	59
	Shalcar	Yes	flood plain	1,3	NO	NO	YES	59
	Wet spots	Yes	alluvial cone	---	---	---	---	---
175: VANZANDT VERY GRAVELLY LOAM, 30 TO 60 PERCENT SLOPES	VANZANDT	No	---	---	---	---	---	1,658
	Bellingham	Yes	depression	2B3	YES	NO	NO	39
	Shalcar	Yes	flood plain	1,3	NO	NO	YES	39
176: WELCOME LOAM, 5 TO 30 PERCENT SLOPES	WELCOME	No	---	---	---	---	---	780
	Unnamed	Yes	alluvial cone	---	---	---	---	---
177: WELCOME LOAM, 30 TO 60 PERCENT SLOPES	WELCOME	No	---	---	---	---	---	910
178: WHATCOM SILT LOAM, 0 TO 3 PERCENT SLOPES	WHATCOM	No	---	---	---	---	---	4,938
	Bellingham	Yes	depression	2B3	YES	NO	NO	174
	Labounty	Yes	depression	2B3	YES	NO	NO	174
	Shalcar	Yes	flood plain	1,3	NO	NO	YES	174
	Whitehorn	Yes	depression	2B3,3	YES	NO	YES	174
	Wet spots	Yes	alluvial cone	---	---	---	---	---

HYDRIC SOILS LIST--Continued
WHATCOM COUNTY AREA, WASHINGTON: Detailed Soil Map Legend

Map symbol and map unit name	Component	Hydric	Local landform	Hydric soils criteria: Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria	Acres
179: WHATCOM SILT LOAM, 3 TO 8 PERCENT SLOPES	WHATCOM	No	---	---	---	---	---	13,719
	Bellingham	Yes	depression	2B3	YES	NO	NO	323
	Labounty	Yes	depression	2B3	YES	NO	NO	323
	Shalcar	Yes	flood plain	1,3	NO	NO	YES	323
	Whitehorn	Yes	depression	2B3,3	YES	NO	YES	323
	Wet spots	Yes	alluvial cone	---	---	---	---	---
180: WHATCOM SILT LOAM, 8 TO 15 PERCENT SLOPES	WHATCOM	No	---	---	---	---	---	5,916
	Bellingham	Yes	depression	2B3	YES	NO	NO	139
	Labounty	Yes	depression	2B3	YES	NO	NO	139
	Shalcar	Yes	flood plain	1,3	NO	NO	YES	139
	Whitehorn	Yes	depression	2B3,3	YES	NO	YES	139
	Wet spots	Yes	alluvial cone	---	---	---	---	---
181: WHATCOM SILT LOAM, 30 TO 60 PERCENT SLOPES	WHATCOM	No	---	---	---	---	---	1,887
	Bellingham	Yes	depression	2B3	YES	NO	NO	44
	Shalcar	Yes	flood plain	1,3	NO	NO	YES	44
182: WHATCOM-LABOUNTY SILT LOAMS, 0 TO 8 PERCENT SLOPES	WHATCOM	No	---	---	---	---	---	9,856
	LABOUNTY	Yes	depression	2B3	YES	NO	NO	4,480
	Bellingham	Yes	depression	2B3	YES	NO	NO	538
	Labounty, art. drained	Yes	depression	2B3	YES	NO	NO	538
	Shalcar	Yes	flood plain	1,3	NO	NO	YES	538
183: WHATCOM-LABOUNTY SILT LOAMS, 0 TO 15 PERCENT SLOPES	WHATCOM	No	---	---	---	---	---	1,166
	LABOUNTY	Yes	depression	2B3	YES	NO	NO	530
	Bellingham	Yes	depression	2B3	YES	NO	NO	64

HYDRIC SOILS LIST--Continued
WHATCOM COUNTY AREA, WASHINGTON: Detailed Soil Map Legend

Map symbol and map unit name	Component	Hydric	Local landform	Hydric soils criteria: Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria	Acres
	Labounty, art. drained	Yes	depression	2B3	YES	NO	NO	64
	Shalcar	Yes	flood plain	3,1	NO	NO	YES	64
184: WHITEHORN SILT LOAM, 0 TO 2 PERCENT SLOPES	WHITEHORN	Yes	depression	2B3,3	YES	NO	YES	5,516
	Bellingham	Yes	depression	2B3	YES	NO	NO	130
	Clipper	Yes	terrace	2A	YES	NO	NO	130
	Hale	Yes	terrace	2A	YES	NO	NO	130
	Labounty	Yes	depression	2B3	YES	NO	NO	130
	Shalcar	Yes	flood plain	1,3	NO	NO	YES	130
	Birchbay	No	---	---	---	---	---	---
185: WICKERSHAM CHANNERY SILT LOAM, 0 TO 8 PERCENT SLOPES	WICKERSHAM	No	---	---	---	---	---	1,180
	Unnamed	Yes	alluvial cone	---	---	---	---	---
186: WINSTON SILT LOAM, 0 TO 3 PERCENT SLOPES	WINSTON	No	---	---	---	---	---	5,117
	Bellingham	Yes	depression	2B3	YES	NO	NO	120
	Clipper	Yes	terrace	2A	YES	NO	NO	120
	Shalcar	Yes	flood plain	1,3	NO	NO	YES	120
187: WINSTON LOAM, 3 TO 15 PERCENT SLOPES	WINSTON	No	---	---	---	---	---	1,062
	Bellingham	Yes	depression	2B3	YES	NO	NO	12
	Clipper	Yes	terrace	2A	YES	NO	NO	12
	Shalcar	Yes	flood plain	1,3	NO	NO	YES	12
	Wet spots	Yes	alluvial cone	---	---	---	---	---
188: WINSTON LOAM, 15 TO 40 PERCENT SLOPES	WINSTON	No	---	---	---	---	---	366
	Bellingham	Yes	depression	2B3	YES	NO	NO	4
	Clipper	Yes	terrace	2A	YES	NO	NO	4
	Shalcar	Yes	flood plain	1,3	NO	NO	YES	4

HYDRIC SOILS LIST--Continued
WHATCOM COUNTY AREA, WASHINGTON: Detailed Soil Map Legend

Map symbol and map unit name	Component	Hydric	Local landform	Hydric soils criteria: Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria	Acres
189: WISEMAN VERY CHANNERY SANDY LOAM, 0 TO 8 PERCENT SLOPES	WISEMAN	No	---	---	---	---	---	325
	Unnamed	Yes	alluvial cone	---	---	---	---	---
190: WOLLARD GRAVELLY SILT LOAM, 30 TO 60 PERCENT SLOPES	WOLLARD	No	---	---	---	---	---	775
191: YELM LOAM, 3 TO 8 PERCENT SLOPES	YELM	No	---	---	---	---	---	926
	Whitehorn	Yes	depression	2B3,3	YES	NO	YES	33
	Wet spots	Yes	alluvial cone	---	---	---	---	---
192: YELM-URBAN LAND COMPLEX, 0 TO 3 PERCENT SLOPES	YELM	No	---	---	---	---	---	195
	URBAN LAND	No	---	---	---	---	---	136
	Whitehorn	Yes	depression	2B3,3	YES	NO	YES	16
W: WATER	WATER	Yes	alluvial cone	---	---	---	---	530

Appendix D: Lummi Nation Joint Aquatic Resource Permit Application

LUMMI NATION

JOINT AQUATIC RESOURCE PERMITS APPLICATION (JARPA)

—INSTRUCTIONS—

This Joint Application can be used to apply for Lummi Land Use Conditional Permit, Lummi Coastal Zone Management Permit, Lummi Tidelands Permit, Lummi Nation Tidelands Use Authorization, Section 401 Water Quality Certification From EPA, Coast Guard Bridge Permits, Washington Department of Natural Resources Use Authorization (waterward of -4.5 MLLW), and Army Corps of Engineers Permits. ***You must submit readable copies of the completed application form together with detailed drawings, prepared in accordance with the drawing guidance in Appendix A to the appropriate agencies. You do not need to send the example drawings, the instructions, or the Appendices.*** Remember, depending on the type of project you are proposing, other permits may be required that are not covered by this application.

☞ Use the following checklist to determine which permits to apply for. Your project may require some or all of these permits. If you have trouble deciding which permits you need, please contact the appropriate agency for questions. Agency telephone numbers are in Appendix B. **IF YOU CHECK ANY BOX UNDER A PERMIT TITLE, THEN YOU MUST APPLY FOR THAT PERMIT**. Complete Sections A & C for any of the permits listed below. Also complete Section B for Coastal Zone and Army Corps of Engineers permits. Detailed drawings are required for any of these permits (see Appendix A for drawing requirements).

☐ **Lummi Land Use Conditional Permit** from the Lummi Planning Department (LIBC Resolution No. 97-104 and Title 15) is required if your project includes construction or other work on the Lummi Reservation. This includes projects that will use, divert, obstruct, or change the natural flow or bed of any fresh or salt water of the Lummi Nation. This includes all construction or other work waterward and over the ordinary high water line, including dry channels, and may include projects landward of the ordinary high water line (e.g., activities outside the ordinary high water line that will directly impact fish life and habitat, falling trees into streams or lakes, etc.).

☐ **Lummi Coastal Zone Management Permit** from the Lummi Planning Department (LIBC Resolutions 82-9, 88-37, and Lummi Coastal Zone Management Plan) is required for work or activity within 200 feet of the ordinary high water mark of certain waters.

☐ **Lummi Tidelands Permit** from the Lummi Planning Department (Title 13) is required for any person to create, erect, maintain, or construct any building, obstruction, barrier, restraint, of any nature whatsoever within the tidelands (from the ordinary high water line to the extreme lower low water line (-4.5 ft MLLW)).

☐ **Lummi Nation Tidelands Use Authorization** from the Lummi Planning Department if your project is on, crosses, or impacts the tidelands from the ordinary high water line to the extreme lower low water line (-4.5 ft MLLW).

◆ **Aquatic Resources Use Authorization Notification** from the Washington Department of Natural Resources is required if your project:

☐ is on, crosses, or impacts the bedlands, tidelands or shorelands of navigable waters waterward of the extreme lower low water line (-4.5 ft MLLW).

◆ **Section 401 Water Quality Certification** from the U.S. Environmental Protection Agency (EPA) under 33 USC § 1341 is needed when a federal approval is required for a project, including the following:

- ☐ Corps of Engineers Nationwide Permit--Send to EPA Aquatic Resources Section,
- ☐ A Corps of Engineers individual permit--Send only to Corps of Engineers; the Corps will notify the EPA.

- **Section 404 Permit** from the Corps of Engineer under 33 USC § 1344 is required if your project includes:

  ☐ discharge or excavation of dredged or fill material waterward of the ordinary high water mark, or the mean higher high tide line in tidal areas, in waters of the United States, **including wetlands**;
  ☐ mechanized land clearing in waters of the United States, **including wetlands.**

- **Section 10 Permit** from the Corps of Engineer is required for:

  ☐ any work in or affecting navigable waters of the United States (e.g., floats, piers, docks, dredging, piles, buoys, overhead power lines, etc.).

- **Section 9 Permit** from the Coast Guard is required for:

  ☐ construction of a new bridge or modification to an existing bridge over a navigable waterway.

USEFUL DEFINITIONS

The following definitions are presented to help applicants in completing the JARPA. They may not necessarily represent specific language from the laws implemented through JARPA.

***Ordinary High Water Mark or Line** means the visible line on the banks where the presence and action of waters are so common as to leave a mark upon the soil or vegetation: Provided, that in any area where the ordinary high water line cannot be found the ordinary high water line adjoining saltwater shall be the line of mean higher high water and the ordinary high water line adjoining freshwater shall be the elevation of the mean annual flood.*

***Mean Lower Low** is the 0.0 tidal elevation, determined by averaging each day's lowest tide at a particular location over a period of 19 years. It is the tidal datum for vertical tidal references in the salt water area.*

Mean High Water and Mean Higher High Water Tidal Elevations at any specific location can be found in tidal benchmark data compiled by the United States Department of Commerce, Environmental Science Services Administration, Coast and Geodetic Survey, dated January 24, 1979. This information can be obtained from the Corps of Engineers at (206) 764-3495.

The determination of tidal elevation is obtained by averaging each day's highest tide at a particular location over a period of 19 years, measured from mean lower low water, which equals 0.0 tidal elevation.

Shorelands or shoreland areas means those lands extending landward for two hundred feet in all directions as measured on a horizontal plane from the ordinary high water mark; floodways and contiguous floodplain areas landward two hundred feet from such floodways; and all wetlands and river deltas associated with the streams, lakes, and tidal waters.

Shorelines means all water areas of the Reservation, including reservoirs, and their associated wetlands, together with the lands underlying them, except stream segments upstream of the point where mean annual flow is less than 20 cubic feet per second, and lakes less than 20 acres in size.

Wetlands means areas that are inundated or saturated by surface water or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

Bridge means any structure including pipelines and conveyor belts, which transports traffic or materials across a navigable water.

Aquatic Tidelands means the area between the ordinary high tide line and extreme low tide line, unless otherwise established.

Aquatic Shorelands means the shore areas of non-tidal navigable lakes or rivers between the ordinary high water line and the line of navigability unless otherwise established.

Aquatic Bedlands means the area waterward of and below the line of navigability on non-tidal rivers and lakes, or below the extreme low tide mark in navigable tidal waters, or below the outer harbor line where a harbor has been created.

AGENCY USE ONLY	
Agency Reference #:______________________________	Date Received:______________
Other:____	

JARPA FORM

(for use on the Lummi Indian Reservation)

PLEASE TYPE OR PRINT IN BLUE OR BLACK INK

Based on the preceding checklist, I am sending copies of this application to the following: *(check all that apply)*

- ☐ Lummi Planning Department for: ☐ Land Use Conditional Permit ☐ Coastal Zone Management Permit ☐ Tidelands Permit ☐ Tidelands Use Authorization
- ☐ United States Environmental Protection Agency for: ☐ 401 Water Quality Certification Permits
- ☐ Washington Department of Natural Resources for: ☐ Aquatic Resources Use Authorization Notification
- ☐ Corps Engineers for: ☐ Section 404 ☐ Section 10 permit
- ☐ Coast Guard for: ☐ Section 9 Bridge Permit

SECTION A - Use for all permits covered by this application. Be sure to also complete Section C (Signature Block) for all permit applications.

1. APPLICANT		
MAILING ADDRESS		
WORK PHONE	HOME PHONE	FAX #

If an agent is acting for the applicant during the permit process, complete #2.

2. AUTHORIZED AGENT		
MAILING ADDRESS		
WORK PHONE	HOME PHONE	FAX #

3. RELATIONSHIP OF APPLICANT TO PROPERTY: ☐ OWNER ☐ PURCHASER ☐ LESSEE ☐ OTHER: __
4. NAME, ADDRESS, AND PHONE NUMBER OF PROPERTY OWNER(S), IF OTHER THAN APPLICANT:

5. LOCATION (STREET ADDRESS, INCLUDING CITY, COUNTY AND ZIP CODE, WHERE PROPOSED ACTIVITY EXISTS OR WILL OCCUR)				
WATERBODY				TRIBUTARY OF
1/4 SECTION	TOWNSHIP	RANGE	GOVERNMENT LOT	SHORELINE DESIGNATION
				ZONING DESIGNATION
TAX PARCEL NO.:				DNR STREAM TYPE, IF KNOWN

6. DESCRIBE THE CURRENT USE OF THE PROPERTY, AND STRUCTURES EXISTING ON THE PROPERTY. IF ANY PORTION OF THE PROPOSED ACTIVITY IS ALREADY COMPLETED ON THIS PROPERTY, INDICATE MONTH AND YEAR OF COMPLETION.

IS THE PROPERTY AGRICULTURAL LAND? ☐ YES ☐ NO

ARE YOU A USDA PROGRAM PARTICIPANT? ☐ YES ☐ NO

7a. DESCRIBE THE PROPOSED WORK: COMPLETE PLANS AND SPECIFICATIONS SHOULD BE PROVIDED FOR ALL WORK WATERWARD OF THE ORDINARY HIGH WATER MARK OR LINE INCLUDING TYPES OF EQUIPMENT TO BE USED. IF APPLYING FOR A SHORELINE PERMIT, DESCRIBE ALL WORK WITHIN AND BEYOND 200 FEET OF THE ORDINARY HIGH WATER MARK. ATTACH A SEPARATE SHEET IF ADDITIONAL SPACE IS NEEDED.

7b. DESCRIBE THE PURPOSE OF THE PROPOSED WORK.

7c. DESCRIBE THE POTENTIAL IMPACTS TO CHARACTERISTIC USES OF THE WATER BODY. THESE USES MAY INCLUDE FISH AND AQUATIC LIFE, WATER QUALITY, WATER SUPPLY, RECREATION, AND AESTHETICS. IDENTIFY PROPOSED ACTIONS TO AVOID, MINIMIZE, AND MITIGATE DETRIMENTAL IMPACTS, AND PROVIDE PROPER PROTECTION OF FISH AND AQUATIC LIFE.

PREPARATION OF DRAWINGS: SEE APPENDIX A - SAMPLE DRAWINGS AND CHECKLIST FOR COMPLETING THE DRAWINGS. ***ONE SET OF ORIGINAL OR GOOD QUALITY REPRODUCIBLE DRAWINGS MUST BE ATTACHED.*** NOTE: APPLICANTS ARE ENCOURAGED TO SUBMIT PHOTOGRAPHS OF THE PROJECT SITE, BUT THESE DO NOT SUBSTITUTE FOR DRAWINGS. ***THE CORPS OF ENGINEERS AND COAST GUARD REQUIRE DRAWINGS ON 8-1/2 X 11 INCH SHEETS. LARGER DRAWINGS MAY BE REQUIRED BY OTHER AGENCIES***

8. WILL THE PROJECT BE CONSTRUCTED IN STAGES? ☐ YES ☐ NO

PROPOSED STARTING DATE: __

ESTIMATED DURATION OF ACTIVITY: __

9. CHECK IF ANY STRUCTURES WILL BE PLACED:

☐ WATERWARD OF THE ORDINARY HIGH WATER MARK OR LINE FOR FRESH OR TIDAL WATERS; AND/OR

☐ WATERWARD OF THE MEAN HIGH WATER LINE IN TIDAL WATERS

10. WILL FILL MATERIAL (ROCK, FILL, BULKHEAD, PILINGS OR OTHER MATERIAL) BE PLACED:

☐ WATERWARD OF THE ORDINARY HIGH WATER MARK OR LINE FOR FRESH WATERS? IF YES, VOLUME (CUBIC YARDS)__/AREA__(ACRES

☐ WATERWARD OF THE MEAN HIGHER HIGH WATER FOR TIDAL WATERS? IF YES, VOLUME (CUBIC YARDS)__/AREA__(ACRES)

11. WILL MATERIAL BE PLACED IN WETLANDS? ☐ YES ☐ NO

IF YES:

A. IMPACTED AREA IN ACRES: __

B. HAS A DELINEATION BEEN COMPLETED? IF YES, PLEASE SUBMIT WITH APPLICATION. ☐ YES ☐ NO

C. HAS A WETLAND REPORT BEEN PREPARED? IF YES, PLEASE SUBMIT WITH APPLICATION. ☐ YES ☐ NO

D. TYPE AND COMPOSITION OF FILL MATERIAL (E.G., SAND, ETC.): __

E. MATERIAL SOURCE: __

F. LIST ALL SOIL SERIES (TYPE OF SOIL) LOCATED AT THE PROJECT SITE, & INDICATE IF THEY ARE HYDRIC SOILS. SOILS INFORMATION CAN BE OBTAINED FROM THE NATURAL RESOURCES CONSERVATION SERVICE (NRCS):

12. WILL PROPOSED ACTIVITY CAUSE FLOODING OR DRAINING OF WETLANDS? ☐ YES ☐ NO

IF YES, IMPACTED AREA IS __ ACRES

13. WILL EXCAVATION OR DREDGING BE REQUIRED IN WATER OR WETLANDS? ☐ YES ☐ NO

IF YES:

A. VOLUME: __(CUBIC YARDS)/AREA __ (ACRES)

B. COMPOSITION OF MATERIAL TO BE REMOVED: __

C. DISPOSAL SITE FOR EXCAVATED MATERIAL: __

D. METHOD OF DREDGING: __

14. LIST OTHER APPLICATIONS, APPROVALS, OR CERTIFICATIONS FROM OTHER TRIBAL, FEDERAL,OR STATE AGENCIES FOR ANY STRUCTURES, CONSTRUCTION, DISCHARGES, OR OTHER ACTIVITIES DESCRIBED IN THE APPLICATION (I.E., PRELIMINARY PLAT APPROVAL, NPDES PERMIT, BUILDING PERMIT, NEPA REVIEW, TIMBER HARVEST APPLICATION, ETC.) ALSO INDICATE WHETHER WORK HAS BEEN COMPLETED AND INDICATE ALL EXISTING WORK ON DRAWINGS.

TYPE OF APPROVAL	ISSUING AGENCY	IDENTIFICATION NO.	DATE OF APPLICATION	DATE APPROVED	COMPLETED?
NEPA LEAD AGENCY		NEPA DECISION:		NEPA DECISION DATE:	

15. HAS ANY AGENCY DENIED APPROVAL FOR THE ACTIVITY DESCRIBED HEREIN OR FOR ANY ACTIVITY DIRECTLY RELATED TO THE ACTIVITY DESCRIBED HEREIN? ☐ YES ☐ NO IF YES, EXPLAIN:

SECTION B - Use for Lummi Use Authorization, Coastal Zone Management Permit, and Corps of Engineers permits only:

16. TOTAL COST OF PROJECT. THIS MEANS THE FAIR MARKET VALUE OF THE PROJECT, INCLUDING MATERIALS, LABOR, MACHINE RENTALS, ETC.

17. LOCAL GOVERNMENT WITH JURISDICTION:

Lummi Nation

18. FOR CORPS, COAST GUARD, AND DNR PERMITS, PROVIDE NAMES, ADDRESSES, AND TELEPHONE NUMBERS OF ADJOINING PROPERTY OWNERS, LESSEES, ETC. PLEASE NOTE: NEPA COMPLIANCE MAY REQUIRE ADDITIONAL NOTICE -- CONSULT THE LUMMI PLANNING DEPARTMENT.

NAME	ADDRESS	PHONE NUMBER

SECTION C - This section MUST be completed for any permit covered by this application.

19. APPLICATION IS HEREBY MADE FOR A PERMIT OR PERMITS TO AUTHORIZE THE ACTIVITIES DESCRIBED HEREIN. I CERTIFY THAT I AM FAMILIAR WITH THE INFORMATION CONTAINED IN THIS APPLICATION, AND THAT TO THE BEST OF MY KNOWLEDGE AND BELIEF, SUCH INFORMATION IS TRUE, COMPLETE, AND ACCURATE. I FURTHER CERTIFY THAT I POSSESS THE AUTHORITY TO UNDERTAKE THE PROPOSED ACTIVITIES. I HEREBY GRANT TO THE AGENCIES TO WHICH THIS APPLICATION IS MADE, THE RIGHT TO ENTER THE ABOVE-DESCRIBED LOCATION TO INSPECT THE PROPOSED, IN-PROGRESS OR COMPLETED WORK. I AGREE TO START WORK ONLY AFTER ALL NECESSARY PERMITS HAVE BEEN RECEIVED.

SIGNATURE OF APPLICANT OR AUTHORIZED AGENT | DATE

I HEREBY DESIGNATE ______________________________

TO ACT AS MY AGENT IN MATTERS RELATED TO THIS APPLICATION FOR PERMIT(S). I UNDERSTAND THAT IF A FEDERAL PERMIT IS ISSUED, I MUST SIGN THE PERMIT.

SIGNATURE OF APPLICANT | DATE

SIGNATURE OF LANDOWNER (EXCEPT PUBLIC ENTITY LANDOWNERS, E.G. DNR) | DATE

THIS APPLICATION MUST BE SIGNED BY THE APPLICANT AND THE AGENT, IF AN AUTHORIZED AGENT IS DESIGNATED.

18 U.S.C §1001 provides that: Whoever, in any manner within the jurisdiction of any department or agency of the United States knowingly falsifies, conceals, or covers up by any trick, scheme, or device a material fact or makes any false, fictitious, or fraudulent statements or representations or makes or uses any false writing or document knowing same to contain any false, fictitious, or fraudulent statement or entry, shall be fined not more than $10,000 or imprisoned not more than 5 years or both.

COMPLETED BY LUMMI PLANNING DEPARTMENT

A. Nature of the existing shoreline. (Describe type of shoreline, such as marine, stream, lake, lagoon, marsh, bog, swamp, flood plain, floodway, delta; type of beach, such as accretion, erosion, high bank, low bank, or dike; material such as sand, gravel, mud, clay, rock, riprap; and extent and type of bulkheading, if any:)

B. In the event that any of the proposed buildings or structures will exceed a height of thirty-five feet above the average grade level, indicate the approximate location of and number of residential units, existing and potential, that will have an obstructed view

C. If the application involves a conditional use or variance, set forth in full that portion of the program which provides that the proposed use may be a conditional use, or, in the case of a variance, from which the variance is being sought:

These Agencies are Equal Opportunity and Affirmative Action employers.

For special accommodation needs, please contact the appropriate agency from Appendix B.

APPENDIX A:
GUIDANCE CHECKLIST FOR COMPLETION OF DRAWINGS

General Information. Three types of illustrations are needed to properly depict the proposed activity: Vicinity Map, Plan View, and Cross-Sectional View. Drawings to scale should be prepared using clear printing, black ink, and the fewest number of sheets possible. Include the scale. The importance of clear accurate drawings cannot be overstated. At a minimum, drawings must contain the following information; other information may be required depending on project type. If you have questions regarding completing the drawings, call the appropriate agency.

1. Vicinity Map. A copy of a county or city road map, or a U.S. Geological Survey topographic map may be used. Include:

( ) a. North arrow.
( ) b. Name of waterbody (and river mile if appropriate).
( ) c. Location of the proposed activity (indicate with a circle, arrow, X, or similar symbol).
( ) d. Provide latitude and longitude of the site to the nearest second.
( ) e. Provide directions to the site.

2. Plan View. This drawing illustrates the proposed project area as if you were looking down at the site from overhead.

( ) a. North arrow.
( ) b. Name of waterbody and direction of water flow.
( ) c. Location of existing shoreline.
Tidal Waters: Show the Ordinary High, Mean High, Mean Low, Mean Higher High, and Mean Lower Low Water Marks or Lines, and/or wetland boundaries. Indicate elevation above datum.
Non-tidal waters: Show the Ordinary High Water Mark or Line, Meander Line, and/or wetland boundary.
( ) d. Dimensions of the activity or structure and impervious surfaces, distance from property lines, and the distance it extends into the waterbody beyond the Ordinary High, Mean High, Mean Higher High, and Mean Low Water Mark or Line, and/or wetland boundaries, as appropriate.
( ) e. For Corps permits, indicate the distance to Federal projects and/or navigation channels (if applicable). To ascertain, call the Corps Regulatory Branch Office at (206) 764-3495.
( ) f. Show existing structures on subject and adjoining properties.
( ) g. Indicate adjoining property ownership.
( ) h. If fill material is to be placed, identify the type of material, amount of material (cubic yards), and area to be filled (acres).
( ) i. If project involves dredging, identify the type of material, amount of material (cubic yards), area to be dredged, method of dredging, and location of disposal site. Dredging in areas shallower than -10 feet needs to be clearly identified on drawings.
( ) j. Identify any part of the activity that has been completed.
( ) k. Indicate types and location of aquatic, wetland, and riparian vegetation.
( ) l. Erosion control measures, stabilization of disturbed areas, etc.
( ) m. Utilities, including water, sanitary sewer, power and stormwater conveyance systems (e.g., bioswales).
( ) n. Indicate stormwater discharge points.

3. Cross-Sectional View. This drawing illustrates the proposed activity as if it were cut from the side and/or front. Include:

( ) a. Location of water lines.
Tidal Waters: Show the Ordinary High, Mean High, Mean Higher High, and Mean Lower Low Water Marks or Lines, and/or wetland boundary.
Non-tidal waters: Show the Ordinary High Water Mark or Line, and/or wetland boundary.
( ) b. Water depth or tidal elevation at waterward face of project.
( ) c. Dimensions of the activity or structure, and the distance it extends into the waterbody beyond the Ordinary High, the Mean High, the Mean Higher High and Mean Low Water Mark or Line, and/or wetland boundaries.
( ) d. Indicate dredge and/or fill grades as appropriate.
( ) e. Indicate existing and proposed contours and elevations.
( ) f. Indicate types and location of aquatic, wetland, and riparian vegetation present on site.
( ) g. Indicate type and location of material used in construction and method of construction.
( ) h. Indicate height of structure.

4. Clearance and Elevations. Applies to Coast Guard Bridge Permits only.

( ) a. Vertical clearance measured from Mean Higher (tidal waters) or Ordinary High (non-tidal water).
( ) b. Horizontal clearance between piers or pilings.
( ) c. Bottom elevation of the waterway at the bridge.

APPENDIX B: AGENCY CONTACTS

Below is a list of agencies to which a copy of the Joint Application may be sent, and which permit each agency issues. Technical assistance and information is also available from these offices.

Lummi Planning Department (Land Use Conditional Use, Coastal Zone Management, Tidelands, Tidelands Use)

Lummi Planning Department
2828 Kwina Road
Bellingham, Washington 98226-9298
Telephone (360) 384-2307 ext 423
FAX (360) 380-6331

Lummi Natural Resources Department

Lummi Natural Resources Department
2616 Kwina Road
Bellingham, Washington 98226-9298
Telephone (360) 384-2272
FAX (360) 384-4737

Department of the Army Permit (Section 404 or Section 10)

U.S. Army Corps of Engineers,
Seattle District
Regulatory Branch
Post Office Box 3755
Seattle, WA 98124-2255
Telephone (206) 764-3495
FAX (206) 764-6602

United States Environmental Protection Agency (401 Certification)

United States Environmental Protection Agency, Region 10
Office of Ecosystems and Communities
Aquatic Resources Section, M/S ECO-083
1200 6th Avenue
Seattle, WA 98101
Telephone (206) 553-6221
FAX (206) 553-1775

Coast Guard (Section 9 Bridge Permit)

Commander 13th Coast Guard District (OAN)
915 Second Avenue
Seattle, WA 98174-1067
Attn: Austin Pratt
Telephone (206) 220-7282

Washington Department of Natural Resources Aquatic Resources regarding authorization to use bedlands of navigable waters waterward of the extreme lower low water line (-4.5 ft MLLW).

Northwest Region — Telephone (360) 856-3500

Headquarters — Telephone (360) 902-1100