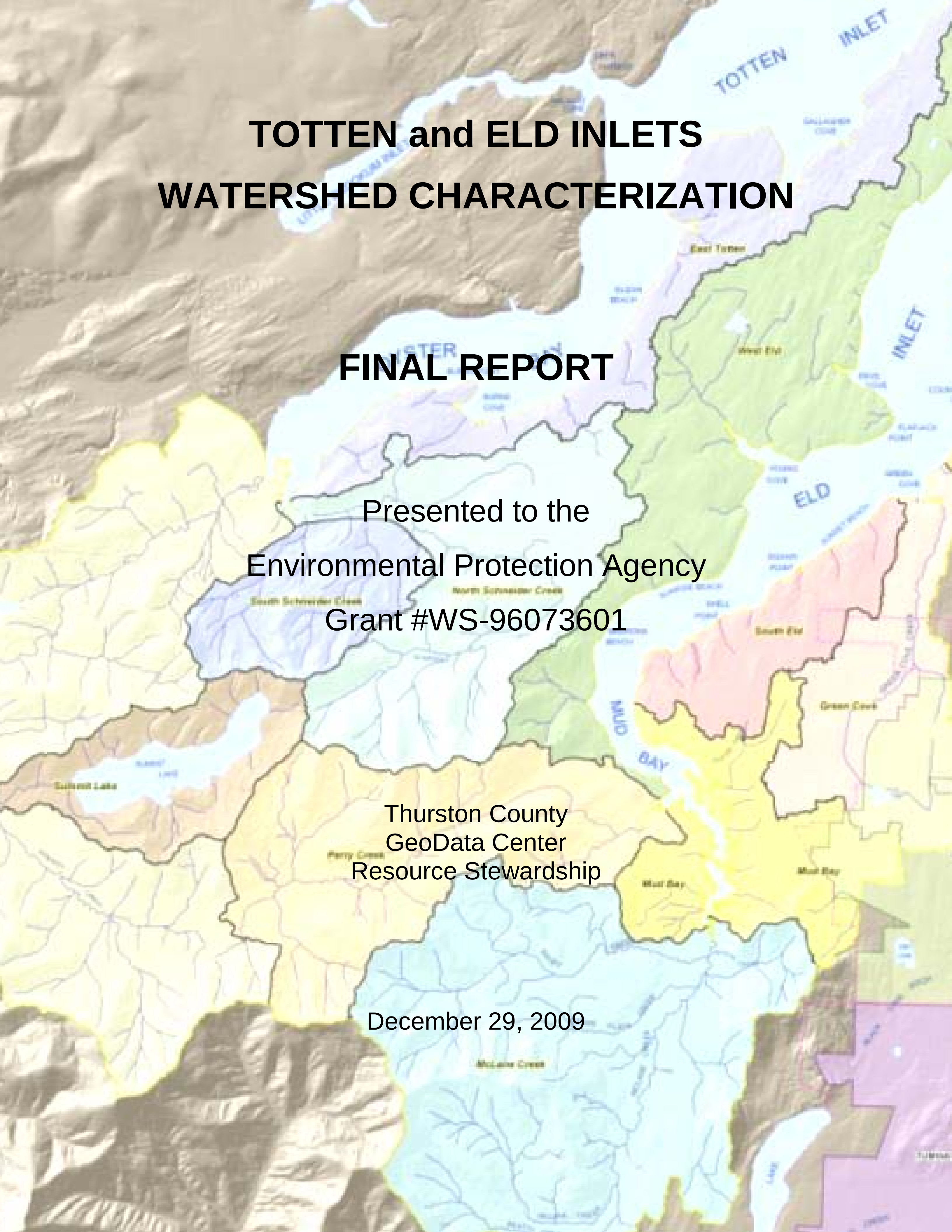
TOTTEN and ELD INLETS WATERSHED CHARACTERIZATION

FINAL REPORT

Presented to the
Environmental Protection Agency
Grant #WS-96073601

Thurston County
GeoData Center
Resource Stewardship

December 29, 2009



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Acknowledgments

We would like to first acknowledge the Environmental Protection Agency (EPA) for providing grant funds to complete this important work for Thurston County and the South Puget Sound.

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List of Acronyms and abbreviations

303(d)	List of impaired water bodies specified in the Clean Water Act, Section 303(d)
Basin	1,000 to 10,000 acres
B-IBI	Benthic – Index of Biological Integrity
Catchment	32 to 320 acres
DAU	Drainage Analysis Unit (approximately 0.25 sq mile or 160 acres)
DBH	Diameter breast height
DEM	Digital Elevation Model
Ecology	Washington State Department of Ecology
EIA	Effective Impervious Area
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESB	Engrossed Senate Bill
FEMA	Federal Emergency Management Agency
FRAGSTATS	FRAGSTATS is a computer software program designed to compute a wide variety of landscape metrics
GeoData	Thurston County's GeoData Center
GIS	Geographical Information System

GLO	General Land Office
LiDAR	Light Detecting and Ranging
LWD	Large Woody Debris
NEPA	National Environmental Policy Act
PHS	Priority Habitats and Species
SEPA	State Environmental Policy Act
SSHIAP	Salmon and Steelhead Habitat Inventory and Assessment Program
Sub-basin	100 to 1,000 acres
Sub-watershed	320 to 19,200 acres
TIA	Total Impervious Area
TMDL	Total Maximum Daily Load
TRPC	Thurston County Regional Planning
USDA	US Department of Agriculture
USGS	US Geological Survey
WAC	Washington Administrative Code
WADNR	Washington Department of Natural Resources
Watershed	19,200 to 320,000 acres
WDFW	Washington State Department of Fish and Wildlife
WRIA	Water Resource Inventory Area as defined in Chapter 173-500 WAC

Executive Summary

This project was initiated to address a top priority in the Puget Sound Partnership's *Puget Sound Conservation and Recovery Plan* to reduce the environmental damage from stormwater runoff. This includes preventing nutrient and pathogen pollution by assessing the feasibility of a watershed-based National Pollutant Discharge Elimination System (NPDES) permit. This report presents the results of a watershed characterization of landscape conditions in the Totten and Eld Inlets that identified preservation, restoration, and mitigation sites at the watershed scale rather than smaller jurisdictional boundaries used in traditional permit approaches.

There are multiple jurisdictions in Thurston County that have applied for their National Pollutant Discharge Elimination System (NPDES) Phase II and Phase I permits. Thurston County, in addition to the cities of Olympia, Lacey, and Tumwater are designated Phase II permittees. The Washington State Department of Transportation (WSDOT) is a NPDES Phase I permittee in Thurston County.

Each jurisdiction has applied for their respective permit separately. Separate permits could lead to duplicative efforts in planning, assessment, and monitoring as each jurisdiction addresses the six core Clean Water Act (CWA) programs and other requirements under the Safe Drinking Water Act (SDWA). These permits are managed by the Washington State Department of Ecology (WDOE) individually.

Watershed based methods will be most effective when the approach is driven by broader landscape needs and conditions rather than individual site needs. The results of this study provides refined existing data in support of CWA, SDWA, Endangered Species Act (ESA), Shoreline Management Act (SMA), and Critical Area Ordinance updates. This method represents a transition from a site-driven to a more holistic *landscape-driven* approach towards assessing ecosystem function and current ecological processes within a watershed.

This report presents the results of steps One, Two and Three of a six step process detailed in EPA's Watershed-Based NPDES Permitting Implementation Guidance drafted in 2003, and updated in 2007 to assess the feasibility of developing a watershed-based permit based on a watershed scale for the Totten and Eld Inlet basin. These steps are as follows:

- <u>Step One:</u> Select a Watershed and Determine the Boundaries
- <u>Step Two:</u> Identify and facilitate multiple jurisdictions to participate in a watershed-based NPDES permit or permit compliance approach using the EPA's guidance;
- <u>Step Three:</u> Collect and analyze data through a watershed characterization for permit development or permit compliance;
- <u>Step Four:</u> Develop watershed-based permit or permit compliance conditions and documentation.
- <u>Step Five:</u> Issue Watershed-Based NPDES Permit
- <u>Step Six:</u> Measure and Report Progress

Steps four, five and six have not been initiated as proposed, but it is anticipated that work will be completed during the first NPDES Phase I permit period (2007 to 2012).

This document presents the work of the technical team using Gersib et al. (2004) methods. *It is recommended that the reader review the methods prior to reading the report to better understand the results.* In addition, it is a culmination of refinements made by our technical team to meet the needs of Thurston County. The report provides a scientific approach to analyzing the ecological and biological processes that maintain a healthy watershed. The central goal of the watershed characterization work is to identify natural resource areas that could serve as stormwater retrofit sites to mitigate existing urban development in the Totten and Eld Inlets.

At a landscape scale, the Totten and Eld Inlet study subdivided the study area into 308 drainage analysis units (DAU) or catchments and used landscape attributes to characterize the condition of key ecological processes (movement of water, sediment, large wood debris, pollutants, and heat) and biological processes (aquatic integrity and upland habitat connectivity) that have been affected by past urban development. This is accomplished by interpreting existing land cover and natural resource data and by developing databases that identify the location and condition of wetland, riparian, and floodplain resources. The goal is to identify targeted landscape areas having the potential to optimize environmental benefits if restored.

The methods identify possible candidate wetland, riparian, and floodplain restoration sites through photo and Geographical Information System (GIS) interpretation of the study area. In addition to creating these natural resource datasets, a stormwater retrofit database was developed to provide additional options for treating stormwater in urban areas where few viable natural resource options exist.

The stormwater retrofit priority list is a sub-set of data intended specifically for identifying potential wetland, riparian, and floodplain restoration sites that have potential to mitigate stormwater quality and quantity impacts of past urban development. The natural resource restoration priority list is intended to identify sites that maximize overall ecosystem function. Finally, the fish habitat priority list ranks sites that have the potential to maximize habitat benefits to anadromous and resident fish species. Those sites are identified and used as a filter to avoid using natural resource sites for stormwater retrofits.

In the study area, it was determined that the Green Cove Sub-watershed was mostly altered by development with total impervious area (TIA) at 14% of the total watershed. These areas include the City of Olympia, as well as unincorporated Thurston County. The Mud Bay Sub-watershed had the second highest value for TIA at 11%. McLane Creek Sub-watershed is least impacted by urban development with only 2% TIA.

To identify and evaluate potential restoration opportunities, the methods used watershed characterization to identify the ecological and biological processes of each DAU. The methods also identified altered wetland, floodplain, and riparian resources. Each potential restoration site was put in the context of the existing landscape. The sites were then evaluated and prioritized for restoration. In the study area, we evaluated 395 riparian areas, 311 wetland areas, and 12 floodplain areas for a total of 718 potential sites. Those sites were further evaluated for potential stormwater retrofit sites that avoided fish habitat. By default, sites not identified high for restoration are candidates for preservation.

Of these sites, 214 potential wetland, floodplain and riparian restoration sites met our minimum criteria for potential use for restoration. Those sites were prioritized for optimizing overall ecosystem function within the DAU.

Background

This report summarizes a scientific framework for watershed characterization and describes a set of methods developed at the watershed scale to assist in better land use decisions. As a conceptual framework, this document serves as the key deliverable to Thurston County summarizing watershed characterization methods and developing key recommendations that other County departments, local jurisdictions, and other entities can use to help meet current and future environmental assessment and planning needs.

Watershed based methods will be most effective when the approach is driven by landscape need and condition rather than an individual site needs. The results will help to refine and provide new data to meet the needs of the Clean Water Act (CWA), Safe Drinking Water Act (SDWA), Endangered Species Act (ESA), Shoreline Management Act (SMA), and Critical Area Ordinance updates. It represents a transition from a site-driven to landscape-driven approach to assessing current ecological processes of the watershed.

Despite dramatic increases in effort, legal mandates, and expenditures for environmental protection and restoration over the past 20 years, the overall condition of natural ecosystems continues to decline (Karr 1995, Montgomery et al. 1995). A growing body of work indicates that declines in ecosystem integrity are perpetuated by existing policies and traditional techniques that tend to treat local symptoms of resource degradation and fail to address the root biological and physical causes of ecosystem degradation and population decline. These policy and traditional techniques perpetuate a narrow “site” review and analysis that often results in restoration that treat symptoms of localized habitat/resource degradation rather than addressing the systemic causes of ecosystem degradation (Frissell 1996, Angermeier and Schlosser 1995, Montgomery et al. 1995, Reeves et al. 1995, Ebersole et al. 1997).

Thurston County was designated a National Pollutant Discharge Elimination (NPDES) Phase II jurisdiction in the 2000 census. Thurston County submitted a NPDES Phase II permit application to Ecology in March 2003. With the issuance of the NPDES Permit for Phase II communities in February 2007, Thurston County determined that a more holistic approach was needed to incorporate all the required regulations at the watershed level to promote efficiency in monitoring, analyzing, and reporting on the health of our water bodies. Current government efforts are segmented and have not proven to provide protection to Thurston County’s streams and the Puget Sound.

This study provides substantial opportunity to blend developing watershed approaches with new modeling and assessment tools to develop outcome-based approaches that Thurston County Resource Stewardship, Strategic Planning, and Public Works, can use to make better land use decisions and management.

General Framework for Watershed Characterization

The following is a very brief summary of how watershed characterizations are conducted in Thurston County. The reader is encouraged to read the methods included in Appendix A to have a better understanding of the landscape indictors, the natural resource attributes, and rules and assumptions used to complete a landscape characterization.

Briefly, the general framework is as follows:

1. Define appropriate spatial scales to be used in watershed characterization;
2. Compile land use/land cover information for pre-development and current conditions and estimate the type and extent of future growth/development;
3. Develop an understanding of the ecological processes within drainages occurring in the area, identify key drivers for those processes, and begin to understand how past and present land use has altered processes and disturbance regimes;
4. Assess landscape sensitivity to process alteration and identify areas most sensitive and most resistant to development;
5. Characterize the general condition of ecological processes within the largest acceptable landscape scale;
6. Identify landscape areas having specific levels of degradation to targeted ecological processes under current conditions;
7. Assess the probability that processes within target landscape areas will be maintained over the long-term using the future build-out scenario; and
8. This framework employs and adapts the five-step strategy outlined by Beechie and Bolton (1999). A complete, detailed scientific framework for watershed characterization is presented in this document.

See Figure A which outlines the process of conducting a watershed characterization

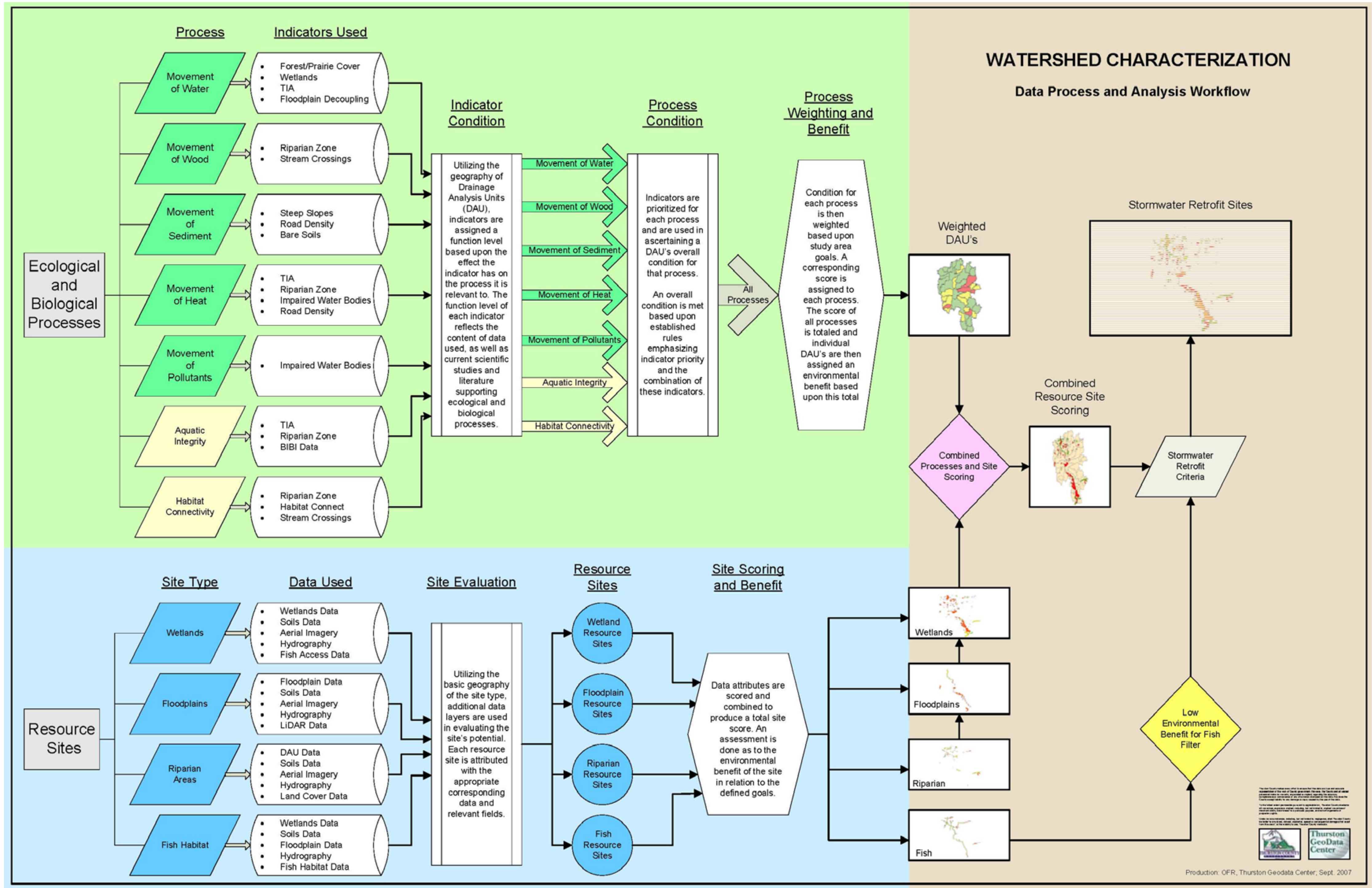


Figure A. Process flowchart

What is in this document?

This document presents the work of the technical team using Gersib et al. (2004) landscape characterization methods and our refinements made by our technical team to meet the needs of Thurston County, a local government. The report provides a scientific approach to analyzing the ecological and biological processes that maintain a healthy watershed. The goal of the watershed characterization work is to identify mitigation projects, restoration sites, and preservation sites to assist in improving watershed function and mitigating impacts from past urban development in the South Puget Sound watersheds, as well as identifying avoidance areas for future development. This work also identifies priority preservation sites that have been identified for potential purchase using Conservation Futures funds.

The methods characterize the condition of key ecological processes (movement of water, sediment, large wood, pollutants, and heat) and biological processes (aquatic integrity and upland habitat connectivity) that have been affected by past urban development. This is accomplished by interpreting existing land cover and natural resource data and by developing databases that identify the location and condition of wetland, riparian, and floodplain resources. Following a description of baseline conditions, areas are then identified that target landscape areas having the potential to optimize environmental benefits if restored.

At the site scale, all possible candidate wetland, riparian, and floodplain restoration sites are identified through photo and Geographical Information System (GIS) interpretation of the study area. In addition to creating these natural resource datasets, a stormwater retrofit database was developed to provide additional options for treating stormwater in urban areas where few viable natural resource options exist.

The stormwater retrofit priority list is intended specifically for identifying potential wetland, riparian, and floodplain restoration sites that have potential to mitigate stormwater quality and quantity impacts of past urban development. The natural resource restoration priority list is intended to identify sites that maximize overall ecosystem function.

What are the general findings of this study?

At the landscape scale, it was determined that the entire study area had a total impervious area (TIA) value of 4%, a coniferous forest value of 20%, a mixed forest value of 29%, and a grasses value of 14%. It should be noted that the TIA values include other landscape attributes (e.g., shadowing) where it couldn't be distinguished from impervious cover. Only the predominant land cover values are listed in the table. It should also be noted that effective impervious area (EIA) is a much stronger indicator for the delivery and routing of water. However, the data required, including stormwater infrastructure is difficult to acquire on a large scale. Thus, by default we use TIA to determine the delivery and routing of water.

Table 1 has the values of major land cover categories of the sub-watersheds

Table 1. Land Cover Values in the Study Areas

Sub-Watershed	Impervious Area (%)	Coniferous Forest (%)	Mixed Forest (%)	Grasses (%)
Kennedy Creek	2	19	36	18
North Schneider	4	21	25	14
South Schneider	2	16	42	15
East Totten	5	24	32	7
Summit Lake	3	17	25	11
McLane Creek	2	20	30	18
West Eld	4	20	29	14
South Eld	4	24	33	11
North Eld	6	24	26	5
Perry Creek	3	24	36	16
Green Cove Creek	12	14	22	9
Mud Bay	9	10	19	9

To identify and evaluate potential restoration opportunities, we used watershed characterization to identify the ecological and biological processes of each drainage analysis unit (DAU). We also identified altered wetland, floodplain, and riparian resources. We then used our understanding of landscape condition to place each potential restoration site in a landscape context. We evaluated and prioritized restoration sites in this context. In the study area, we evaluated 395 riparian areas, over 311 wetland areas, and 12 floodplain areas for a total of 718 potential sites. Those sites were further evaluated for potential stormwater retrofit and fish habitat potential.

Of these sites, 214 potential wetland, floodplain and riparian restoration sites met the minimum criteria of potential use for restoration. Those sites were prioritized for optimizing overall ecosystem function within the DAU.

Introduction to Watershed Characterization

What is watershed characterization?

Watershed characterization is a series of steps that identify, screen, and prioritize hundreds of potential wetland, riparian, and floodplain restoration sites. These steps focus on gathering ecological and biological watershed data needed to identify where landscapes are and are not functioning properly, where degraded natural resources exist, and where to target restoration to maximize environmental benefits. In the end, this analysis will allow Thurston County to choose restoration sites that will provide the greatest function, have a high probability of being successful, and ensure that we get the highest value for our investments.

Through watershed characterization, the technical team seeks to integrate the restoration of wetland, riparian, floodplain, and stormwater impacts by restoring the landscape's capacity to function. We do this by assessing the condition of ecological processes, such as the movement of water, sediment, pollutants, large wood, and heat and aquatic integrity and upland habitat connectivity. We then target restoration to degraded natural wetlands, riparian areas, and floodplains having the greatest potential to mitigate past development impacts and result in measurable environmental benefits.

How is a watershed characterization conducted?

Watershed characterization consists of four key steps.

In Part I, the condition of landscape-scale ecological processes and the extent of human alteration to these systems is analyzed. Key physical processes include the movement of water, sediment, pollutants, large wood, and heat through stream systems within the study area. Key biological processes include aquatic integrity and upland habitat connectivity.

At a landscape scale, the Totten and Eld Inlet study area was subdivided into 308 drainage analysis units (DAU) catchments and multiple landscape attributes were used to characterize how land use change has altered the natural movement of water, sediment, pollutants, and large wood, along with aquatic integrity and upland habitat connectivity. This information was used to target restoration efforts within landscapes that have the greatest potential to restore and maintain environmental benefits over the long-term.

In Part II, natural resource sites (wetlands, riparian, and floodplain) were identified that have the potential to mitigate past development if restored.

Site datasets for wetlands, riparian areas, and floodplains were created which were then used to identify potential restoration sites. Stormwater retrofit projects were identified that could address existing stormwater runoff problems. Existing data and extensive photo interpretation were used to develop wetland, riparian, and floodplain datasets. These datasets differ significantly from existing natural resource data, such as local and state agencies might develop, in that they identify potential restoration sites rather than inventorying existing wetlands, riparian areas, and floodplains.

These potential restoration sites include intact existing wetlands and degraded or destroyed wetlands that have potential, if restored, to meet mitigation needs. The technical team established both site and landscape criteria to evaluate and rank potential floodplain, wetland, and riparian restoration and stormwater retrofit sites.

This process results in two prioritized restoration site lists; one for potential natural resource restoration sites (with potential floodplain, wetland, and riparian restoration sites); and one for potential stormwater retrofit sites using natural resource sites that avoid high quality fish habitat.

In Part III, the ecological benefit of each DAU and the environmental benefit of each resource site is assessed.

In Part IV, potential restoration sites are identified and ranked.

More details on methods used in watershed characterization can be found in the Appendix A of this report.

As the Gersib et al., 2004 methods were applied, it was determined that the methodology needed to be updated and refined. In applying the Gersib et al methods, the following modifications and/ or clarifications were made:

- The indicator "percent change in drainage network" in the matrix was not used in some areas. This was necessary because we did not have sufficient stormwater infrastructure data.
- Further defined "mature forest" to mean "hydrologically mature forest" (Douglas fir 25 years old) (WADNR 1999).
- A "prairie landscape" was added to the matrix. Some studies indicate that the addition of impervious surface over outwash soils has a larger hydrological effect than covering till soils (Brascher, 2006).
- There is the need to develop better indicators for the "movement of sediment". The original use of the matrix was for forestry activities. In an urban environment, with required stormwater best management practices (BMP), cleared earth is typically paved within a limited amount of time, thus no bare soils in the DAU. The exception would be agricultural activities, but they are also temporarily exposed prior to replanting.
- The Totten and Eld Inlets do not include the typical altered floodplain as regulated under the Federal Emergency Management Agency (FEMA).
- There was a lack of data for the condition process "movement of pollutants" thus only areas that had data were analyzed.
- 67 meter buffers were applied throughout the analysis vs. 33 meter, as stated in the matrix for the movement of heat. The 67 meter buffer reflects the standard aquatic buffer that Thurston County currently has in effect, and the 67 meter also accounts for stream layers that are inaccurate.

- The rules and assumptions were updated and developed based on best available science.
- The stormwater retrofit ranking criteria was modified to avoid high quality salmonid habitat.
- Attributes for initial natural resource site identification and condition descriptions were standardized (e.g. a value given for adjacency to public lands).

Further work is required to improve the Gersib et al 2004 methods for future watershed characterizations:

- While estuarine and marine landscape indicators exist in various forms we did not find them complete enough to use in this analysis. The best available science for the nearshore condition includes the Squaxin Island Tribe's nearshore model.
- Thurston County's FEMA maps are outdated and incomplete. Future goals include updating the Federal Insurance Rate Maps (FIRM) using LiDAR.
- Thurston County's stormwater infrastructure maps are incomplete. This data is essential to fully understand the delivery and routing of water. Thurston County has initiated an aggressive program of collecting stormwater infrastructure data to better analyze the movement of water.
- Aquatic integrity and habitat connectivity indicators could be further defined and improved. Based on this work, Thurston County added additional Benthic Indicator Biotic Indicators (BIBI) sites in our proposed study areas to assess aquatic integrity. Additionally, Thurston County is exploring conducting habitat connectivity for specie specific habitat connectivity.

How was local information and expertise acquired and used?

An important part of the watershed characterization effort is coordination with local and regional governmental entities and watershed groups. The reasons for doing this are:

- To ensure that local natural resources managers and interest groups are aware of what studies are being conducted within their area, what a watershed characterization is, and how it works.
- To gain insight into local permitting criteria and policies.
- To ensure that information developed through watershed characterization is compatible with existing planning efforts by local, tribal, or regional governments, whenever possible.
- To acquire locally developed datasets of relevance to watershed characterization.
- To identify and acquire local watershed recovery plans, priorities, and locally identified restoration opportunities.

An integral part of watershed characterization is the identification and use of locally identified themes. These themes are included in Limiting Factors Analyses, watershed plans, salmon recovery plans, etc. The local themes are used, in part, to establish criteria for prioritizing potential restoration sites.

Draft and final reports containing watershed priorities for habitat restoration, salmonid recovery, water quantity and base flow improvements, and water quality improvements were reviewed for incorporation into the ranking of potential restoration sites.

Each of these documents contains locally defined projects or targeted stream reaches for water quality enhancement, runoff control, ecosystem recovery, salmon recovery, sediment control, flood amelioration, or similar benefits. We matched locally identified recovery sites to sites identified through watershed characterization and used this information to help prioritize our candidate restoration sites found in Appendix C.

What are the project deliverables?

Watershed characterization deliverables for the Totten and Eld Inlets Study are:

- Extensive documentation of technical methods, assumptions, and results of watershed characterization in a manner that is comprehensive and understandable.
- Extensive information on the landscape condition of key ecological processes.
- Potential wetland, floodplain, riparian, stormwater retrofit, and fish habitat data layers with all site-specific data.
- A prioritized list of potential natural resource restoration sites for overall ecosystem function in the study area.
- A prioritized list of potential natural resource preservation sites.
- A list of potential Stormwater restoration sites that avoid high quality salmonid habitat sites.

The goal is to make this report clear and understandable to the average person, while still providing all of the technical documentation necessary to support science-based decision-making. To do this, there is a multi-level presentation:

- In the main report body, the format seeks to “tell the story” of the study area and of the results
- Detailed step-by-step results are provided in the appendices
- The technical methods in a separate methods document (Appendix A)
- The GIS data, modeling assumptions, and other technical details are available electronically upon request or on the website

It is hopeful that this format will be more understandable for the non-technical reader and yet ensure that all methods, data, assumptions, and results are readily accessible to technical and regulatory reviewers.

What are the limitations?

The most significant limitation of the results is the data used in the analysis. While the study utilized relatively recent satellite data (SPOT imagery August 2005 and LiDAR 2001), other coverages used include 2005/2006 aerials and other state data. Thus, the landscape has probably significantly changed, and thus all sites should be verified as still available (e.g., not developed).

Another caveat is the Department of Natural Resources (DNR) stream hydro layer used in the analysis. When the DNR hydro layer was compared to LiDAR data, it was obvious that the stream layer is not accurate in some reaches. To compensate for the errors we applied a 67 meter buffer vs. a 33 meter buffer as detailed in the original methods.

The Study Area

What is the study area and how was it defined and subdivided for analysis?

The Totten and Eld Inlets Study Area is shown in *Figure 1. Totten and Eld Inlet Study Area*. The study area was delineated using LiDAR data. Multiple scales were established including approximately 0.25 sq mile DAUs, 12 sub-watersheds, and the entire Totten and Eld study area. These scales were based on the Center for Watershed Protection definitions and the goal of the study to develop stormwater retrofit sites (Zielinski, 2002). The analysis used the 0.25 sq mile DAUs, sub-watersheds, and the watershed (Figure 2. Study Area Drainage Analysis Units). The delineation excluded all direct discharges to Budd Inlet

Potential Restoration Opportunities

Potential natural resource restoration sites were determined by assessing several ecological and biological landscape indicators that were then used to assess the ecological and biological processes at the DAU scale.

Step One: Follow the Matrix and Pathways of Landscape Indicators (Matrix) to assess biological and ecological processes at the DAU scale.

Step Two: Identify potential natural resource sites using aerial photos and other GIS data in the study area.

Step Three: Determine current state of all ecological and biological processes at the DAU scale to determine their ecological benefit to maintain sites if restored.

Step Four: Rank natural resource sites for their environmental benefit if restored.

How were preservation and restoration sites identified?

The goal of this study was to determine natural resource sites that can be restored to provide greater function in the DAU to mitigate past disturbances, specifically the movement of water. By default, all natural resource sites not ranked medium or high for restoration can be assumed to be of high ecological value for avoidance and preservation.

There are two essential steps to identify and assess natural resource sites; determine the ecological and biological processes at the DAU scale using the Matrix; and identify all degraded natural resource sites in the study area. These two data sets are the foundation of the watershed characterization.

The matrix was used to identify DAUs that are "properly functioning" (PF), "at risk" (AR) or "not properly functioning" (NPF) for the five ecological processes (movement of water, wood, sediment, pollutants, and heat), and the two biological processes (aquatic integrity and habitat connectivity).

The natural resource site (potential wetland, riparian, and floodplain restoration sites) datasets were determined primarily through aerial photo and LiDAR interpretation of the study area and supplemented by existing natural resource inventories, and locally identified natural resource recovery areas. See the revised watershed characterization methods document (Appendix A) for detailed descriptions of the methods specific to the development of each natural resource database.

How were preservation and restoration sites prioritized?

The focus of this work is to identify natural resource sites that can be restored with a high probability of success given their location in the landscape. All natural resource sites having a low restoration value are assumed to have a high avoidance and preservation value.

Based on the needs within the study area, three priority restoration site lists were developed. The first, a natural resource restoration priority list, identifies and prioritizes potential wetland, riparian, and floodplain restoration sites having potential to maximize environmental benefit within the study area. The second is a list of restoration sites that are prioritized for anadromous fish habitat restoration. The third, a stormwater quality and quantity restoration priority list, identifies and prioritizes potential wetland, riparian, and floodplain restoration sites having potential to provide stormwater water quality improvement within the study area.

Data on the following key environmental attributes were compiled on each candidate restoration site:

- All ecological and biological process condition rankings
- Anticipated environmental benefits gained if the resource is restored
- Type of natural resource
- Site targeted for restoration in a local or regional recovery plan
- Site on or adjacent to publicly owned land
- The size of the candidate restoration site

Detailed methods for prioritizing natural resource restoration sites are described in Appendix A and detailed data and results are presented in Appendices B and C.

When developing the priority list for natural resource restoration, all potential riparian, wetland, and floodplain restoration sites were initially considered candidates for natural resource restoration. Attributes of each candidate site were then compared to criteria established for all landscape attributes. These sites were further evaluated based on the DAU ecological rank of PF, AR, or NPF. This process eliminated sites from further consideration and, at the same time, ranked remaining sites. The resulting potential natural resource sites environmental benefit lists are presented in Table 2.

The potential natural resource restoration site database consists of 718 polygons that were created in ArcMap as a data layer, including:

- 395 unique wetland sites
- 311 unique riparian sites
- 12 unique floodplains sites

Table 2. Potential Natural Resource Restoration Sites

All Potential Resource Sites				
	Wetland	Riparian	Floodplain	Total
Totten Drainages				
Kennedy Creek	28	22		50
North Schneider	37	46		83
South Schneider	9	13		21
East Totten	30	18		48
Summit Lake	7	20		27
Eld Drainages				
McLane Creek	38	51	6	95
West Eld	80	60		140
South Eld	11	11		22
North Eld	11	6		17
Perry Creek	24	35		59
Green Cove	22	17	6	45
Mud Bay	13	20		33

We initially considered all potential riparian, wetland, and floodplain restoration sites when developing the priority list. Attributes of each candidate site were then evaluated using established criteria. This process eliminated sites from further consideration and ranked remaining sites.

After criteria were applied to the initial site database, a total of 214 sites were further evaluated to determine if they could be viable as stormwater retrofit sites (see Table 3).

Table 3. Actual Natural Resource Restoration Opportunities

Resource Sites			
	Wetland	Riparian	Floodplain
Totten Drainages			
Kennedy Creek	11	23	
North Schneider	12	22	
South Schneider	2	4	
East Totten	4	1	
Summit Lake	1	4	
Eld Drainages			
McLane Creek	11	26	0
West Eld	21	21	
South Eld	1	4	
North Eld	2	1	
Perry Creek	8	13	
Green Cove	4	6	2
Mud Bay	3	7	
TOTAL	80	132	2

What are the preservation and restoration opportunities within the study area?

Based on the site's environmental ranking and the ecological process rank of the DAU that it resides in, a total of 214 potential wetland, riparian, and floodplain restoration sites met minimum ranking criteria and were prioritized. These sites were further evaluated for stormwater retrofit sites and fish habitat sites. These prioritized lists and data used in the prioritization process are presented in Appendix C.

Were any of the sites given closer examination?

Upon availability of the 2009 aerial photography, the sites will be verified as still existing. If sites are still available (haven't been developed), then an economical analysis will be completed to determine which sites are viable and practicable to pursue further for restoration and/or preservation opportunities.

How should this information be used?

The information in this report should be used as the first screening tool to evaluate restoration opportunities in the sub-watersheds in the study area. The prioritized sites list can be used to select projects that provide the greatest ecological benefit if restored. The information should also be used to rank preservation sites for Conversation Futures purchases.

Conditions of Natural Resources in the Study Area

All the candidate floodplain, wetland, and riparian restoration sites using aerial photo interpretation have been analyzed, but only a limited number have had preliminary field verification. The potential restoration site priority lists developed through watershed characterization should be considered as the starting point for a more extensive site assessment effort by project environmental staff or their consultant support. This is, in reality, recognition that the selection of the best potential restoration sites requires both a landscape-scale assessment and a detailed site-specific analysis.

Watershed characterization products are limited by the number, location, and extent of potential wetland, floodplain, and riparian restoration sites within the study area to mitigate past development. The goal of a watershed characterization is to eliminate or reduce the need for hard stormwater infrastructures, such as a conveyance system to engineered ponds, and use the natural function of the resources as a benefit to flow control.

What are the conditions in the Totten and Eld Inlet study area?

The Totten and Eld Inlet study area drains 73.5 sq miles. Draining to Totten Inlet includes Kennedy Creek, Schneider Creek, Summit Lake, and various unnamed tributaries. Draining to Eld, includes McLane, Perry, and Green Cove creeks, as well as various unnamed tributaries (see Figure 3. Study Area Sub-Watersheds).

Totten and Eld Inlets, located in Thurston County, are two of five inlets that form the southern terminus of Puget Sound. It is located between Budd Inlet on the east and Totten on the west.

Pre-development land cover

Eld Inlet has long played an important role in Thurston .County's history and economy. The rich shellfish beds in Eld Inlet provided a steady source of foods for the Indian tribes who lived in the region. In 1841 a Navy sloop, the U.S. Vincennes, commanded by Lt, Charles Wilkes, explored and charted the inlets and channels around the Cooper Point Peninsula while on a surveying expedition.

Many of the well-known geographic features throughout the Puget Sound region were named by Wilkes for the seamen on that expedition. Among these men, was Thomas Budd, acting master of the Vincennes; midshipman Henry Eld; and John Cooper, an armorer. In 1845 Michael T. Simmons led a group of settlers across the Columbia River and north to the Olympia area. After founding the town of Tumwater, the Simmons family later settled in the southwest corner of the Cooper Point peninsula on Mud Bay.

In 1853, natural beds of Olympia oysters were found in Budd Inlet, and soon a new industry began. The Brenner brothers were among the first settlers to industrialize the oyster. The Callow Act and the Bush Act enabled all occupants of the oyster lands to own their property, and deeds were awarded to both the Indians and the white settlers. As other industry started to appear on the Sound, a pulp mill began operation in Shelton in 1927, adversely affecting the shellfish industry in the south Sound. Members of the Olympia Oyster Growers Association took on the long battle to keep the delicate Olympia Oyster alive. Experimentation with Pacific oysters showed that it was a hardier species and soon brought improvement to the industry. Today, there are multiple commercial growers of clams, oysters, and mussels operate in Eld Inlet. The shellfish industry in Eld Inlet is expanding, as well, as efforts are made to seed geoduck clams in the sub-tidal waters of Eld Inlet.

Early settlers to the region were able to take the clean waters of Eld Inlet and its tributaries for granted. There were so many shellfish, so many salmon, so much clean water, and so few people. The decimation of the Olympia oyster beds in the late 1920's by the Shelton pulp mill was one of the early indications that our natural resources are fragile.

In the late 1970s and early 1980's people in south Puget Sound became aware of a threat to the good water quality previously enjoyed by the region. That threat was from Nonpoint Pollution. Previous studies had pointed to sewage treatment outfall pipes and industrial plant effluent as the source of pollution. New research was pointing to a more diffuse source--one that we all shared a part in. That source of pollution, called Nonpoint because it doesn't come out of the end of a pipe, comes from such sources as failing septic systems, livestock wastes, untreated stormwater, wastes from boats, sediments washed off cleared lands. Early in the 1980's six areas of Puget Sound were closed either totally or intermittently to commercial shellfish harvesting because of bacterial contamination mostly from nonpoint sources of pollution. During the previous ten years, no closures had occurred. The southern portion of Eld Inlet was one of the areas that was closed intermittently to commercial shellfish harvest. During heavy rainfalls, bacterial pollution is washed into the Inlet from the watershed, causing water to exceed commercial water quality public health standards (Eld Inlet Watershed Action Plan, October 1989).

Current conditions

The topography of the Eld watershed is best described by dividing the .watershed into three parts: the Cooper Point peninsula, the Griffin peninsula (also called the Steamboat Island peninsula), and the Delphi Valley. The Inlet itself has about 30 miles of shoreline with its widest section stretching 7,000 feet between Frye Cove on the west and Countryside Beach on the east. The Cooper Paint peninsula extends 7-1/2 miles into ·the southernmost reaches of .Puget Sound.

While its narrow northern end is less than a mile across, it widens to over four miles toward its southern end. The land rises steeply from the coastal beaches, with banks often reaching a height of 100 feet within 500 feet of the beach. The steep slopes are indented many places by draws, ravines and gullies holding small, seasonal stream courses. The one significant exception to this coastal topography is the estuarine area at the southwest comer of the peninsula where the land adjacent to Mud Bay is very low and flat, only a few feet above high tide level.

In the interior of the peninsula the land is a rolling terrace punctuated by small depressions and a few low hills. At the northern end of the peninsula the land rises gradually and smoothly to a center spine that is rarely more than 50 feet higher than the top of the coastal bluffs. This center spine defines the easternmost boundary of the watershed. To the south a low hill rises in the west. It reaches a height of 243 feet just west of The Evergreen State College core area.

Surrounding this hill is land of low relief with several shallow, closed depressions holding wetlands. A broad low, valley, containing the principal stream on the peninsula, runs north along the eastern boundary of the watershed. This stream, Green Cove Creek, flows through a sizable ravine that leads to Green Cove on Eld Inlet.

The topography of the Griffin peninsula is similar to that of the Cooper Point peninsula. The Griffin peninsula extends six- miles into Puget Sound. Sections of the shoreline rise sharply from the beach. The steep banks, varying from 5 to 80 feet in height, are indented occasionally by gullies, draws and ravines carrying seasonal runoff into Eld Inlet. Small creeks and seasonal drainage flow into Sanderson Harbor, Frye Cove, and Young Cove.

The interior of the northern section of the peninsula is a forested plateau of rolling hills and small depressions. The terrain of the southern areas has fewer variations. The Delphi Valley and surrounding Black Hills exhibit a wide variety of topography. The highest point is 807 feet in the Black Hills north of Black Lake, while the lowest is Mud Bay at sea level.

The Black Hills are steep and sharply dissected by fast-flowing streams. Perry Creek, McLane Creek, and Swift Creek are the major streams that have their headwaters in the Black Hills and flow through this area. The Delphi Valley sits at the base of the Black Hills and provides a broad valley through which McLane and Swift Creeks flow. Because of the varied topography of the Eld watershed, wetland areas dot the watershed. Wetlands are defined as areas that are "inundated or saturated by ground or surface 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." (excerpted from the Thurston County Zoning Ordinance) The Griffin Peninsula contains small scattered wetlands, particularly in the vicinity of Young Road. On the Cooper Point Peninsula, the largest wetland is the one along Green Cove Creek as it flows along Kaiser Road. This one originates in the Grass Lakes area. There are numerous other wetland areas scattered throughout the Peninsula. At the southern end of Eld Inlet there are extensive wetlands in the Mud Bay area. Some of these areas have drainage channels and are grazed' by cattle. In the Delphi Valley there are wetlands associated with McLane Creek Along Perry Creek, there are extensive wetlands, particularly at the headwaters of the creek. (Eld Inlet Watershed Action Plan, October 1989).

Kennedy Creek basin has a drainage area of 17.76 square miles. Approximately 9.6 miles long, this is by far the largest tributary to Totten Inlet. The creek originates in the Black Hills and descends gradually to lowlands. With the exception of a series of falls, cascades, and log jams at river mile 2.5, the rest of the creek is rather gentle in slope. Almost half of the watershed is used for forestry. Much of the rest is undeveloped.

The Green Diamond timberland on Kennedy Creek extends from the public fish viewing area (about a mile upstream of the mouth of Kennedy Creek) to just below the mouth of the tributary that drains Summit Lake into Kennedy Creek. Water quality issues related to forest practices on Green Diamond timberland are covered by a habitat conservation plan.

There is scattered residential development and small commercial areas in the upper watershed, above Green Diamond timberland. There is sparse development below the Green Diamond timberland, near the mouth of the creek. Summit Lake discharges to Kennedy Creek, although the discharge usually stops in late summer. There is recreational use throughout the watershed. Kennedy Creek is one of the highest chum producing streams in Washington State (Washington Department of Fish and Wildlife 2000). The creek discharges to the head of Totten Inlet.

Four percent of the entire Totten and Eld study area is covered by urban land uses (see Figure 4 and 4a, Classification Percent Totals for the Totten and Eld Study Area).

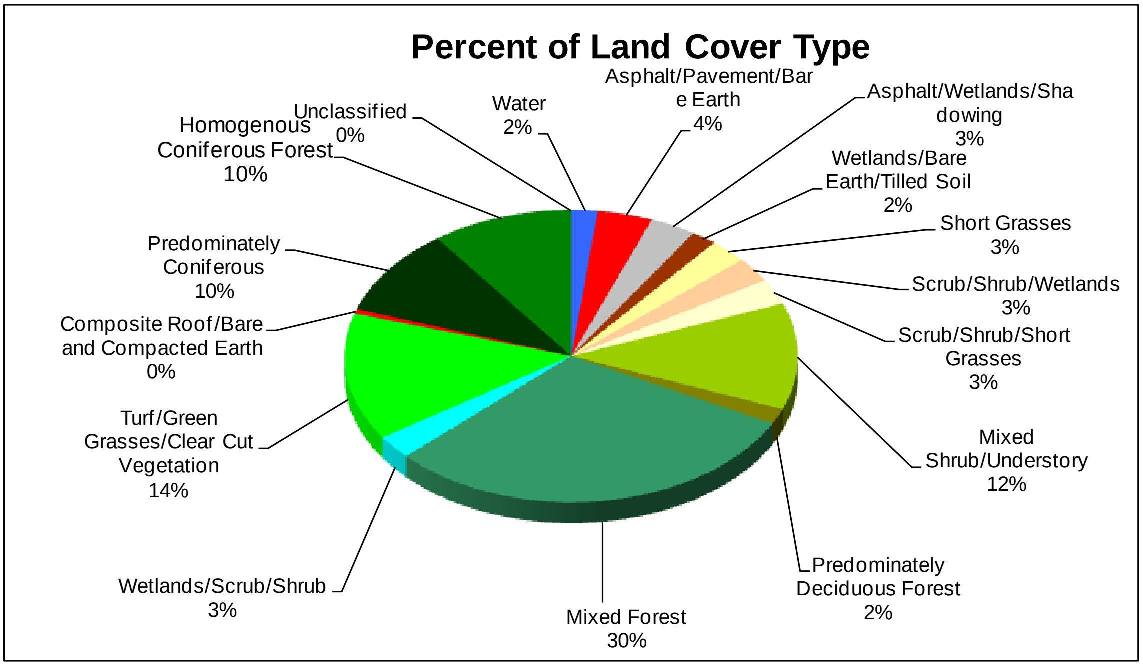


Figure 4a. Classification Percent Totals for Totten and Eld Study Area

Land cover data derived from 2005 SPOT imagery.

In addition to classifying land cover in the study area, 14 landscape indicators were evaluated (see Figure 5, Landscape Indicators). We analyzed the condition of each of the following indicators within each DAU:

1. Forest Land Cover
2. Prairie Resources
3. Wetlands-Assimilative capacity and hydro alteration
4. Total Impervious Surface (TIA)
5. Riparian Zones
6. Steep Slopes
7. Habitat Connectivity
8. Impaired Water Bodies
9. Benthic Indices of Biotic Indicators (BIBI)
10. Road Density
11. Stream Crossings
12. Stream Channel Straightening
13. Floodplain Decoupling
14. Bare Soils
15. Heat
16. Pollutants

The current condition of each DAU was determined to be "properly functioning", "at risk" or "not properly functioning" based on methods detailed in the Matrix (see Appendix A for complete methods).

Hydrogeology and groundwater recharge

With the exception of the Black Hills area, which was formed during the earlier Tertiary Period, the Griffin and Cooper Point peninsulas were formed during the Ice Age. Beginning 2.5 million years ago at the beginning of the' Ice Ages, at least four times the Puget Sound Lowlands were invaded' by glacial ice from the north, retreating most recently only 10,000 years ago. Two main glacial advances are most important to the watershed: the Salmon Springs glaciation and the later Vashon glaciation. Each time the massive glacier advanced, it dammed up the Puget lowlands so that a huge lake was formed. The outlet for its waters was through the Black and Chehalis River valleys, since the Straits of Juan de' Fuca were blocked by the ice. On the bottom of the lakes, "rockflour", the finely ground remains of rocks pulverized by glacial action settled out. These deposits became the familiar "blue clays" of the Puget lowland. Each time the ice age glacier advanced, it also compacted underlying sediments with its great weight and deposited a concrete like material called "till" (or hardpan) beneath it. Each time it retreated, water from the melting ice deposited thick layers of sand and gravel known as "outwash."

Each of these glacial sediments, clay, till, and outwash, is present from place to place in the watershed and in varied combinations. They provide both the formations that hold the ground water for the area's wells, and the parent material for most of the different soils.

The following descriptions discuss the composition of the different geological formations present in the watershed:

l. **Volcanic bedrock** underlies the Black Hills and most of the area's glacial deposits. It is unreliable as an aquifer.

2. **Pre-Salmon Springs deposits,** generally of clay and silt, include some highly productive confined aquifers. These deposits should supply much of the groundwater for future wells on the peninsulas.

3. **Salmon Springs Drift** underlies most of the watershed at a maximum altitude of about 30 feet above mean sea level. It is the source of water for almost all of the deep wells on the upland areas. These wells generally penetrate the regional water table at or within a few tens of feet above sea level. The Drift, which has relatively low permeability, but is important as an aquifer, is missing in places and is rarely more than 30 feet thick (although it can be up to 90 feet thick in places).

4. **Kitsap Formation** is unimportant as an aquifer in Thurston County. Its fine-grained sediments are relatively impermeable. It does, however, play a significant part in the occurrence of ground water underlying the peninsulas in that it confines water in the underlying Salmon Springs Drift at some places. In other places the Kitsap Formation effectively retards the downward percolation of water thereby causing storage of large volumes of water in the overlaying deposits of Vashon Advance Outwash or Colvos Sand.

5. **Vashon Advance Outwash and Colvos Sand** are sands and gravels deposited by the advancing Vashon glacier. They are generally of moderate permeability and are the source of many domestic supplies throughout the peninsulas where the deposits are under water table conditions.

6. **Vashon Till** in gravelly clay, has a very low permeability and is not a source of water. It plays an important role in the availability of groundwater, however. Till acts as an effective barrier that retards the downward percolation of water, and perched zones of water often occur on and within its upper parts.
7. **Vashon Recessional Outwash** are gravels and sands deposited with the retreat of the Vashon-glacier. Below the water table it is an excellent aquifer. Wells that tap the Vashon recessional outwash and till are located chiefly on the higher parts of the watershed, about 100 to 160 feet above sea level. The water is either perched above the till, in the outwash, or is within the till. Permeabilities are generally low and these wells normally yield only enough water for small scale domestic use. Late summer water levels are so low in many of these wells that the supplies are not dependable.
8. **Recent Alluvium** deposits are silts and sands deposited after the complete recession of the Vashon ice sheet. Generally, the alluvium is a shallow valley fill covering the underlying deposits. Large ground water supplies can be developed from alluvium deposits. The valley bottom of McLane Creek is a principal example of recent alluvium deposits in the watershed (Eld Inlet Watershed Action Plan, October 1989).

Water quality

Totten and Eld Inlet and several of its tributaries are on the 303(d) list of water bodies not meeting water quality standards for at least one water quality parameter. Some waterbodies are not currently on the 303(d) list, but they do not meet water quality standards. The parameters of concern include fecal coliform bacteria, dissolved oxygen, pH, and temperature (Ecology TMDL 2006).

Table 4. Tributaries to Totten, Eld, and Little Skookum inlets on the 2004 303(d) list for fecal coliform bacteria and temperature.

Inlets	Tributaries	Listing[a] Parameter	Location on the Creek	Township	Range	Section	Listing ID
Totten	Pierre Creek	FC	Near mouth	19N	3W	27	40958[b]
	Burns Creek	FC	Near mouth	19N	3W	27	40605[c]
	Kennedy Creek	Temp	125m above Old Olympic Hwy bridge	19N	3W	32	23545
		FC					41736
	Schneider Creek	FC	Near mouth, RM 0.3	19N	3W	33	12583
Eld	McLane Creek	FC	RM 0.2	18N	3W	24	12581
				18N	2W	19	41707
	Perry Creek	FC	RM 1	18N	3W	13	12582
		FC	RM 2.2 @ Hwy 108				7601

[a] FC = fecal coliform; Temp = temperature
[b] the 2004 303(d) list contains other FC listing IDs which will be consolidated to a single listing ID of 40958
[c] the 2004 303(d) list contains other FC listing IDs which will be consolidated to a single listing ID of 40605

Fish Resources

Totten Inlet Stock

Wild spawning in Kennedy Creek accounts for the majority of fall chum production from Totten Inlet. Spawning begins in November with the peak in mid-November, early for fall chum. This timing separates the fish from Skookum Creek stocks. Kennedy Creek fall chum are genetically unique when compared to other Puget Sound chum. The stock was considered "healthy" in 1992 (Washington Department of Fish and Wildlife and Western Washington Treaty Tribes 1994). Escapement from 1968 to 1992 ranged from 1,100 to 35,000, averaging 10,700 fish. Escapement declined in the late 1970s when a hatchery rack was installed to collect broodstock for a South Sound chum enhancement program. The program was discontinued and the run recovered, averaging about 16,000 fish from 1984 to 1992 (Washington Department of Fish and Wildlife and Western Washington Treaty Tribes 1994). More recent escapements have been good, ranging from 19,200 to 85,300 between 1993 and 2000. Mean escapement for that period was 38,700 (Baranski 2002, personal communication (Salmonid Habitat Limiting Factors Water Resource Inventory Area (WRIA) 14 (Kuttle, 2002)

WRIA 14's streams support two species of salmonids, chum and coho, as well as winter steelhead and coastal cutthroat. These species also use nearshore areas, along with chinook salmon, which were listed under the Endangered Species Act (ESA) in 1999. Steelhead were listed under the ESA in 2007. The limiting factors analysis conducted for the WRIA 14 salmon recovery plan indicates that salmonid habitat has been degraded by land use practices associated with forest management, removal of large woody debris (LWD), development, and agriculture. Other issues include culvert problems, nearshore habitat and riparian degradation, loss of channel complexity, and high sedimentation levels.

Eld Inlet Stock

The primary fall chum spawning streams in Eld Inlet are McLane, Swift (both in WRIA 13), and Perry Creeks. Spawning occurs from late-November to early January, relatively broad compared to other fall chum stocks. The stock is unique genetically from other Puget Sound chum stocks (Washington Department of Fish and Wildlife and Western Washington Treaty Tribes 1994). Chum were not planted in either Swift or Perry Creeks. Hood Canal chum were planted in McLane Creek from 1976 to 1983. The stock was characterized as "healthy" in 1992. Escapement from 1968 to 1992 ranged from 4,300 to 37,600 fish and averaged 14,800 for that period. Stock abundance was stable and showed signs of increasing (Washington Department of Fish and Wildlife and Western Washington Treaty Tribes 1994). More recent escapements have been good, ranging from 26,600 to 89,900 between 1993 and 2000, with a mean escapement of 50,400 for that period (Baranski 2002, personal communication).

Table 5. Salmon and Winter Steelhead Distribution for Totten and Eld Inlet Streams.

Inlet	*Stream Name*	*Species*	*Uppermost Distribution River Mile (RM)*
Totten			
	Kennedy Creek	Chinook	2.5
		Coho	2.5
		Chum	2.5
		Steelhead	2.5
		Cutthroat	2.5
	Schneider Creek	Coho	5
		Chum	5
		Steelhead	5
		Cutthroat	5
Eld			
	McLane Creek	Chinook	0.9
		Coho	1
		Chum	2
		Cutthroat	3.5
	Swift Creek	Chinook	1
		Coho	1
		Chum	1
		Pink	1
		Cutthroat	1
	Beatty Creek	Coho	1
		Cutthroat	1
	Perry Creek		
	Green Cove Creek	Coho	3.4
		Chum	1.8
		Winter steelhead	3.4

The Washington State Conservation Commission report on Habitat Limiting Factors for WRIA 13 (Haring and Konovsky, 1999) and Washington State Conservation Commission report on Habitat Limiting Factors for WRIA 14 (Kuttle, 2002)

Shellfish Resources

The cool, clean waters of South Puget Sound provide some of the finest shellfish habitat in the world and present an array of recreational, commercial and tribal harvest opportunities. Commercial production of oysters, clams and mussels from these waters and tidelands contribute significantly to Washington's position as the nation's leading producer of farmed bivalve shellfish, generating nearly $97 million in 2005. The commercial shellfish industry is thriving, demand is expanding in markets worldwide, and clean water is the essential catalyst for continued success.

Shellfish Classifications

The Washington Department of Health (DOH) monitors levels of fecal coliform bacteria in the marine waters to determine suitability for shellfish harvesting. The department also periodically surveys shorelines and drainages to look for pollution problems that might affect the growing areas.

Four of the five South Sound inlets are classified for commercial shellfish harvesting, and the classification of these areas tends to correlate with population and development levels in the adjacent watersheds (Table 1). Budd Inlet, with the most developed of the five watersheds, has been closed to shellfish harvesting for decades. In contrast, Totten Inlet, with the least developed watershed, has never been closed due to fecal pollution. DOH closed a portion of Eld Inlet in the early 1980s because of fecal pollution, then reopened much of the area in 1998 following successful control of the pollution sources and improvements in water quality. The work in Henderson Inlet has been more challenging due largely to the scale and complexity of the pollution problems and continued population growth and urbanization in the watershed. In Nisqually Reach, the story has been more mixed, with both downgrades and upgrades over the past 15 years, but with some notable successes in recent years due to targeted cleanup efforts. DOH also oversees an early warning system to help identify and respond to declining conditions in shellfish growing areas. Since the system was first instituted in 1997, Totten Inlet has not yet appeared on the annual list of “threatened shellfish growing areas,” while at least a portion of Eld Inlet has been listed four times, Nisqually Reach four times, and Henderson Inlet nine times through 2005 (Thurston Regional Planning Council. 2006. South Puget Sound Forum Indicators Report).

Area	Year	Acreage	Classification Change
Totten Inlet	*no classification changes – approved for commercial harvest*		
Eld Inlet	1983	690 acres	↓ downgraded from Approved to Conditional
	1998	450 acres	↑ upgraded from Conditional to Approved
Budd Inlet	*no classification changes -- prohibited for commercial harvest*		
Henderson Inlet	1984	180 acres	↓ downgraded from Approved to Conditional
	1985	120 acres	↓ downgraded from Conditional to Prohibited
	2000	8 acres	↓ downgraded from Conditional to Restricted
	2001	300 acres	↓ downgraded from Approved to Conditional
	2005	49 acres	↓ downgraded from Conditional to Prohibited
Nisqually Reach	1992	1000 acres	↓ downgraded from Approved to Conditional
	2000	74 acres	↓ downgraded from Conditional to Restricted
	2000	20 acres	↑ upgraded from Conditional to Approved
	2002	900 acres	↑ upgraded from Conditional to Approved
	2002	60 acres	↑ upgraded from Restricted to Approved

Table 1. Commercial shellfish classifications for Totten Inlet, Eld Inlet, Budd Inlet, Henderson Inlet and Nisqually Reach (DOH 2005).

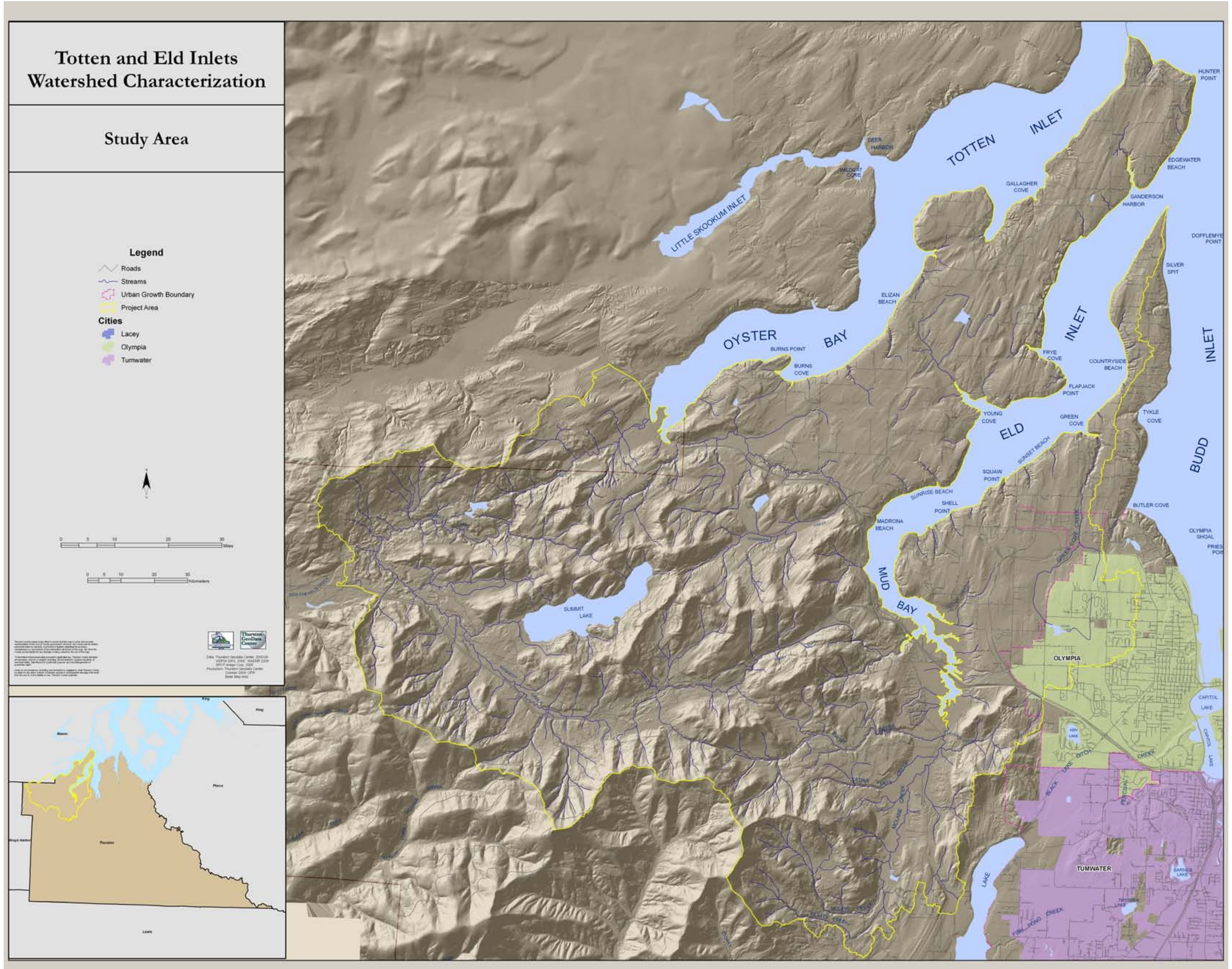


Figure 1 Totten and Eld Inlets Study Area

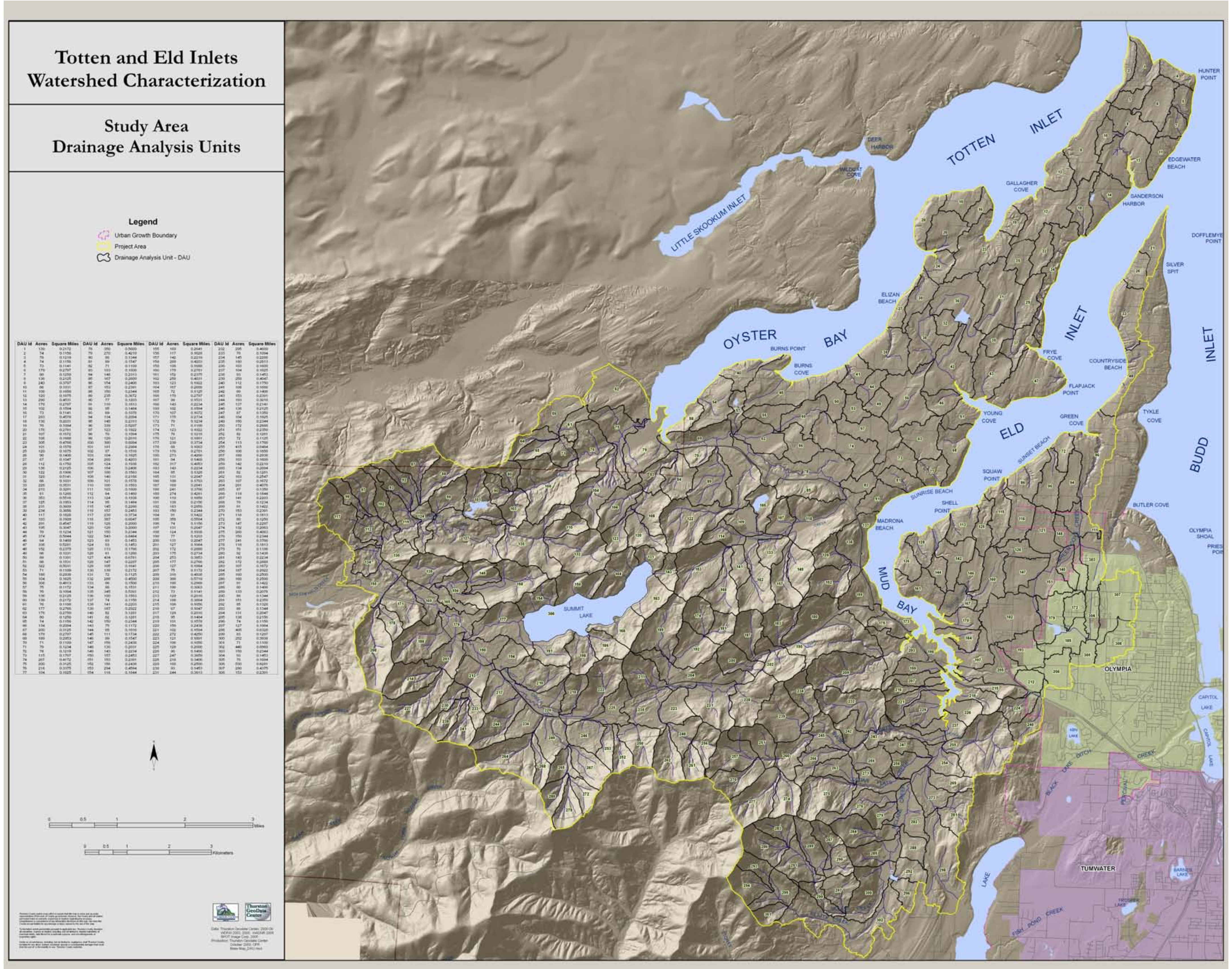
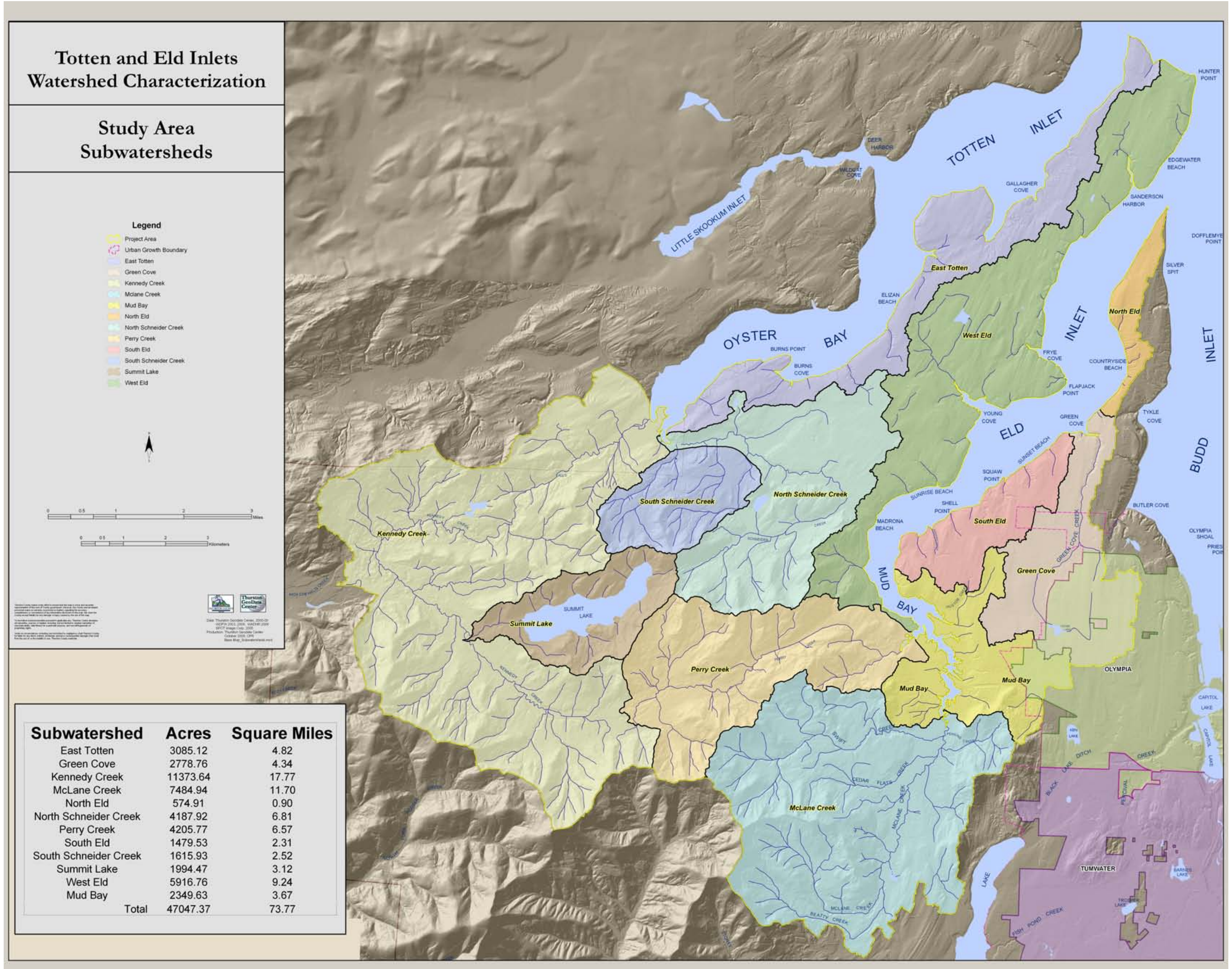


Figure 2 Totten and Eld Inlets Study Area Drainage Analysis Units



Subwatershed	Acres	Square Miles
East Totten	3085.12	4.82
Green Cove	2778.76	4.34
Kennedy Creek	11373.64	17.77
McLane Creek	7484.94	11.70
North Eld	574.91	0.90
North Schneider Creek	4187.92	6.81
Perry Creek	4205.77	6.57
South Eld	1479.53	2.31
South Schneider Creek	1615.93	2.52
Summit Lake	1994.47	3.12
West Eld	5916.76	9.24
Mud Bay	2349.63	3.67
Total	47047.37	73.77

Figure 3 Totten and Eld Inlets Study Area Sub-watersheds

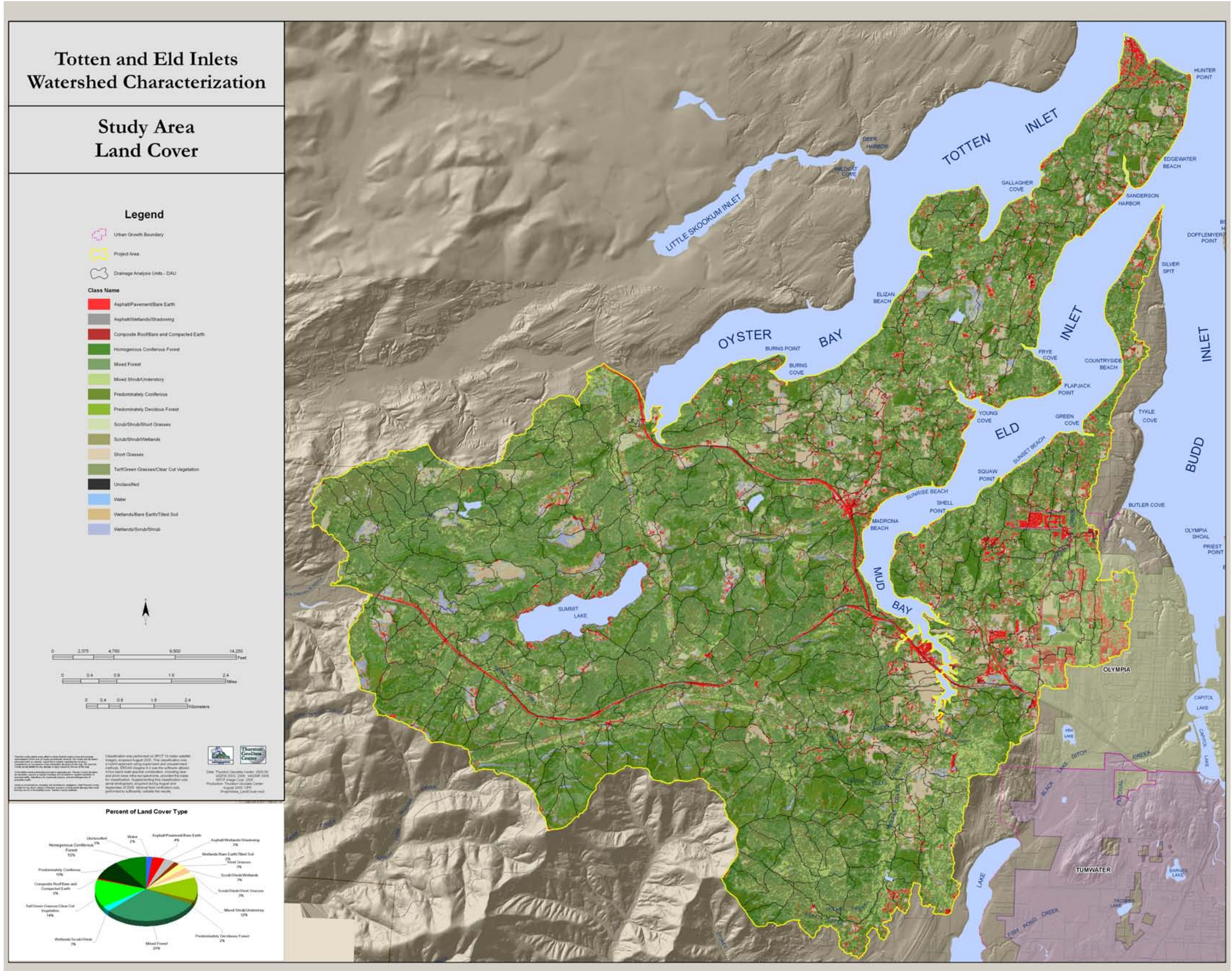
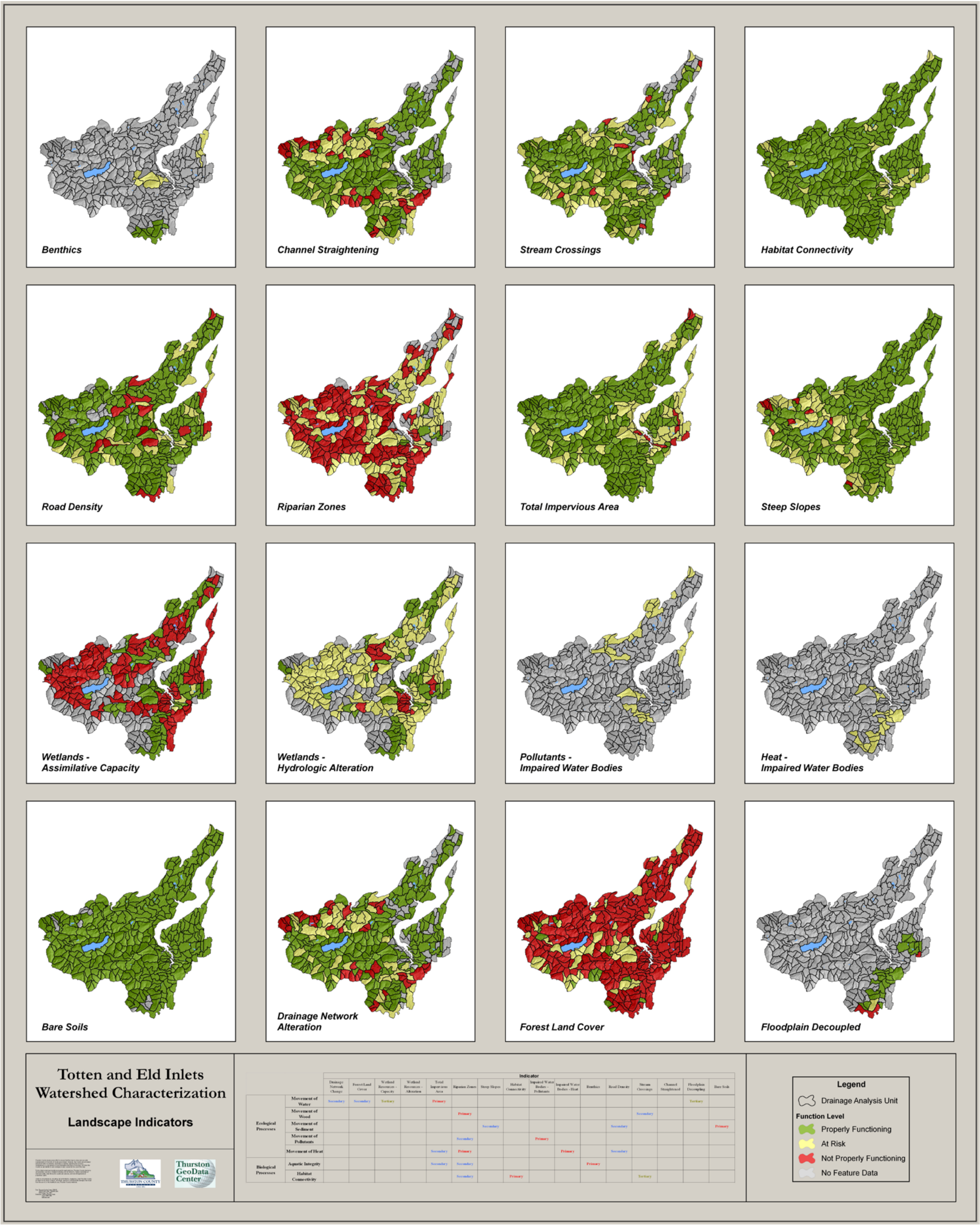


Figure 4 Totten and Eld Inlets Study Area Land Cover



		Indicator															
		Drainage Network Change	Forest Land Cover	Wetland Resources - Capacity	Wetland Resources - Alteration	Total Impervious Area	Riparian Zones	Steep Slopes	Habitat Connectivity	Impaired Water Bodies - Pollutants	Impaired Water Bodies - Heat	Benthics	Road Density	Stream Crossings	Channel Straightened	Floodplain Decoupling	Bare Soils
Ecological Processes	Movement of Water	Secondary	Secondary	Tertiary		Primary										Tertiary	
	Movement of Wood						Primary							Secondary			
	Movement of Sediment							Secondary					Secondary				Primary
	Movement of Pollutants						Secondary			Primary							
	Movement of Heat					Secondary	Primary				Primary		Secondary				
Biological Processes	Aquatic Integrity					Secondary	Secondary					Primary					
	Habitat Connectivity						Secondary		Primary					Tertiary			

Figure 5 Totten and Eld Inlets Study Area Landscape Indicators

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What are the conditions in the Kennedy Creek Sub-watershed?

Current conditions

Approximately two percent of the Kennedy Creek Sub-watershed is covered by urban land uses (see Figure 6 and 6a, Classification Percent Totals for Kennedy Creek Sub-watershed). Kennedy Creek basin has a drainage area of 17.76 square miles.

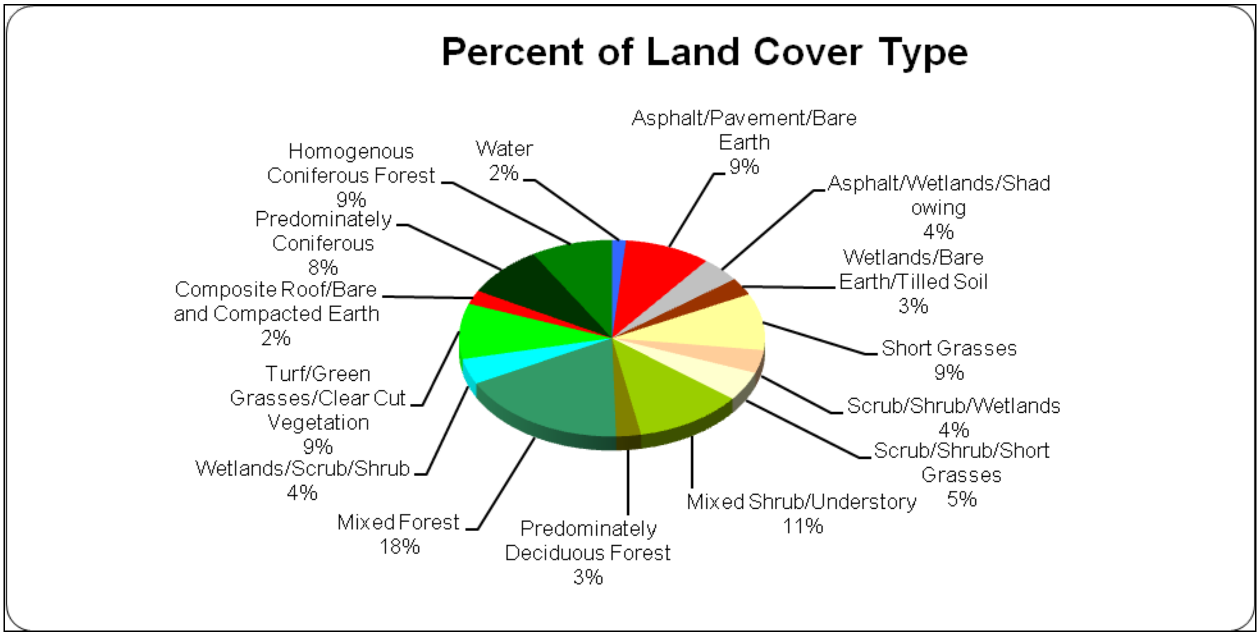


Figure 6a. Classification Percent Totals for Kennedy Creek Sub-watershed

Land cover data from 2005 SPOT imagery.

Human alteration to the movement of water

The effects of human land use on the natural delivery of water to the Kennedy Creek and its tributaries in the Kennedy Creek Sub-watershed were characterized using the following landscape attributes: percent TIA, percent forest land, and percent wetland cover at the DAU scale. Results indicate that the Kennedy Creek Sub-watershed is in an “at risk” condition for the delivery of water, with three of 75 DAUs “properly functioning.”

Human alteration to the natural movement of sediment

The effects of human land use on the natural delivery of sediment to the Kennedy Creek and its tributaries in the Kennedy Creek Sub-watershed were characterized using the following landscape attributes: percent bare soils, road density, and percent unstable slopes at the DAU scale. Results indicate that the Kennedy Creek Sub-watershed is in an “at risk” and “properly functioning condition for the delivery of sediment, with approximately two-thirds of the 75 DAUs “properly functioning.”

Human alteration to the natural movement of large wood

The effects of human land use on the natural delivery and routing of large wood in the Kennedy Creek and its tributaries were characterized using the following landscape attributes: percent forested riparian and average number of stream crossings per kilometer of stream at the DAU scale. Results indicate that the Kennedy Creek Sub-watershed is primarily in a “not properly functioning” and “at risk” condition for the delivery and routing of wood. The exception includes one DAU that is “properly functioning.”

Human alteration to the natural movement of pollutants

The effects of human land use on the natural delivery and routing of pollutants in the Kennedy Creek and its tributaries were characterized using the following landscape attributes: Extent of 303(d) listed water bodies for nutrients, toxicants, and bacteria and condition and extent of wetlands at the DAU scale. Pollutants were not ranked based on the lack of data, thus a N/A.

Human alteration to the natural movement of heat

The effects of human land use on the natural delivery and routing of heat in the Kennedy Creek and its tributaries were characterized using the following landscape attributes: Extent of 303(d) listed water bodies for nutrients, toxicants, and bacteria, percent 67 meter riparian zone with mature canopy, road density, and percent TIA at the DAU scale. Results indicate that the Kennedy Creek Sub-watershed is primarily in an "at risk" condition for the delivery and routing of heat. The exception is two DAUs that are conditioned to be in “not properly functioning, and one DAU that is “properly functioning.”

Aquatic integrity

The effects of human land use on aquatic integrity in the Kennedy Creek and its tributaries in the Kennedy Creek Sub-watershed were characterized using the following landscape attributes: percent riparian forest, percent TIA, and available B-IBI scores at the DAU scale. Aquatic integrity was not ranked based on the lack of data, thus a N/A.

Habitat Connectivity

Forest covers 55 percent of the Kennedy Creek Sub-watershed, concentrated in the south west sub-watershed. Most of the forest is in rural residential areas and the sub-watershed’s primary land cover is composed of commercial and long-term forestry. The Kennedy Creek Sub-watershed is considered “at risk” with only two DAUs considered “properly functioning” for habitat connectivity.

Ecological Benefit

All DAUs within the study area having ecological and biological processes that are considered "at risk" under current land use conditions were identified for further consideration. DAUs in the "at risk" category for multiple key ecological and biological processes are assumed to provide the greatest potential to maximize environmental benefits when restored. The process scores are then ranked according to the weight criteria, and converted to a high, medium, or low process rank. Kennedy Creek has 75 DAUs, with only three DAUs ranked as low, thus no restoration potential (Figure 7. Kennedy Creek Sub-watershed Weighted Processes).

Environmental Benefit

Once all the DAUs were ranked for their ecological benefit, all natural resource sites were ranked for their environmental benefit. Only the high and medium scoring sites were used in further evaluation to develop natural resource, fish habitat, and stormwater preservation and restoration sites.

Table 6. Kennedy Creek Environmental Benefit Ranking of Natural Resource Sites

Kennedy Creek Potential Restoration Sites				
Rank	Wetland	Riparian	Floodplain	Total
High	4	3	NA	7
Medium	7	20	NA	27
Low	17	50	NA	67

The following wetlands, riparian and floodplain sections describe the environmental benefit ranking of the natural resource sites.

Wetlands

Prior to human alteration, wetlands in the Kennedy Creek Sub-watershed totaled approximately 1086 acres. It is estimated that approximately 825 acres of the sub-watershed, are currently wetlands or degraded/destroyed wetlands with some restoration potential. (Figure 8. Kennedy Creek Sub-Watershed Resource Sites).

Riparian condition

Forest harvesting and agricultural activities have encroached on approximately 522 acres of the 67-meter wide riparian corridors in the Kennedy Creek basin. Of the 3510 acres, approximately 522 acres have some restoration potential (Figure 8. Kennedy Creek Sub-Watershed Resource Sites).

Floodplain Condition

There is no regulated floodplain in the Kennedy Creek sub-watershed.

Natural Resource Sites

All potential natural resource sites were evaluated for their environmental benefit and ranked high, medium, or low. Following evaluation, a total of 34 sites were of high or medium environmental benefit and ranked within the corresponding DAU (Figure 9. Kennedy Creek Ecological Processes and Resource Site Scoring).

Fish Habitat

There were 23 riparian sites evaluated for habitat value to salmonid fish species. These sites were then used to evaluate potential natural resource sites that have the potential to be stormwater retrofits sites. While the goal is to use natural resource sites as stormwater retrofit sites, the goal is not to compromise high quality fish habitat sites.

Stormwater Retrofit

All the natural resource sites were evaluated for stormwater retrofit sites (Figure 10. Kennedy Creek Potential Stormwater Restoration Sites).

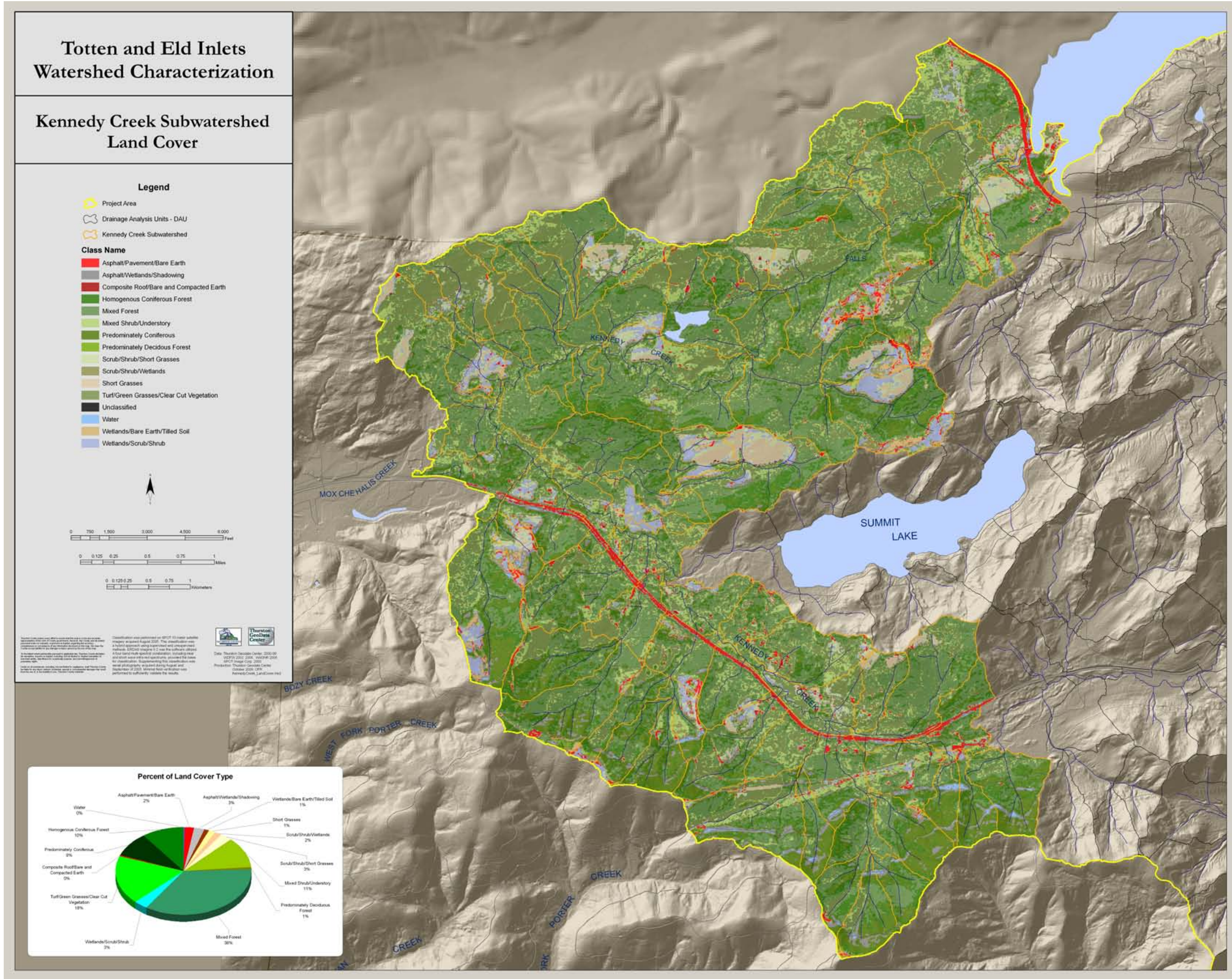


Figure 6 Kennedy Creek Sub-watershed Land Cover

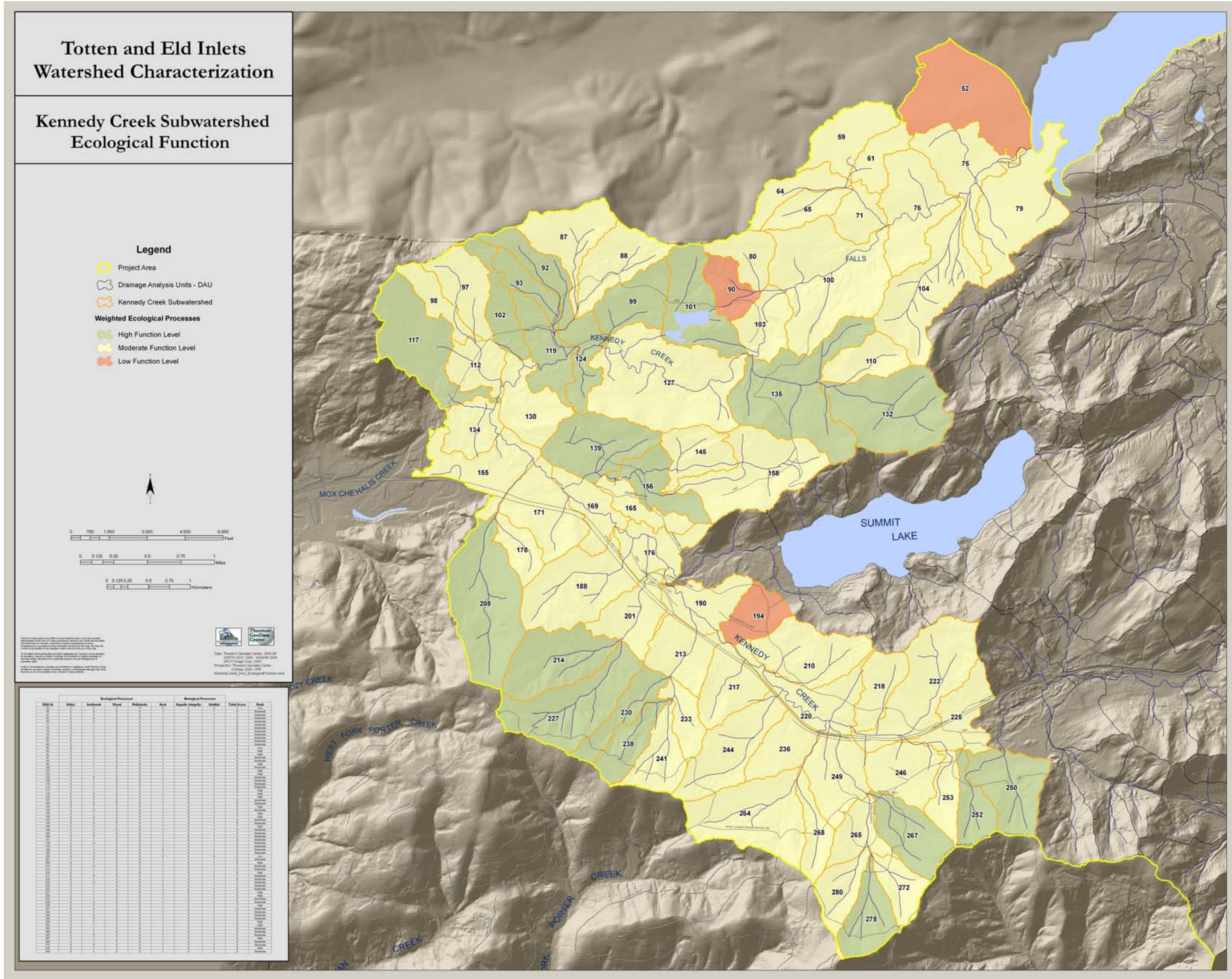


Figure 7 Kennedy Creek Sub-watershed Weighted Processes

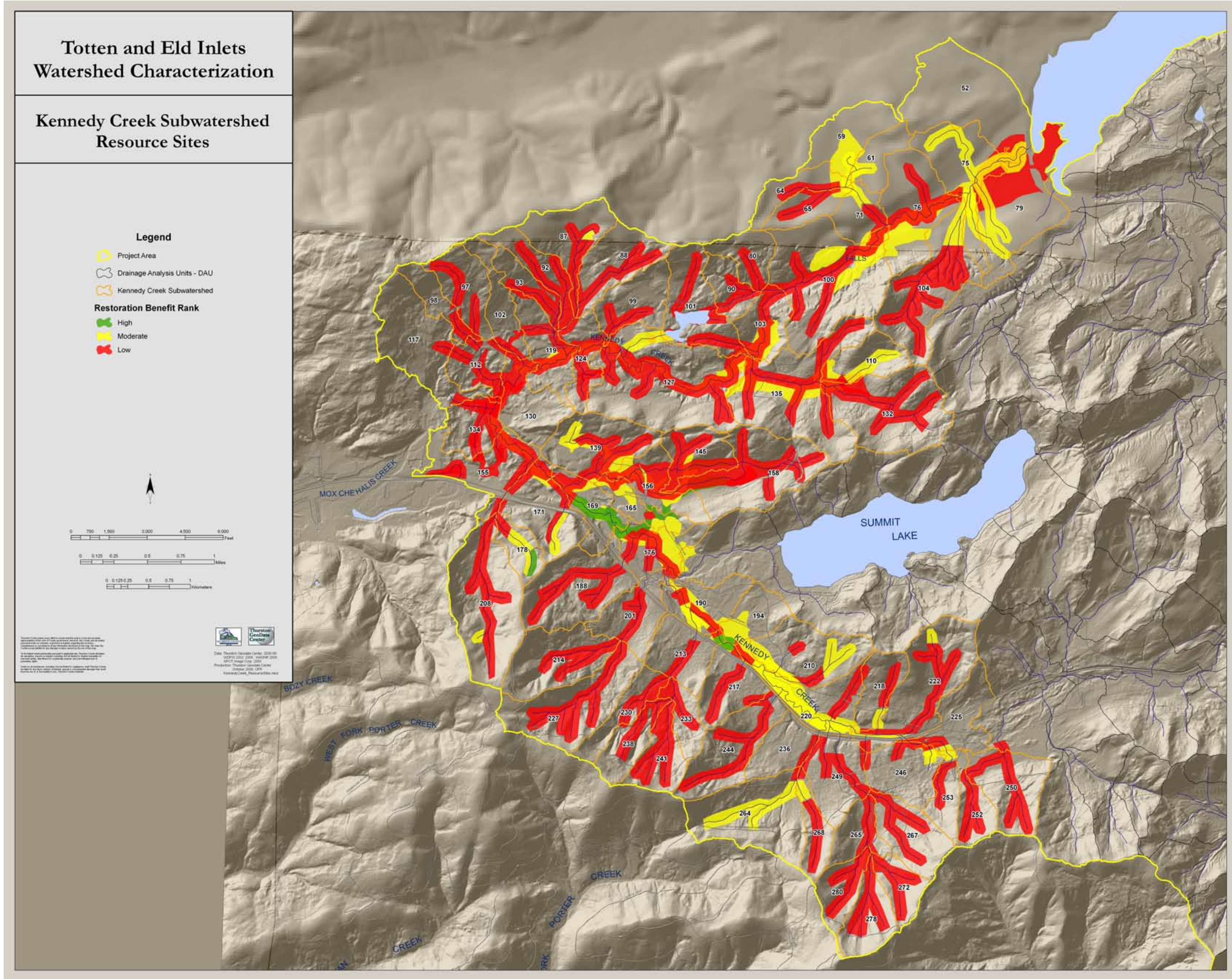


Figure 8 Kennedy Creek Sub-watershed Resource Sites

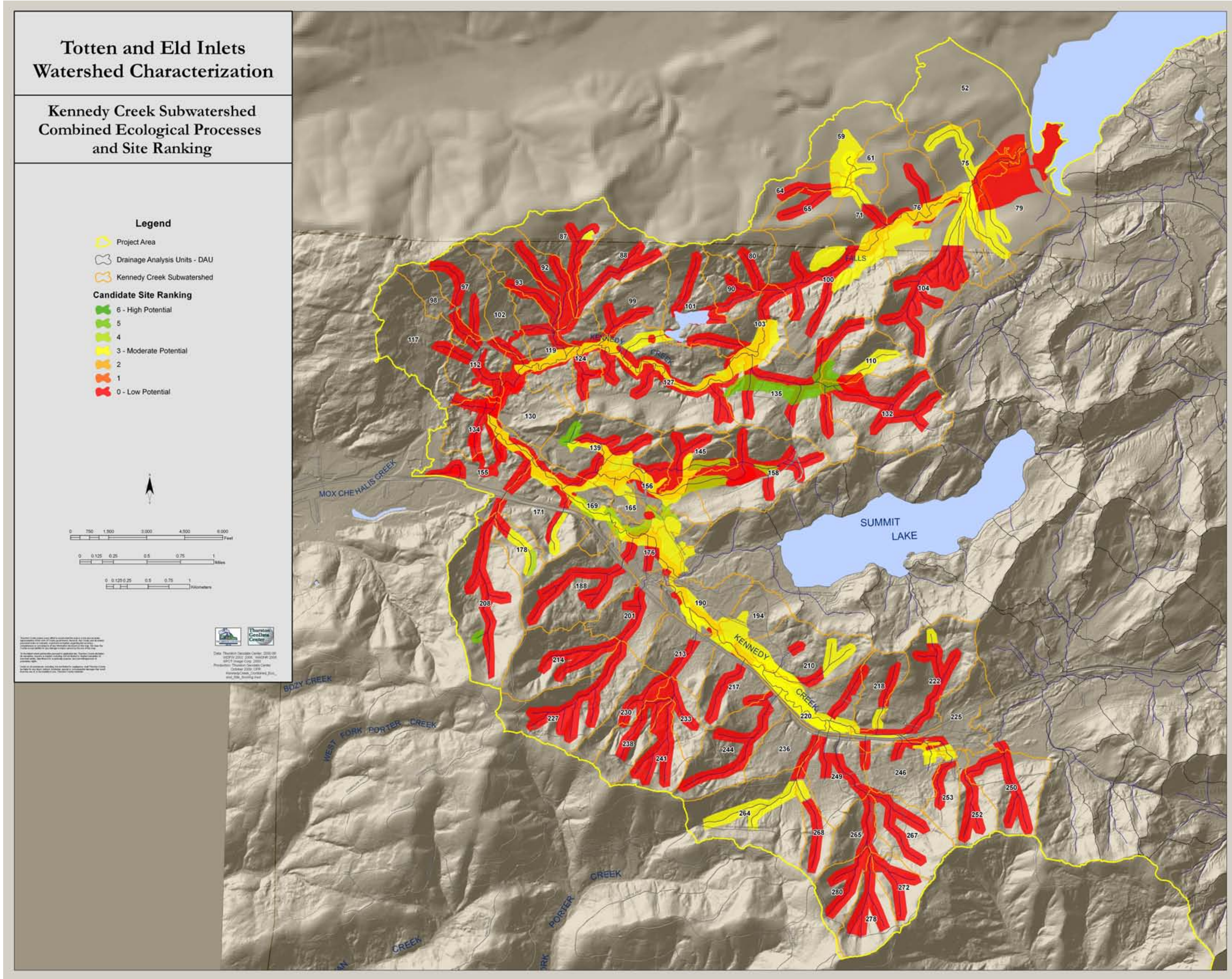


Figure 9 Kennedy Creek Sub-watershed Ecological Processes and Site Scoring

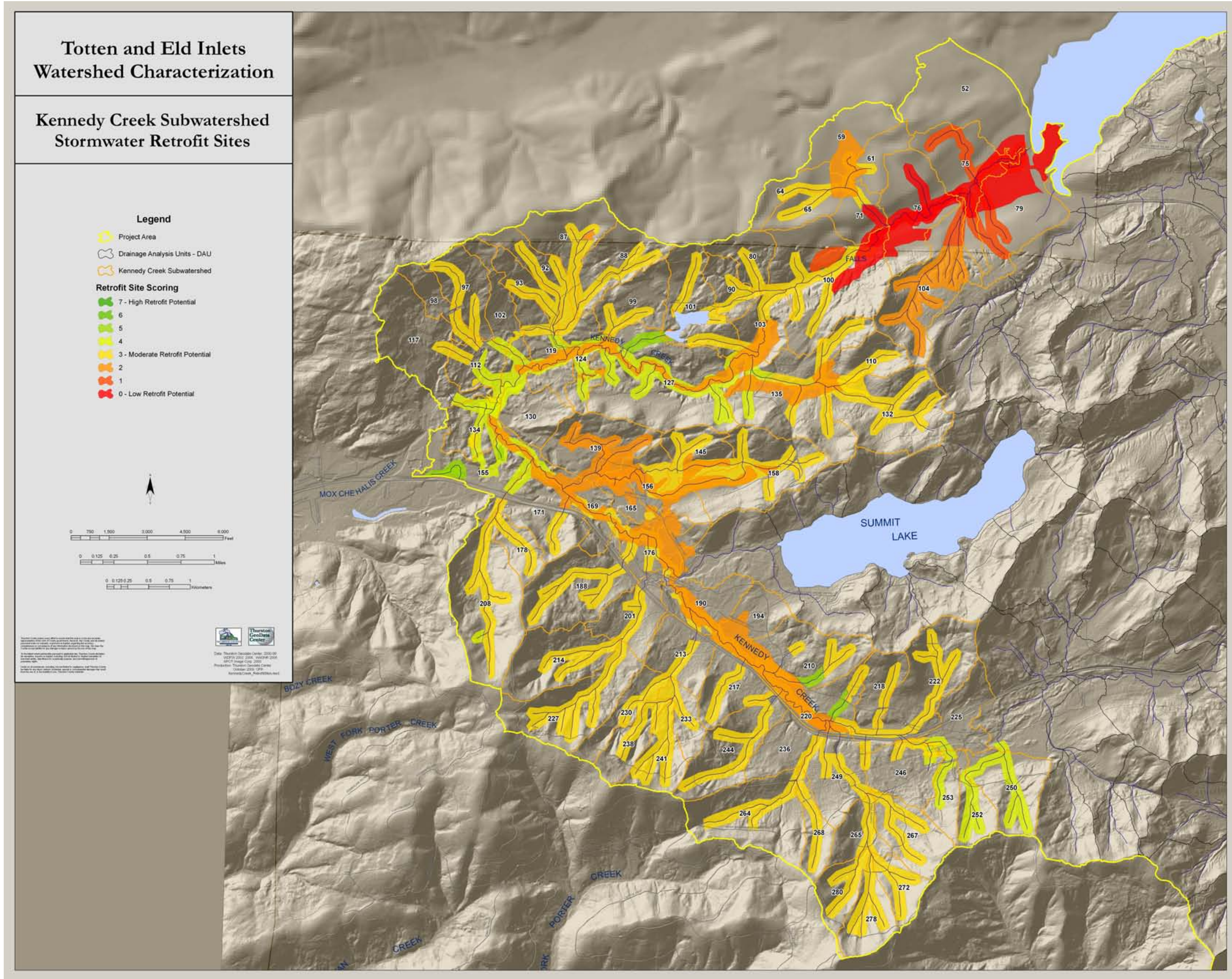


Figure 10 Kennedy Creek Sub-watershed Retrofit Sites

What are the conditions in the North Schneider Sub-watershed?

Current conditions

Approximately four percent of the North Schneider Sub-watershed is covered by urban land uses (see Figure 11 and 11a, Classification Percent Totals for North Schneider Sub-watershed). North Schneider basin has a drainage area of 6.5 square miles.

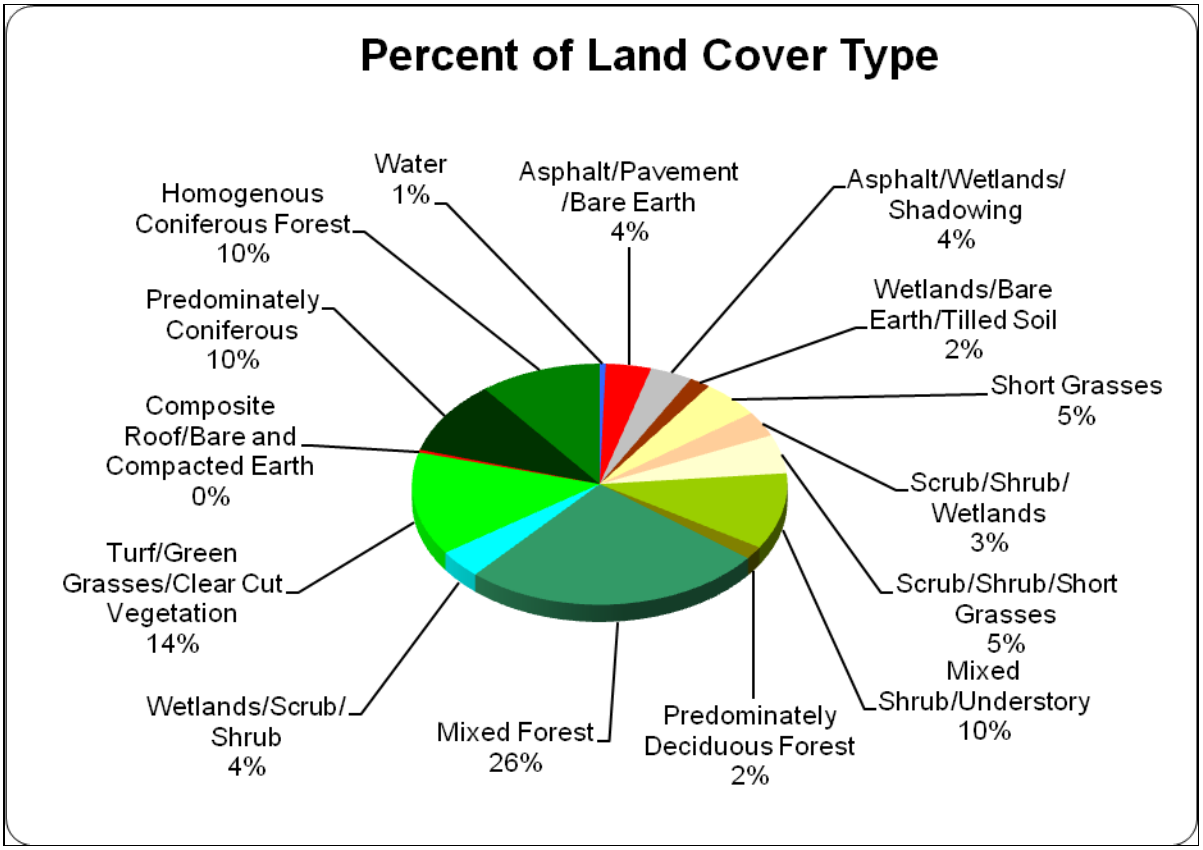


Figure 11a. Classification Percent Totals for North Schneider Sub-watershed

Land cover data from 2005 SPOT imagery.

Human alteration to the movement of water

The effects of human land use on the natural delivery of water to the North Schneider and its tributaries in the North Schneider Sub-watershed were characterized using the following landscape attributes: percent TIA, percent forest land, and percent wetland cover at the DAU scale. Results indicate that the North Schneider Sub-watershed is in an “at risk” condition for the delivery of water.

Human alteration to the natural movement of sediment

The effects of human land use on the natural delivery of sediment to the North Schneider and its tributaries in the Kennedy Creek Sub-watershed were characterized using the following landscape attributes: percent bare soils, road density, and percent unstable slopes at the DAU scale. The result was "properly functioning" and "at risk" conditions.

Human alteration to the natural movement of large wood

The effects of human land use on the natural delivery and routing of large wood in the North Schneider and its tributaries were characterized using the following landscape attributes: percent forested riparian and average number of stream crossings per kilometer of stream at the DAU scale. Results indicate that the North Schneider Sub-watershed is primarily in a "not properly functioning" and "at risk" condition for the delivery and routing of large wood.

Human alteration to the natural movement of pollutants

The effects of human land use on the natural delivery and routing of pollutants in the North Schneider and its tributaries were characterized using the following landscape attributes: Extent of 303(d) listed water bodies for nutrients, toxicants, and bacteria and condition and extent of wetlands at the DAU scale. Limited data indicates that the North Schneider Sub-watershed is in an "at risk" condition for the delivery and routing of pollutants.

Human alteration to the natural movement of heat

The effects of human land use on the natural delivery and routing of heat in the North Schneider tributaries were characterized using the following landscape attributes: Extent of 303(d) listed water bodies for nutrients, toxicants, and bacteria, percent 67 meter riparian zone with mature canopy, road density, and percent TIA at the DAU scale. Results indicate that the North Schneider Sub-watershed is primarily in an "at risk" condition for the delivery and routing of heat.

Aquatic integrity

The effects of human land use on aquatic integrity in the North Schneider and its tributaries in the North Schneider Sub-watershed were characterized using the following landscape attributes: percent riparian forest, percent TIA, and available B-IBI scores at the DAU scale. There is no data available to rank the aquatic integrity.

Habitat Connectivity

Forest covers forty-eight percent of the North Schneider Sub-watershed, The North Schneider Sub-watershed is considered "at risk", for habitat connectivity.

Ecological Benefit

All DAUs within the study area having ecological and biological processes that are considered "at risk" under current land use conditions were identified for further consideration. DAUs in the "at risk" category for multiple key ecological and biological processes are assumed to provide the greatest potential to maximize environmental benefits when restored. The process scores are then ranked according to the weight criteria, and converted to a high, medium, or low process rank. North Schneider has primarily high and moderate ecological benefit, with only one DAU ranked as low (Figure 12. North Schneider Sub-watershed Weighted Processes).

Environmental Benefit

Once all the DAUs were ranked for their ecological benefit, all natural resource sites were ranked for their environmental benefit. Only the high and medium scoring sites were used in further evaluation to develop natural resource, fish habitat, and stormwater preservation and restoration sites.

Table 7. North Schneider Environmental Benefit Ranking of Natural Resource Sites

North Schneider Potential Restoration Sites				
Rank	Wetland	Riparian	Floodplain	Total
High	4	0	NA	4
Medium	8	22	NA	30
Low	25	24	NA	49

The following wetlands, riparian and floodplain sections describe the environmental benefit ranking of the natural resource sites.

Wetlands

Prior to human alteration, wetlands in the North Schneider Sub-watershed totaled approximately 493 acres. We estimate that approximately 247 acres of the sub-watershed, are currently wetlands or degraded/destroyed wetlands with some restoration potential. (Figure 13. North Schneider Sub-Watershed Resource Sites).

Riparian condition

Development has encroached on approximately 178 acres of the 67-meter wide riparian corridors in the North Schneider basin. Of the 746 acres, approximately 178 acres have some restoration potential (Figure 13. North Schneider Sub-Watershed Resource Sites).

Floodplain Condition

There are no floodplain sites in the North Schneider Sub-watershed.

Natural Resource Sites

All potential natural resource sites were evaluated for their environmental benefit and ranked high, medium, or low. Following evaluation, a total of 34 sites were of high or medium environmental benefit (Figure 14. North Schneider Ecological Processes and Resource Site Scoring).

Fish Habitat

There were 46 sites evaluated for habitat value to salmonid fish species. These sites were then used to evaluate potential natural resource sites that have the potential to be stormwater retrofits sites. While the goal is to use natural resource sites as stormwater retrofit sites, we don't want to compromise high quality fish habitat sites.

Stormwater Retrofit

All the natural resource sites were evaluated for stormwater retrofit sites (Figure 15. North Schneider Potential Stormwater Restoration Sites).

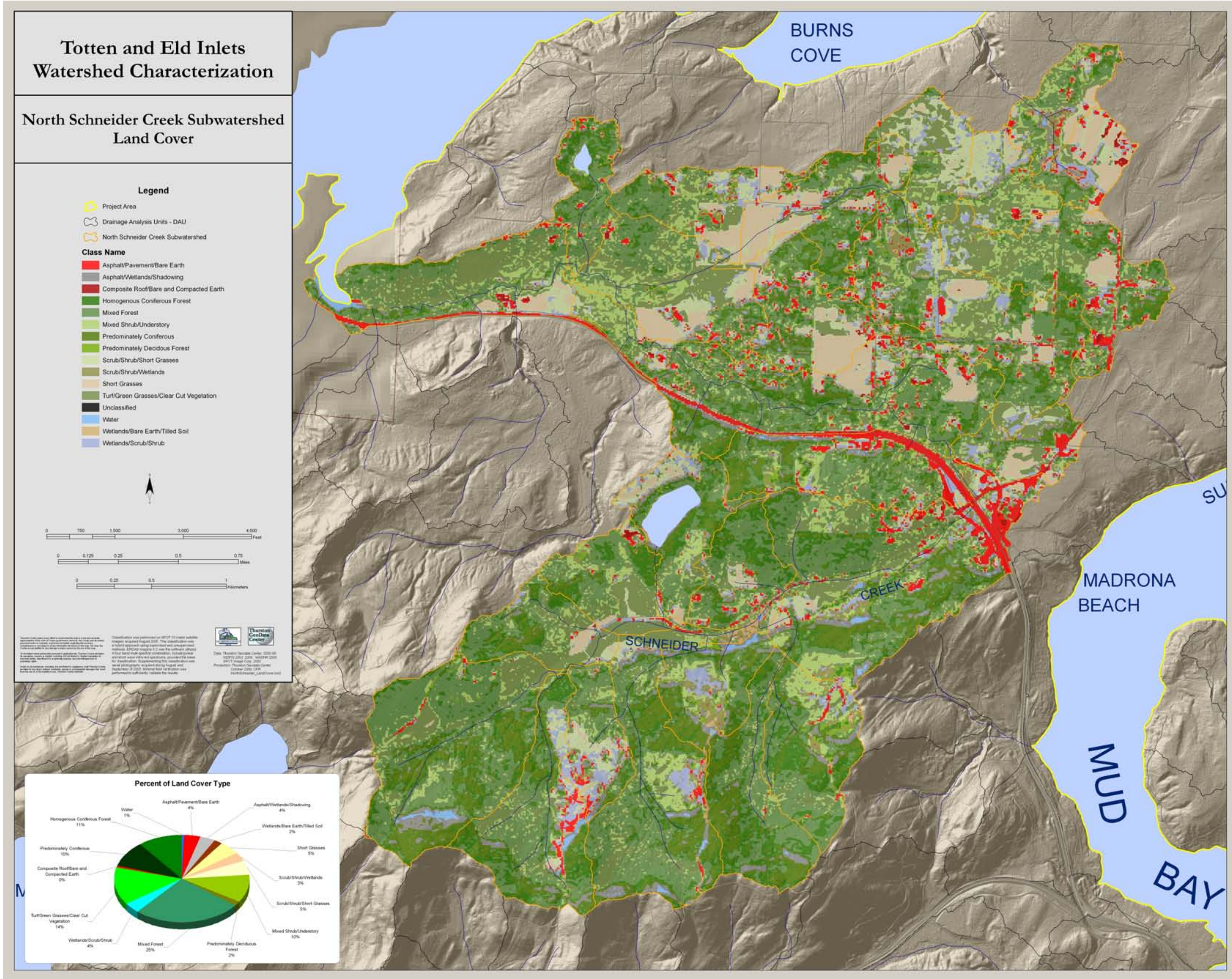


Figure 11 North Schneider Creek Sub-watershed Land Cover

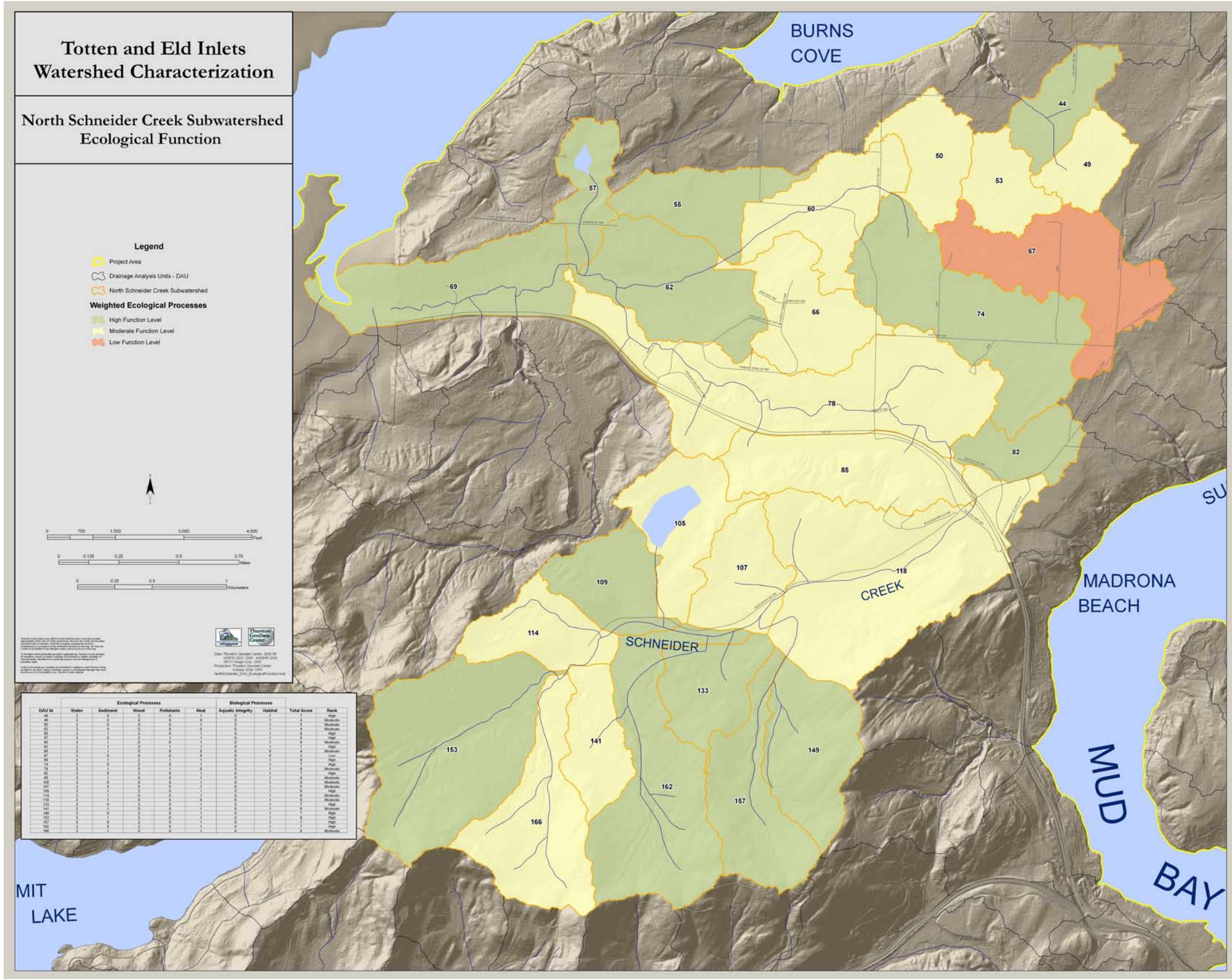


Figure 12 North Schneider Creek Sub-watershed Weighted Processes

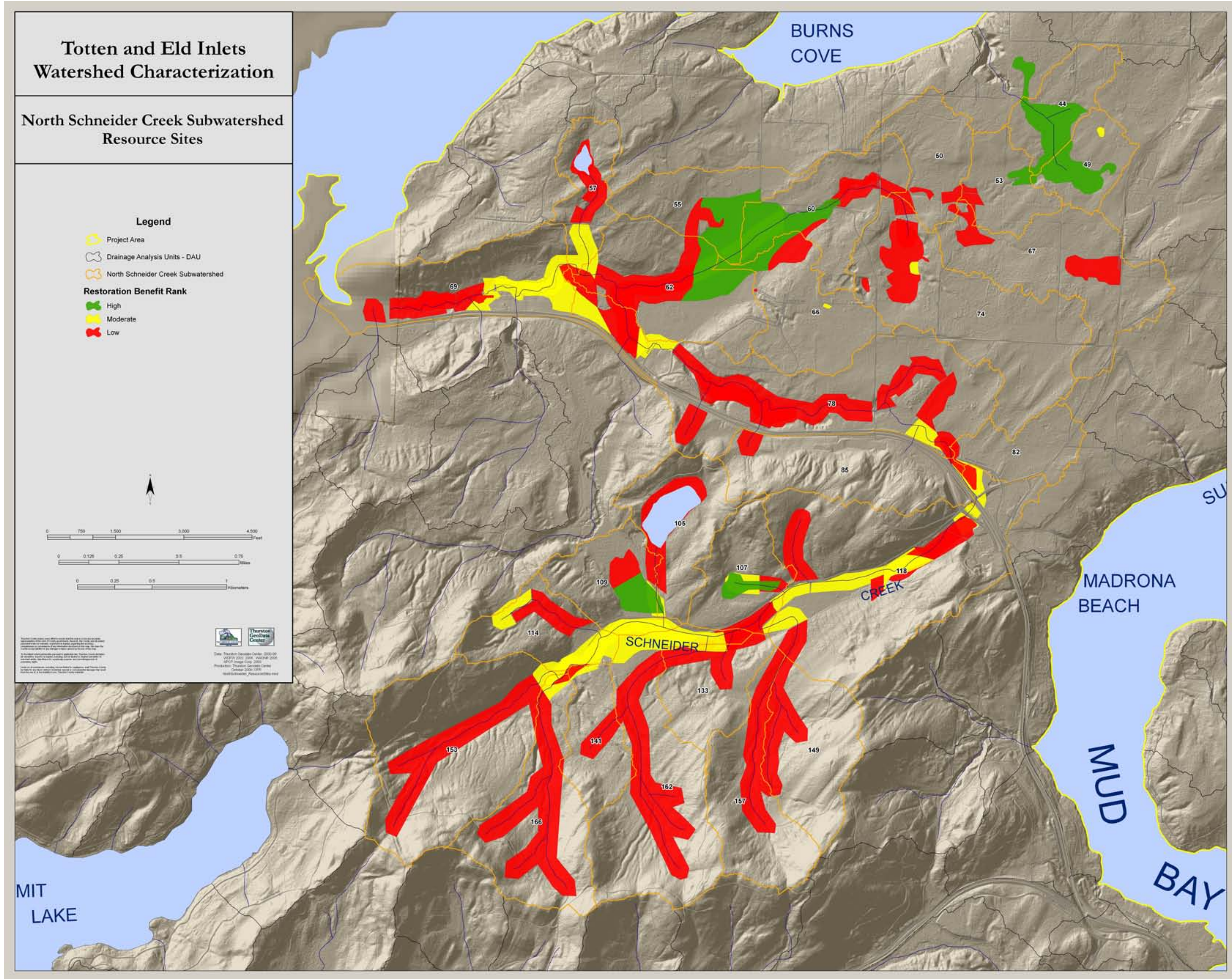


Figure 13 North Schneider Creek Sub-watershed Resource Sites

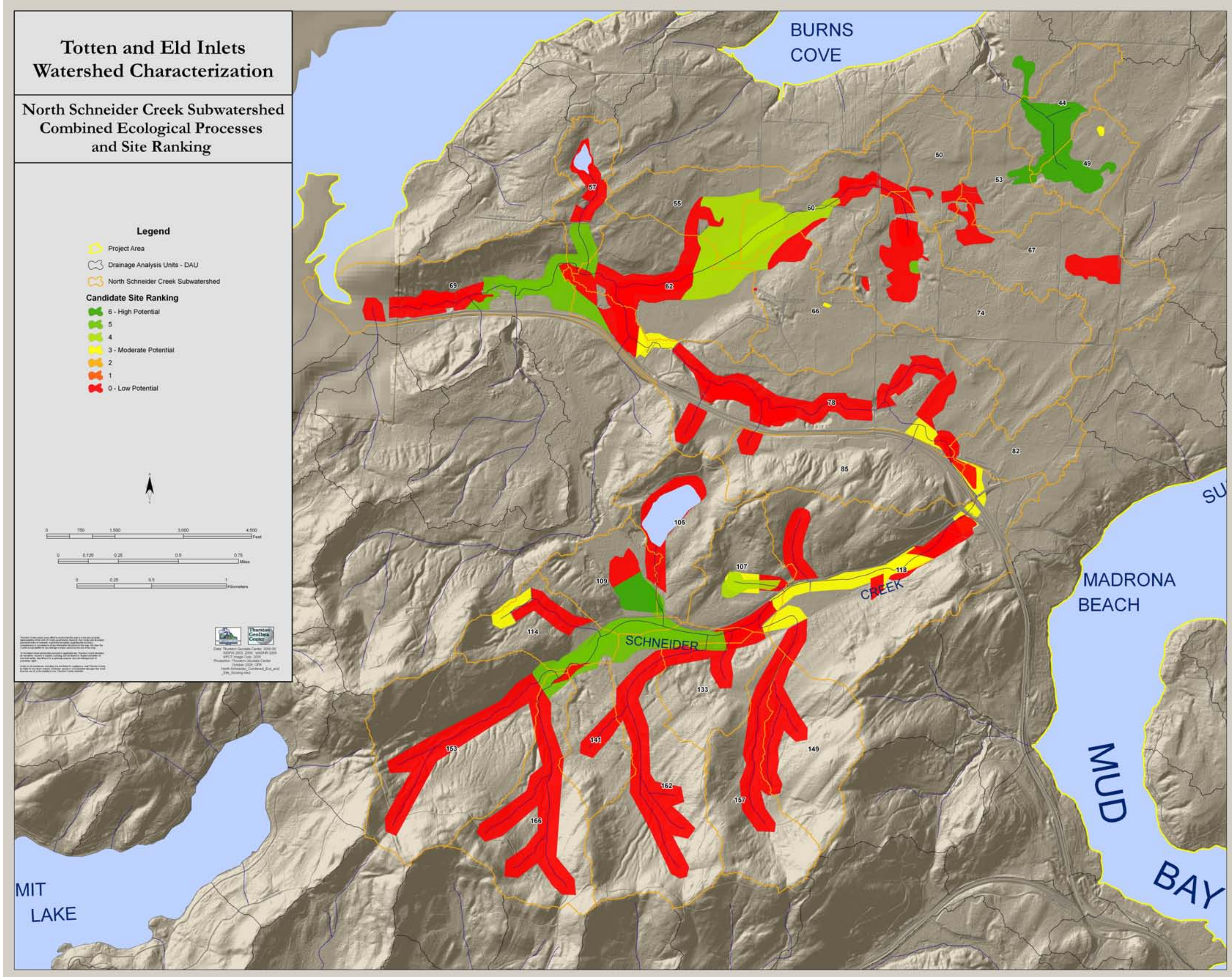


Figure 14 North Schneider Creek Sub-watershed Ecological Processes and Resource Site Scoring

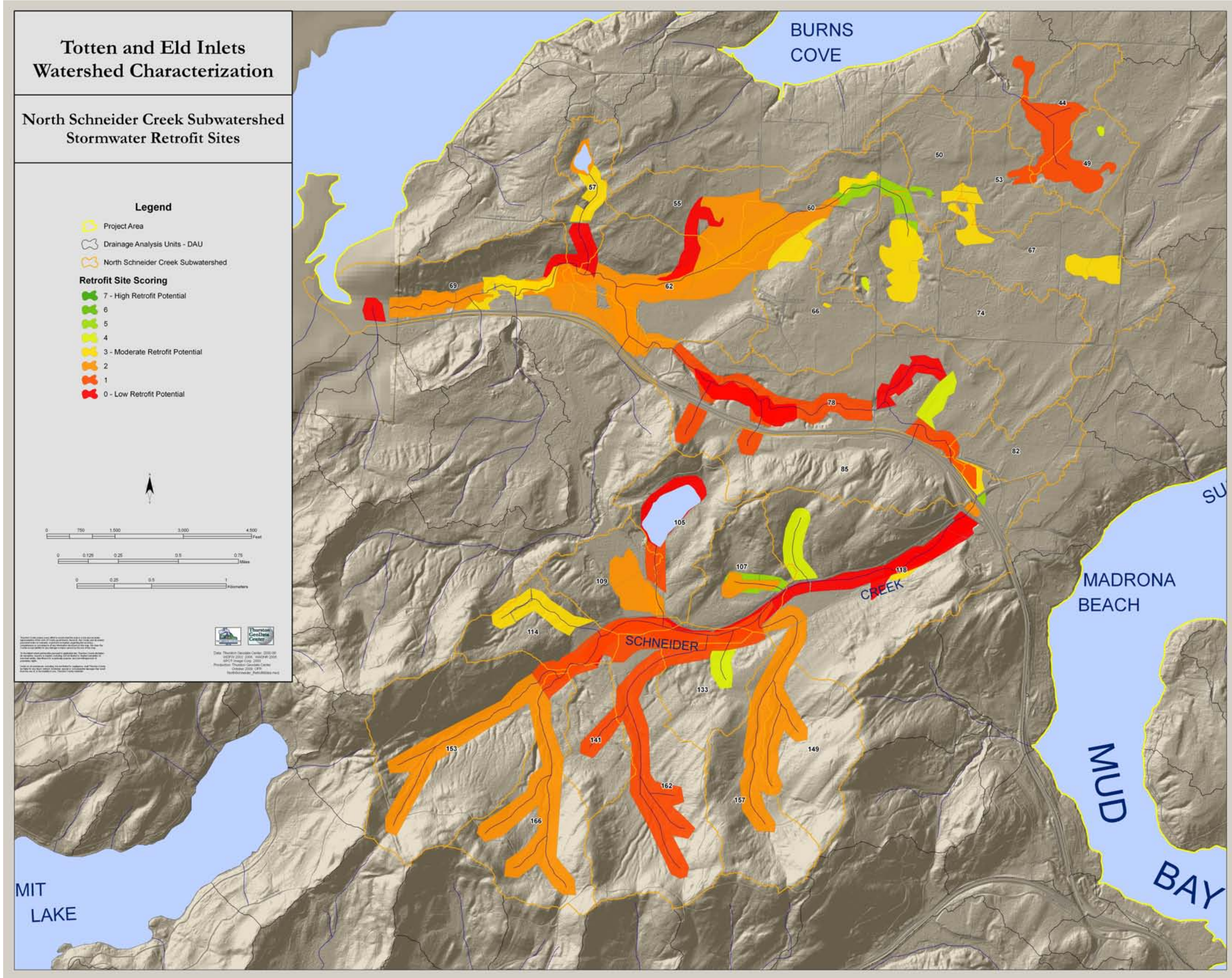


Figure 15 North Schneider Creek Sub-watershed Retrofit Sites

What are the conditions in the South Schneider Sub-watershed?

Current conditions

Approximately two percent of the South Schneider Sub-watershed is covered by urban land uses (see Figure 16 and 16a. Classification Percent Totals for South Schneider Sub-watershed). South Schneider basin has a drainage area of 2.5 square miles.

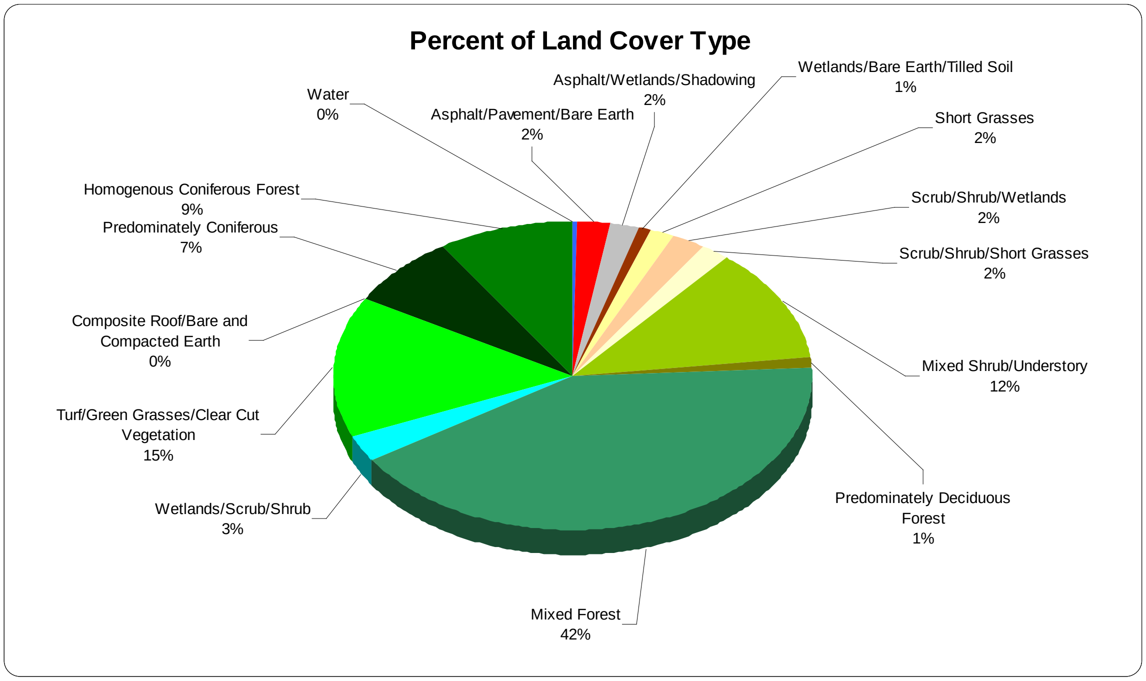


Figure 16a. Classification Percent Totals for South Schneider Sub-watershed

Land cover data from 2005 SPOT imagery.

Human alteration to the movement of water

The effects of human land use on the natural delivery of water in the South Schneider Sub-watershed were characterized using the following landscape attributes: percent TIA, percent forest land, and percent wetland cover at the DAU scale. Results indicate that the South Schneider Sub-watershed is in a “at risk” condition for the delivery of water

Human alteration to the natural movement of sediment

The effects of human land use on the natural delivery of sediment to the South Schneider Sub-watershed were characterized using the following landscape attributes: percent bare soils, road density, and percent unstable slopes at the DAU scale. The result was an "at risk" condition, with two DAUs “properly functioning”.

Human alteration to the natural movement of large wood

The effects of human land use on the natural delivery and routing of large wood in the South Schneider and its tributaries were characterized using the following landscape attributes: percent forested riparian and average number of stream crossings per kilometer of stream at the DAU scale. Results indicate that the South Schneider Sub-watershed is primarily in a “not properly functioning” condition for the delivery and routing of large wood. Exceptions include two DAUs that are conditioned to be in an “at risk” condition.

Human alteration to the natural movement of pollutants

The effects of human land use on the natural delivery and routing of pollutants in the South Schneider and its tributaries were characterized using the following landscape attributes: Extent of 303(d) listed water bodies for nutrients, toxicants, and bacteria and condition and extent of wetlands at the DAU scale. There is no data to rank pollutants.

Human alteration to the natural movement of heat

The effects of human land use on the natural delivery and routing of heat in the South Schneider tributaries were characterized using the following landscape attributes: Extent of 303(d) listed water bodies for nutrients, toxicants, and bacteria, percent 67 meter riparian zone with mature canopy, road density, and percent TIA at the DAU scale. Results indicate that the South Schneider Sub-watershed is primarily in an “at risk” condition for the delivery and routing of large wood. The exception is one DAU that is “not properly functioning.”

Aquatic integrity

The effects of human land use on aquatic integrity in the South Schneider and its tributaries in the South Schneider Sub-watershed were characterized using the following landscape attributes: percent riparian forest, percent TIA, and available B-IBI scores at the DAU scale. There is no data to rank aquatic integrity.

Habitat Connectivity

Forest covers sixty percent of the South Schneider Sub-watershed, concentrated in the south west sub-watershed. Most of the forest is in rural residential areas and the sub-watershed’s primary land cover is composed of commercial and long-term forestry. The South Schneider Sub-watershed is considered "at risk" for habitat connectivity.

Ecological Benefit

All DAUs within the study area having ecological and biological processes that are considered “at risk” under current land use conditions were identified for further consideration. DAUs in the “at risk” category for multiple key ecological and biological processes are assumed to provide the greatest potential to maximize environmental benefits when restored. The process scores are then ranked according to the weight criteria, and converted to a high, medium, or low process rank. South Schneider has primarily high and moderate ecological benefit, with no DAUs ranked as low (Figure 17. South Schneider Sub-watershed Weighted Processes).

Environmental Benefit

Once all the DAUs were ranked for their ecological benefit, all natural resource sites were ranked for their environmental benefit. Only the high and medium scoring sites were used in further evaluation to develop natural resource, fish habitat, and stormwater preservation and restoration sites.

Table 8. South Schneider Environmental Benefit Ranking of Natural Resource Sites

South Schneider Potential Restoration Sites				
Rank	Wetland	Riparian	Floodplain	Total
High	1	2	NA	3
Medium	1	2	NA	3
Low	7	9	NA	16

The following wetlands, riparian and floodplain sections describe the environmental benefit ranking of the natural resource sites.

Wetlands

Prior to human alteration, wetlands in the South Schneider Sub-watershed totaled approximately 82 acres. It is estimated that approximately 13 acres of the sub-watershed, are currently wetlands or degraded/destroyed wetlands with some restoration potential. (Figure 18. South Schneider Sub-Watershed Resource Sites).

Riparian condition

Development has encroached on approximately 109 acres of the 67-meter wide riparian corridors in the South Schneider basin. Of the 595 acres, approximately 109 acres have some restoration potential (Figure 18. South Schneider Sub-Watershed Resource Sites).

Floodplain Condition

There is no regulated floodplain in the South Schneider Sub-watershed.

Natural Resource Sites

All potential natural resource sites were evaluated for their environmental benefit and ranked high, medium, or low. Following evaluation, a total of six sites were of high or medium environmental benefit (Figure 19. South Schneider Ecological Processes and Resource Site Scoring).

Fish Habitat

There were 13 sites evaluated for habitat value to salmonid fish species. These sites were then used to evaluate potential natural resource sites that have the potential to be stormwater retrofits sites. While the goal is to use natural resource sites as stormwater retrofit sites, we don't want to compromise high quality fish habitat sites.

Stormwater Retrofit

All the natural resource sites were evaluated for stormwater retrofit sites (Figure 20. South Schneider Potential Stormwater Restoration Sites).

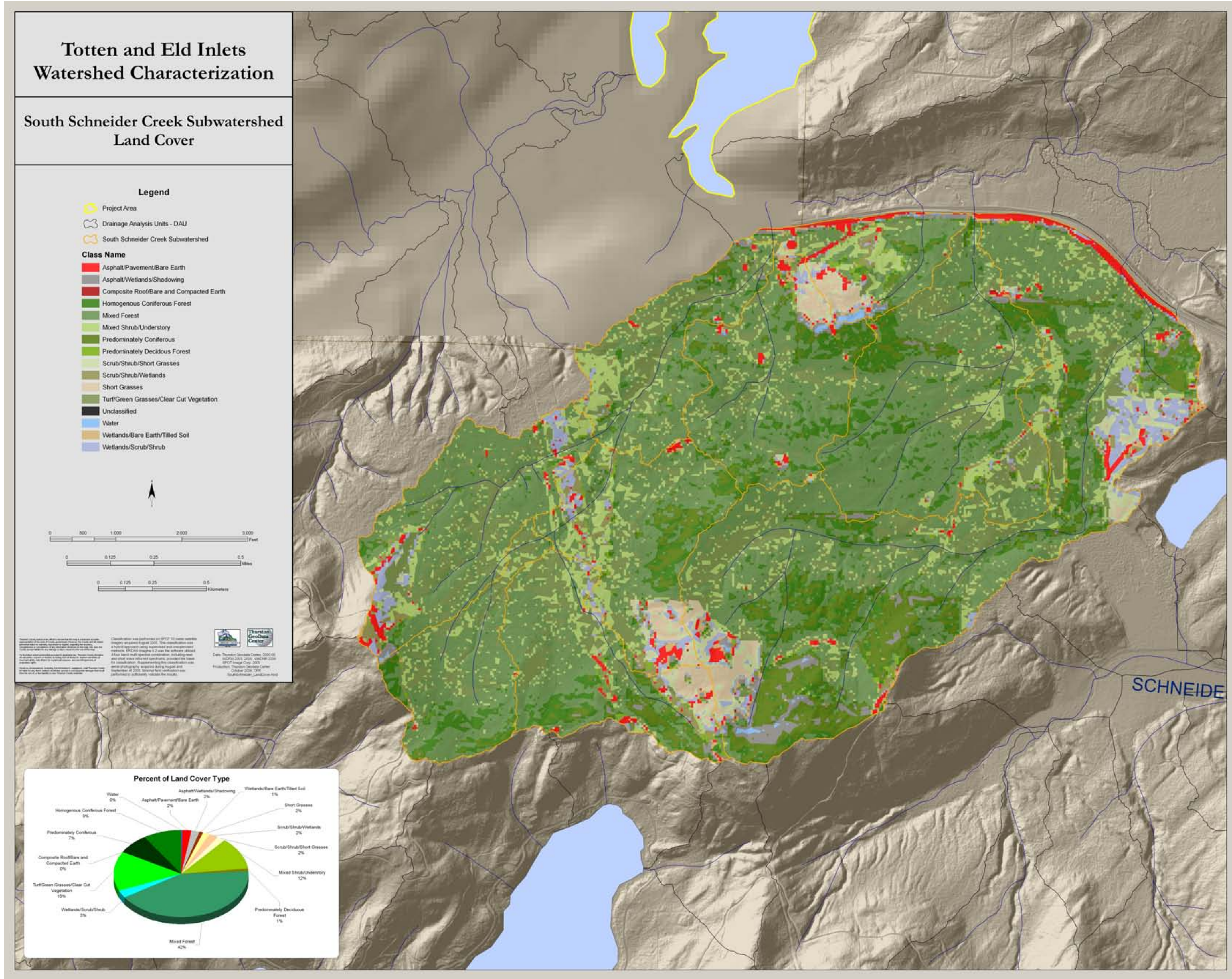
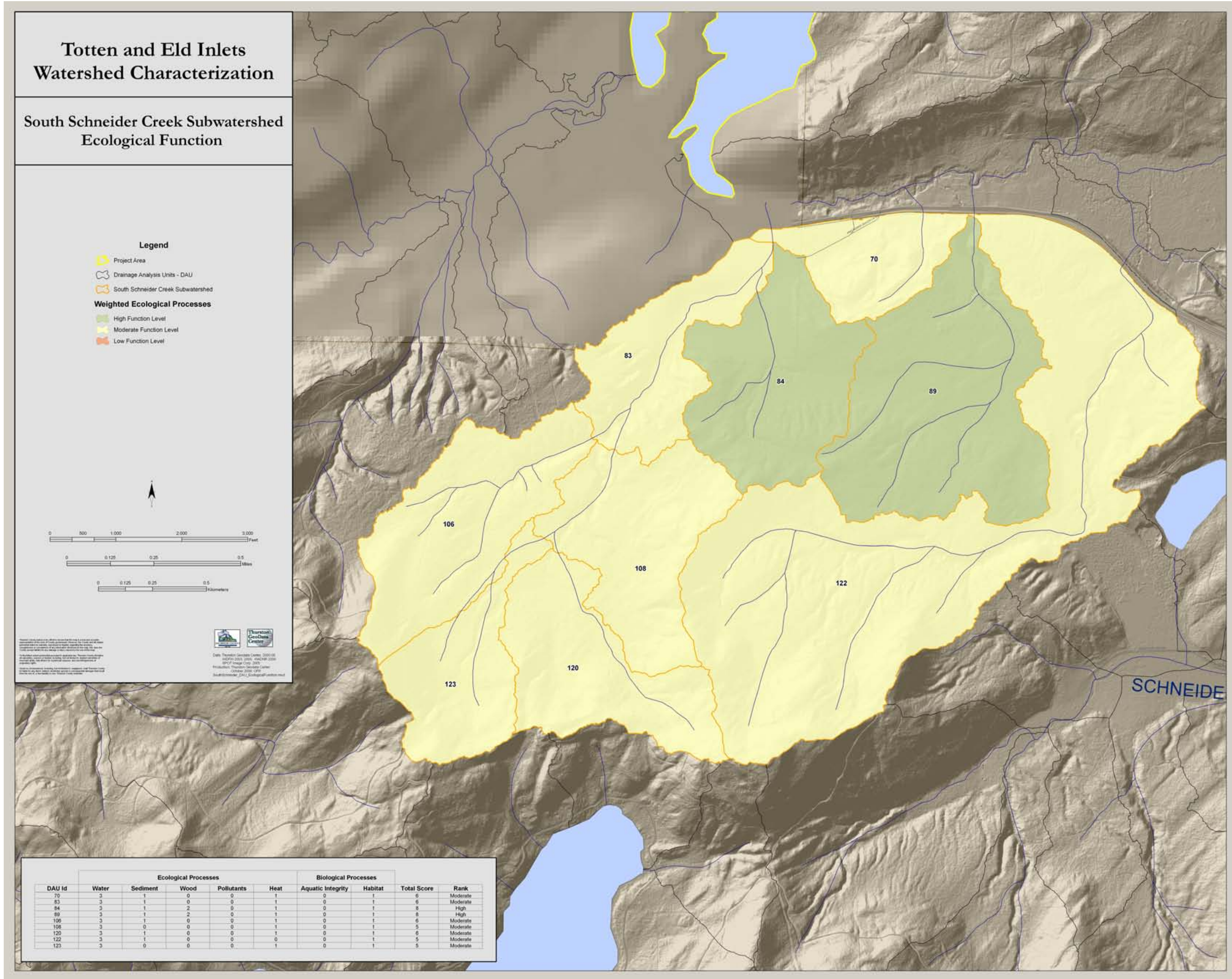


Figure 16 South Schneider Creek Sub-watershed Land Cover



DAU Id	Ecological Processes: Water	Sediment	Wood	Pollutants	Heat	Biological Processes: Aquatic Integrity	Habitat	Total Score	Rank
70	3	1	0	0	1	0	1	6	Moderate
83	3	1	0	0	1	0	1	6	Moderate
84	3	1	2	0	1	0	1	8	High
89	3	1	2	0	1	0	1	8	High
106	3	1	0	0	1	0	1	6	Moderate
108	3	0	0	0	1	0	1	5	Moderate
120	3	1	0	0	1	0	1	6	Moderate
122	3	1	0	0	0	0	1	5	Moderate
123	3	0	0	0	1	0	1	5	Moderate

Figure 17 South Schneider Creek Sub-watershed Weighted Processes

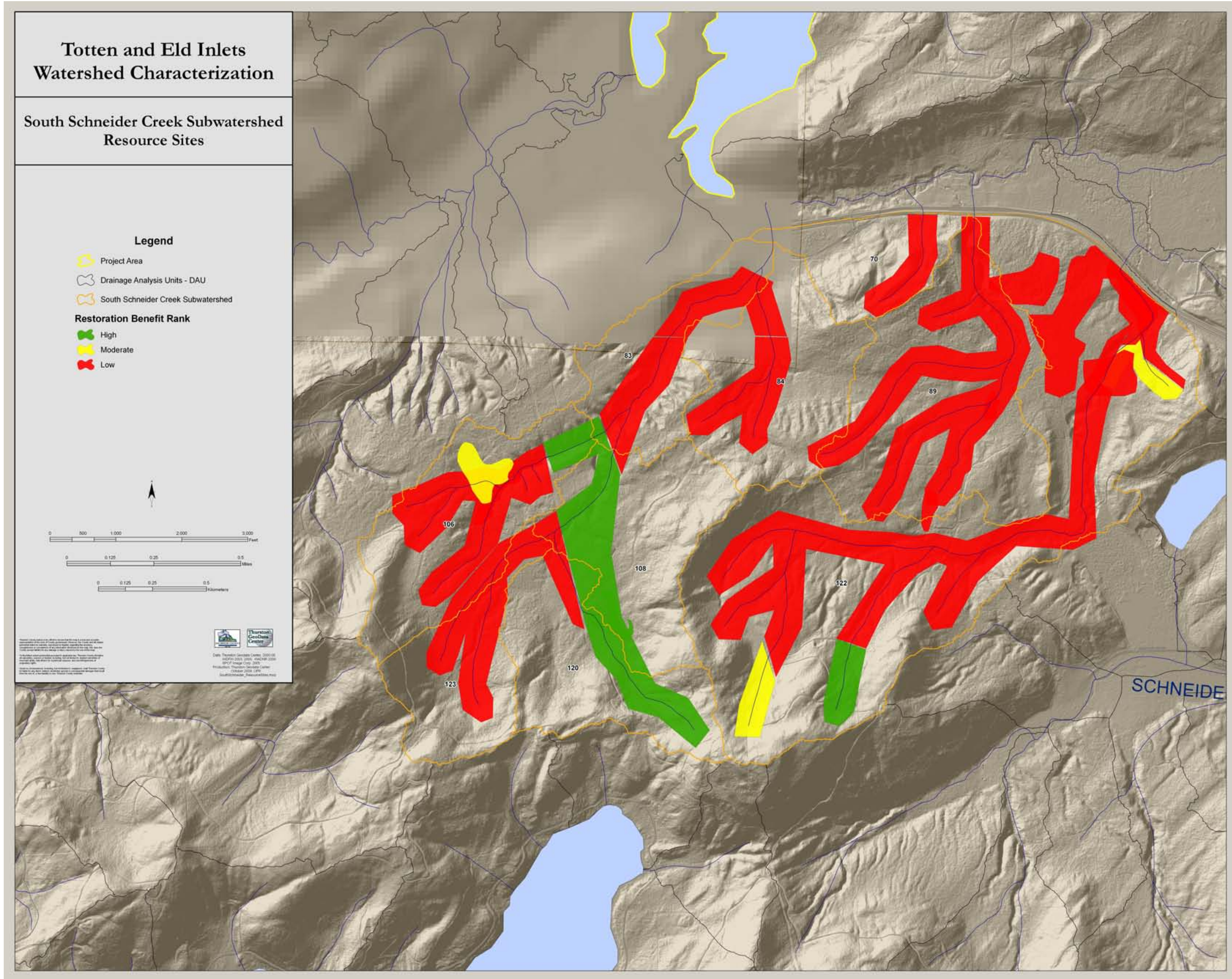


Figure 18 South Schneider Creek Sub-watershed Resource Sites

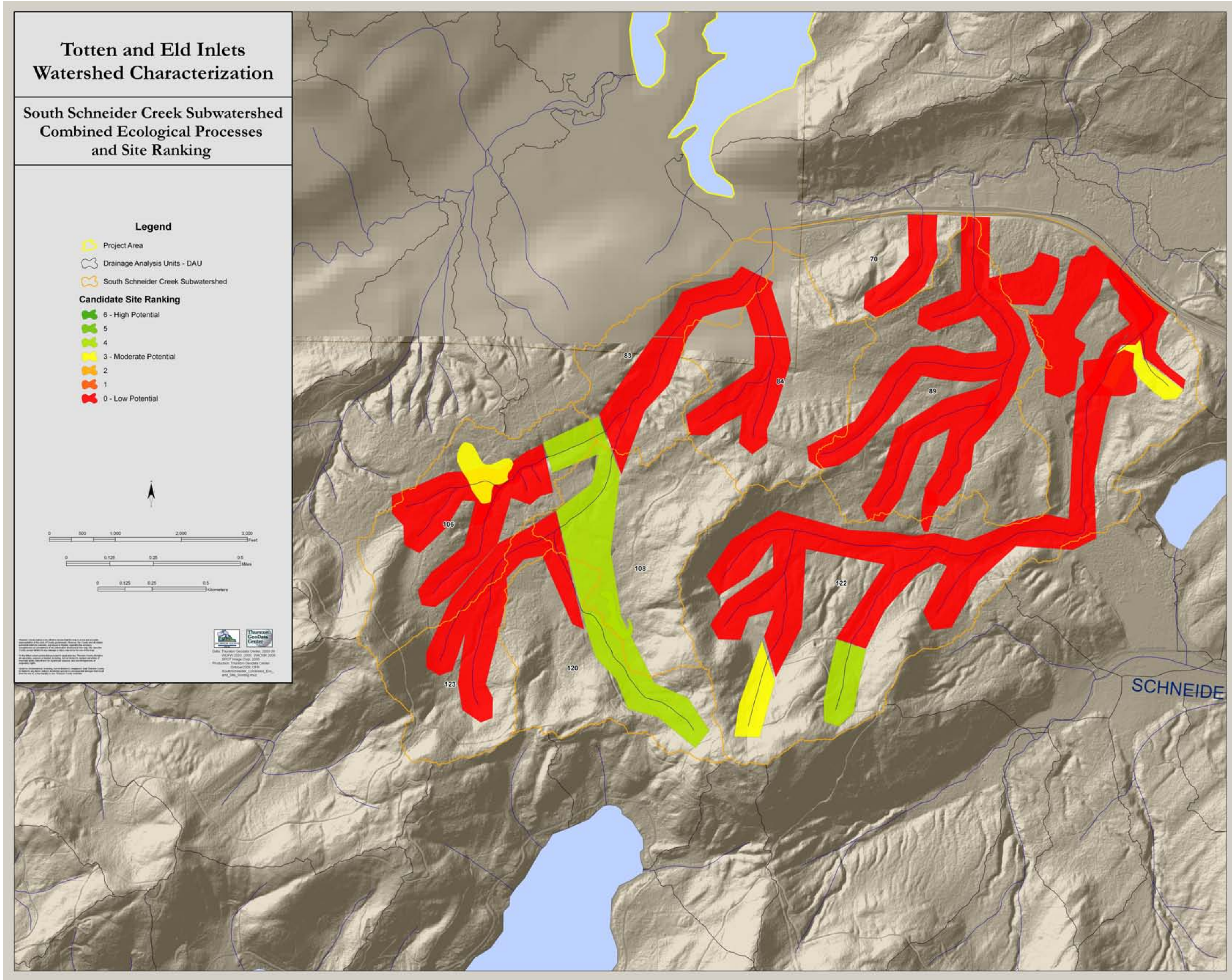


Figure 19 South Schneider Creek Sub-watershed Ecological Processes and Resource Site Scoring

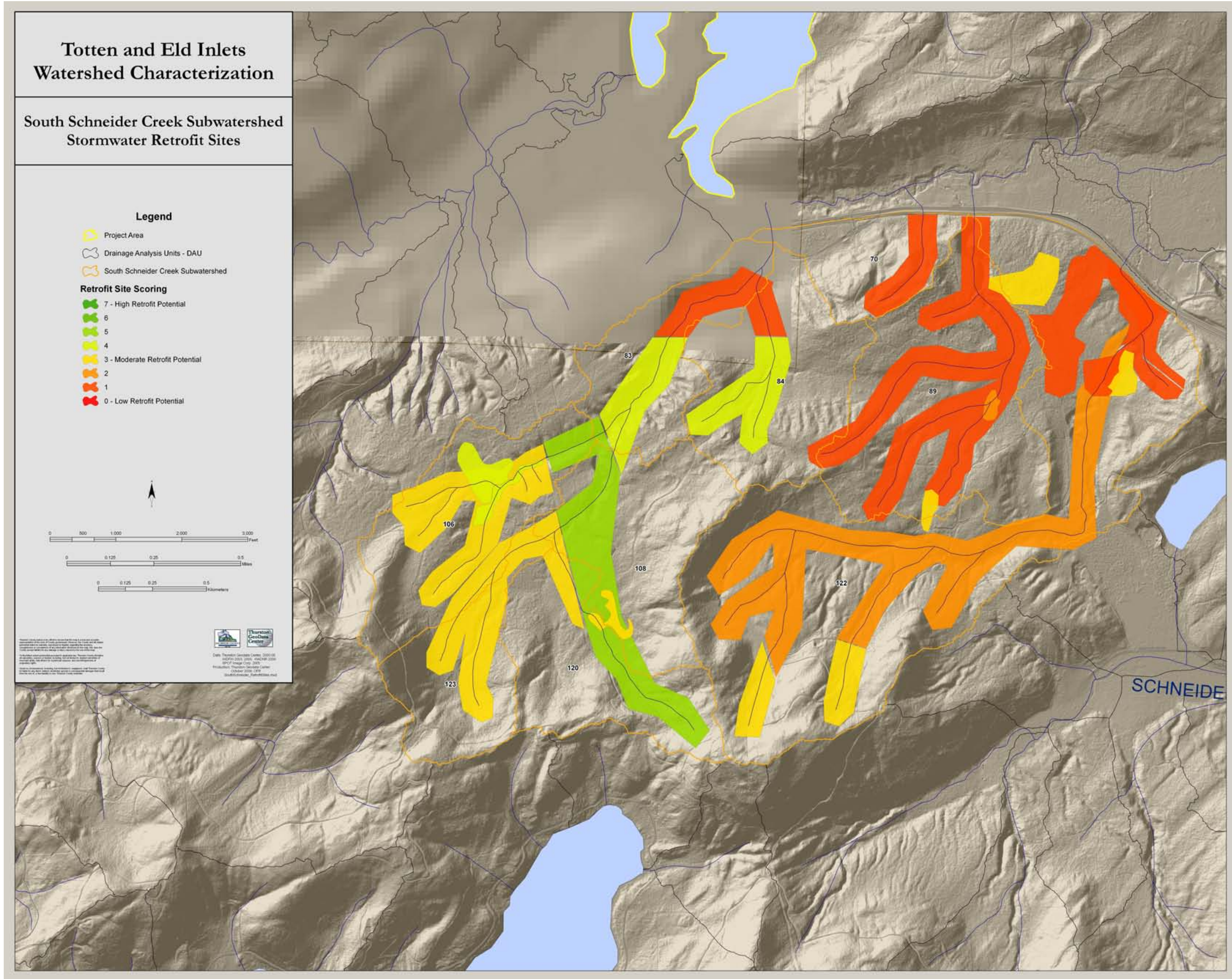


Figure 20 South Schneider Creek Sub-watershed Retrofit Sites

What are the conditions in the East Totten Sub-watershed?

Current conditions

Approximately five percent of the East Totten Sub-watershed is covered by urban land uses (see Figure 21 and 21a, Classification Percent Totals for East Totten Sub-watershed). East Totten has a drainage area of 4.8 square miles.

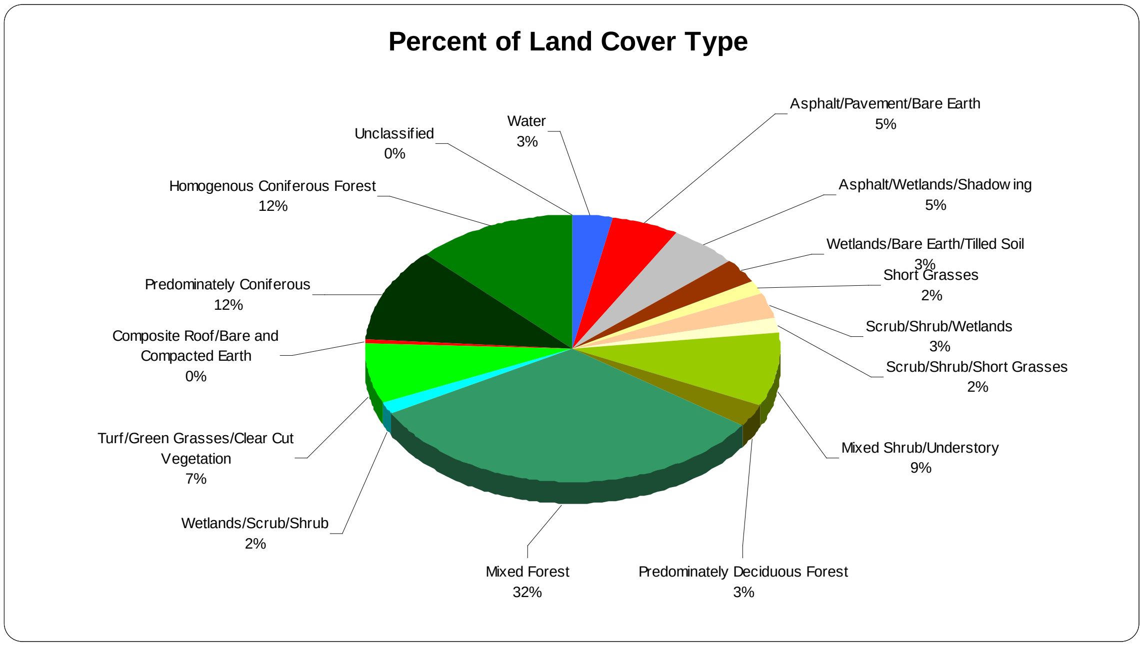


Figure 21a. Classification Percent Totals for East Totten Sub-watershed

Land cover data from 2005 SPOT imagery.

Human alteration to the movement of water

The effects of human land use on the natural delivery of water in the East Totten Sub-watershed were characterized using the following landscape attributes: percent TIA, percent forest land, and percent wetland cover at the DAU scale. Results indicate that the East Totten Sub-watershed is in an “at risk” condition for the delivery of water, with one “properly functioning” and two “not properly functioning.”

Human alteration to the natural movement of sediment

The effects of human land use on the natural delivery of sediment to the East Totten Sub-watershed were characterized using the following landscape attributes: percent bare soils, road density, and percent unstable slopes at the DAU scale. However, because there are no forestry activities or unstable slopes in the sub-watershed, road density was the only applicable indicator.

The result was a “properly functioning” condition, with the exception of five in an “at risk” condition.

Human alteration to the natural movement of large wood

The effects of human land use on the natural delivery and routing of large wood in the East Totten and its tributaries were characterized using the following landscape attributes: percent forested riparian and average number of stream crossings per kilometer of stream at the DAU scale. Results indicate that the East Totten Sub-watershed is primarily in a “not properly functioning” condition for the delivery and routing of large wood. Exceptions include three “at risk.”

Human alteration to the natural movement of pollutants

The effects of human land use on the natural delivery and routing of pollutants in the East Totten and its tributaries were characterized using the following landscape attributes: Extent of 303(d) listed water bodies for nutrients, toxicants, and bacteria and condition and extent of wetlands at the DAU scale. Results indicate that the East Totten Sub-watershed is in an “at risk” condition for the delivery and routing of pollutants.

Human alteration to the natural movement of heat

The effects of human land use on the natural delivery and routing of heat in the East Totten tributaries were characterized using the following landscape attributes: Extent of 303(d) listed water bodies for nutrients, toxicants, and bacteria, percent 67 meter riparian zone with mature canopy, road density, and percent TIA at the DAU scale. Results indicate that the East Totten Sub-watershed is primarily in an “at risk” condition for the delivery and routing of heat. The exception is two DAUs that are conditioned to be in “not properly functioning.”

Aquatic integrity

The effects of human land use on aquatic integrity in the East Totten and its tributaries in the East Totten Sub-watershed were characterized using the following landscape attributes: percent riparian forest, percent TIA, and available B-IBI scores at the DAU scale. There is no data to rank aquatic integrity.

Habitat Connectivity

Forest covers fifty-nine percent of the East Totten Sub-watershed, concentrated in the south west sub-watershed. Most of the forest is in rural residential areas and the sub-watershed’s primary land cover is composed of commercial and long-term forestry. The East Totten Sub-watershed is considered “at risk” and “properly functioning”, with only one DAU considered “not properly functioning” for habitat connectivity.

Ecological Benefit

All DAUs within the study area having ecological and biological processes that are considered "at risk" under current land use conditions were identified for further consideration. DAUs in the "at risk" category for multiple key ecological and biological processes are assumed to provide the greatest potential to maximize environmental benefits when restored. The process scores are then ranked according to the weight criteria, and converted to a high, medium, or low process rank. East Totten has primarily high and moderate ecological benefit, with only five DAUs ranked as low (Figure 22. East Totten Sub-watershed Weighted Processes).

Environmental Benefit

Once all the DAUs were ranked for their ecological benefit, all natural resource sites were ranked for their environmental benefit. Only the high and medium scoring sites were used in further evaluation to develop natural resource, fish habitat, and stormwater preservation and restoration sites.

Table 9. East Totten Environmental Benefit Ranking of Natural Resource Sites

East Totten Potential Restoration Sites				
Rank	Wetland	Riparian	Floodplain	Total
High	0	0	NA	0
Medium	4	1	NA	5
Low	26	17	NA	43

The following wetlands, riparian and floodplain sections describe the environmental benefit ranking of the natural resource sites.

Wetlands

Prior to human alteration, wetlands in the East Totten Sub-watershed totaled approximately 141 acres. We estimate that approximately 28 acres are currently wetlands or degraded/destroyed wetlands with some restoration potential. (Figure 23. East Totten Sub-Watershed Resource Sites).

Riparian condition

Development has encroached on approximately seven acres of the 67-meter wide riparian corridors in the East Totten basin. Of the 184 acres, approximately seven acres have some restoration potential (Figure 23. East Totten Sub-Watershed Resource Sites).

Floodplain Condition

There is no regulated floodplain in the East Totten Sub-watershed.

Natural Resource Sites

All potential natural resource sites were evaluated for their environmental benefit and ranked high, medium, or low. Following evaluation, a total of five sites were of high or medium environmental benefit (Figure 24. East Totten Ecological Processes and Resource Site Scoring).

Fish Habitat

There were 18 riparian sites evaluated for habitat value to salmonid fish species. These sites were then used to evaluate potential natural resource sites that have the potential to be stormwater retrofits sites. While the goal is to use natural resource sites as stormwater retrofit sites, we don't want to compromise high quality fish habitat sites.

Stormwater Retrofit

All the natural resource sites were evaluated for stormwater retrofit sites (Figure 25. East Totten Potential Stormwater Restoration Sites).

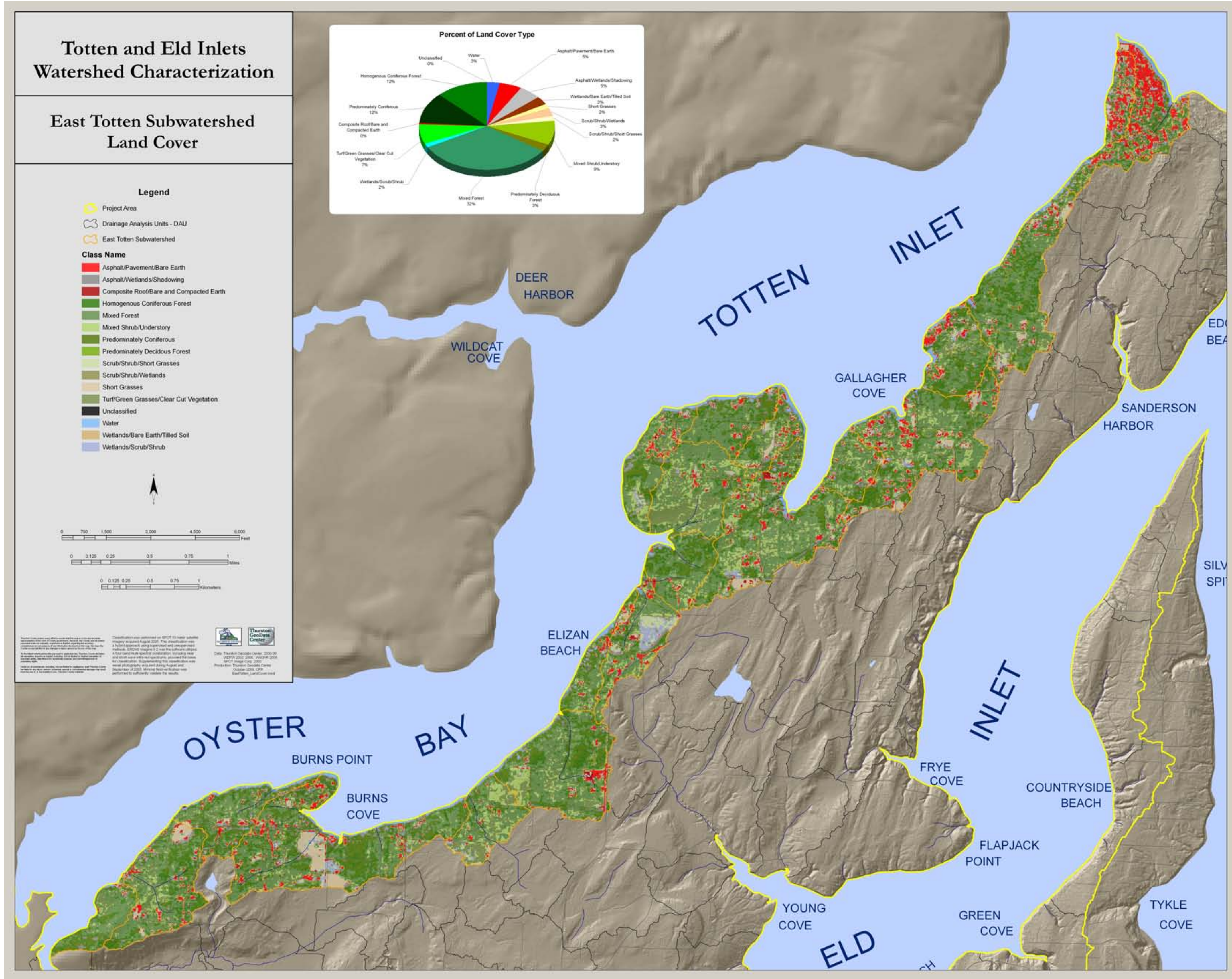
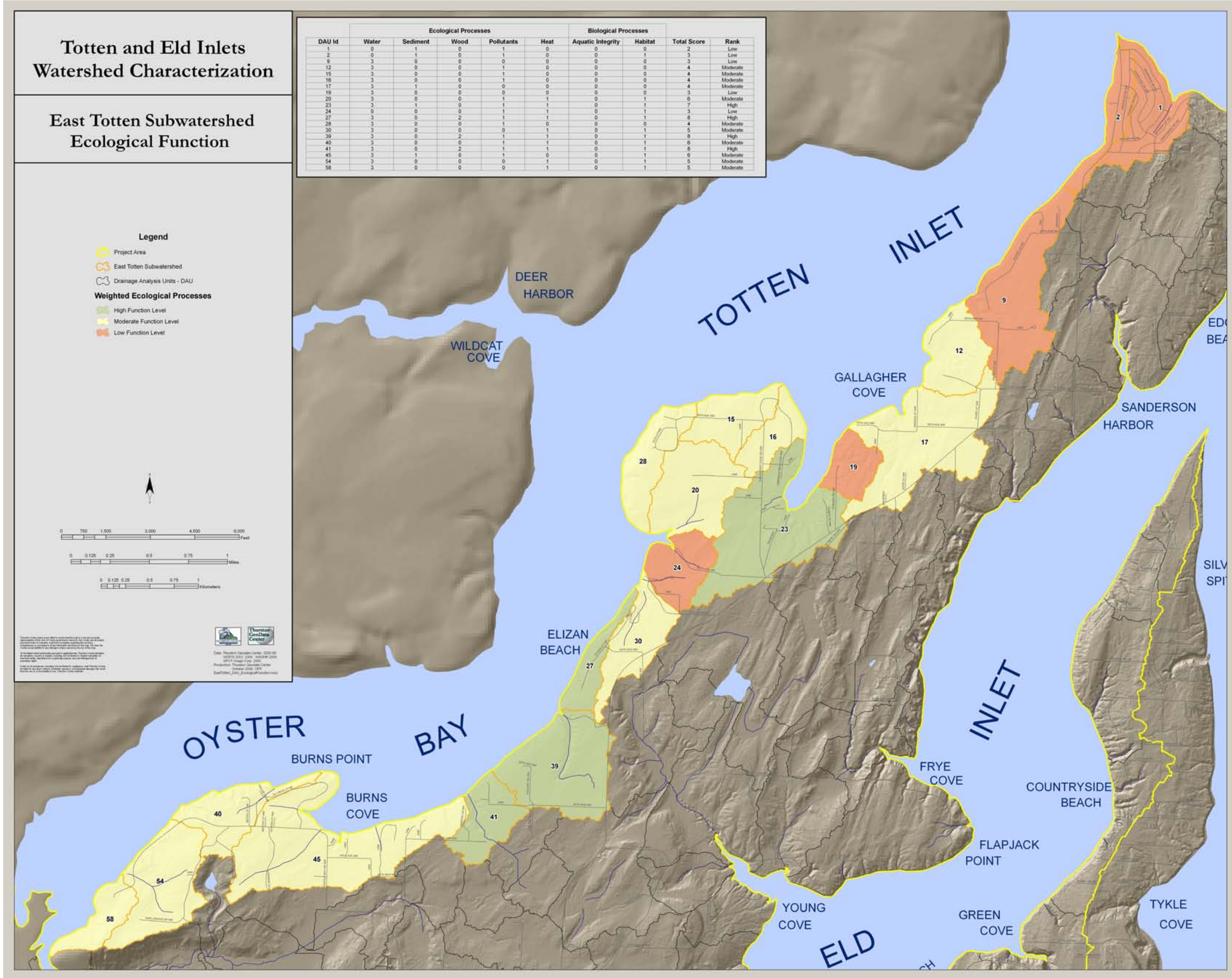


Figure 21 East Totten Sub-watershed Land Cover



	Ecological Processes					Biological Processes			
DAU Id	Water	Sediment	Wood	Pollutants	Heat	Aquatic Integrity	Habitat	Total Score	Rank
1	0	1	0	1	0	0	0	2	Low
2	0	1	0	1	0	0	1	3	Low
9	3	0	0	0	0	0	0	3	Low
12	3	0	0	1	0	0	0	4	Moderate
15	3	0	0	1	0	0	0	4	Moderate
16	3	0	0	1	0	0	0	4	Moderate
17	3	1	0	0	0	0	0	4	Moderate
19	3	0	0	0	0	0	0	3	Low
20	3	0	0	1	1	0	1	6	Moderate
23	3	1	0	1	1	0	1	7	High
24	0	0	0	1	1	0	1	3	Low
27	3	0	2	1	1	0	1	8	High
28	3	0	0	1	0	0	0	4	Moderate
30	3	0	0	0	1	0	1	5	Moderate
39	3	0	2	1	1	0	1	8	High
40	3	0	0	1	1	0	1	6	Moderate
41	3	0	2	1	1	0	1	8	High
45	3	1	0	1	0	0	1	6	Moderate
54	3	0	0	0	1	0	1	5	Moderate
58	3	0	0	0	1	0	1	5	Moderate

Figure 22 East Totten Sub-watershed Weighted Processes

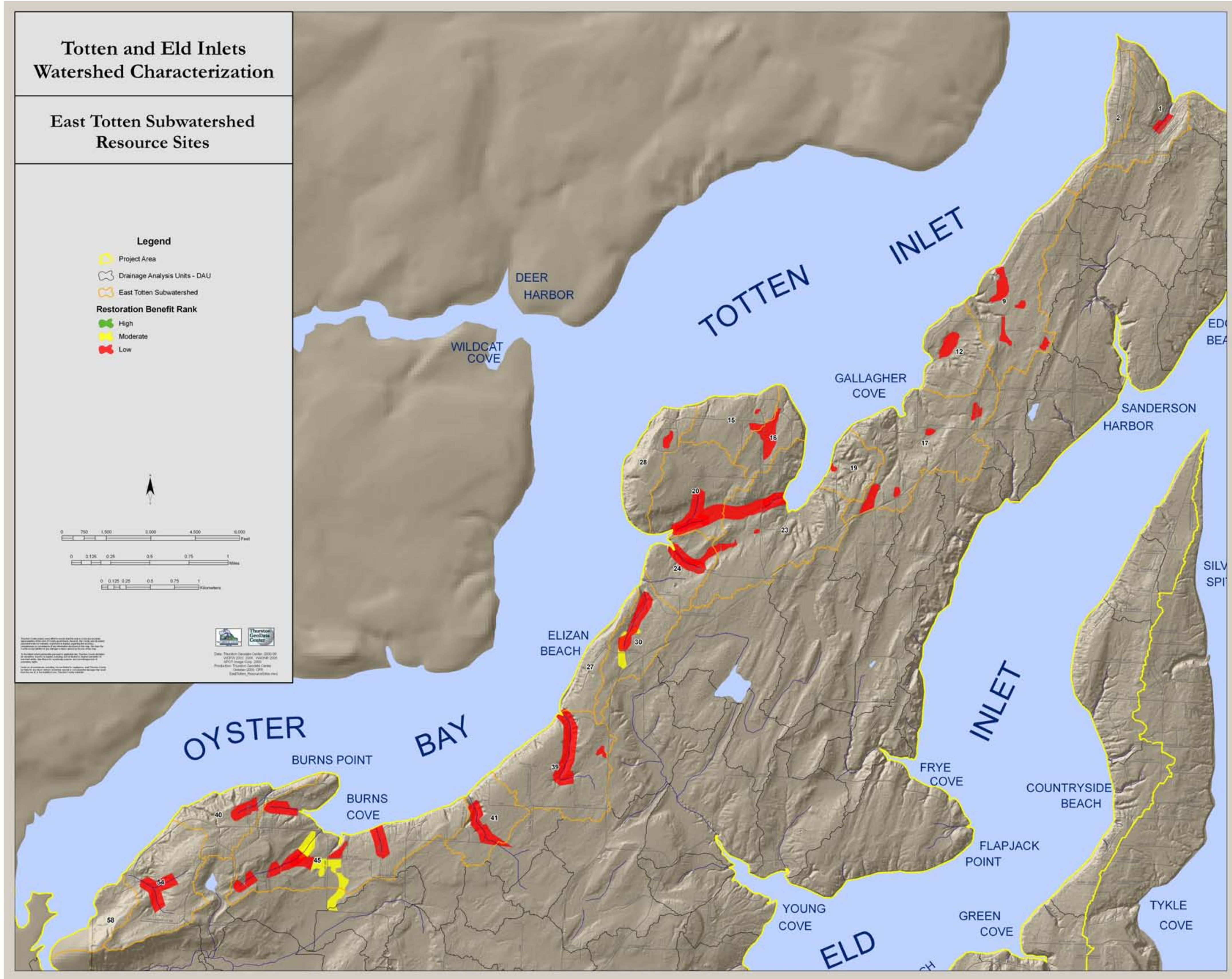


Figure 23 East Totten Sub-watershed Resource Sites

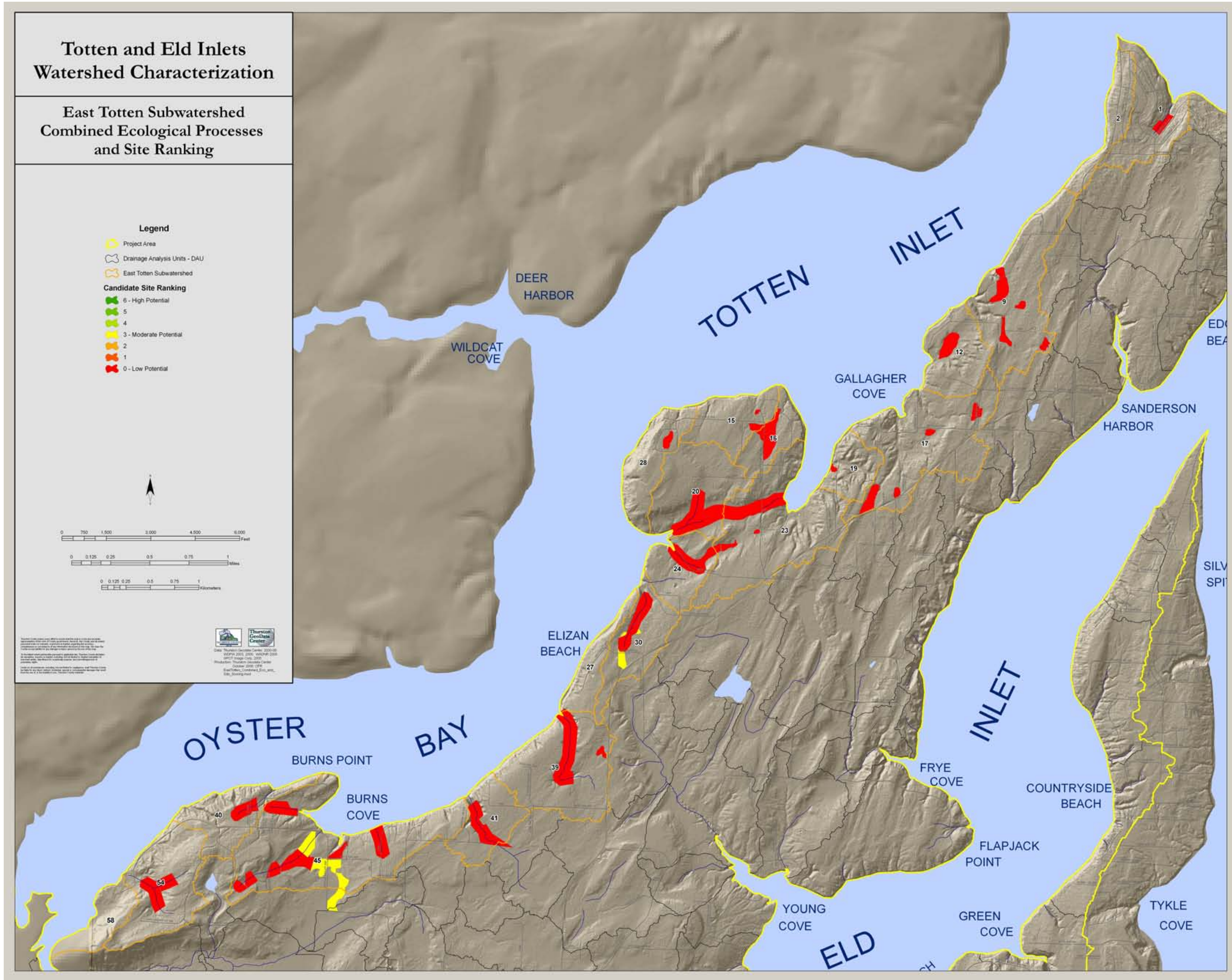


Figure 24 East Totten Sub-watershed Ecological Processes and Resource Site Scoring

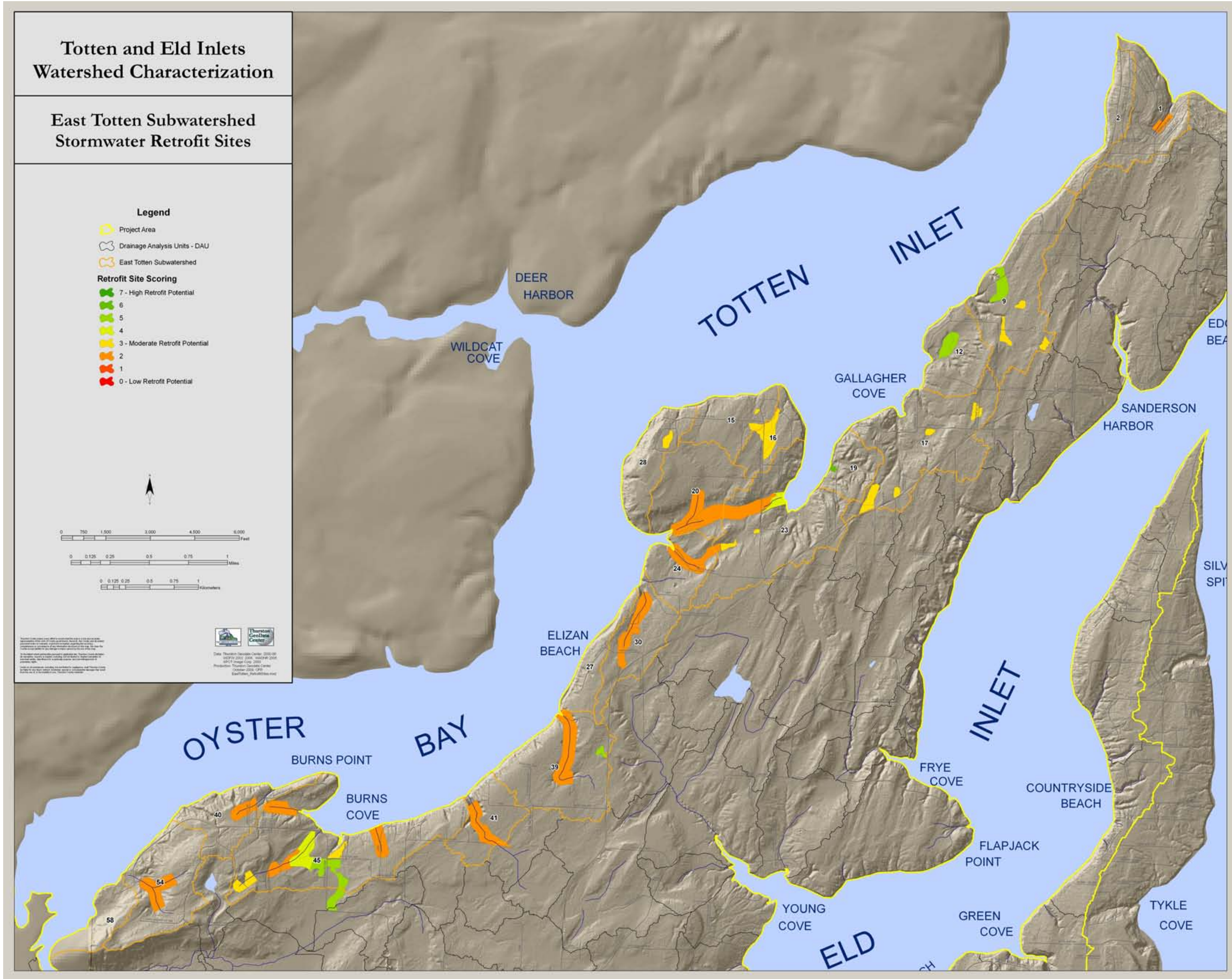


Figure 25 East Totten Sub-watershed Retrofit Sites

What are the conditions in the Summit Lake Sub-watershed?

Current conditions

Approximately three percent of the Summit Lake Sub-watershed is covered by urban land uses (see Figure 26 and 26a, Classification Percent Totals for Summit Lake Sub-watershed). Summit lake has a drainage area of 3.1 square miles.

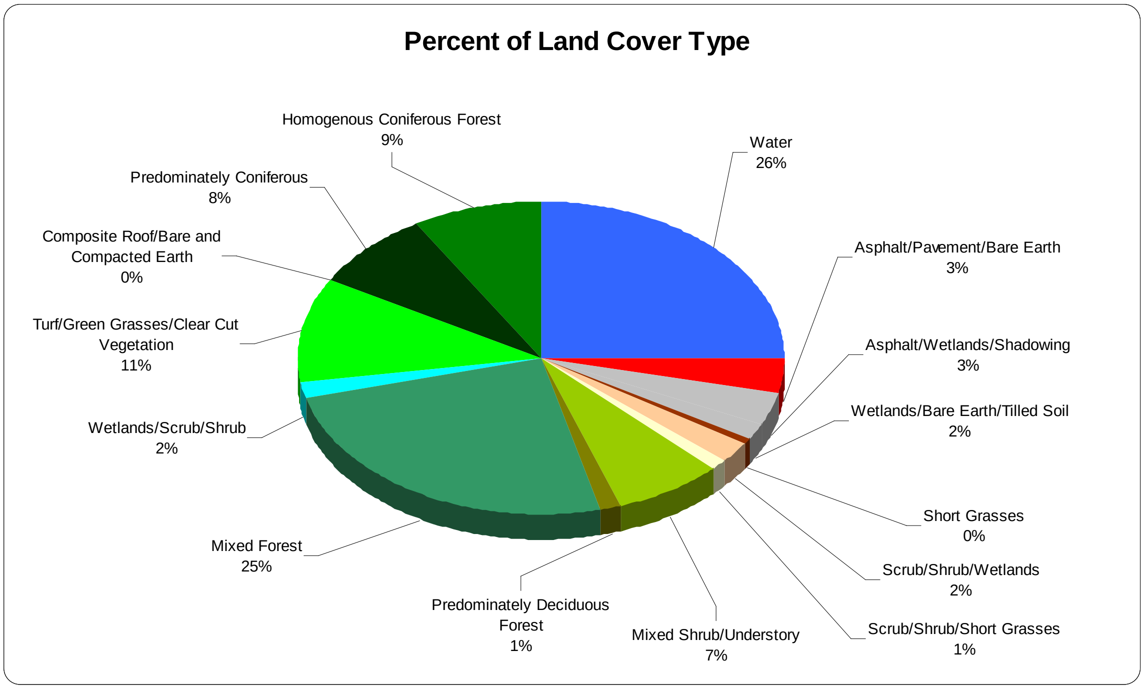


Figure 26a. Classification Percent Totals for Summit Lake Sub-watershed

Land cover data from 2005 SPOT imagery.

Human alteration to the movement of water

The effects of human land use on the natural delivery of water in the Summit Lake Sub-watershed were characterized using the following landscape attributes: percent TIA, percent forest land, and percent wetland cover at the DAU scale. Results indicate that the Summit Lake Sub-watershed is in an "at risk" condition for the delivery of water.

Human alteration to the natural movement of sediment

The effects of human land use on the natural delivery of sediment to the Summit Lake Sub-watershed were characterized using the following landscape attributes: percent bare soils, road density, and percent unstable slopes at the DAU scale. The result is “at risk” and “properly functioning” condition.

Human alteration to the natural movement of large wood

The effects of human land use on the natural delivery and routing of large wood in the Summit Lake and its tributaries were characterized using the following landscape attributes: percent forested riparian and average number of stream crossings per kilometer of stream at the DAU scale. Results indicate that the Summit Lake Sub-watershed is primarily in a “not properly functioning” condition for the delivery and routing of large wood. Exceptions include three “at risk” and one “properly functioning” DAUs.

Human alteration to the natural movement of pollutants

The effects of human land use on the natural delivery and routing of pollutants in the Summit Lake and its tributaries were characterized using the following landscape attributes: Extent of 303(d) listed water bodies for nutrients, toxicants, and bacteria and condition and extent of wetlands at the DAU scale. There is no data to rank pollutants.

Human alteration to the natural movement of heat

The effects of human land use on the natural delivery and routing of heat in the McLane Creek Sub-watershed were characterized using the following landscape attributes: Extent of 303(d) listed water bodies for nutrients, toxicants, and bacteria, percent 67 meter riparian zone with mature canopy, road density, and percent TIA at the DAU scale. Results indicate that the McLane Creek Sub-watershed is primarily in an “at risk” condition for the delivery and routing of heat. The exception is one DAU that is “properly functioning.”

Aquatic integrity

The effects of human land use on aquatic integrity in the Summit Lake and its tributaries in the Summit Lake Sub-watershed were characterized using the following landscape attributes: percent riparian forest, percent TIA, and available B-IBI scores at the DAU scale. There is no data to rank aquatic integrity.

Habitat Connectivity

Forest covers forty-three percent of the Summit Lake Sub-watershed. The Summit Lake Sub-watershed is considered “at risk” with only one DAU considered “not properly functioning” for habitat connectivity.

Ecological Benefit

DAUs within the study area having ecological and biological processes that are considered "at risk" under current land use conditions were identified for further consideration. DAUs in the “at risk” category for multiple key ecological and biological processes are assumed to provide the greatest potential to maximize environmental benefits when restored. The process scores are then ranked according to the weight criteria, and converted to a high, medium, or low process rank. Summit Lake has primarily high and moderate ecological benefit, with only one DAUs ranked as low (Figure 27. Summit Lake Sub-watershed Weighted Processes).

Environmental Benefit

Once all the DAUs were ranked for their ecological benefit, all natural resource sites were ranked for their environmental benefit. Only the high and medium scoring sites were used in further evaluation to develop natural resource, fish habitat, and stormwater preservation and restoration sites.

Table 10. Summit Lake Environmental Benefit Ranking of Natural Resource Sites

Summit Lake Potential Restoration Sites				
Rank	Wetland	Riparian	Floodplain	Total
High	1	0	NA	1
Medium	0	4	NA	4
Low	7	16	NA	23

The following wetlands, riparian and floodplain sections describe the environmental benefit ranking of the natural resource sites.

Wetlands

Prior to human alteration, wetlands in the Summit Lake Sub-watershed totaled approximately 62 acres. We estimate that approximately 1 acre of the sub-watershed is currently wetlands or degraded/destroyed wetlands with some restoration potential. (Figure 28. Summit lake Sub-Watershed Resource Sites).

Riparian condition

Urban development has encroached on approximately X acres of the 67-meter wide riparian corridors in the Summit Lake basin. Of the X acres, approximately X acres have some restoration potential (Figure 28. Summit lake Sub-Watershed Resource Sites).

Floodplain Condition

There is no regulated floodplain in the Summit Lake Sub-watershed.

Natural Resource Sites

All potential natural resource sites were evaluated for their environmental benefit and ranked high, medium, or low. Following evaluation, a total of five sites were of high or medium environmental benefit (Figure 29. Summit Lake Ecological Processes and Resource Site Scoring).

Fish Habitat

There were 20 riparian sites evaluated for habitat value to salmonid fish species. These sites were then used to evaluate potential natural resource sites that have the potential to be stormwater retrofits sites. While the goal is to use natural resource sites as stormwater retrofit sites, we don't want to compromise high quality fish habitat sites.

Stormwater Retrofit

All the natural resource sites were evaluated for stormwater retrofit sites (Figure 30. Summit Lake Potential Stormwater Restoration Sites).

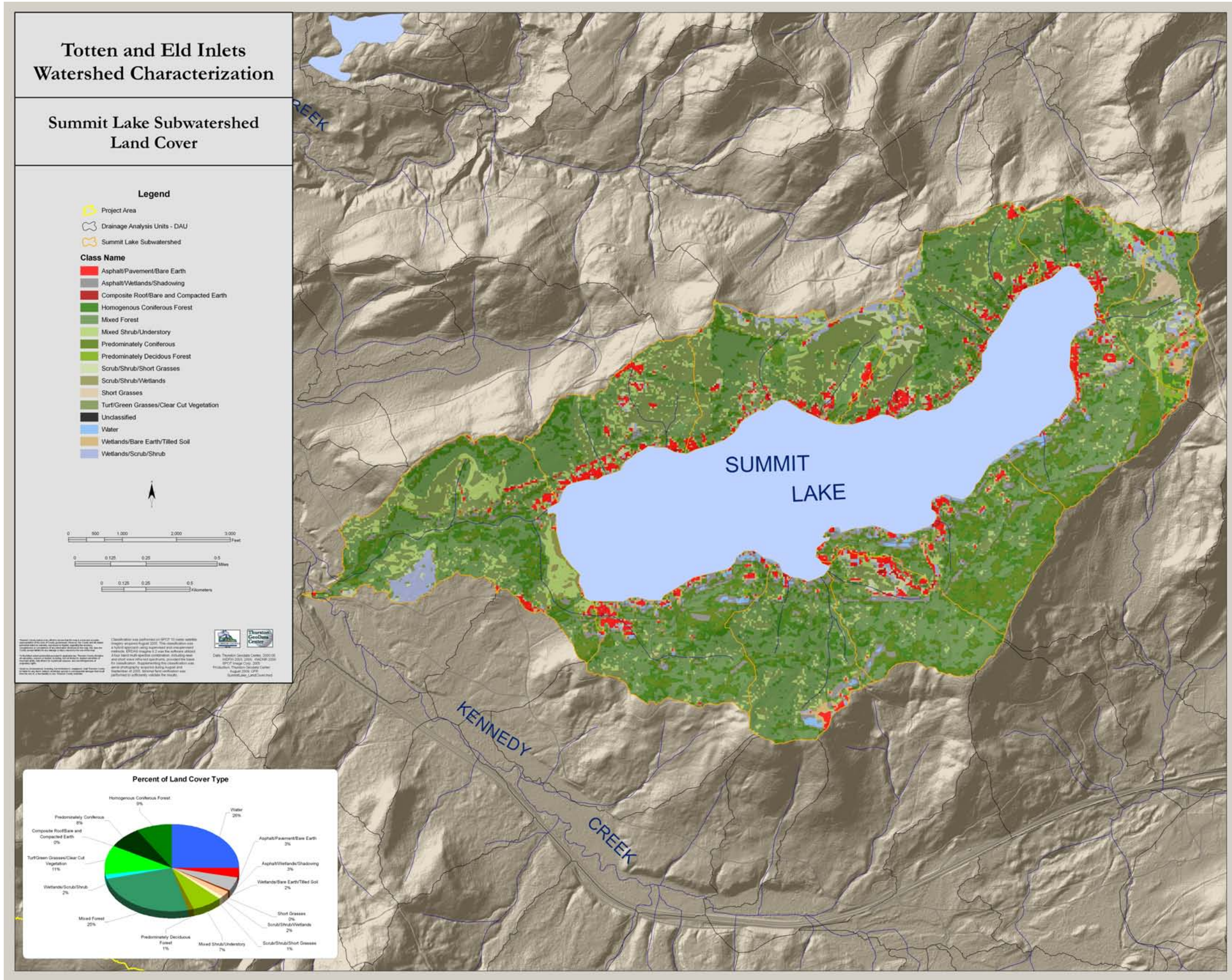
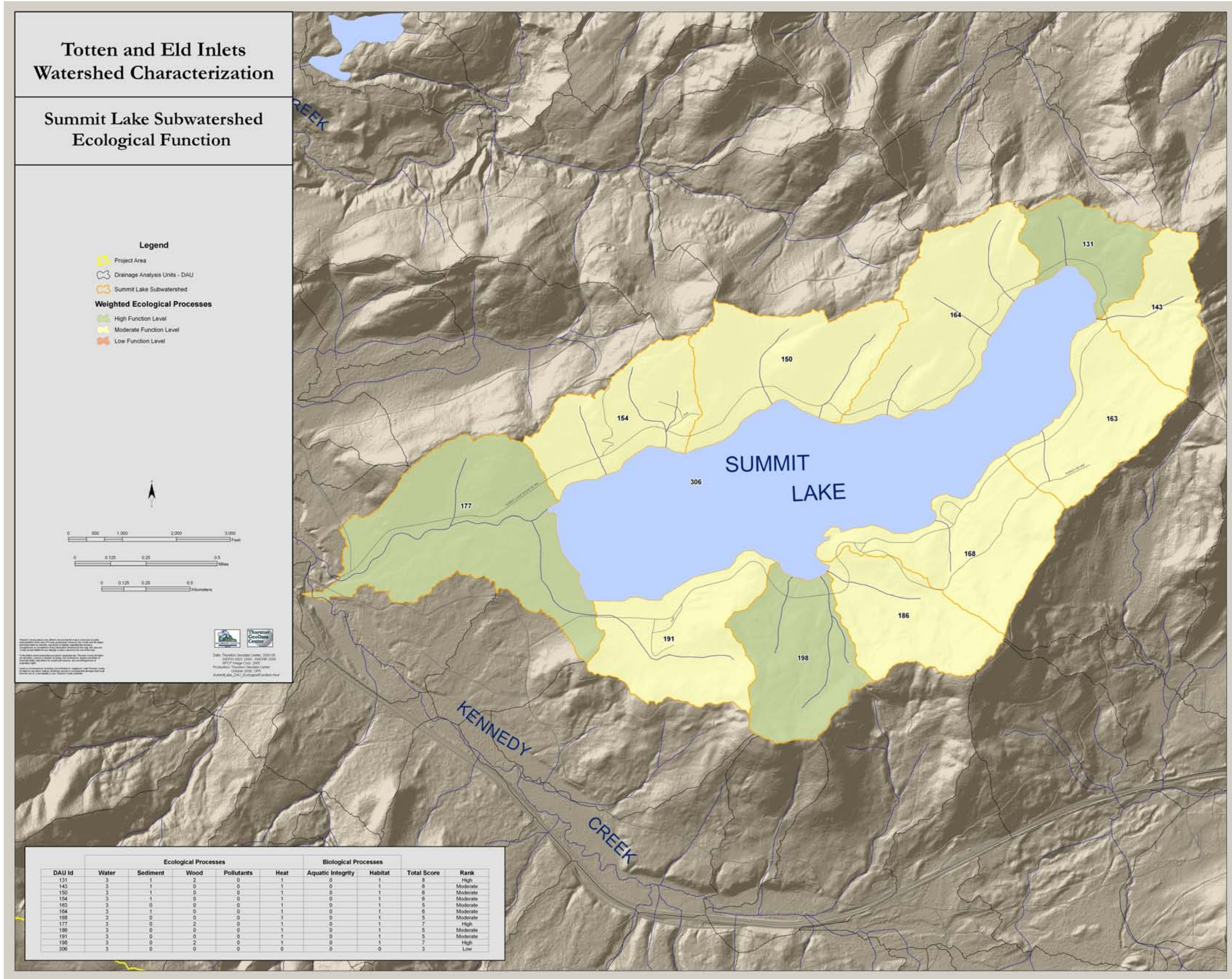


Figure 26 Summit Lake Sub-watershed Land Cover



	Ecological Processes					Biological Processes			
DAU Id	Water	Sediment	Wood	Pollutants	Heat	Aquatic Integrity	Habitat	Total Score	Rank
131	3	1	2	0	1	0	1	8	High
143	3	1	0	0	1	0	1	6	Moderate
150	3	1	0	0	1	0	1	6	Moderate
154	3	1	0	0	1	0	1	6	Moderate
163	3	0	0	0	1	0	1	5	Moderate
164	3	1	0	0	1	0	1	6	Moderate
168	3	0	0	0	1	0	1	5	Moderate
177	3	0	2	0	1	0	1	7	High
186	3	0	0	0	1	0	1	5	Moderate
191	3	0	0	0	1	0	1	5	Moderate
198	3	0	2	0	1	0	1	7	High
306	3	0	0	0	0	0	0	3	Low

Figure 27 Summit Lake Sub-watershed Weighted Processes

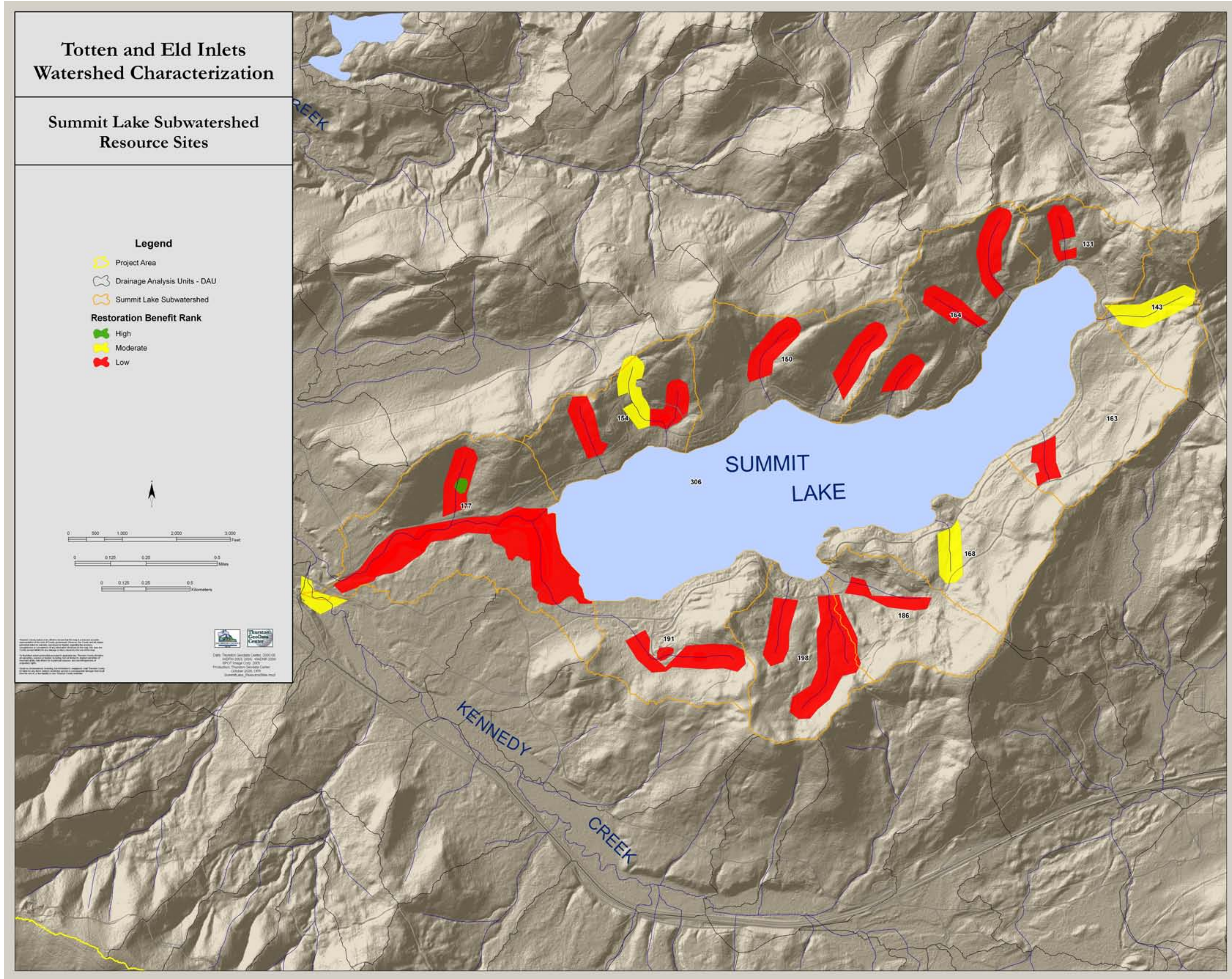


Figure 28 Summit Lake Sub-watershed Resource Sites

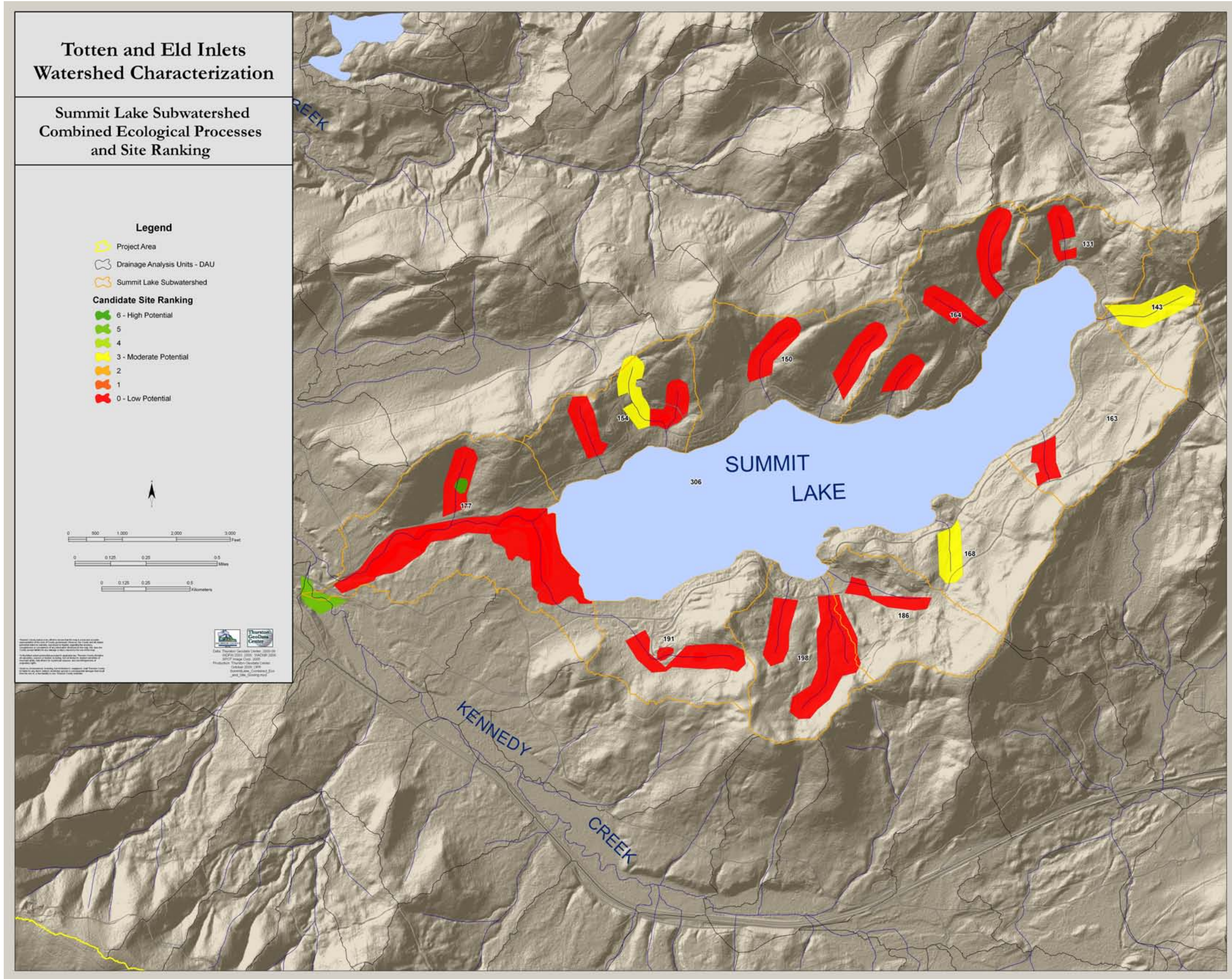


Figure 29 Summit Lake Sub-watershed Ecological Processes and Resource Site Scoring

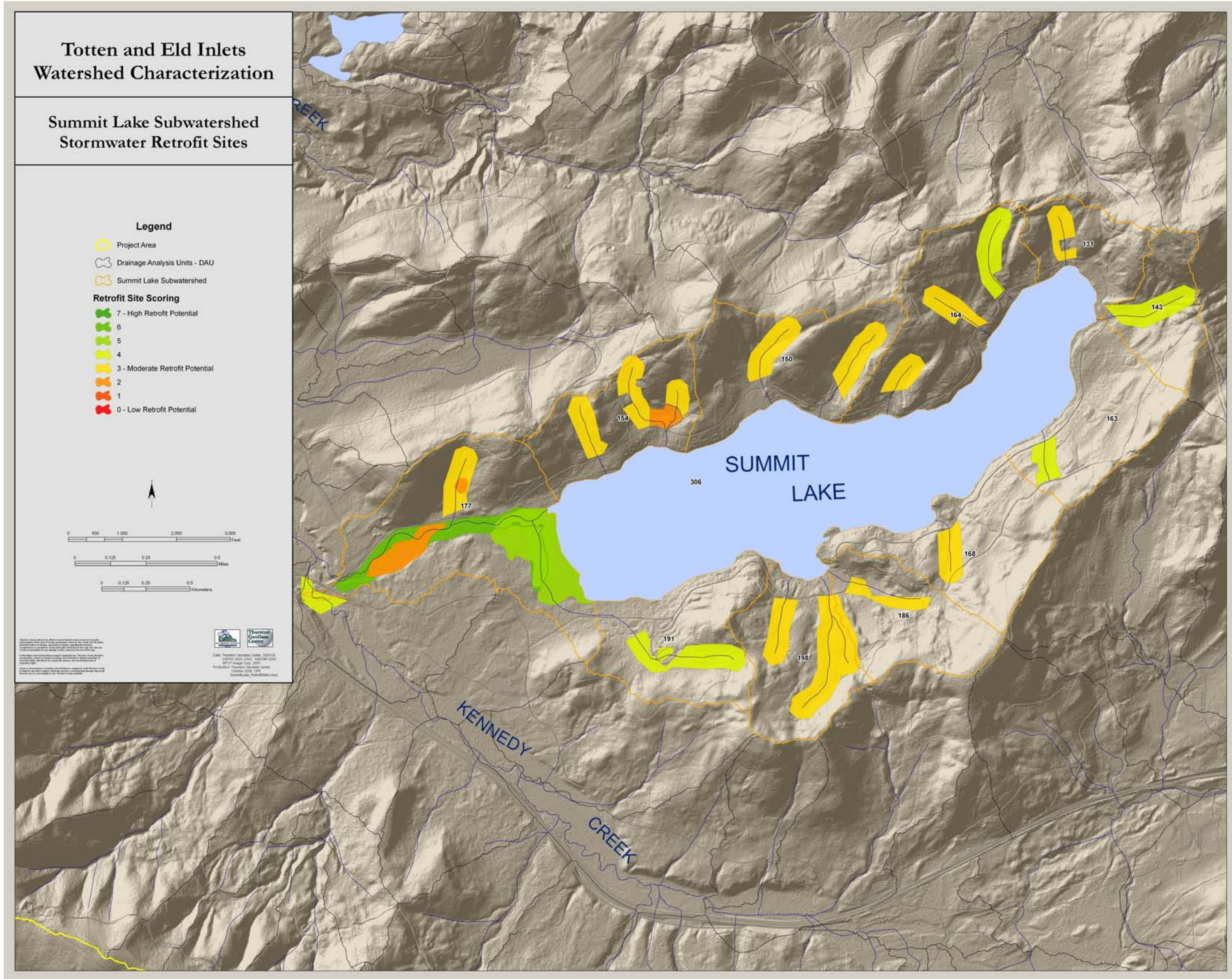


Figure 30 Summit Lake Sub-watershed Retrofit Sites

What are the conditions in the McLane Creek Sub-watershed?

Current conditions

Approximately two percent of the McLane Creek Sub-watershed is covered by urban land uses (see Figure 31 and 31a, Classification Percent Totals for McLane Creek Sub-watershed). McLane Creek basin has a drainage area of 11.7 square miles.

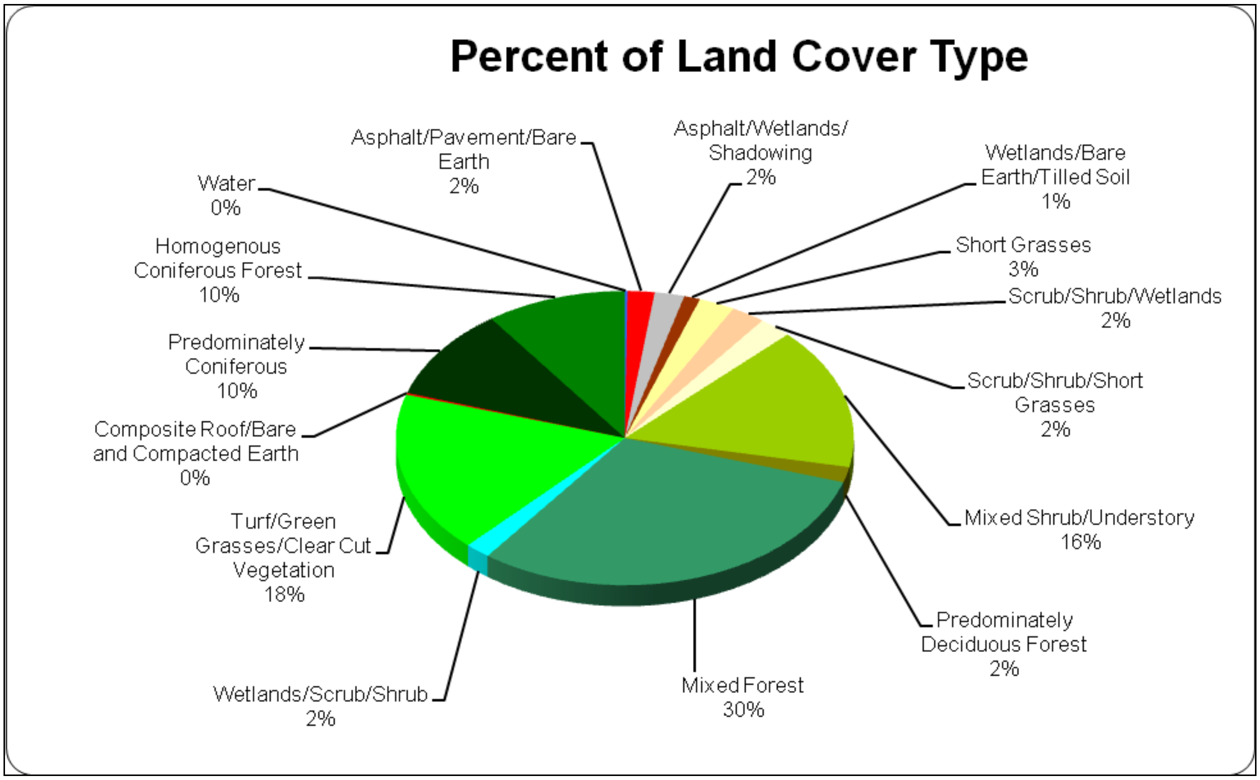


Figure 31a. Classification Percent Totals for McLane Creek Sub-watershed

Land cover data from 2005 SPOT imagery.

Human alteration to the movement of water

The effects of human land use on the natural delivery of water to the McLane Creek and its tributaries in the McLane Creek Sub-watershed were characterized using the following landscape attributes: percent TIA, percent forest land, and percent wetland cover at the DAU scale. Results indicate that the McLane Creek Sub-watershed is in an "at risk" condition for the delivery of water, with four DAUs "properly functioning."

Human alteration to the natural movement of sediment

The effects of human land use on the natural delivery of sediment to the McLane Creek and its tributaries in the Kennedy Creek Sub-watershed were characterized using the following landscape attributes: percent bare soils, road density, and percent unstable slopes at the DAU scale. However, because there are no forestry activities or unstable slopes in the sub-watershed, road density was the only applicable indicator. The result was an "at risk" and "properly functioning."

Human alteration to the natural movement of large wood

The effects of human land use on the natural delivery and routing of large wood in the McLane Creek and its tributaries were characterized using the following landscape attributes: percent forested riparian and average number of stream crossings per kilometer of stream at the DAU scale. Results indicate that the McLane Creek Sub-watershed is primarily in a "not properly functioning" and "at risk" condition for the delivery and routing of large wood.

Human alteration to the natural movement of pollutants

The effects of human land use on the natural delivery and routing of pollutants in the McLane Creek and its tributaries were characterized using the following landscape attributes: Extent of 303(d) listed water bodies for nutrients, toxicants, and bacteria and condition and extent of wetlands at the DAU scale. Only five DAUs had data to rank pollutants. Results indicate that the McLane Creek Sub-watershed is in an "at risk" condition for the delivery and routing of pollutants.

Human alteration to the natural movement of heat

The effects of human land use on the natural delivery and routing of heat in the McLane Creek tributaries were characterized using the following landscape attributes: Extent of 303(d) listed water bodies for nutrients, toxicants, and bacteria, percent 67 meter riparian zone with mature canopy, road density, and percent TIA at the DAU scale. Results indicate that the McLane Creek Sub-watershed is primarily in an "at risk" condition for the delivery and routing of large wood. The exception is one DAU that are conditioned to be in "not properly functioning condition and one DAU that is "properly functioning."

Aquatic integrity

The effects of human land use on aquatic integrity in the McLane Creek and its tributaries in the McLane Creek Sub-watershed were characterized using the following landscape attributes: percent riparian forest, percent TIA, and available B-IBI scores at the DAU scale. Results indicate that the McLane Creek Sub-watershed is in an "at risk" condition for aquatic integrity, with one DAU "properly functioning."

Habitat Connectivity

Forest covers forty-two percent of the McLane Creek Sub-watershed. Most of the forest is in rural residential areas and the sub-watershed's primary land cover is composed of commercial and long-term forestry. The McLane Creek Sub-watershed is considered "not properly functioning" and "at risk", with only one DAU considered "properly functioning" for habitat connectivity.

Ecological Benefit

All DAUs within the study area having ecological and biological processes that are considered "at risk" under current land use conditions were identified for further consideration. DAUs in the "at risk" category for multiple key ecological and biological processes are assumed to provide the greatest potential to maximize environmental benefits when restored. The process scores are then ranked according to the weight criteria, and converted to a high, medium, or low process rank. McLane Creek has primarily high and moderate ecological benefit, with only two DAUs ranked as low (Figure 32. McLane Creek Sub-watershed Weighted Processes).

Environmental Benefit

Once all the DAUs were ranked for their ecological benefit, all natural resource sites were ranked for their environmental benefit. Only the high and medium scoring sites were used in further evaluation to develop natural resource, fish habitat, and stormwater preservation and restoration sites.

Table 11. McLane Creek Environmental Benefit Ranking of Natural Resource Sites

McLane Creek Potential Restoration Sites				
Rank	Wetland	Riparian	Floodplain	Total
High	4	0	0	4
Medium	7	26	0	33
Low	27	25	6	58

The following wetlands, riparian and floodplain sections describe the environmental benefit ranking of the natural resource sites.

Wetlands

Prior to human alteration, wetlands in the McLane Creek Sub-watershed totaled approximately 772 acres. We estimate that approximately 430 acres are currently wetlands or degraded/destroyed wetlands with some restoration potential. (Figure 33. McLane Creek Sub-Watershed Resource Sites).

Riparian condition

Development has encroached on approximately 591 acres of the 67-meter wide riparian corridors in the McLane Creek basin. Of the 2135 acres, approximately 591 acres have some restoration potential (Figure 33. McLane Creek Sub-Watershed Resource Sites).

Floodplain Condition

The floodplain condition of McLane Creek is relatively intact with little to no restoration potential (Figure 33. McLane Creek Sub-Watershed Resource Sites).

Natural Resource Sites

All potential natural resource sites were evaluated for their environmental benefit and ranked high, medium, or low. Following evaluation, a total of 37 sites were of high or medium environmental benefit (Figure 34. McLane Creek Ecological Processes and Resource Site Scoring).

Fish Habitat

There were 51 riparian sites evaluated for habitat value to salmonid fish species. These sites were then used to evaluate potential natural resource sites that have the potential to be stormwater retrofits sites. While the goal is to use natural resource sites as stormwater retrofit sites, we don't want to compromise high quality fish habitat sites.

Stormwater Retrofit

All the natural resource sites were evaluated for stormwater retrofit sites (Figure 35. McLane Creek Potential Stormwater Restoration Sites).

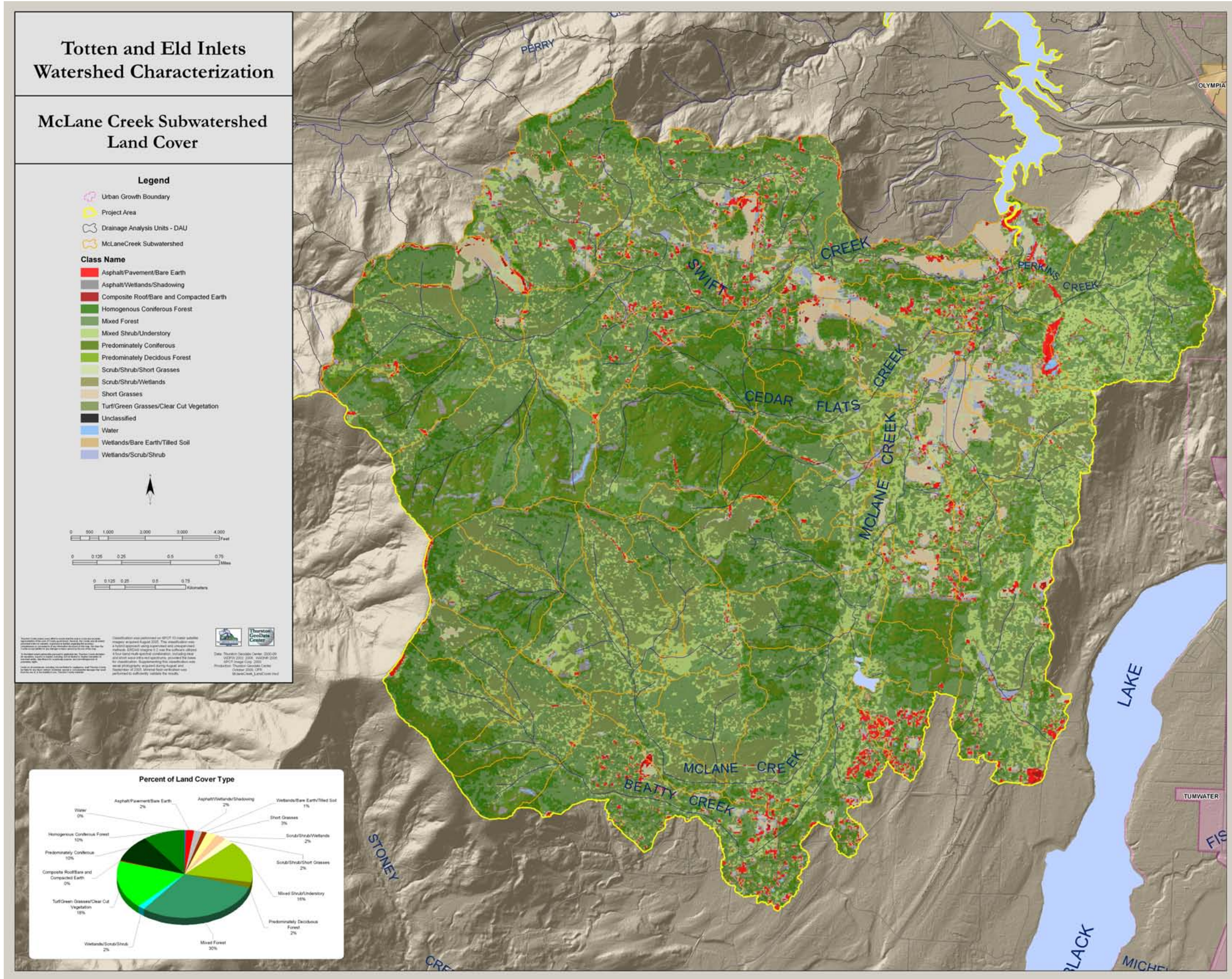
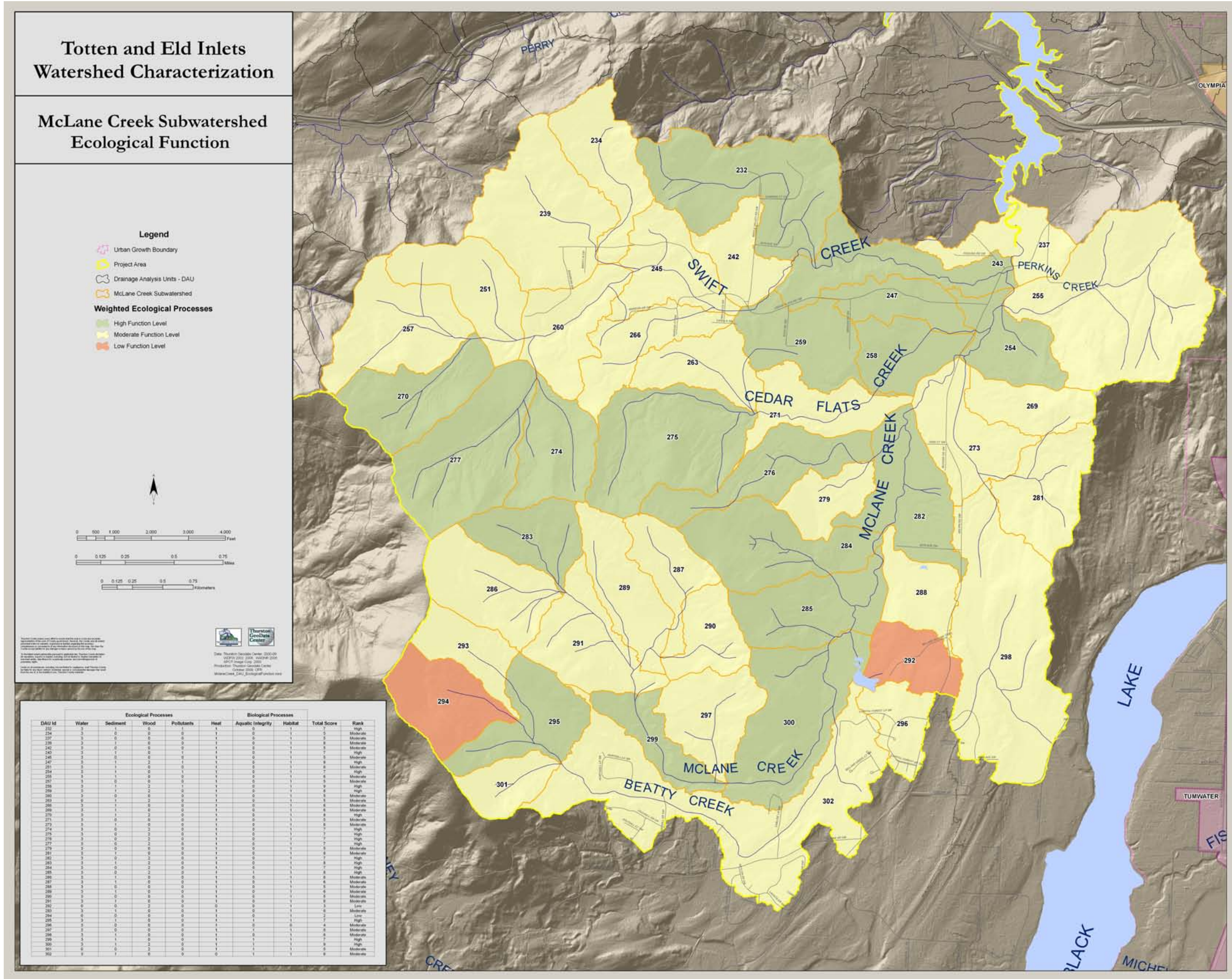


Figure 31 McLane Creek Sub-watershed Land Cover



	Ecological Processes					Biological Processes			
DAU Id	Water	Sediment	Wood	Pollutants	Heat	Aquatic Integrity	Habitat	Total Score	Rank
232	3	1	0	1	1	0	1	7	High
234	3	0	0	0	1	0	1	5	Moderate
237	3	0	0	0	1	0	1	5	Moderate
239	3	1	0	0	1	0	1	6	Moderate
242	3	0	0	0	1	0	1	5	Moderate
243	3	1	0	1	1	0	1	7	High
245	3	0	0	0	1	0	1	5	Moderate
247	3	1	2	1	1	0	1	9	High
251	3	1	0	0	1	0	1	6	Moderate
254	3	1	0	1	1	0	1	7	High
255	3	1	0	0	1	0	1	6	Moderate
257	3	0	0	0	1	0	1	5	Moderate
258	3	1	2	1	1	0	1	9	High
259	3	1	2	0	1	0	1	8	High
260	3	0	0	0	1	0	1	5	Moderate
263	0	1	2	0	1	0	1	5	Moderate
266	3	1	0	0	1	0	1	6	Moderate
269	3	1	0	0	1	0	1	6	Moderate
270	3	1	2	0	1	0	1	8	High
271	3	0	0	0	1	0	1	5	Moderate
273	3	1	0	0	1	0	1	6	Moderate
274	3	0	2	0	1	0	1	7	High
275	3	0	2	0	1	0	1	7	High
276	3	0	2	0	1	0	1	7	High
277	3	0	2	0	1	0	1	7	High
279	3	0	0	0	1	0	1	5	Moderate
281	3	1	0	0	1	0	1	6	Moderate
282	3	0	2	0	1	0	1	7	High
283	3	1	2	0	1	0	1	8	High
284	3	0	2	0	1	0	1	7	High
285	3	0	2	0	1	1	1	8	High
286	3	1	0	0	1	0	1	6	Moderate
287	3	1	0	0	1	0	1	6	Moderate
288	3	0	0	0	1	0	1	5	Moderate
289	3	1	0	0	1	0	1	6	Moderate
290	3	0	0	0	1	0	1	5	Moderate
291	3	1	0	0	1	0	1	6	Moderate
292	0	0	2	0	0	0	1	3	Low
293	3	1	0	0	1	0	1	6	Moderate
294	0	0	0	0	1	0	1	2	Low
295	3	1	0	0	1	1	1	7	High
296	3	0	0	0	1	0	0	4	Moderate
297	3	0	0	0	1	1	1	6	Moderate
298	3	1	0	0	1	0	1	6	Moderate
299	3	1	0	0	1	1	1	7	High
300	3	1	2	0	1	1	1	9	High
301	0	0	2	0	1	1	1	5	Moderate
302	3	1	0	0	0	1	1	6	Moderate

Figure 32 McLane Creek Sub-watershed Weighted Processes

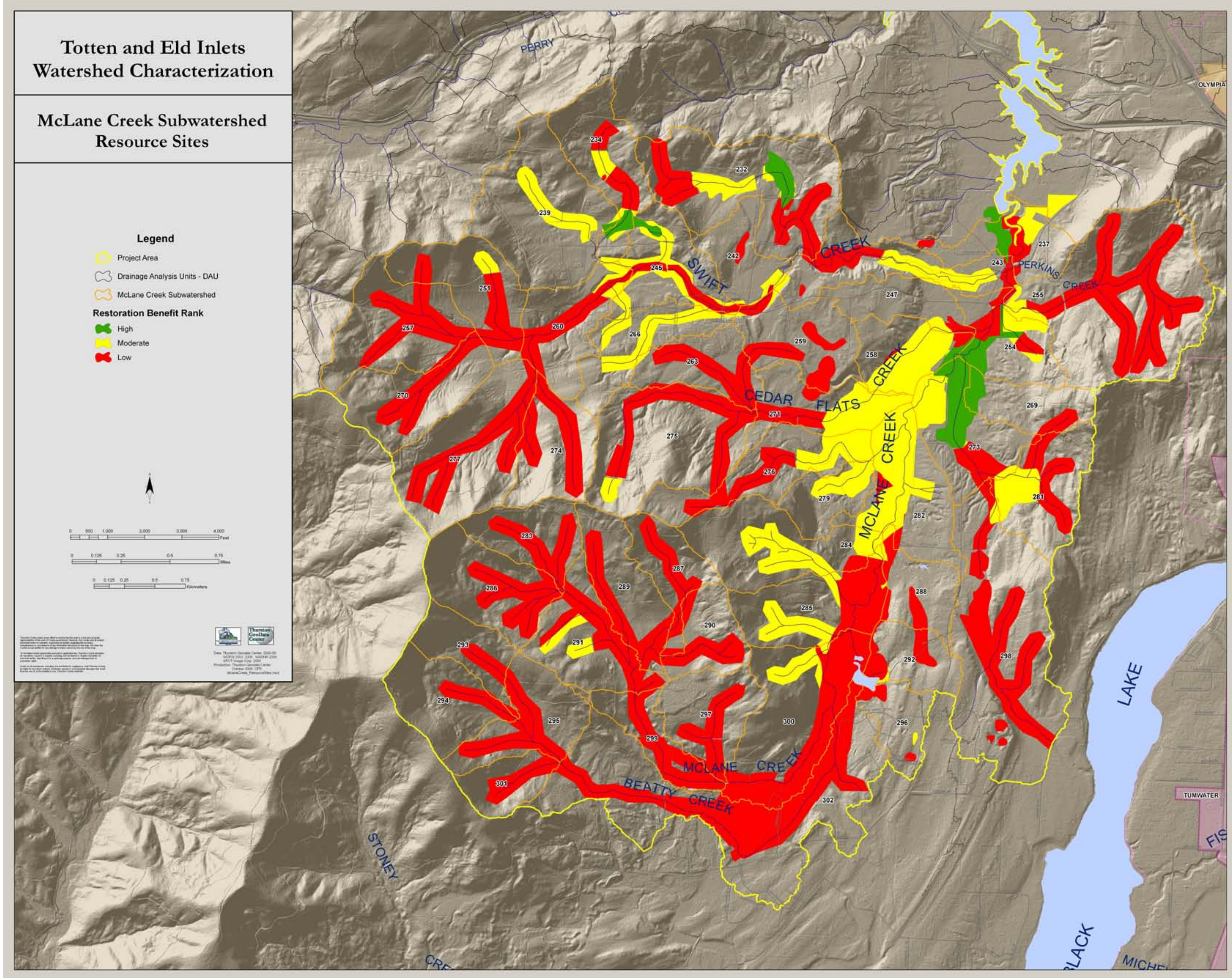


Figure 33 McLane Creek Sub-watershed Resource Sites

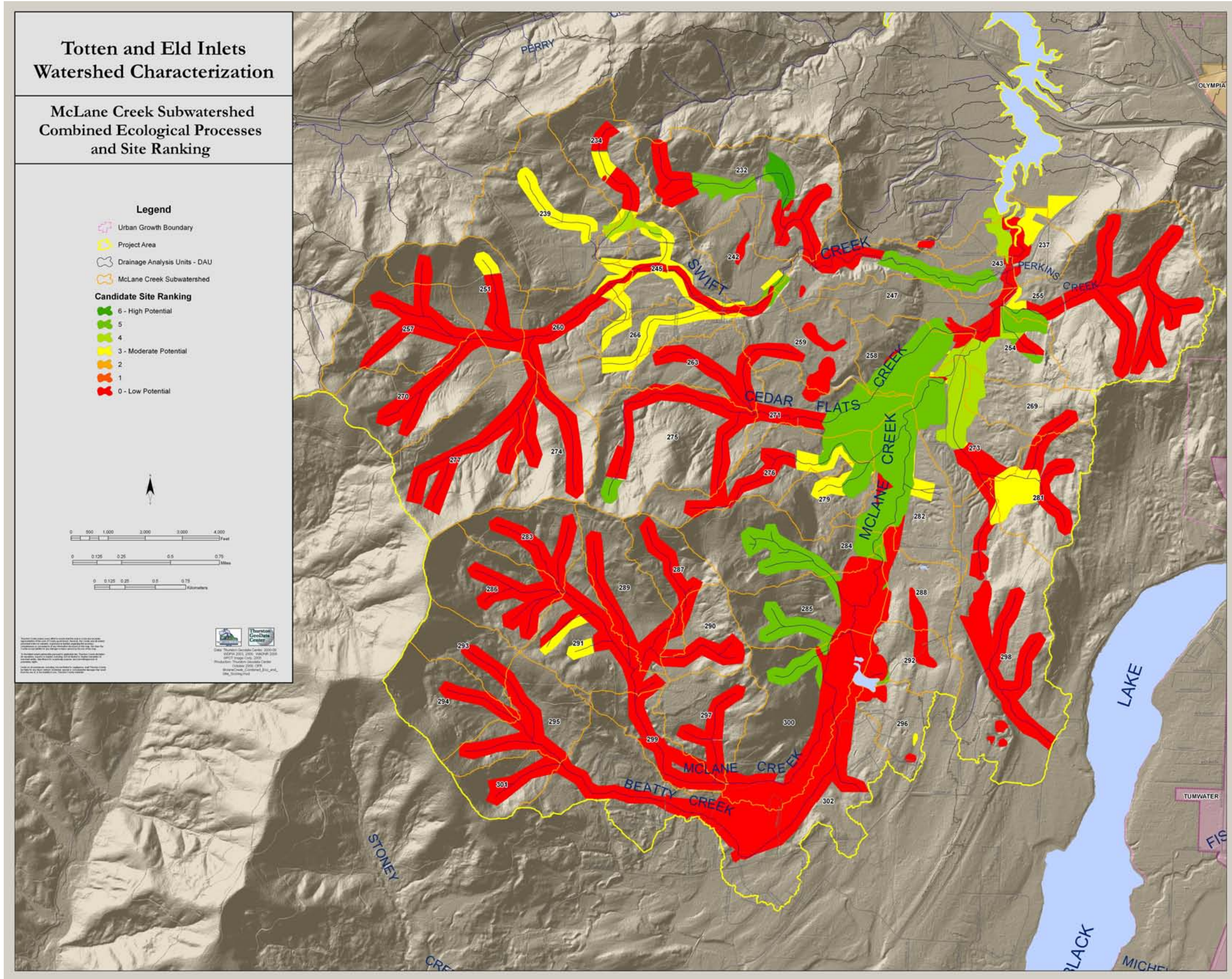


Figure 34 McLane Creek Sub-watershed Ecological Processes and Resource Site Scoring

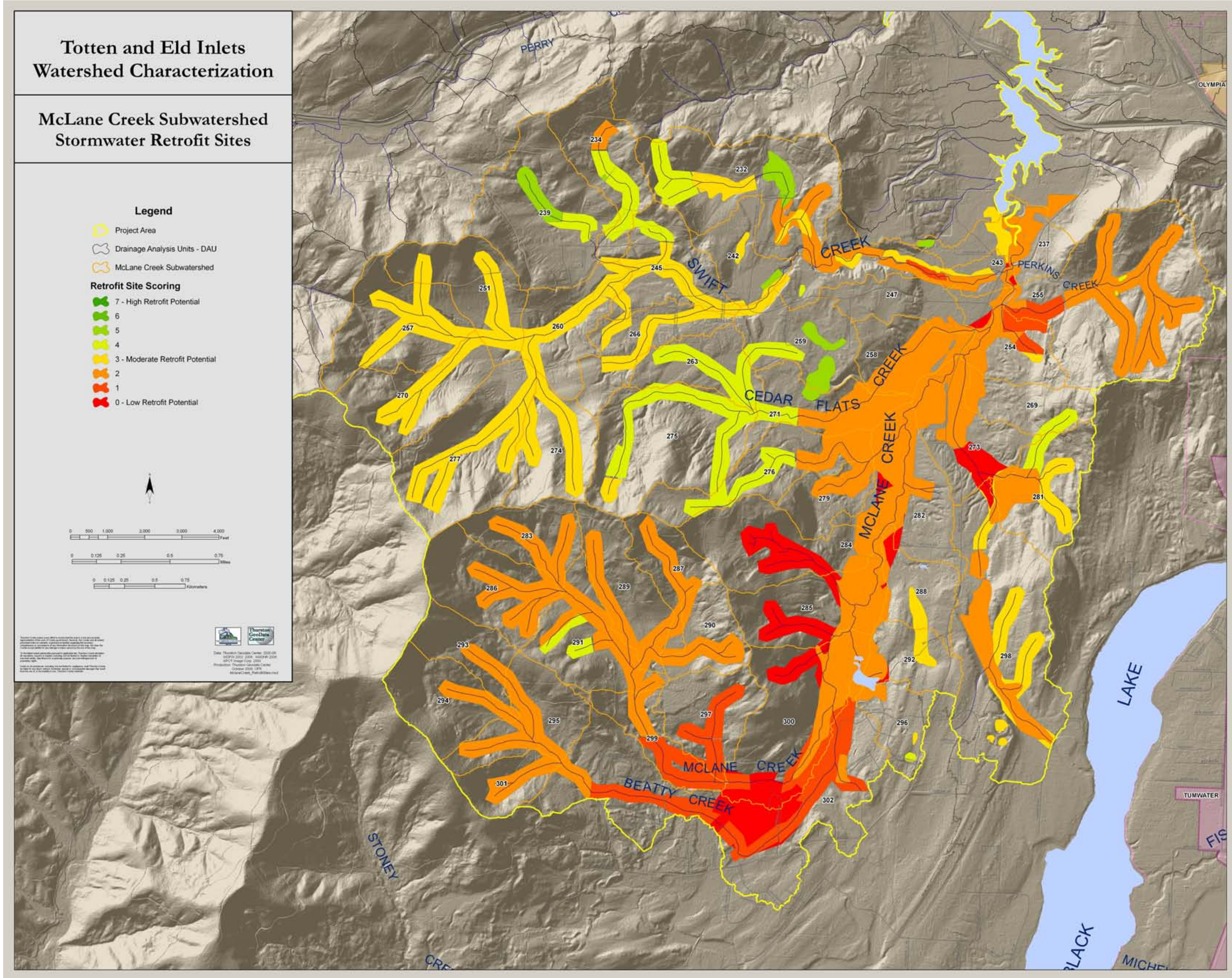


Figure 35 McLane Creek Sub-watershed Retrofit Sites

What are the conditions in the West Eld Sub-watershed?

Current conditions

Approximately four percent of the West Eld Sub-watershed is covered by urban land uses (see Figure 36 and 36a. Classification Percent Totals for West Eld Sub-watershed). West Eld has a drainage area of 9.2 square miles.

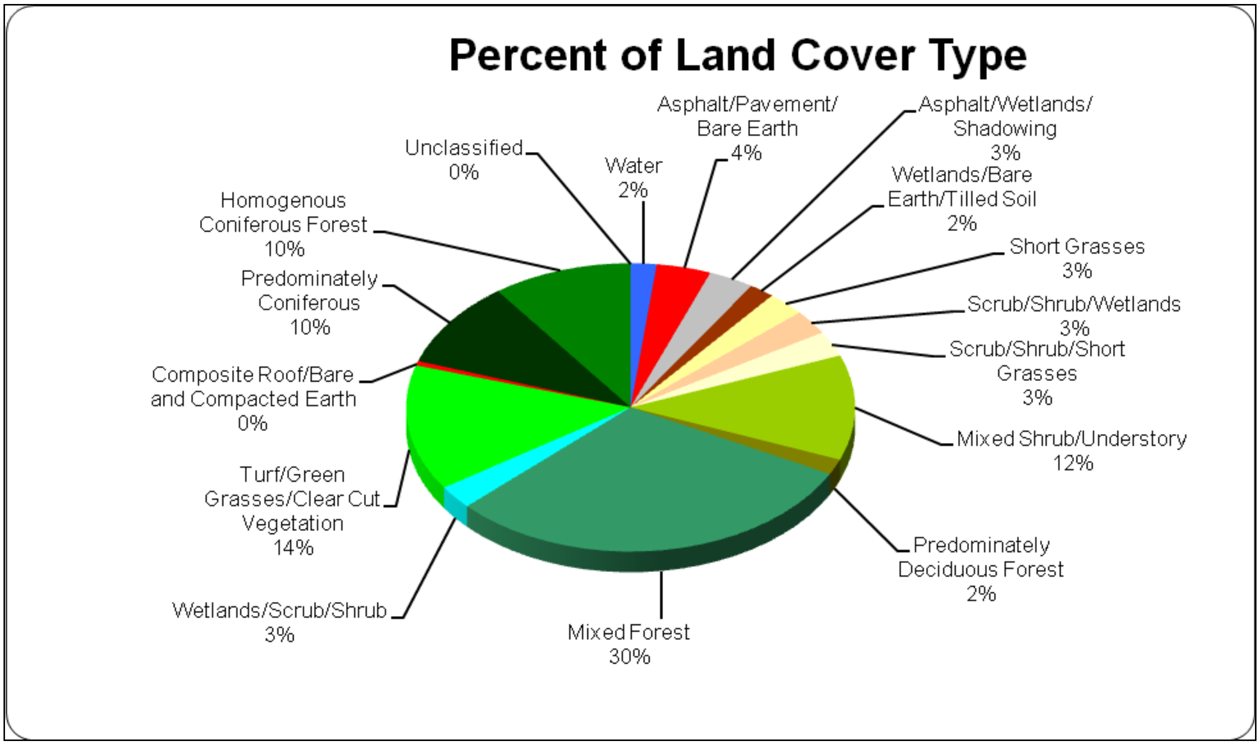


Figure 36a. Classification Percent Totals for West Eld Sub-watershed

Land cover data from 2005 SPOT imagery.

Human alteration to the movement of water

The effects of human land use on the natural delivery of water to the West Eld and its tributaries in the West Eld Sub-watershed were characterized using the following landscape attributes: percent TIA, percent forest land, and percent wetland cover at the DAU scale. Results indicate that the West Eld Sub-watershed is in an “at risk” condition for the delivery of water.

Human alteration to the natural movement of sediment

The effects of human land use on the natural delivery of sediment to the West Eld and its tributaries in the Kennedy Creek Sub-watershed were characterized using the following landscape attributes: percent bare soils, road density, and percent unstable slopes at the DAU scale. The result was a "properly functioning" condition, with only four "at risk" DAUs.

Human alteration to the natural movement of large wood

The effects of human land use on the natural delivery and routing of large wood in the West Eld and its tributaries were characterized using the following landscape attributes: percent forested riparian and average number of stream crossings per kilometer of stream at the DAU scale. Results indicate that the West Eld Sub-watershed is primarily in an "at risk" and "not properly functioning" condition for the delivery and routing of large wood.

Human alteration to the natural movement of pollutants

The effects of human land use on the natural delivery and routing of pollutants in the West Eld and its tributaries were characterized using the following landscape attributes: Extent of 303(d) listed water bodies for nutrients, toxicants, and bacteria and condition and extent of wetlands at the DAU scale. There is no data to rank the pollutants.

Human alteration to the natural movement of heat

The effects of human land use on the natural delivery and routing of heat in the West Eld tributaries were characterized using the following landscape attributes: Extent of 303(d) listed water bodies for nutrients, toxicants, and bacteria, percent 67 meter riparian zone with mature canopy, road density, and percent TIA at the DAU scale. Results indicate that the West Eld Sub-watershed is primarily in an "at risk" condition for the delivery and routing of large wood. The exception is one "properly functioning" DAU.

Aquatic integrity

The effects of human land use on aquatic integrity in the West Eld and its tributaries in the West Eld Sub-watershed were characterized using the following landscape attributes: percent riparian forest, percent TIA, and available B-IBI scores at the DAU scale. There is no data to rank aquatic integrity.

Habitat Connectivity

Forest covers ten percent of the West Eld Sub-watershed. Most of the forest is in rural residential areas. The West Eld Sub-watershed is considered "at risk" with 10 DAUs "properly functioning" for habitat connectivity.

Ecological Benefit

All DAUs within the study area having ecological and biological processes that are considered "at risk" under current land use conditions were identified for further consideration. DAUs in the "at risk" category for multiple key ecological and biological processes are assumed to provide the greatest potential to maximize environmental benefits when restored. The process scores are then ranked according to the weight criteria, and converted to a high, medium, or low process rank. West Eld has primarily high and moderate ecological benefit, with only eight DAUs ranked as low (Figure 37. West Eld Sub-watershed Weighted Processes).

Environmental Benefit

Once all the DAUs were ranked for their ecological benefit, all natural resource sites were ranked for their environmental benefit. Only the high and medium scoring sites were used in further evaluation to develop natural resource, fish habitat, and stormwater preservation and restoration sites.

Table 12. West Eld Environmental Benefit Ranking of Natural Resource Sites

West Eld Potential Restoration Sites				
Rank	Wetland	Riparian	Floodplain	Total
High	1	1	NA	2
Medium	20	20	NA	40
Low	59	39	NA	98

The following wetlands, riparian and floodplain sections describe the environmental benefit ranking of the natural resource sites.

Wetlands

Prior to human alteration, wetlands in the West Eld Sub-watershed totaled approximately 805 acres. We estimate that approximately 249 acres are currently wetlands or degraded/destroyed wetlands with some restoration potential. (Figure 38. West Eld Sub-Watershed Resource Sites).

Riparian condition

Development has encroached on approximately 215 acres of the 67-meter wide riparian corridors in the West Eld basin. Of the 642 acres, approximately 215 acres have some restoration potential (Figure 38. West Eld Sub-Watershed Resource Sites).

Floodplain Condition

There is no regulated floodplain in West Eld.

Natural Resource Sites

All potential natural resource sites were evaluated for their environmental benefit and ranked high, medium, or low. Following evaluation, a total of 42 sites were of high or medium environmental benefit (Figure 39. West Eld Ecological Processes and Resource Site Scoring).

Fish Habitat

There were 60 riparian sites evaluated for habitat value to salmonid fish species. These sites were then used to evaluate potential natural resource sites that have the potential to be stormwater retrofits sites. While the goal is to use natural resource sites as stormwater retrofit sites, we don’t want to compromise high quality fish habitat sites.

Stormwater Retrofit

All the natural resource sites were evaluated for stormwater retrofit sites (Figure 40. West Eld Potential Stormwater Restoration Sites).

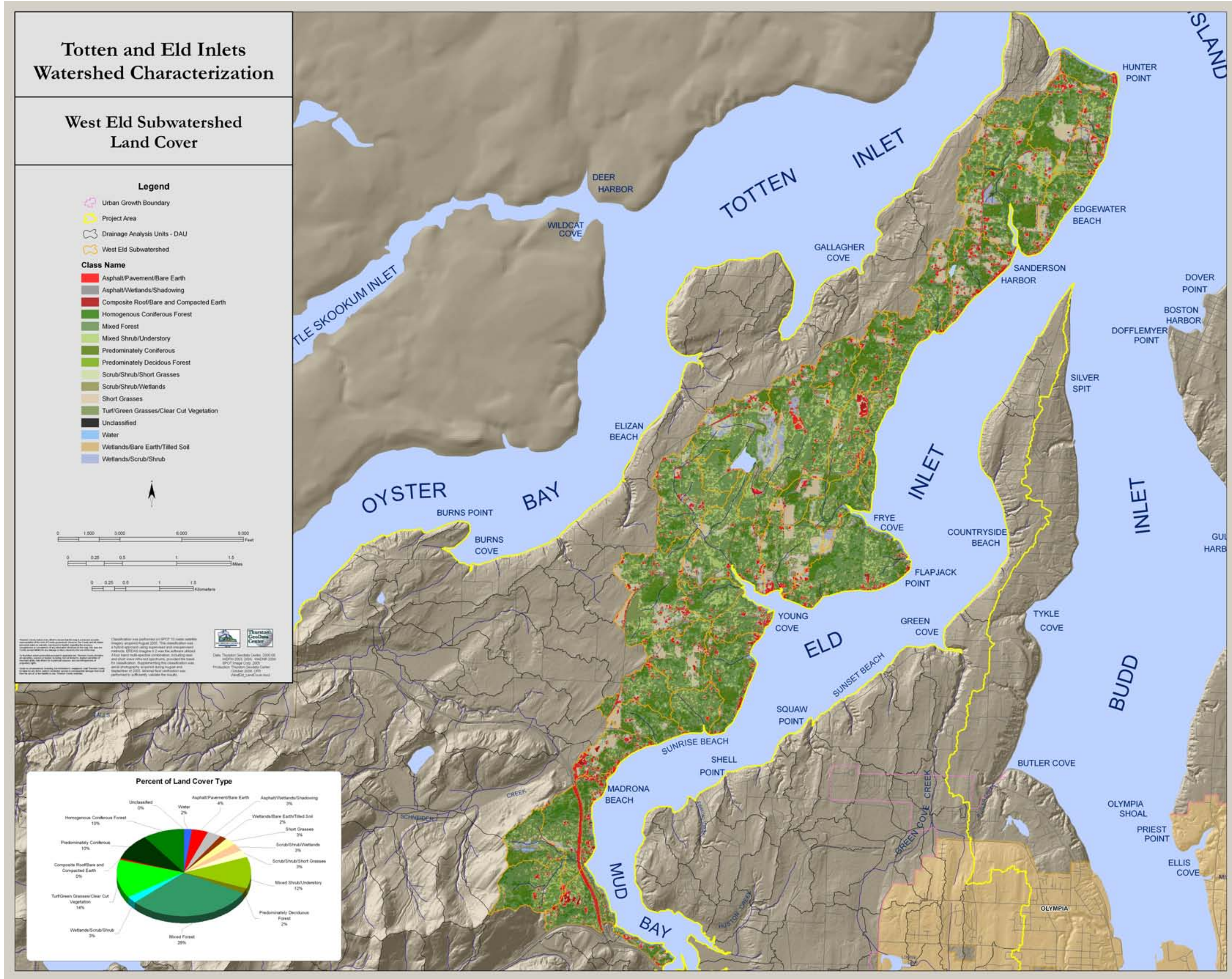
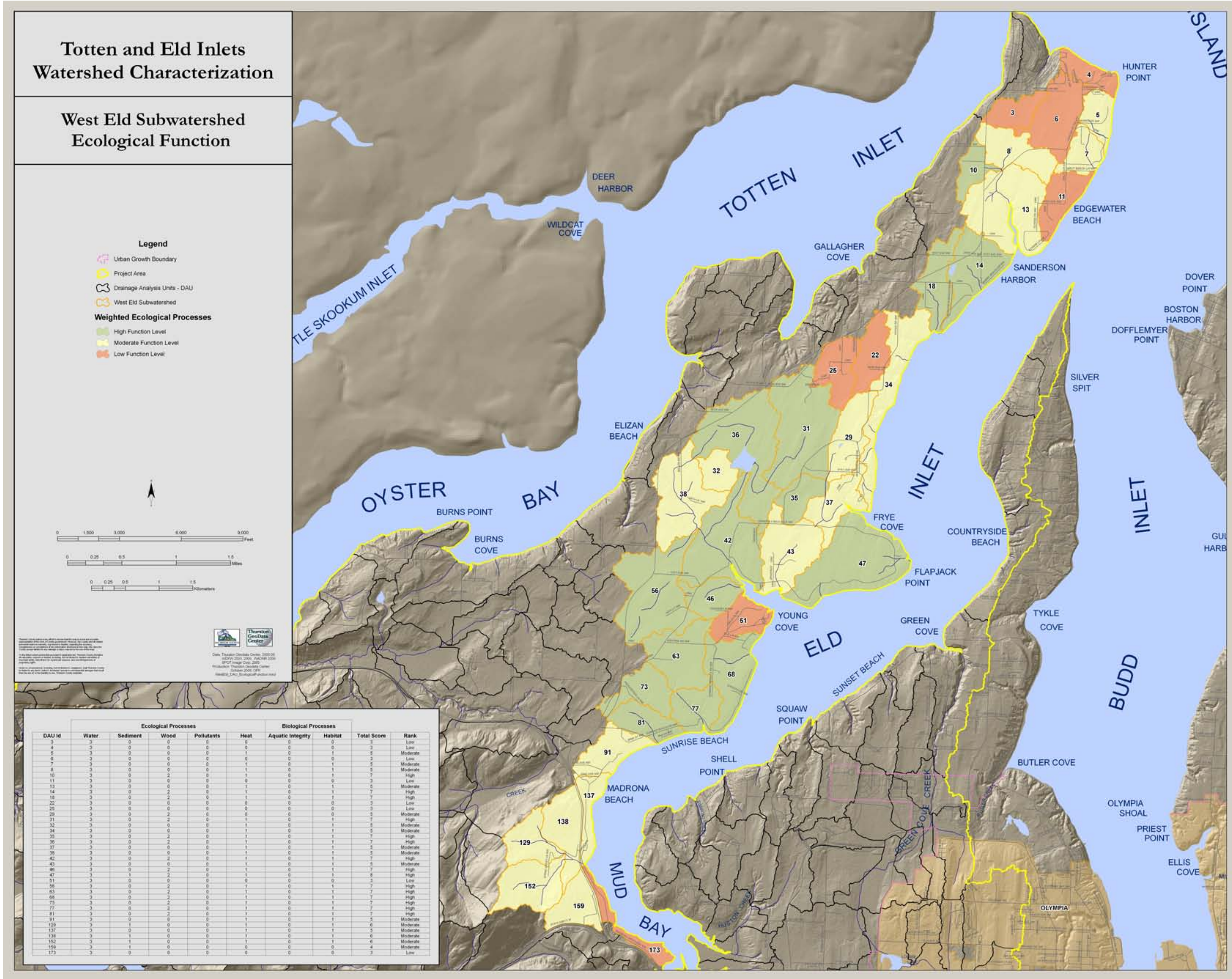


Figure 36 West Eld Sub-watershed Land Cover



	Ecological Processes					Biological Processes			
DAU Id	Water	Sediment	Wood	Pollutants	Heat	Aquatic Integrity	Habitat	Total Score	Rank
3	3	0	0	0	0	0	0	3	Low
4	3	0	0	0	0	0	0	3	Low
5	3	0	0	0	1	0	1	5	Moderate
6	3	0	0	0	0	0	0	3	Low
7	3	0	0	0	1	0	1	5	Moderate
8	3	0	0	0	1	0	1	5	Moderate
10	3	0	2	0	1	0	1	7	High
11	3	0	0	0	0	0	0	3	Low
13	3	0	0	0	1	0	1	5	Moderate
14	3	0	2	0	1	0	1	7	High
18	3	0	2	0	1	0	1	7	High
22	3	0	0	0	0	0	0	3	Low
25	3	0	0	0	0	0	0	3	Low
29	3	0	2	0	0	0	0	5	Moderate
31	3	0	2	0	1	0	1	7	High
32	3	0	0	0	1	0	1	5	Moderate
34	3	0	0	0	1	0	1	5	Moderate
35	3	0	2	0	1	0	1	7	High
36	3	0	2	0	1	0	1	7	High
37	3	0	0	0	1	0	1	5	Moderate
38	3	0	0	0	1	0	1	5	Moderate
42	3	0	2	0	1	0	1	7	High
43	3	0	0	0	1	0	1	5	Moderate
46	3	0	2	0	1	0	1	7	High
47	3	1	2	0	1	0	1	8	High
51	3	0	0	0	0	0	0	3	Low
56	3	0	2	0	1	0	1	7	High
63	3	0	2	0	1	0	1	7	High
68	3	0	2	0	1	0	1	7	High
73	3	0	2	0	1	0	1	7	High
77	3	0	2	0	1	0	1	7	High
81	3	0	2	0	1	0	1	7	High
91	3	0	0	0	1	0	1	5	Moderate
129	3	1	0	0	1	0	1	6	Moderate
137	3	0	0	0	1	0	1	5	Moderate
138	3	1	0	0	1	0	1	6	Moderate
152	3	1	0	0	1	0	1	6	Moderate
159	3	1	0	0	0	0	0	4	Moderate
173	3	0	0	0	0	0	0	3	Low

Figure 37 West Eld Sub-watershed Weighted Processes

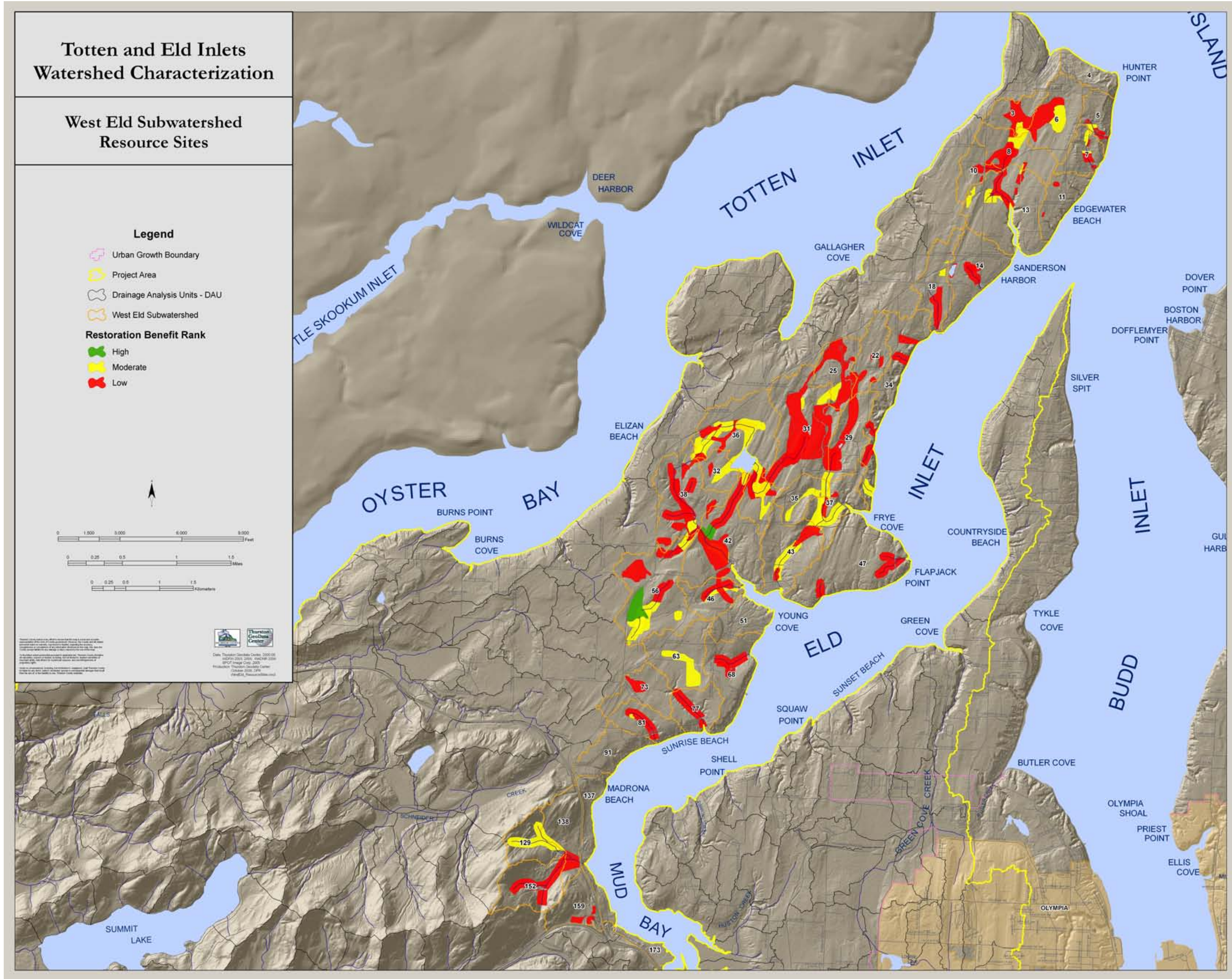


Figure 38 West Eld Sub-watershed Resource Sites

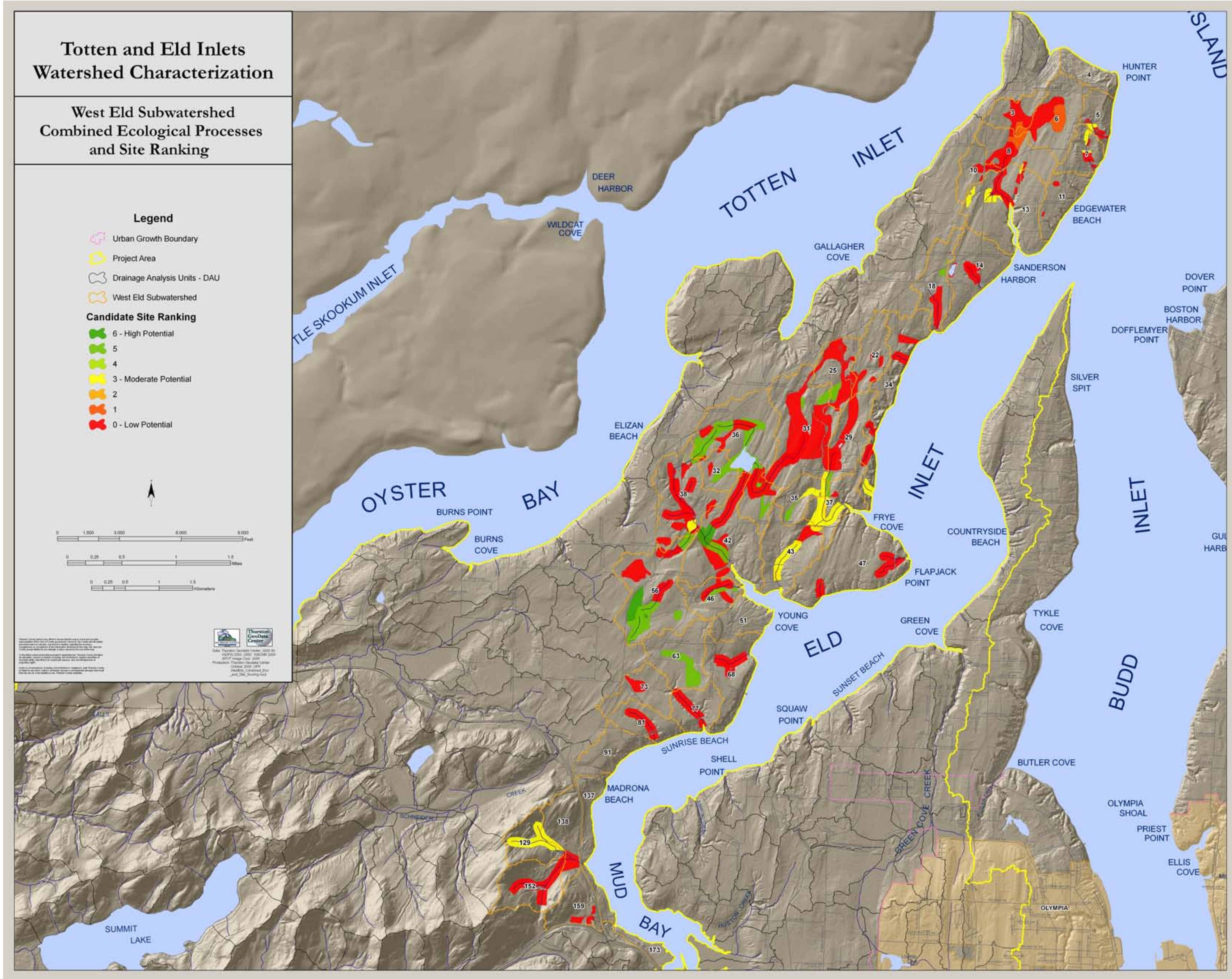


Figure 39 West Eld Sub-watershed Ecological Processes and Resource Site Scoring

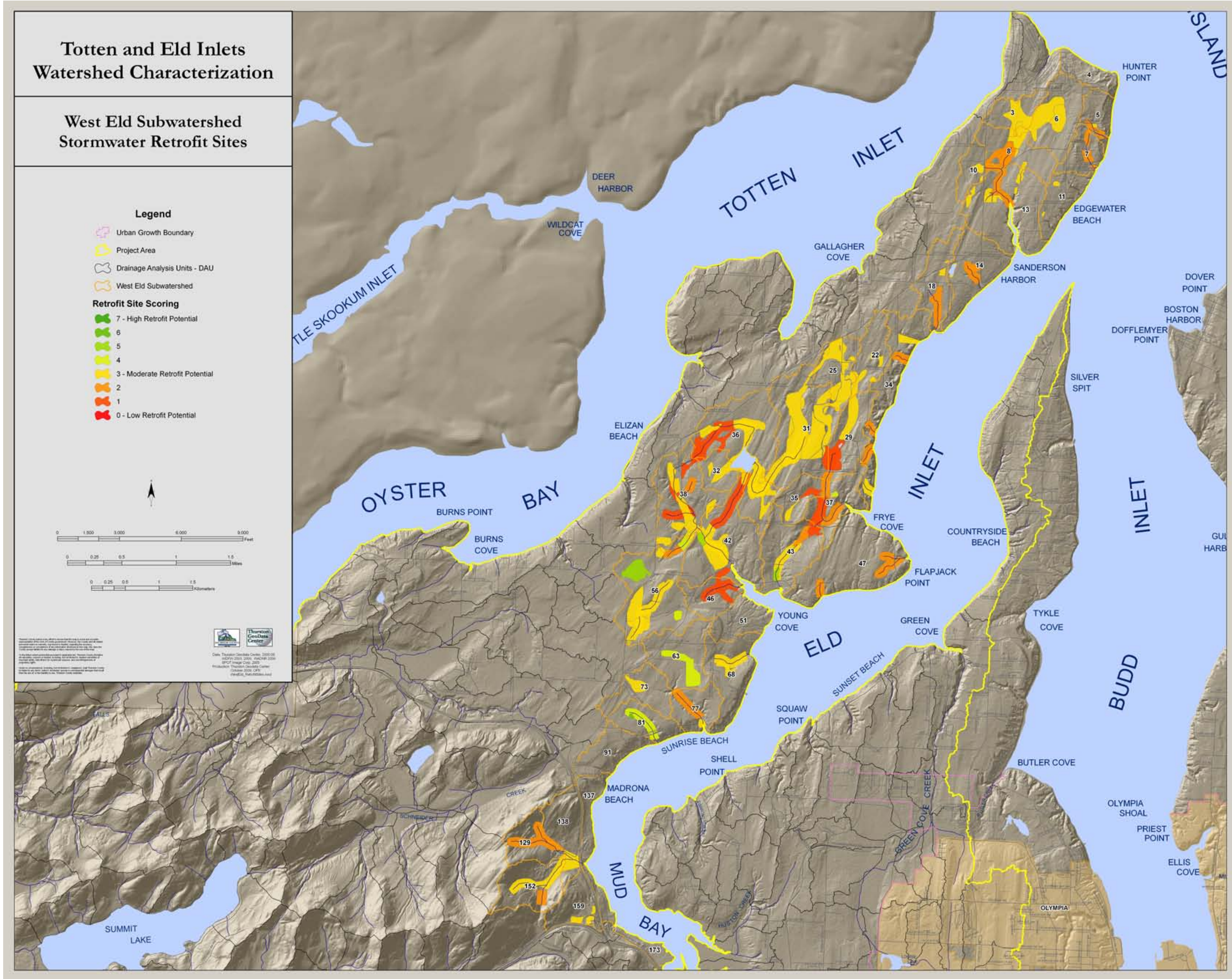


Figure 40 West Eld Sub-watershed Retrofit Sites

What are the conditions in the South Eld Sub-watershed?

Current conditions

Approximately five percent of the South Eld Sub-watershed is covered by urban land uses (see Figure 41 and 41a, Classification Percent Totals for South Eld Sub-watershed). South Eld has a drainage area of 2.3 square miles.

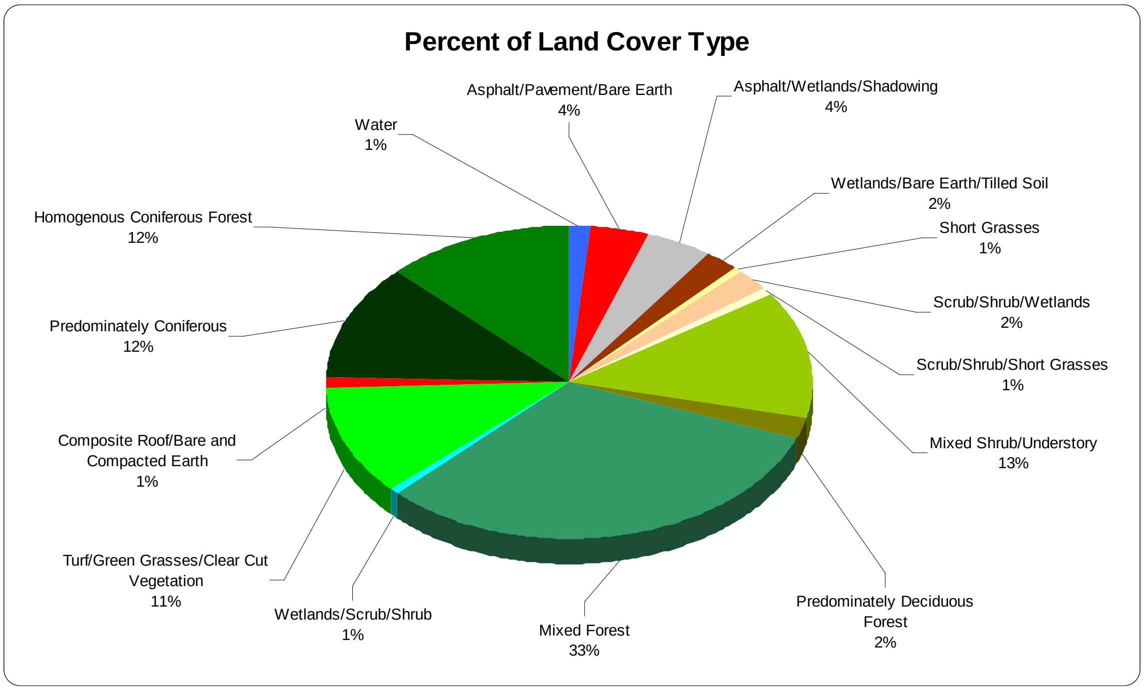


Figure 41a. Classification Percent Totals for South Eld Sub-watershed

Land cover data from 2005 SPOT imagery.

Human alteration to the movement of water

The effects of human land use on the natural delivery of water to the South Eld and its tributaries in the South Eld Sub-watershed were characterized using the following landscape attributes: percent TIA, percent forest land, and percent wetland cover at the DAU scale. Results indicate that the South Eld Sub-watershed is in “at risk” condition, with the exception of one “properly functioning” DAU for the delivery of water.

Human alteration to the natural movement of sediment

The effects of human land use on the natural delivery of sediment to the South Eld and its tributaries in the Kennedy Creek Sub-watershed were characterized using the following landscape attributes: percent bare soils, road density, and percent unstable slopes at the DAU scale. However, because there are no forestry activities or unstable slopes in the sub-watershed, road density was the only applicable indicator. The result is a “properly functioning” condition, with one DAU “at risk” for sediment.

Human alteration to the natural movement of large wood

The effects of human land use on the natural delivery and routing of large wood in the South Eld and its tributaries were characterized using the following landscape attributes: percent forested riparian and average number of stream crossings per kilometer of stream at the DAU scale. Results indicate that the South Eld Sub-watershed is primarily in a "not properly functioning" and an “at risk” condition for the delivery and routing of large wood.

Human alteration to the natural movement of pollutants

The effects of human land use on the natural delivery and routing of pollutants in the South Eld and its tributaries were characterized using the following landscape attributes: Extent of 303(d) listed water bodies for nutrients, toxicants, and bacteria and condition and extent of wetlands at the DAU scale. There is no data to rank pollutants.

Human alteration to the natural movement of heat

The effects of human land use on the natural delivery and routing of heat in the South Eld tributaries were characterized using the following landscape attributes: Extent of 303(d) listed water bodies for nutrients, toxicants, and bacteria, percent 67 meter riparian zone with mature canopy, road density, and percent TIA at the DAU scale. Results indicate that the South Eld Sub-watershed is primarily in an “at risk” condition for the delivery and routing of heat.

Aquatic integrity

The effects of human land use on aquatic integrity in the South Eld and its tributaries in the South Eld Sub-watershed were characterized using the following landscape attributes: percent riparian forest, percent TIA, and available B-IBI scores at the DAU scale. There is no data to rank aquatic integrity.

Habitat Connectivity

Forest covers fifty-eight percent of the South Eld Sub-watershed, concentrated in the south west sub-watershed. Most of the forest is in rural residential areas and the sub-watershed’s primary land cover is composed of commercial and long-term forestry. The South Eld Sub-watershed is considered "at risk" and "properly functioning" for habitat connectivity.

Ecological Benefit

All DAUs within the study area having ecological and biological processes that are considered “at risk” under current land use conditions were identified for further consideration. DAUs in the “at risk” category for multiple key ecological and biological processes are assumed to provide the greatest potential to maximize environmental benefits when restored. The process scores are then ranked according to the weight criteria, and converted to a high, medium, or low process rank. South Eld has primarily high and moderate ecological benefit, with only three DAUs ranked as low (Figure 42. South Eld Sub-watershed Weighted Processes).

Environmental Benefit

Once all the DAUs were ranked for their ecological benefit, all natural resource sites were ranked for their environmental benefit. Only the high and medium scoring sites were used in further evaluation to develop natural resource, fish habitat, and stormwater preservation and restoration sites.

Table 13. South Eld Environmental Benefit Ranking of Natural Resource Sites

South Eld Potential Restoration Sites				
Rank	Wetland	Riparian	Floodplain	Total
High	1	0	NA	1
Medium	0	4	NA	4
Low	10	7	NA	17

The following wetlands, riparian and floodplain sections describe the environmental benefit ranking of the natural resource sites.

Wetlands

Prior to human alteration, wetlands in the South Eld Sub-watershed totaled approximately 147 acres. We estimate that approximately 18 acres are currently wetlands or degraded/destroyed wetlands with some restoration potential. (Figure 43. South Eld Sub-Watershed Resource Sites).

Riparian condition

Urban development has encroached on approximately 89 acres of the 67-meter wide riparian corridors in the South Eld basin. Of the 196 acres, approximately 89 acres have some restoration potential (Figure 43. South Eld Sub-Watershed Resource Sites).

Floodplain Condition

There is no regulated floodplain in South Eld.

Natural Resource Sites

All potential natural resource sites were evaluated for their environmental benefit and ranked high, medium, or low. Following evaluation, a total of 5 sites were of high or medium environmental benefit (Figure 44. South Eld Ecological Processes and Resource Site Scoring).

Fish Habitat

There were 11 riparian sites evaluated for habitat value to salmonid fish species. These sites were then used to evaluate potential natural resource sites that have the potential to be stormwater retrofits sites. While the goal is to use natural resource sites as stormwater retrofit sites, we don't want to compromise high quality fish habitat sites.

Stormwater Retrofit

All the natural resource sites were evaluated for stormwater retrofit sites (Figure 45. South Eld Potential Stormwater Restoration Sites).

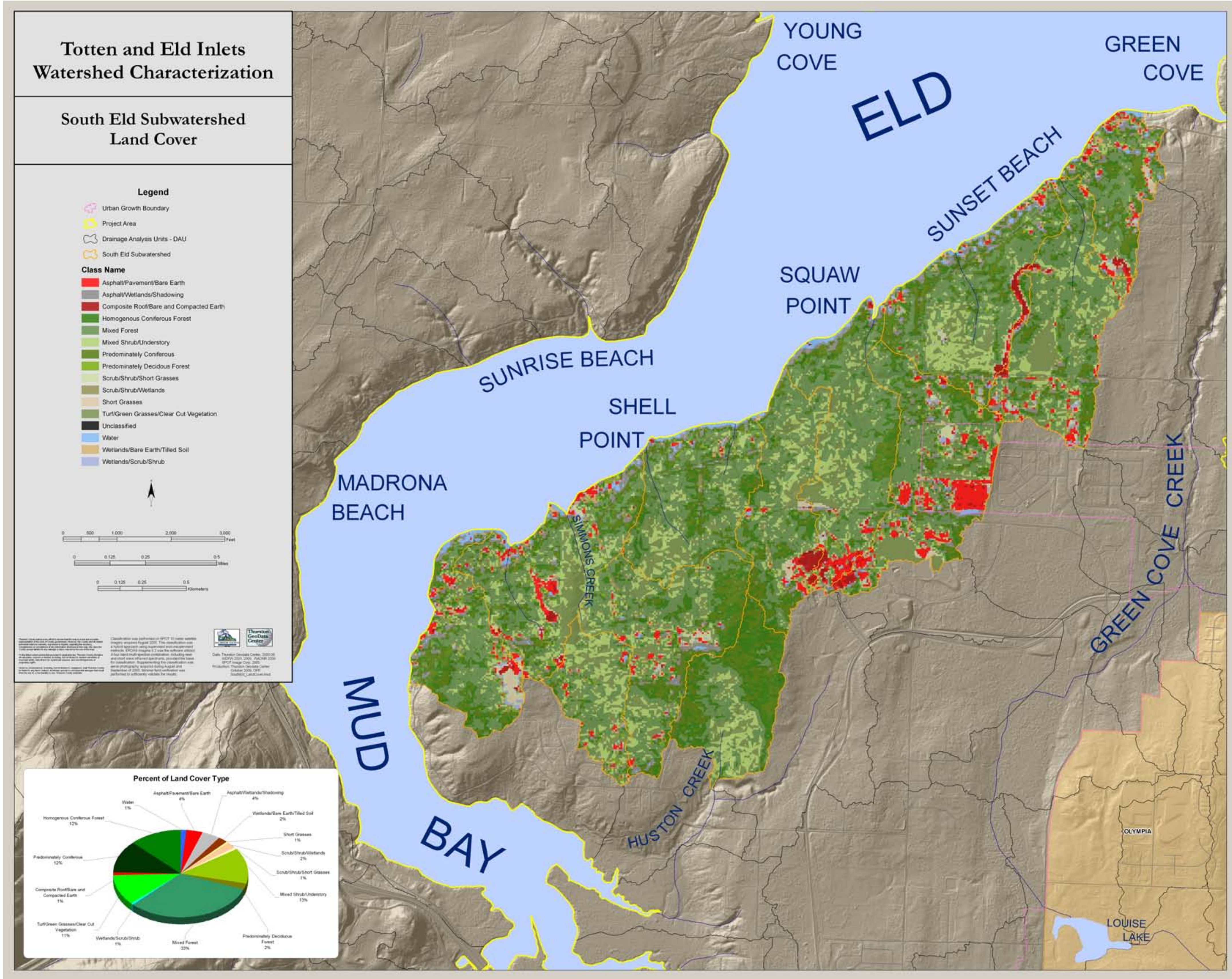
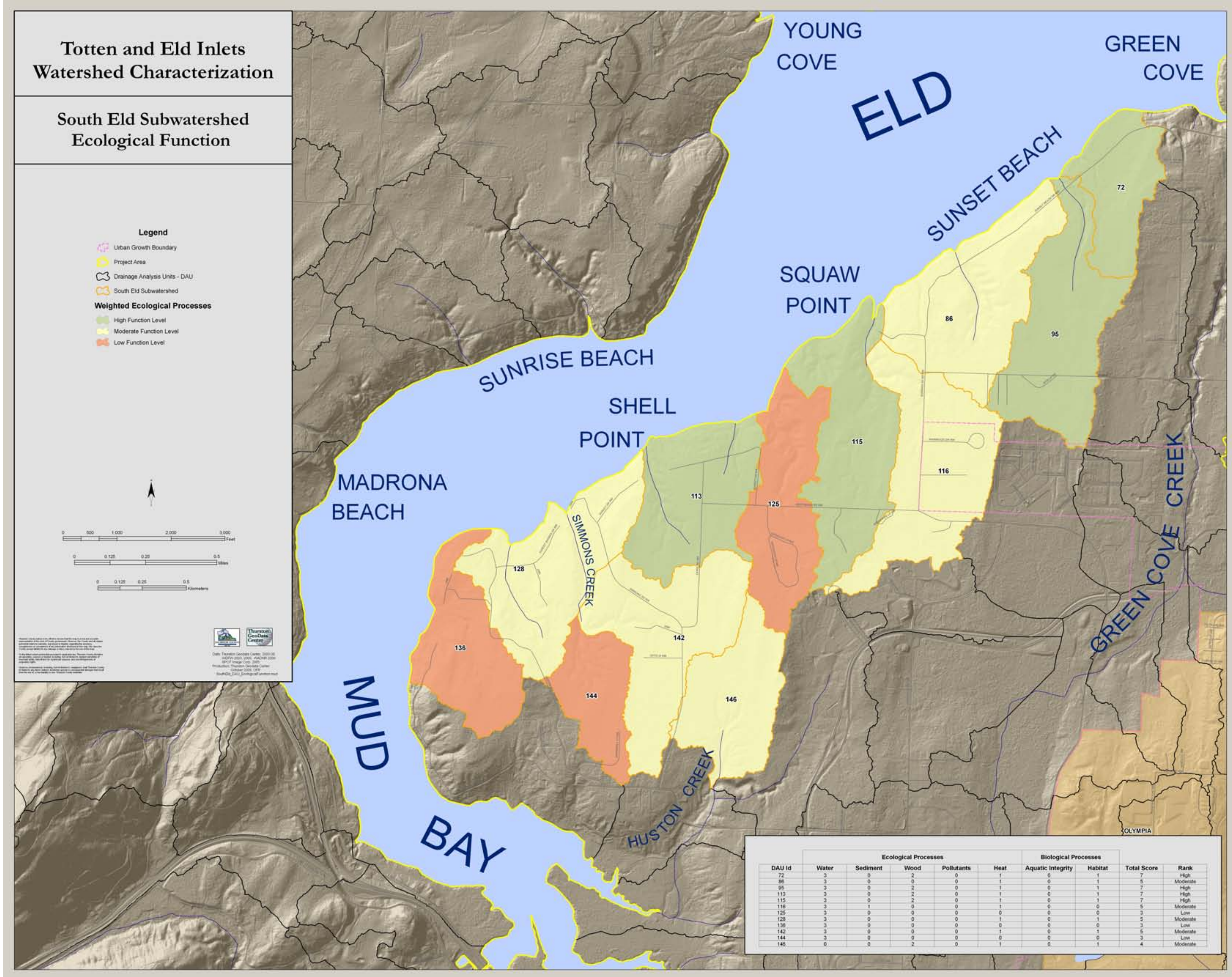


Figure 41 South Eld Sub-watershed Land Cover



	Ecological Processes					Biological Processes			
DAU Id	Water	Sediment	Wood	Pollutants	Heat	Aquatic Integrity	Habitat	Total Score	Rank
72	3	0	2	0	1	0	1	7	High
86	3	0	0	0	1	0	1	5	Moderate
95	3	0	2	0	1	0	1	7	High
113	3	0	2	0	1	0	1	7	High
115	3	0	2	0	1	0	1	7	High
116	3	1	0	0	1	0	0	5	Moderate
125	3	0	0	0	0	0	0	3	Low
128	3	0	0	0	1	0	1	5	Moderate
136	3	0	0	0	0	0	0	3	Low
142	3	0	0	0	1	0	1	5	Moderate
144	3	0	0	0	0	0	0	3	Low
146	0	0	2	0	1	0	1	4	Moderate

Figure 42 South Eld Sub-watershed Weighted Processes

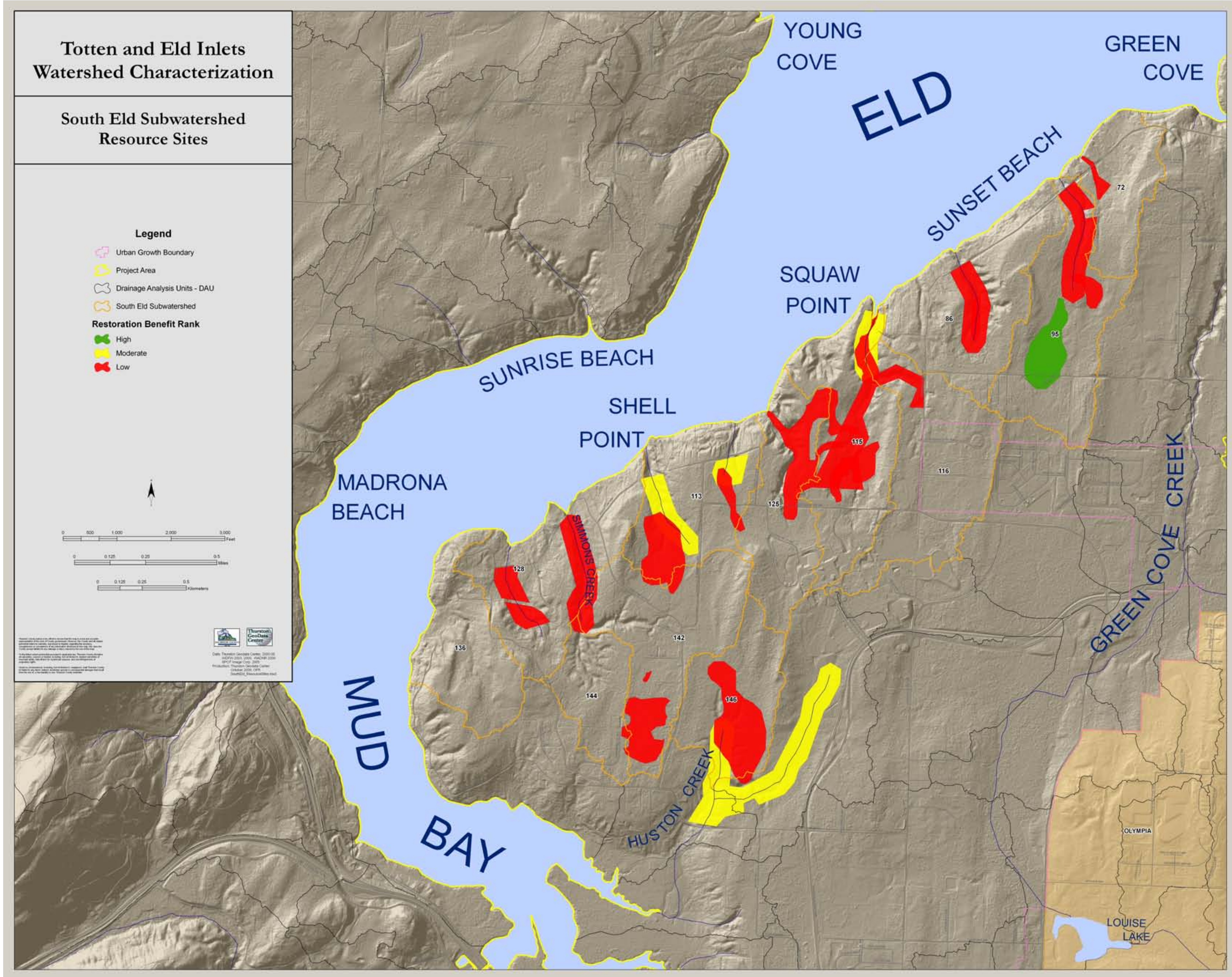


Figure 43 South Eld Sub-watershed Resource Sites

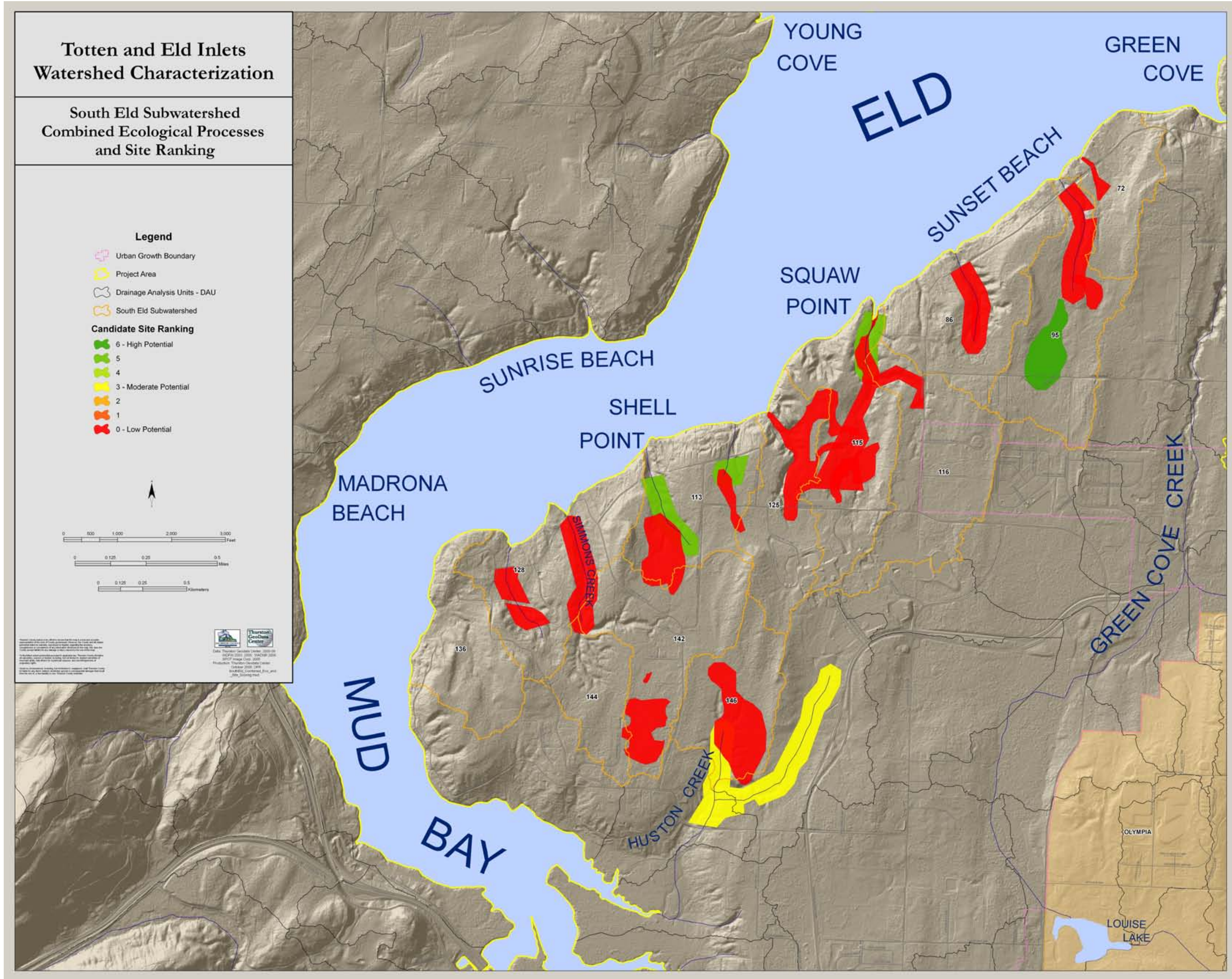


Figure 44 South Eld Sub-watershed Ecological Processes and Resource Site Scoring

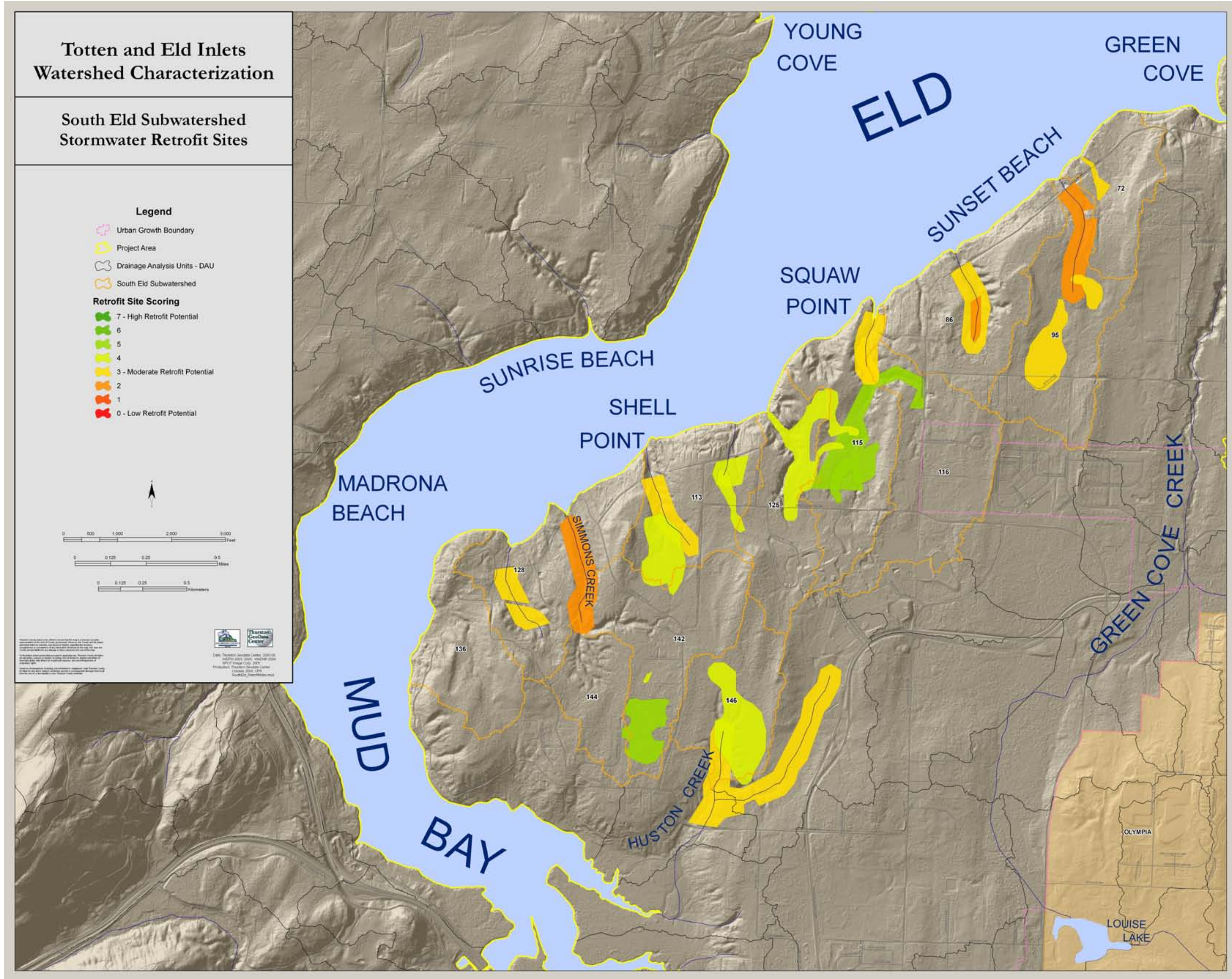


Figure 45 South Eld Sub-watershed Retrofit Sites

What are the conditions in the North Eld Sub-watershed?

Current conditions

Approximately seven percent of the North Eld Sub-watershed is covered by urban land uses (see Figure 46 and 46a, Classification Percent Totals for North Eld Sub-watershed). North Eld has a drainage area of 0.9 square miles.

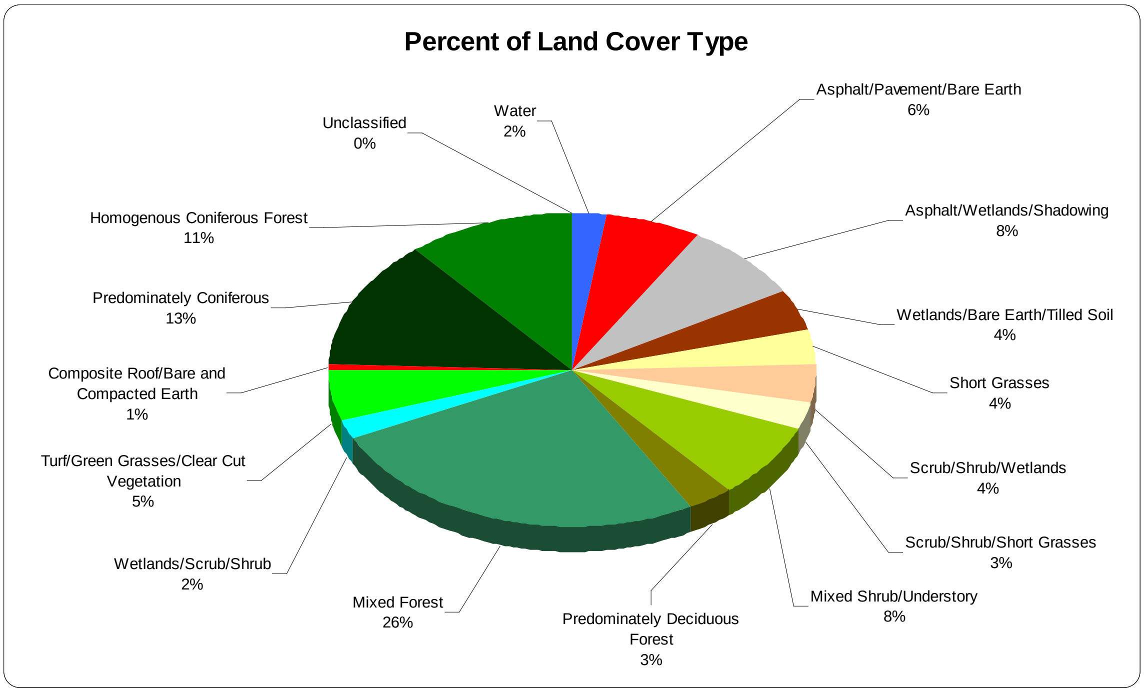


Figure 46a. Classification Percent Totals for North Eld Sub-watershed

Land cover data from 2005 SPOT imagery.

Human alteration to the movement of water

The effects of human land use on the natural delivery of water to the Kennedy Creek and its tributaries in the North Eld Sub-watershed were characterized using the following landscape attributes: percent TIA, percent forest land, and percent wetland cover at the DAU scale. Results indicate that the North Eld Sub-watershed is in an “at risk” condition for the delivery of water.

Human alteration to the natural movement of sediment

The effects of human land use on the natural delivery of sediment to the North Eld and its tributaries in the Kennedy Creek Sub-watershed were characterized using the following landscape attributes: percent bare soils, road density, and percent unstable slopes at the DAU scale. However, because there are no forestry activities or unstable slopes in the sub-watershed, road density was the only applicable indicator. The result is "properly functioning" and "at risk" condition for sediment.

Human alteration to the natural movement of large wood

The effects of human land use on the natural delivery and routing of large wood in the North Eld and its tributaries were characterized using the following landscape attributes: percent forested riparian and average number of stream crossings per kilometer of stream at the DAU scale. Results indicate that the North Eld Sub-watershed is primarily in an "at risk" and "not properly functioning" condition for the delivery and routing of large wood.

Human alteration to the natural movement of pollutants

The effects of human land use on the natural delivery and routing of pollutants in the North Eld and its tributaries were characterized using the following landscape attributes: Extent of 303(d) listed water bodies for nutrients, toxicants, and bacteria and condition and extent of wetlands at the DAU scale. Results indicate that the North Eld Sub-watershed is in an "at risk" condition for the delivery and routing of pollutants.

Human alteration to the natural movement of heat

The effects of human land use on the natural delivery and routing of heat in the North Eld tributaries were characterized using the following landscape attributes: Extent of 303(d) listed water bodies for nutrients, toxicants, and bacteria, percent 67 meter riparian zone with mature canopy, road density, and percent TIA at the DAU scale. Results indicate that the North Eld Sub-watershed is primarily in an "at risk" condition for the delivery and routing of heat.

Aquatic integrity

The effects of human land use on aquatic integrity in the North Eld and its tributaries in the North Eld Sub-watershed were characterized using the following landscape attributes: percent riparian forest, percent TIA, and available B-IBI scores at the DAU scale. There is no data to rank aquatic integrity.

Habitat Connectivity

Forest covers fifty-three percent of the North Eld Sub-watershed, concentrated in the south west sub-watershed. Most of the forest is in rural residential areas and the sub-watershed's primary land cover is composed of commercial and long-term forestry. The North Eld Sub-watershed is considered "properly functioning" and "at risk" for habitat connectivity.

Ecological Benefit

All DAUs within the study area having ecological and biological processes that are considered "at risk" under current land use conditions were identified for further consideration. DAUs in the "at risk" category for multiple key ecological and biological processes are assumed to provide the greatest potential to maximize environmental benefits when restored. The process scores are then ranked according to the weight criteria, and converted to a high, medium, or low process rank. North Eld has primarily high and moderate ecological benefit, with only one DAU ranked as low (Figure 47. North Eld Sub-watershed Weighted Processes).

Environmental Benefit

Once all the DAUs were ranked for their ecological benefit, all natural resource sites were ranked for their environmental benefit. Only the high and medium scoring sites were used in further evaluation to develop natural resource, fish habitat, and stormwater preservation and restoration sites.

Table 14. North Eld Environmental Benefit Ranking of Natural Resource Sites

North Eld Potential Restoration Sites				
Rank	Wetland	Riparian	Floodplain	Total
High	0	0	NA	0
Medium	2	1	NA	3
Low	9	5	NA	14

The following wetlands, riparian and floodplain sections describe the environmental benefit ranking of the natural resource sites.

Wetlands

Prior to human alteration, wetlands in the North Eld Sub-watershed totaled approximately 66 acres. We estimate that approximately 4 acres are currently wetlands or degraded/destroyed wetlands with some restoration potential. (Figure 48. North Eld Sub-Watershed Resource Sites).

Riparian condition

Development has encroached on approximately 2 acres of the 67-meter wide riparian corridors in the North Eld basin. Of the 34 acres, approximately 2 acres have some restoration potential (Figure 48. North Eld Sub-Watershed Resource Sites).

Floodplain Condition

There is no regulated floodplain in North Eld.

Natural Resource Sites

All potential natural resource sites were evaluated for their environmental benefit and ranked high, medium, or low. Following evaluation, a total of three sites were of high or medium environmental benefit (Figure 49. North Eld Ecological Processes and Resource Site Scoring).

Fish Habitat

There were six sites evaluated for habitat value to salmonid fish species. These sites were then used to evaluate potential natural resource sites that have the potential to be stormwater retrofits sites. While the goal is to use natural resource sites as stormwater retrofit sites, we don't want to compromise high quality fish habitat sites.

Stormwater Retrofit

All the natural resource sites were evaluated for stormwater retrofit sites (Figure 50. North Eld Potential Stormwater Restoration Sites).

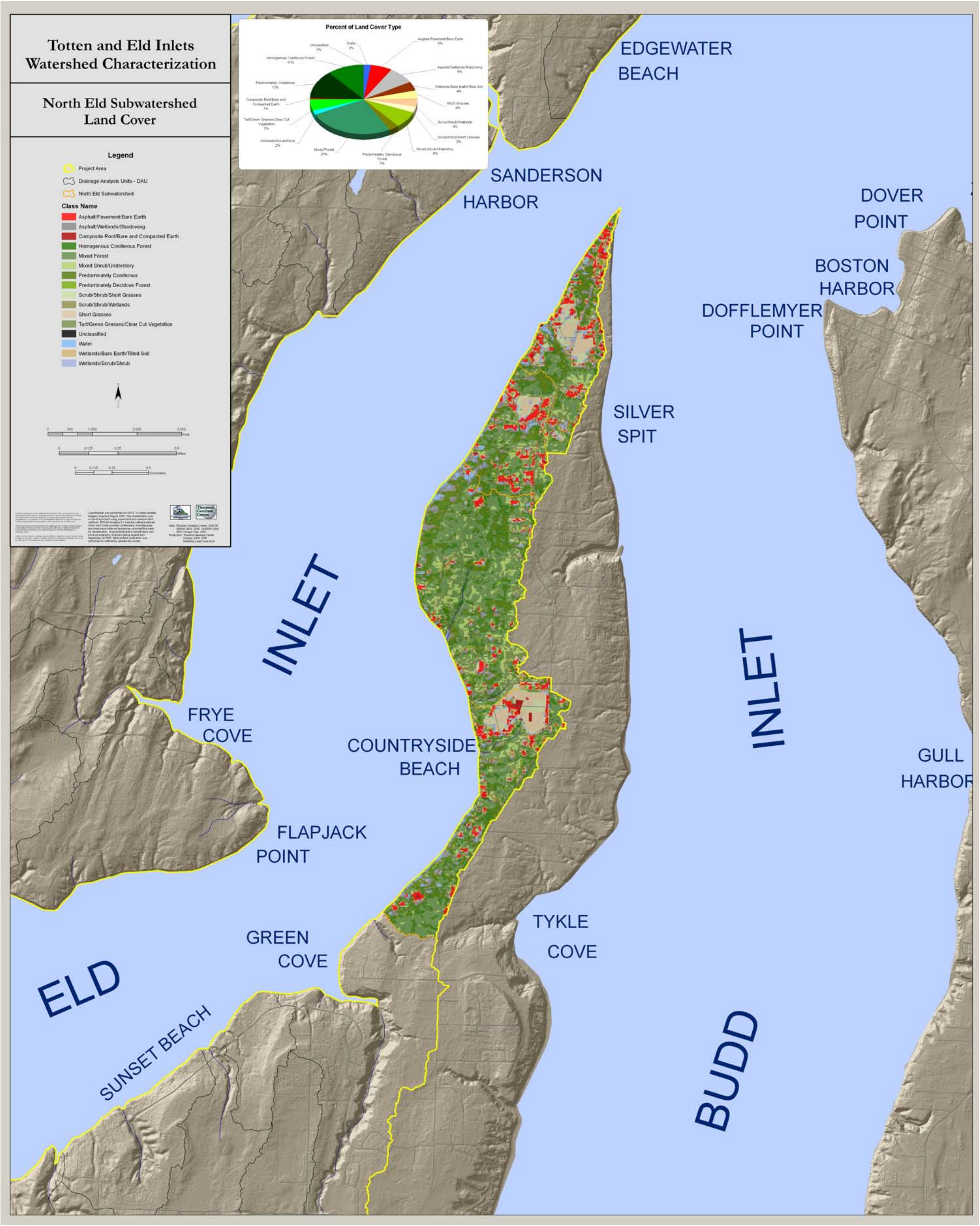


Figure 46 North Eld Sub-watershed Land Cover

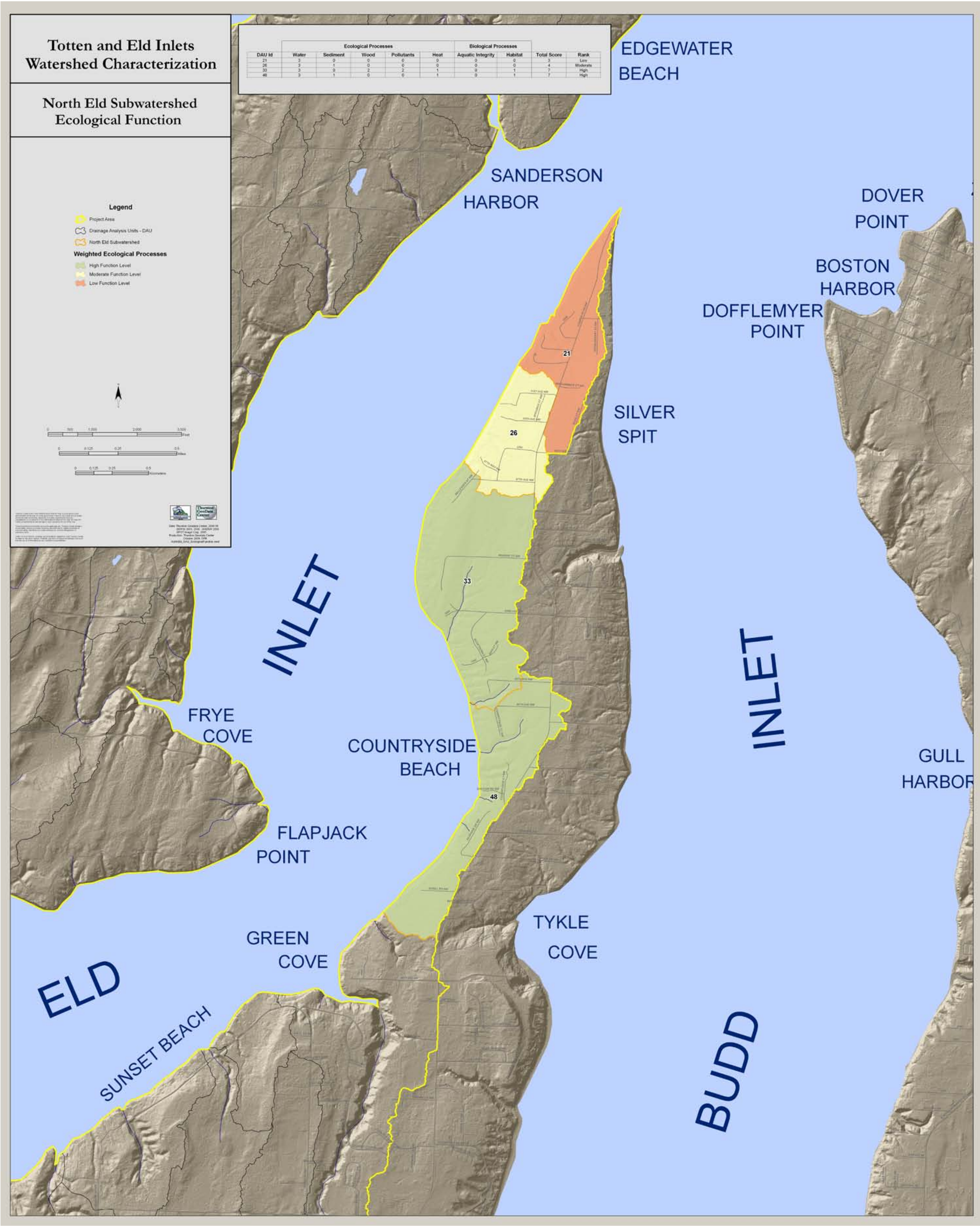


Figure 47 North Eld Sub-watershed Weighted Processes

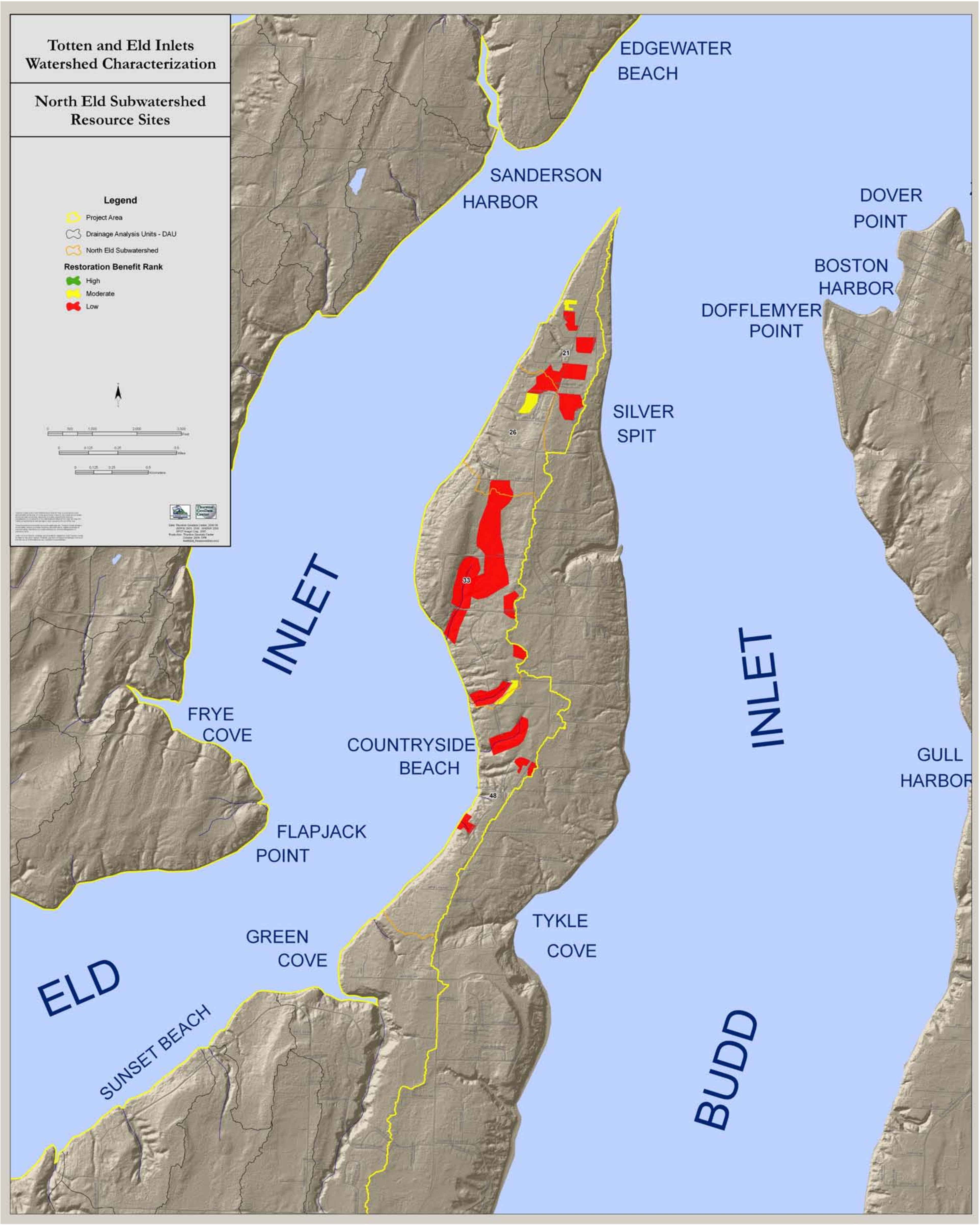


Figure 48 North Eld Sub-watershed Resource Sites

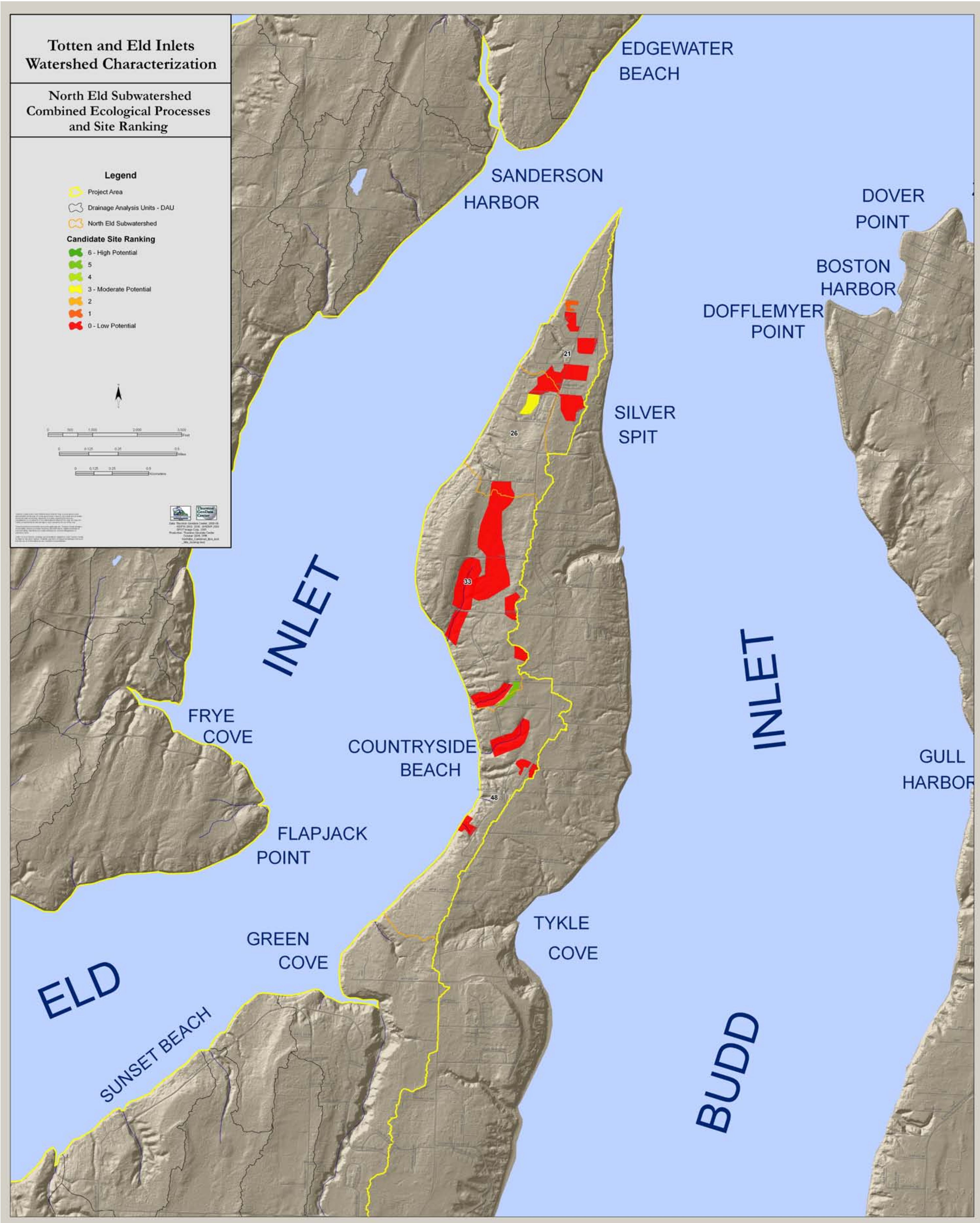


Figure 49 North Eld Sub-watershed Ecological Processes and Resource Site Scoring

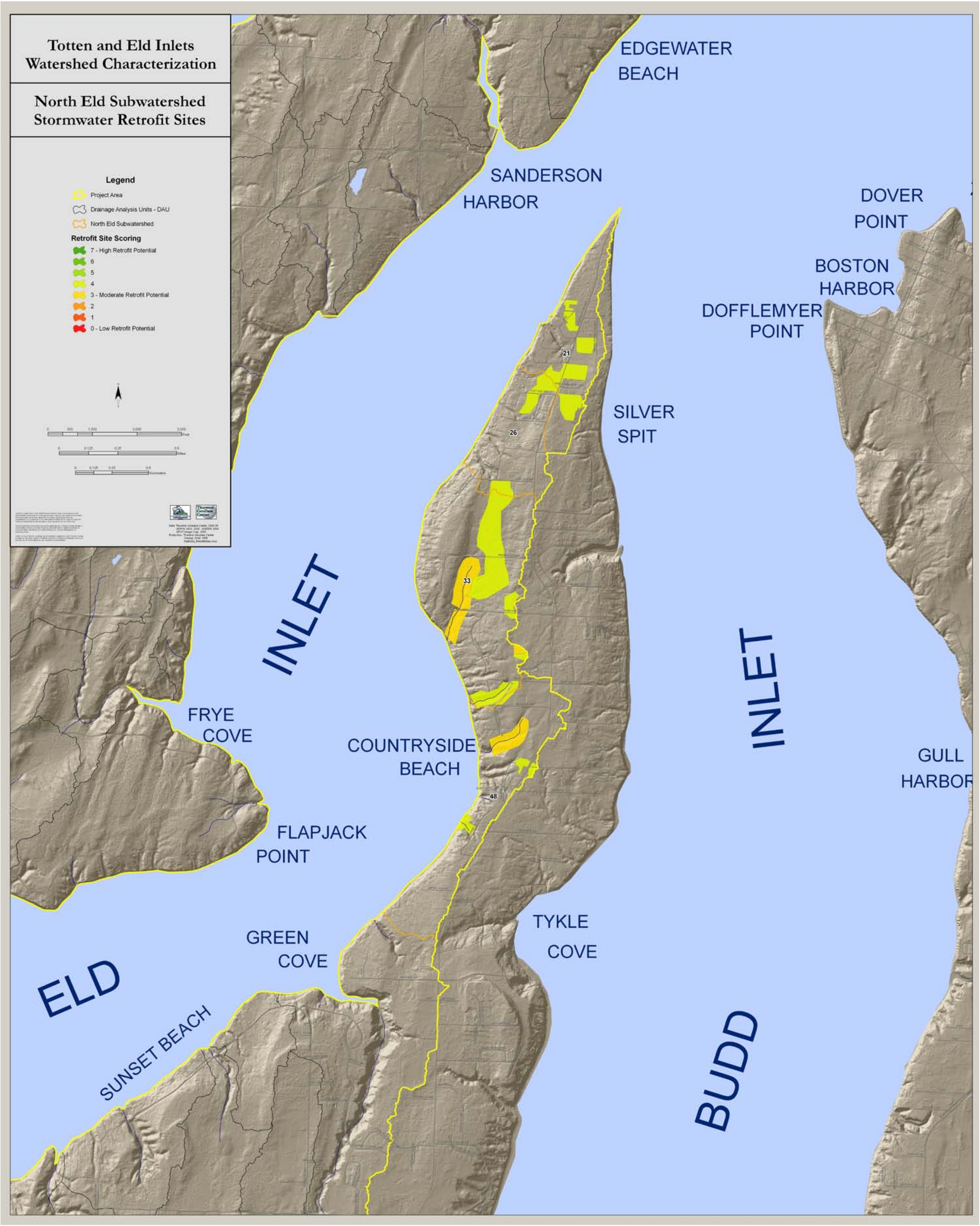


Figure 50 North Eld Sub-watershed Retrofit Sites

What are the conditions in the Perry Creek Sub-watershed?

Current conditions

Approximately four percent of the Perry Creek Sub-watershed is covered by urban land uses (see Figure 51 and 51a, Classification Percent Totals for Perry Creek Sub-watershed). Perry Creek has a drainage area of 6.6 square miles.

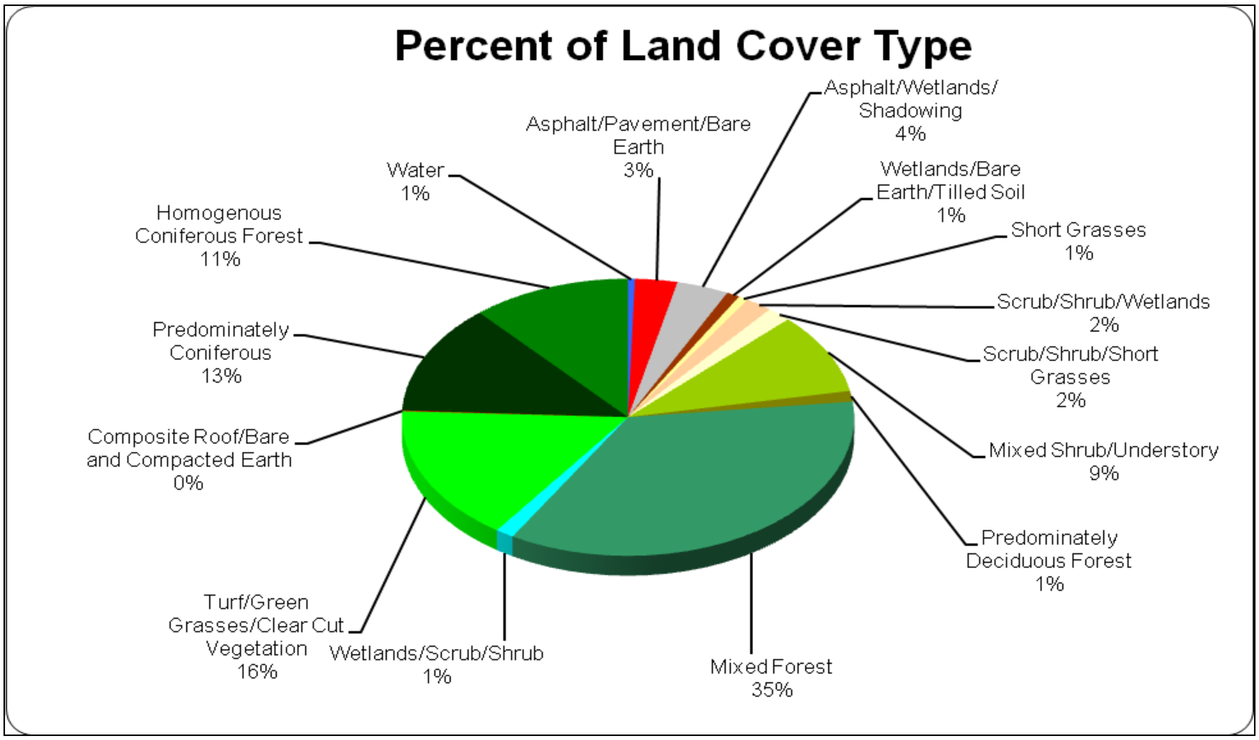


Figure 51a. Classification Percent Totals for Perry Creek Sub-watershed

Land cover data from 2005 SPOT imagery.

Human alteration to the movement of water

The effects of human land use on the natural delivery of water to the Perry Creek and its tributaries in the Perry Creek Sub-watershed were characterized using the following landscape attributes: percent TIA, percent forest land, and percent wetland cover at the DAU scale. Results indicate that the Perry Creek Sub-watershed is in an “at risk” condition for the delivery of water.

Human alteration to the natural movement of sediment

The effects of human land use on the natural delivery of sediment to the Perry Creek and its tributaries in the Kennedy Creek Sub-watershed were characterized using the following landscape attributes: percent bare soils, road density, and percent unstable slopes at the DAU scale. However, because there are no forestry activities or unstable slopes in the sub-watershed, road density was the only applicable indicator. The result is a "properly functioning" and SR condition for sediment.

Human alteration to the natural movement of large wood

The effects of human land use on the natural delivery and routing of large wood in the Perry Creek and its tributaries were characterized using the following landscape attributes: percent forested riparian and average number of stream crossings per kilometer of stream at the DAU scale. Results indicate that the Perry Creek Sub-watershed is primarily in an "at risk" and "not properly functioning" condition for the delivery and routing of large wood.

Human alteration to the natural movement of pollutants

The effects of human land use on the natural delivery and routing of pollutants in the Perry Creek and its tributaries were characterized using the following landscape attributes: Extent of 303(d) listed water bodies for nutrients, toxicants, and bacteria and condition and extent of wetlands at the DAU scale. Results indicate that the Perry Creek Sub-watershed is in an "at risk" condition for the delivery and routing of pollutants**.**

Human alteration to the natural movement of heat

The effects of human land use on the natural delivery and routing of heat in the Perry Creek tributaries were characterized using the following landscape attributes: Extent of 303(d) listed water bodies for nutrients, toxicants, and bacteria, percent 67 meter riparian zone with mature canopy, road density, and percent TIA at the DAU scale. Results indicate that the Perry Creek Sub-watershed is primarily in an "at risk" condition for the delivery and routing of heat.

Aquatic integrity

The effects of human land use on aquatic integrity in the Perry Creek and its tributaries in the Perry Creek Sub-watershed were characterized using the following landscape attributes: percent riparian forest, percent TIA, and available B-IBI scores at the DAU scale. There is no data to rank aquatic integrity.

Habitat Connectivity

Forest covers sixty-one percent of the Perry Creek Sub-watershed, concentrated in the south west sub-watershed. Most of the forest is in rural residential areas and the sub-watershed's primary land cover is composed of commercial and long-term forestry. The Perry Creek Sub-watershed is considered "properly functioning" and "at risk" for habitat connectivity.

Ecological Benefit

All DAUs within the study area having ecological and biological processes that are considered "at risk" under current land use conditions were identified for further consideration. DAUs in the "at risk" category for multiple key ecological and biological processes are assumed to provide the greatest potential to maximize environmental benefits when restored. The process scores are then ranked according to the weight criteria, and converted to a high, medium, or low process rank. Perry Creek has primarily high and moderate ecological benefit, with only one DAU ranked as low (Figure 52. Perry Creek Sub-watershed Weighted Processes).

Environmental Benefit

Once all the DAUs were ranked for their ecological benefit, all natural resource sites were ranked for their environmental benefit. Only the high and medium scoring sites were used in further evaluation to develop natural resource, fish habitat, and stormwater preservation and restoration sites.

Table 15. Perry Creek Environmental Benefit Ranking of Natural Resource Sites

Perry Creek Potential Restoration Sites				
Rank	Wetland	Riparian	Floodplain	Total
High	5	0	NA	5
Medium	3	13	NA	16
Low	16	22	NA	38

The following wetlands, riparian and floodplain sections describe the environmental benefit ranking of the natural resource sites.

Wetlands

Prior to human alteration, wetlands in the Perry Creek Sub-watershed totaled approximately 98 acres. We estimate that approximately 37 acres are currently wetlands or degraded/destroyed wetlands with some restoration potential. (Figure 53. Perry Creek Sub-Watershed Resource Sites).

Riparian condition

Development has encroached on approximately 156 acres of the 67-meter wide riparian corridors in the Perry Creek basin. Of the 951 acres, approximately 156 acres have some restoration potential (Figure 53. Perry Creek Sub-Watershed Resource Sites).

Floodplain Condition

There is no regulated floodplain in the Perry Creek sub-watershed.

Natural Resource Sites

All potential natural resource sites were evaluated for their environmental benefit and ranked high, medium, or low. Following evaluation, a total of 21 sites were of high or medium environmental benefit (Figure 54. Perry Creek Ecological Processes and Resource Site Scoring).

Fish Habitat

There were 35 sites evaluated for habitat value to salmonid fish species. These sites were then used to evaluate potential natural resource sites that have the potential to be stormwater retrofits sites. While the goal is to use natural resource sites as stormwater retrofit sites, we don’t want to compromise high quality fish habitat sites.

Stormwater Retrofit

All the natural resource sites were evaluated for stormwater retrofit sites (Figure 55. Perry Creek Potential Stormwater Restoration Sites).

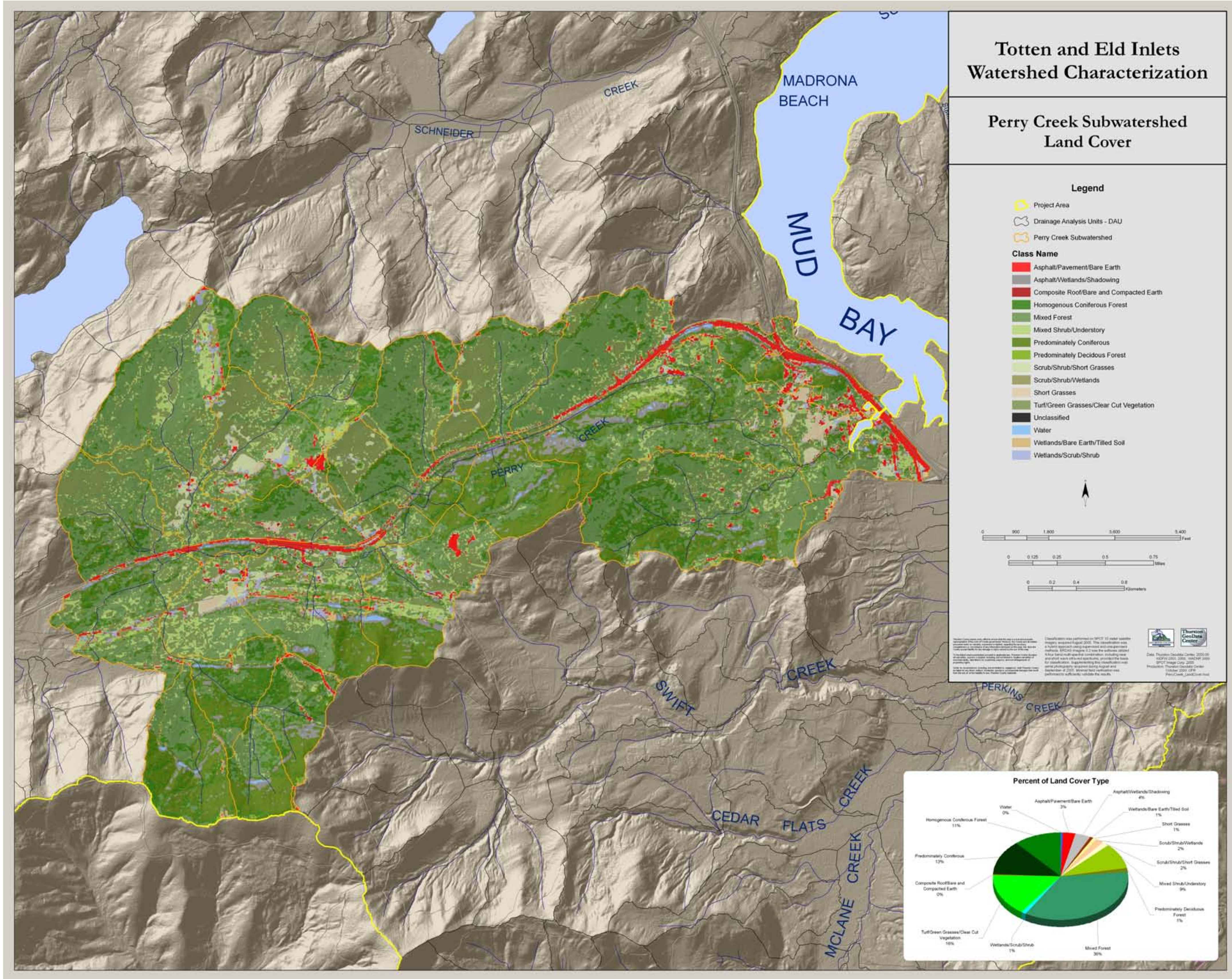
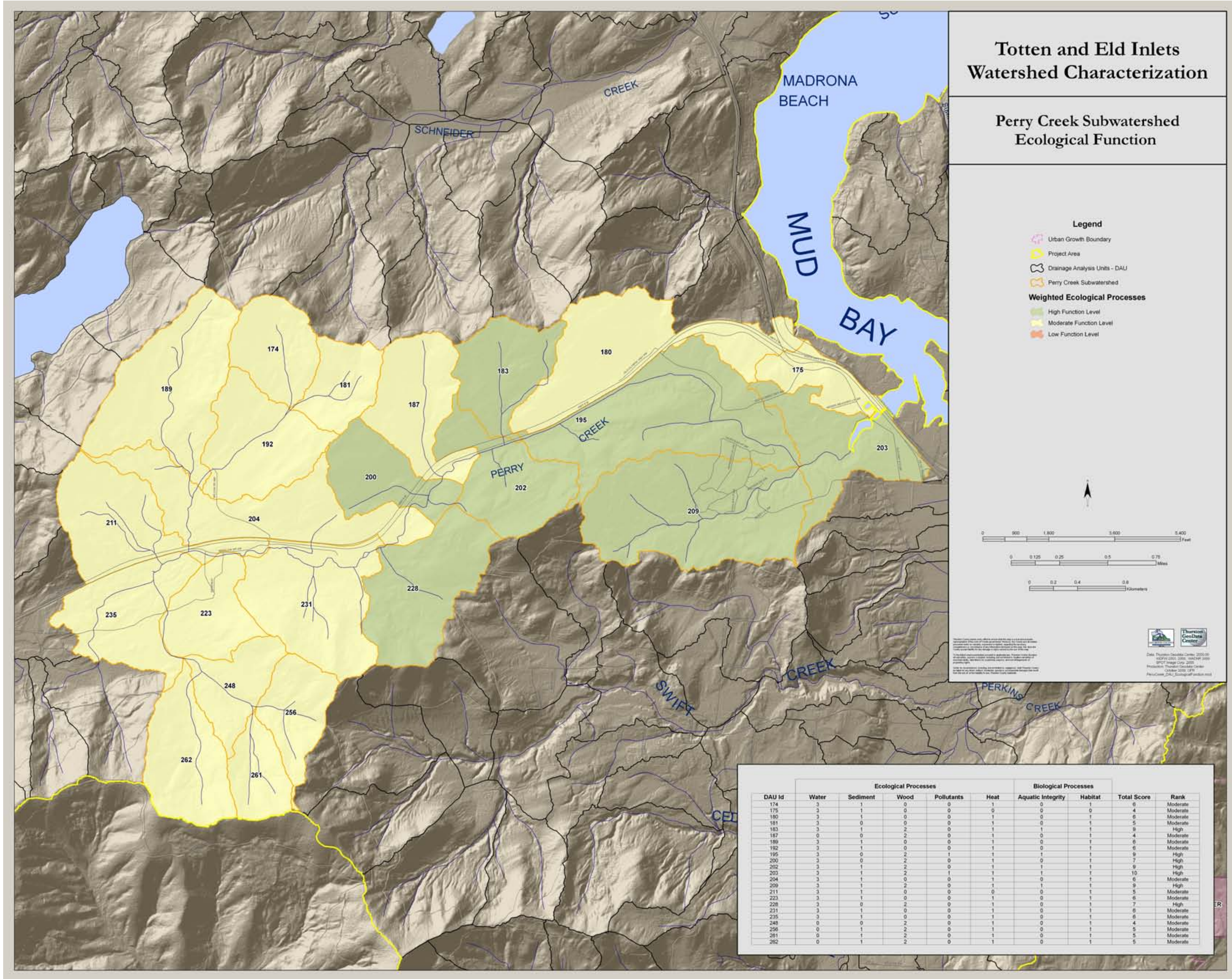


Figure 51 Perry Creek Sub-watershed Land Cover



	Ecological Processes					Biological Processes			
DAU Id	Water	Sediment	Wood	Pollutants	Heat	Aquatic Integrity	Habitat	Total Score	Rank
174	3	1	0	0	1	0	1	6	Moderate
175	3	1	0	0	0	0	0	4	Moderate
180	3	1	0	0	1	0	1	6	Moderate
181	3	0	0	0	1	0	1	5	Moderate
183	3	1	2	0	1	1	1	9	High
187	0	0	2	0	1	0	1	4	Moderate
189	3	1	0	0	1	0	1	6	Moderate
192	3	1	0	0	1	0	1	6	Moderate
195	3	0	2	1	1	1	1	9	High
200	3	0	2	0	1	0	1	7	High
202	3	1	2	0	1	1	1	9	High
203	3	1	2	1	1	1	1	10	High
204	3	1	0	0	1	0	1	6	Moderate
209	3	1	2	0	1	1	1	9	High
211	3	1	0	0	0	0	1	5	Moderate
223	3	1	0	0	1	0	1	6	Moderate
228	3	0	2	0	1	0	1	7	High
231	3	1	0	0	1	0	1	6	Moderate
235	3	1	0	0	1	0	1	6	Moderate
248	0	0	2	0	1	0	1	4	Moderate
256	0	1	2	0	1	0	1	5	Moderate
261	0	1	2	0	1	0	1	5	Moderate
262	0	1	2	0	1	0	1	5	Moderate

Figure 52 Perry Creek Sub-watershed Weighted Processes

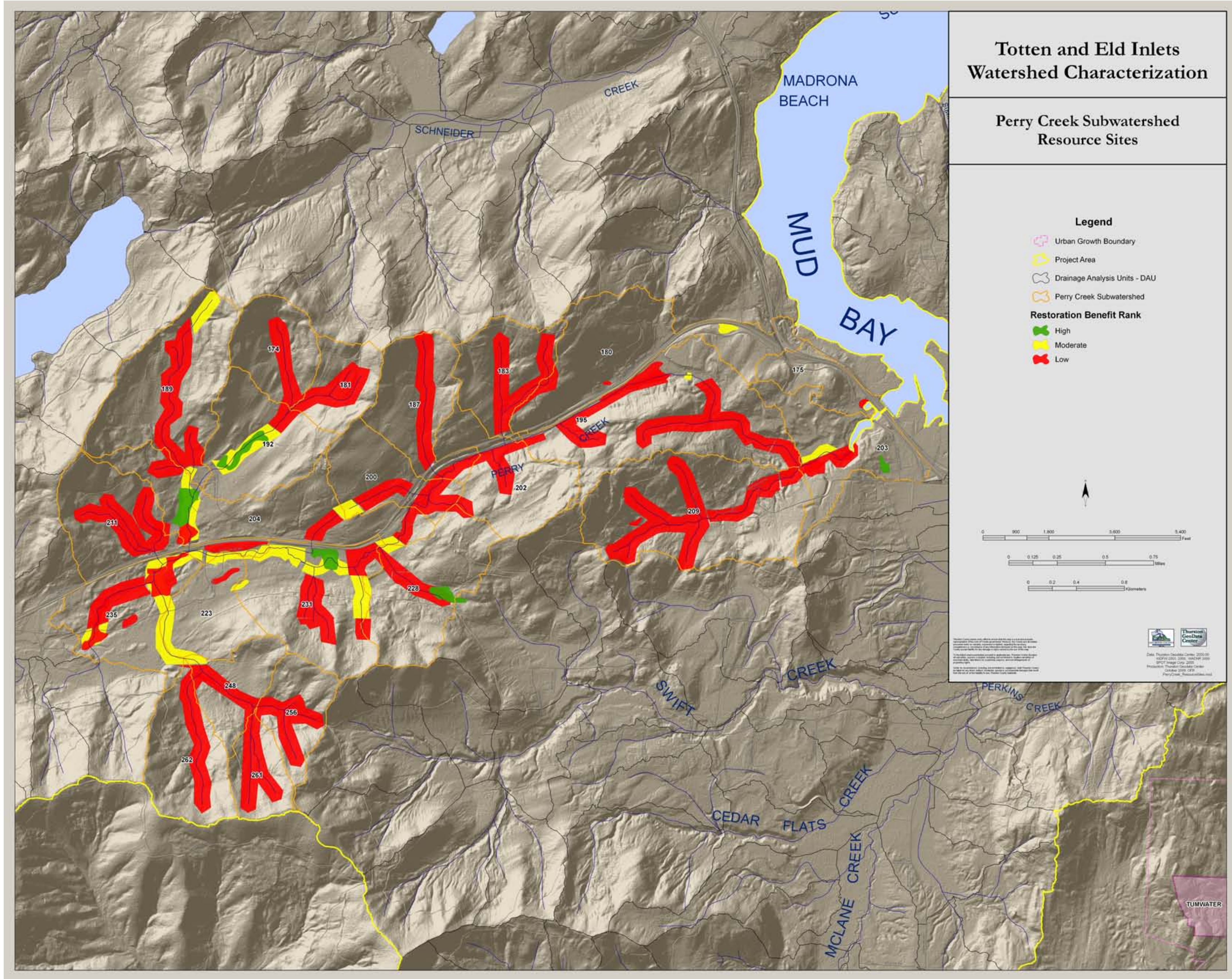


Figure 53 Perry Creek Sub-watershed Resource Sites

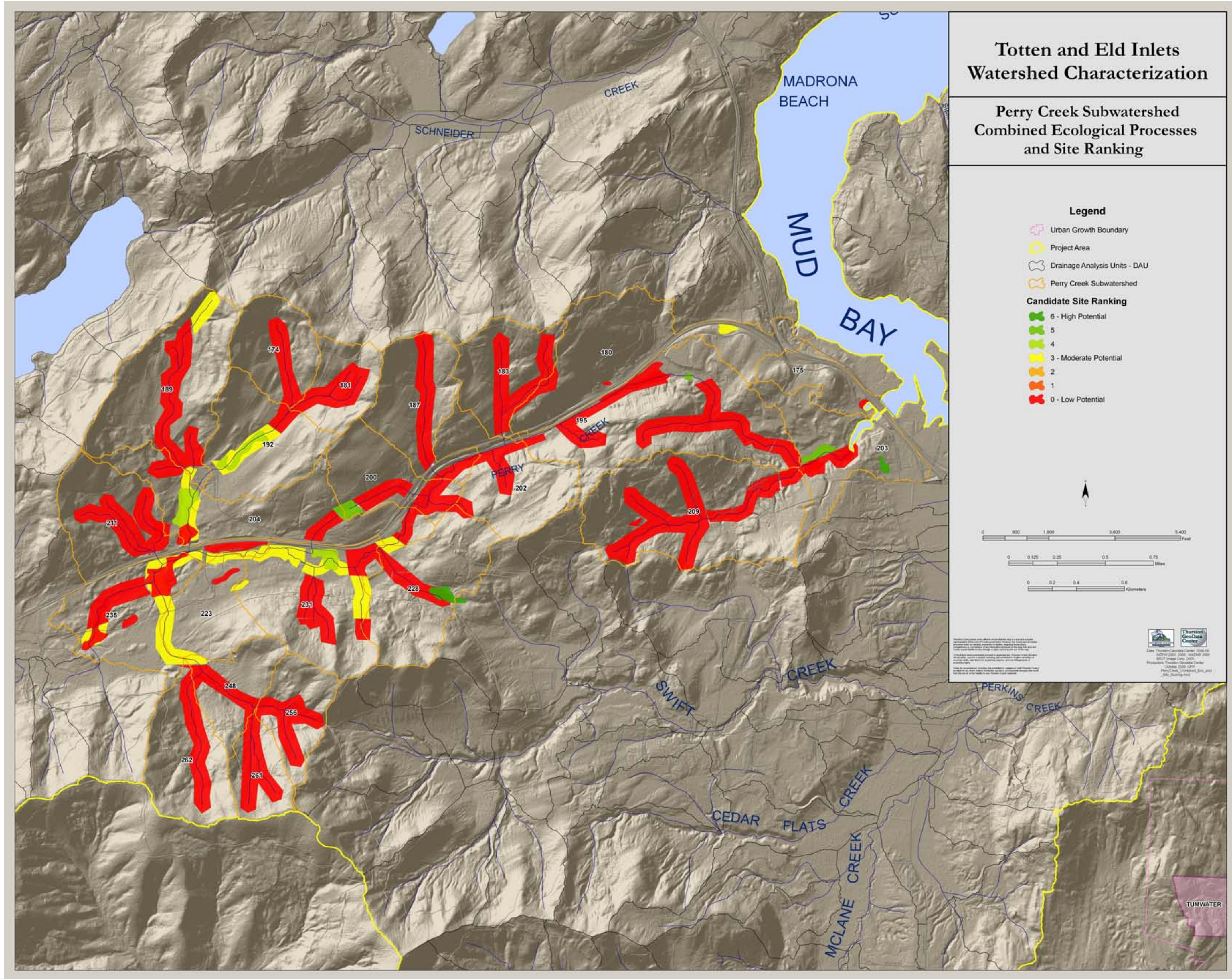


Figure 54 Perry Creek Sub-watershed Ecological Processes and Resource Site Scoring

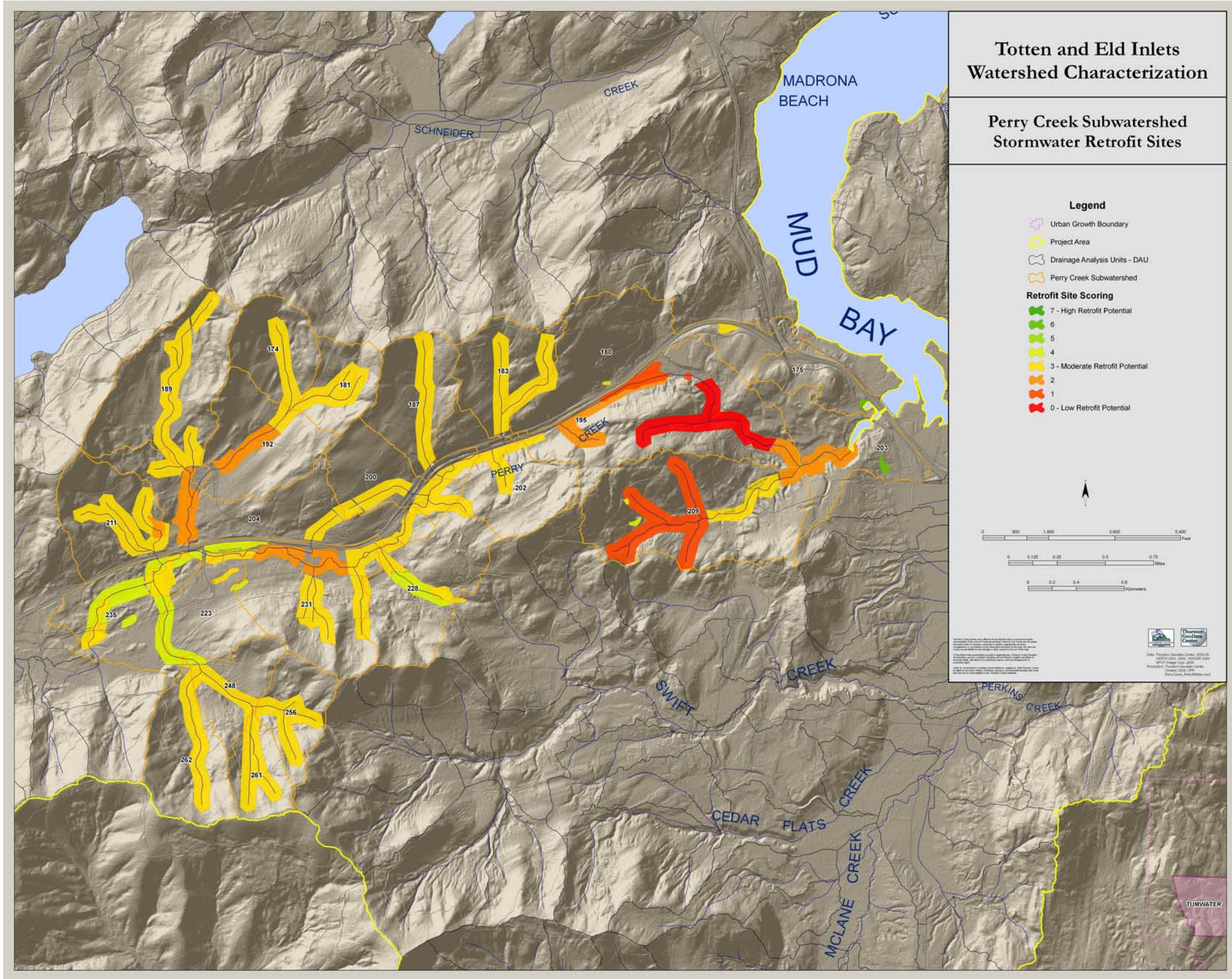


Figure 55 Perry Creek Sub-watershed Retrofit Sites

What are the conditions in the Green Cove Creek Sub-watershed?

Current conditions

Approximately fourteen percent of the Green Cove Creek Sub-watershed is covered by urban land uses (see Figure 56 and 56a, Classification Percent Totals for Green Cove Creek Sub-watershed). Green Cove Creek has a drainage area of 4.3 square miles.

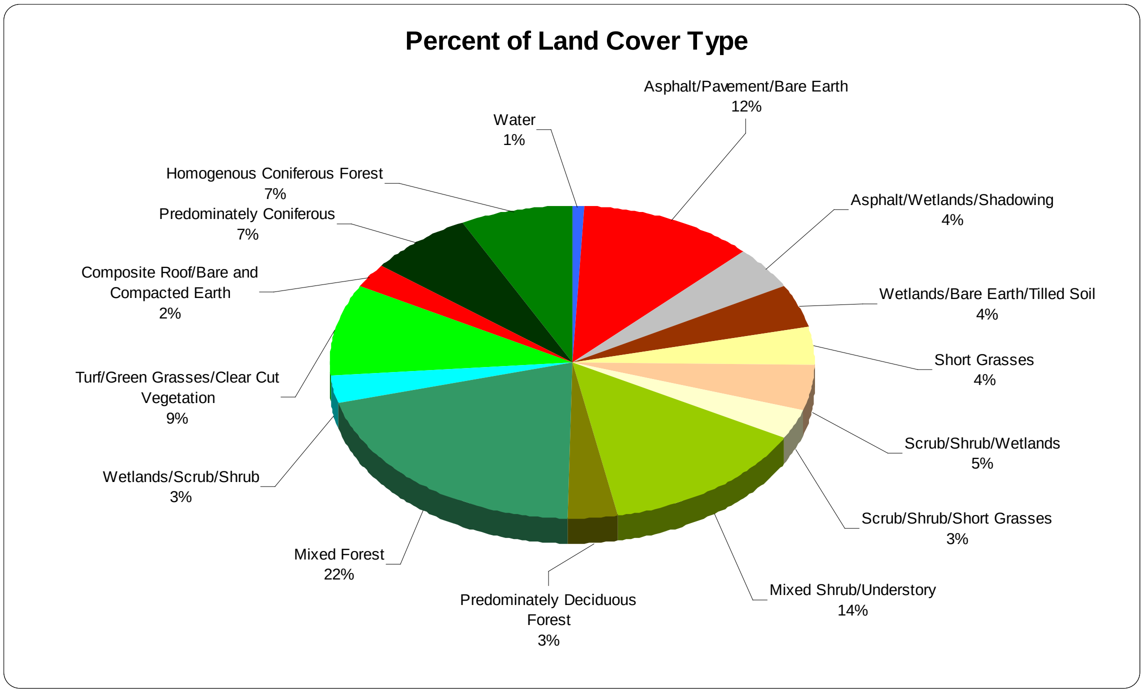


Figure 56a. Classification Percent Totals for Green Cove Creek Sub-watershed

Land cover data from 2005 SPOT imagery.

Human alteration to the movement of water

The effects of human land use on the natural delivery of water to the Kennedy Creek and its tributaries in the Green Cove Creek Sub-watershed were characterized using the following landscape attributes: percent TIA, percent forest land, and percent wetland cover at the DAU scale. Results indicate that the Green Cove Creek Sub-watershed is in an "at risk" condition for the delivery of water, with one DAU in a "not properly functioning" condition.

Human alteration to the natural movement of sediment

The effects of human land use on the natural delivery of sediment to the Green Cove Creek and its tributaries in the Kennedy Creek Sub-watershed were characterized using the following landscape attributes: percent bare soils, road density, and percent unstable slopes at the DAU scale. However, because there are no forestry activities or unstable slopes in the sub-watershed, road density was the only applicable indicator. The result is a "properly functioning" and "at risk" condition for sediment.

Human alteration to the natural movement of large wood

The effects of human land use on the natural delivery and routing of large wood in the Green Cove Creek and its tributaries were characterized using the following landscape attributes: percent forested riparian and average number of stream crossings per kilometer of stream at the DAU scale. Results indicate that the Green Cove Creek Sub-watershed is primarily in an "at risk" condition for the delivery and routing of large wood. Exceptions include three "properly functioning" and one "not properly functioning" DAUs.

Human alteration to the natural movement of pollutants

The effects of human land use on the natural delivery and routing of pollutants in the Green Cove Creek and its tributaries were characterized using the following landscape attributes: Extent of 303(d) listed water bodies for nutrients, toxicants, and bacteria and condition and extent of wetlands at the DAU scale. Results indicate that the Green Cove Creek Sub-watershed is in an AR condition for the delivery and routing of pollutants. However, that is based on very limited data.

Human alteration to the natural movement of heat

The effects of human land use on the natural delivery and routing of heat in the Green Cove Creek tributaries were characterized using the following landscape attributes: Extent of 303(d) listed water bodies for nutrients, toxicants, and bacteria, percent 67 meter riparian zone with mature canopy, road density, and percent TIA at the DAU scale. Results indicate that the Green Cove Creek Sub-watershed is primarily in an "at risk" condition for the delivery and routing of heat.

Aquatic integrity

The effects of human land use on aquatic integrity in the Green Cove Creek and its tributaries in the Green Cove Creek Sub-watershed were characterized using the following landscape attributes: percent riparian forest, percent TIA, and available B-IBI scores at the DAU scale. Results indicate that the Green Cove Creek Sub-watershed is in an "at risk" condition for aquatic integrity. However, that is based on limited data.

Habitat Connectivity

Forest covers 55 percent of the Green Cove Creek Sub-watershed, concentrated in the south west sub-watershed. The Green Cove Creek Sub-watershed is considered "at risk" and "properly functioning" for habitat connectivity.

Ecological Benefit

All DAUs within the study area having ecological and biological processes that are considered "at risk" under current land use conditions were identified for further consideration. DAUs in the "at risk" category for multiple key ecological and biological processes are assumed to provide the greatest potential to maximize environmental benefits when restored. The process scores are then ranked according to the weight criteria, and converted to a high, medium, or low process rank. Green Cove Creek has primarily high and moderate ecological benefit, with only one DAU ranked as low (Figure 57. Green Cove Creek Sub-watershed Weighted Processes).

Environmental Benefit

Once all the DAUs were ranked for their ecological benefit, all natural resource sites were ranked for their environmental benefit. Only the high and medium scoring sites were used in further evaluation to develop natural resource, fish habitat, and stormwater preservation and restoration sites.

Table 16. Green Cove Creek Environmental Benefit Ranking of Natural Resource Sites

Green Cove Creek Potential Restoration Sites				
Rank	Wetland	Riparian	Floodplain	Total
High	1	0	0	1
Medium	3	6	2	11
Low	18	11	4	33

The following wetlands, riparian and floodplain sections describe the environmental benefit ranking of the natural resource sites.

Wetlands

Prior to human alteration, wetlands in the Green Cove Creek Sub-watershed totaled approximately 611 acres. We estimate that approximately 133 acres are currently wetlands or degraded/destroyed wetlands with some restoration potential. (Figure 58. Green Cove Sub-Watershed Resource Sites).

Riparian condition

Development has encroached on approximately 116 acres of the 67-meter wide riparian corridors in the Green Cove Creek basin. Of the X acres, approximately 116 acres have some restoration potential (Figure 58. Green Cove Sub-Watershed Resource Sites).

Floodplain Condition

Development has encroached on approximately 33 acres in the Green Cove Creek floodplain. Of the 96 acres, approximately 33 acres have some restoration potential (Figure 58. Green Cove Sub-Watershed Resource Sites).

Natural Resource Sites

All potential natural resource sites were evaluated for their environmental benefit and ranked high, medium, or low. Following evaluation, a total of 12 sites were of high or medium environmental benefit (Figure 59. Green Cove Creek Ecological Processes and Resource Site Scoring).

Fish Habitat

There were 17 sites evaluated for habitat value to salmonid fish species. These sites were then used to evaluate potential natural resource sites that have the potential to be stormwater retrofits sites. While the goal is to use natural resource sites as stormwater retrofit sites, we don't want to compromise high quality fish habitat sites.

Stormwater Retrofit

All the natural resource sites were evaluated for stormwater retrofit sites (Figure 60. Green Cove Creek Potential Stormwater Restoration Sites).

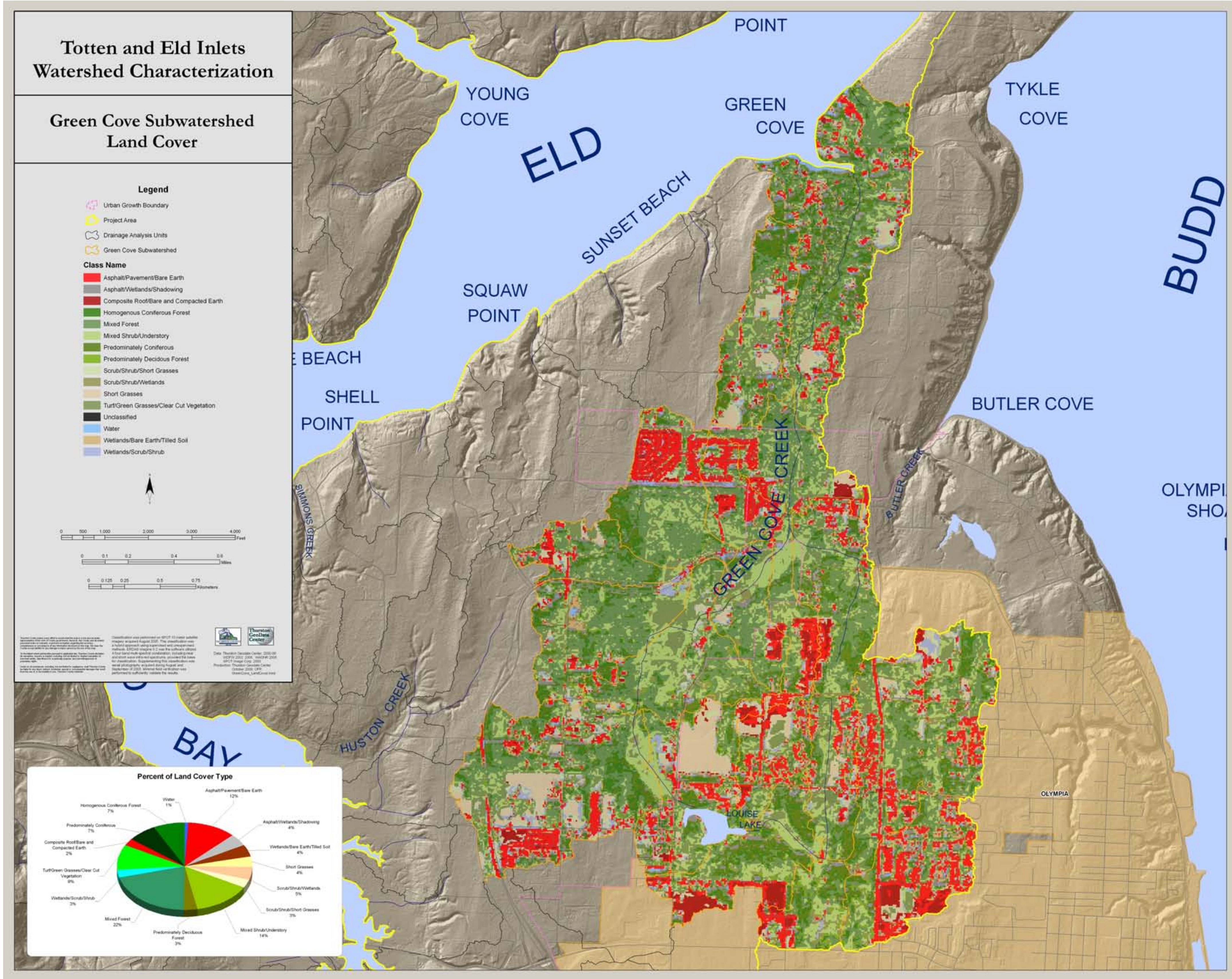
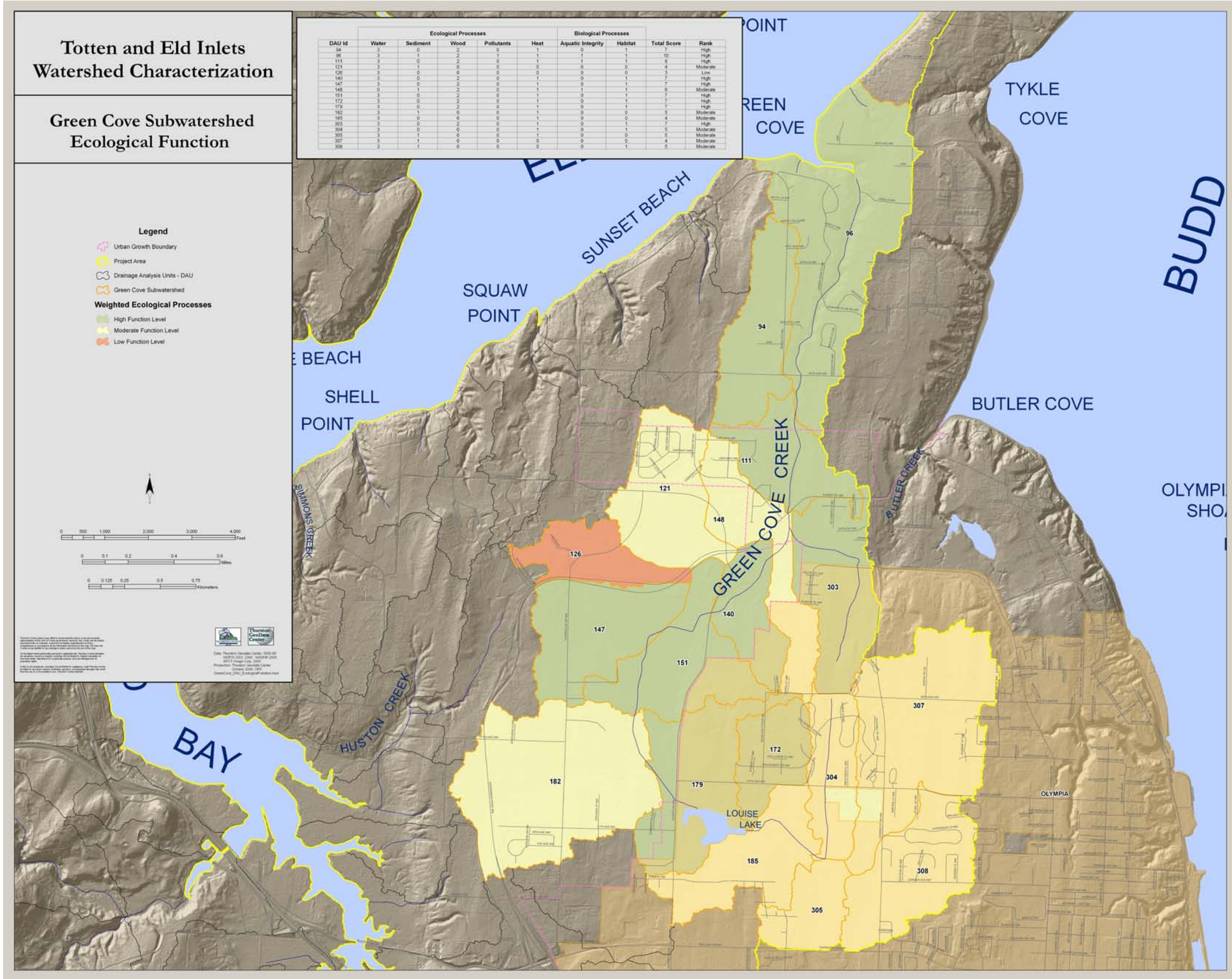


Figure 56 Green Cove Creek Sub-watershed Land Cover



DAU Id	Ecological Processes: Water	Sediment	Wood	Pollutants	Heat	Biological Processes: Aquatic Integrity	Habitat	Total Score	Rank
94	3	0	2	0	1	0	1	7	High
96	3	1	2	1	1	1	1	10	High
111	3	0	2	0	1	1	1	8	High
121	3	1	0	0	0	0	0	4	Moderate
126	3	0	0	0	0	0	0	3	Low
140	3	0	2	0	1	0	1	7	High
147	3	0	2	0	1	0	1	7	High
148	0	1	2	0	1	1	1	6	Moderate
151	3	0	2	0	1	0	1	7	High
172	3	0	2	0	1	0	1	7	High
179	3	0	2	0	1	0	1	7	High
182	3	1	0	0	1	0	0	5	Moderate
185	3	0	0	0	1	0	0	4	Moderate
303	3	0	2	0	1	0	1	7	High
304	3	0	0	0	1	0	1	5	Moderate
305	3	1	0	0	1	0	0	5	Moderate
307	3	1	0	0	0	0	0	4	Moderate
308	3	1	0	0	0	0	1	5	Moderate

Figure 57 Green Cove Creek Sub-watershed Weighted Processes

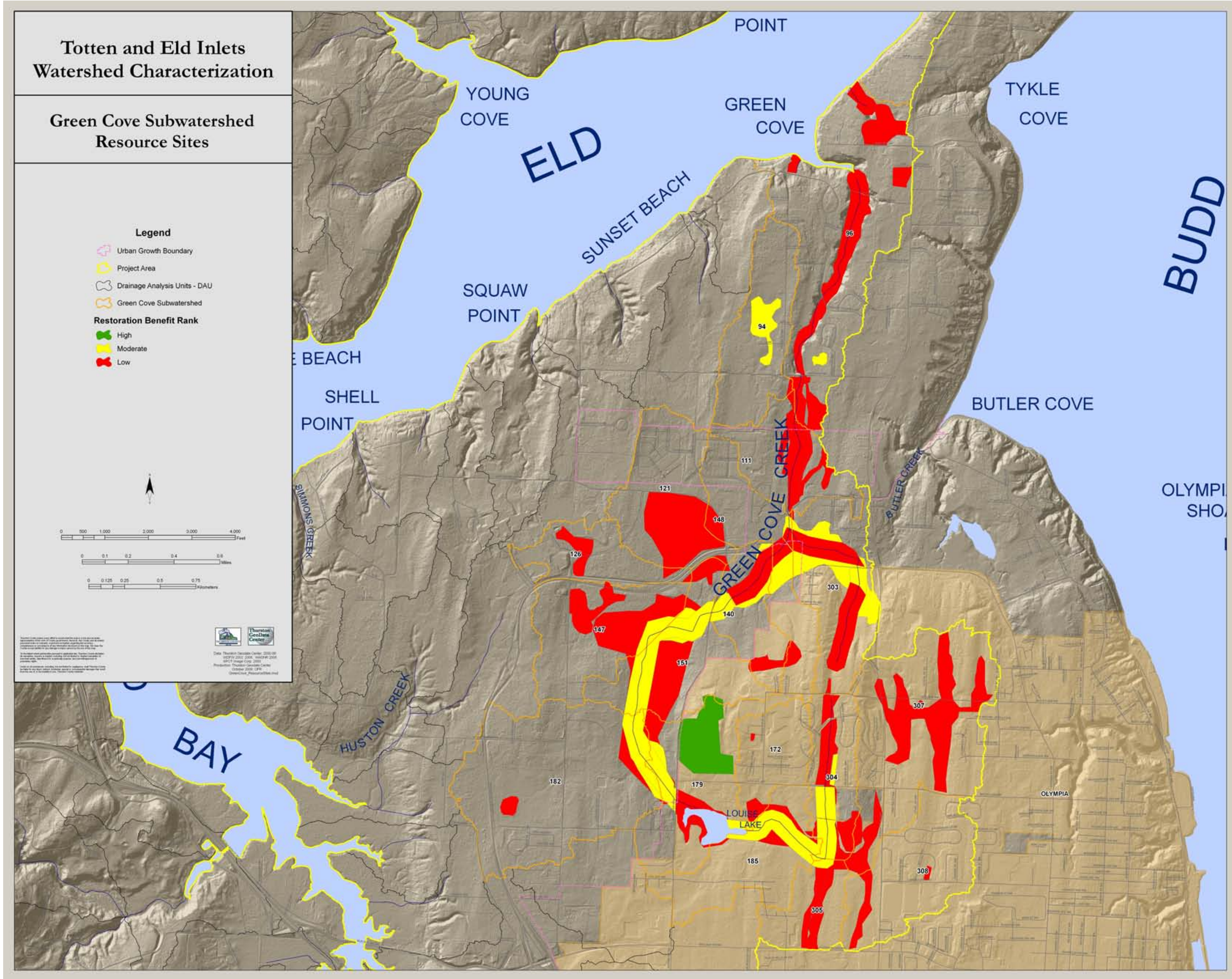


Figure 58 Green Cove Creek Sub-watershed Resource Sites

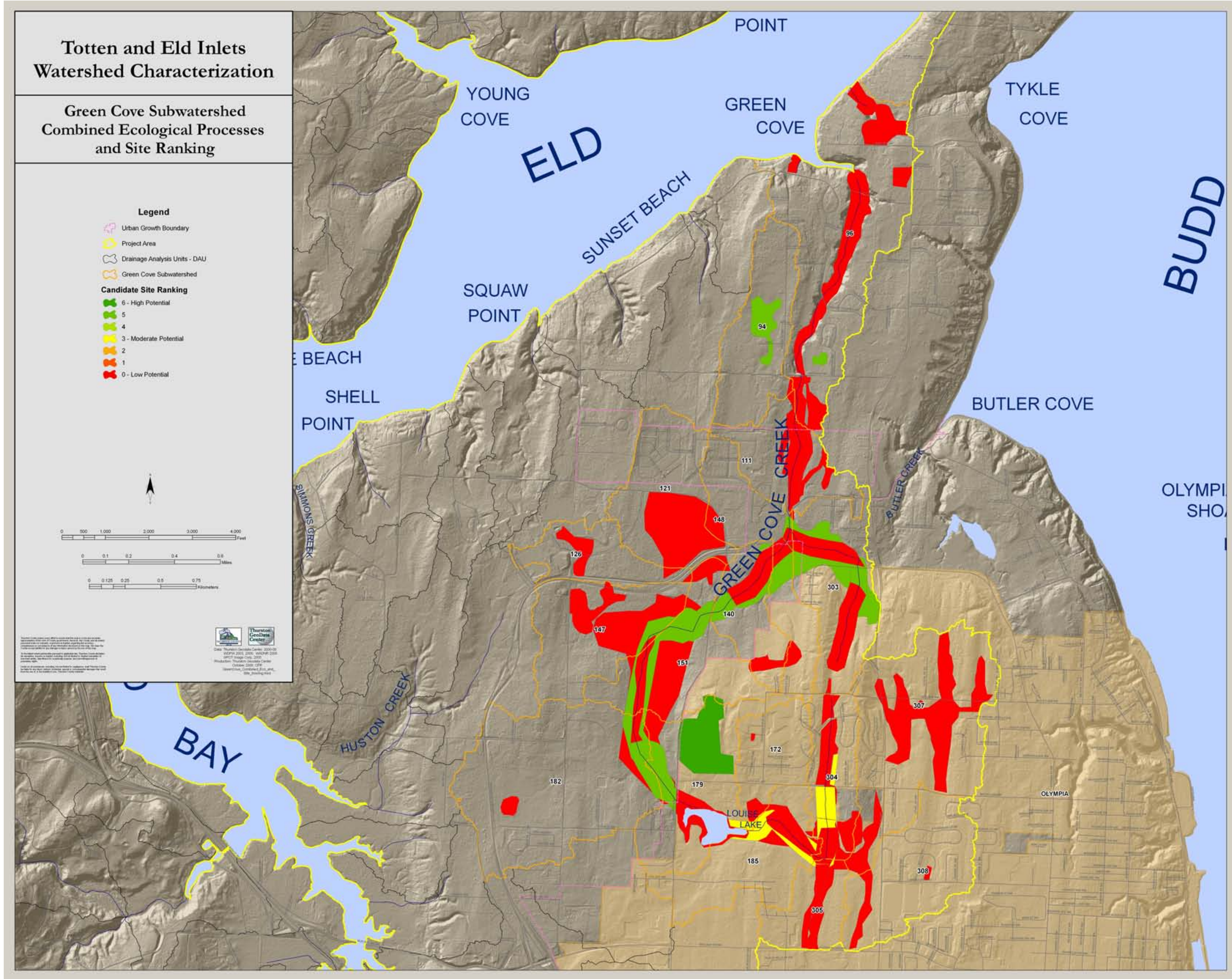


Figure 59 Green Cove Creek Sub-watershed Ecological Processes and Resource Site Scoring

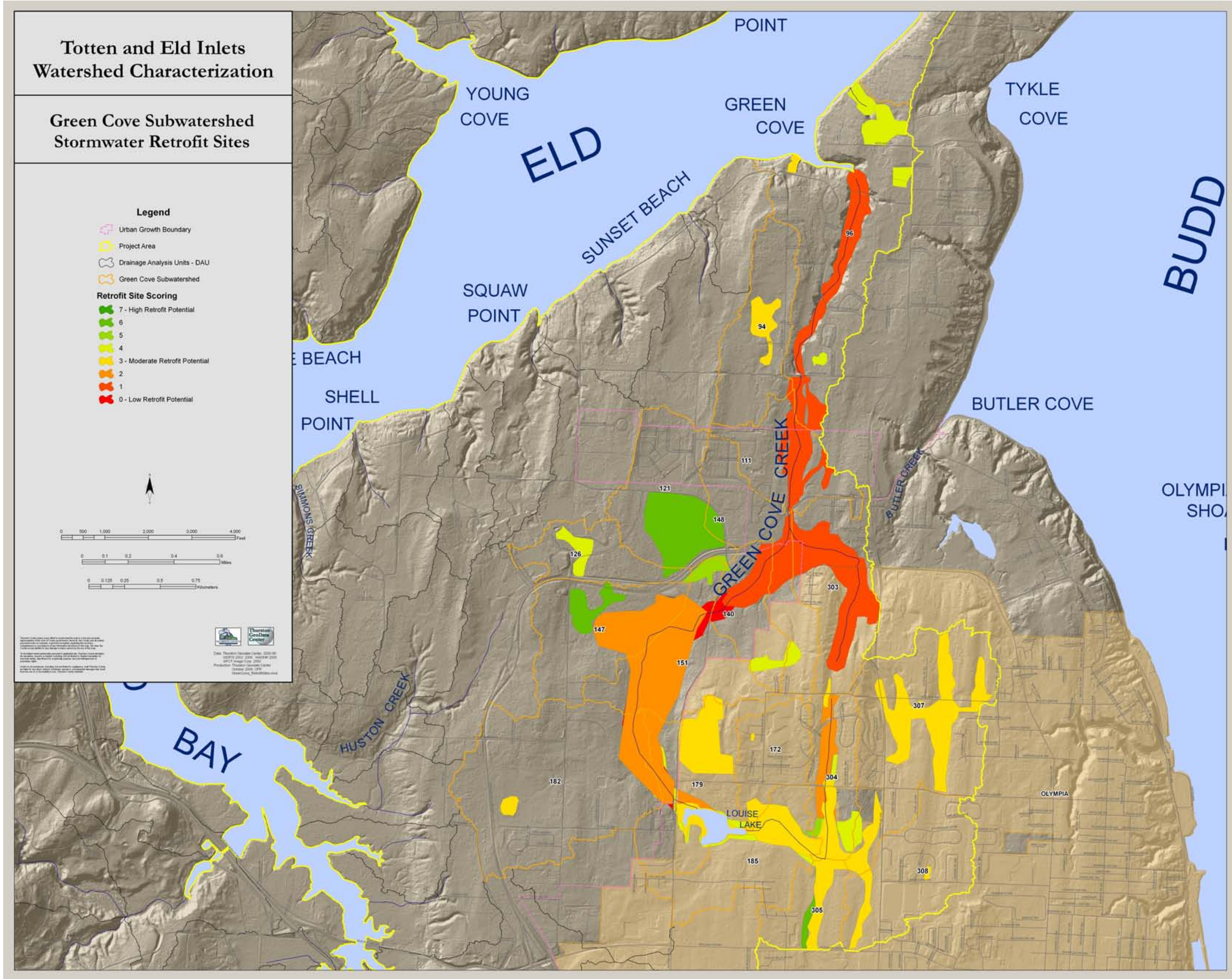


Figure 60 Green Cove Creek Sub-watershed Retrofit Sites

What are the conditions in the Mud Bay Sub-watershed?

Current conditions

Approximately eleven percent of the Mud Bay Sub-watershed is covered by urban land uses (see Figure 61 and 61a. Classification Percent Totals for Mud Bay Sub-watershed). Mud Bay has a drainage area of 3.7 square miles.

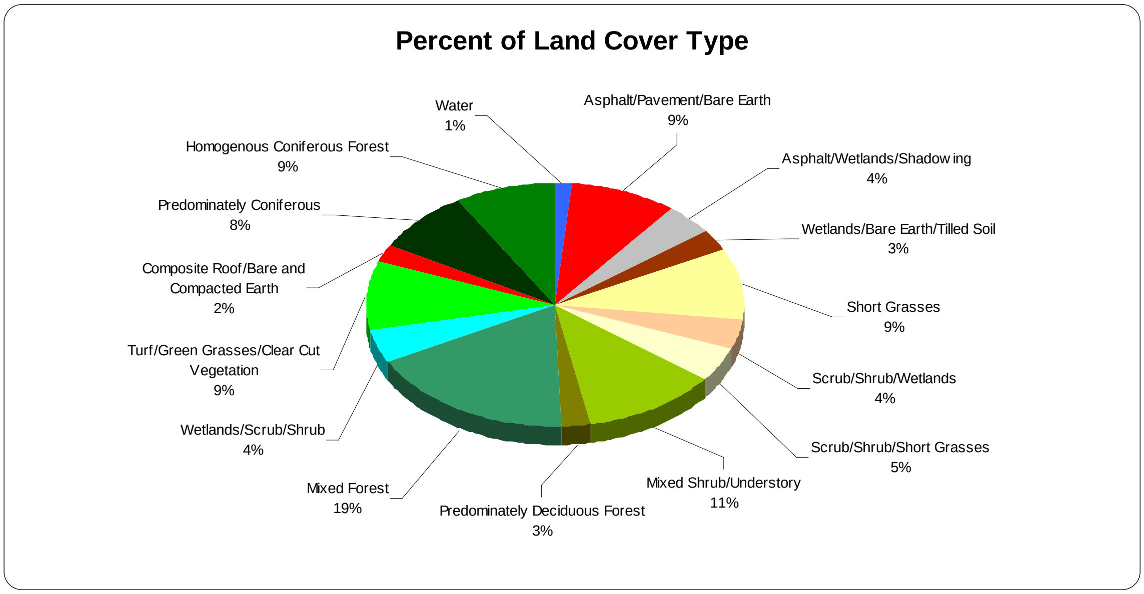


Figure 61a. Classification Percent Totals for Mud Bay Sub-watershed

Land cover data from 2005 SPOT imagery.

Human alteration to the movement of water

The effects of human land use on the natural delivery of water to the Mud Bay and its tributaries in the Mud Bay Sub-watershed were characterized using the following landscape attributes: percent TIA, percent forest land, and percent wetland cover at the DAU scale. Results indicate that the Mud Bay Sub-watershed is in an “at risk” condition for the delivery of water, with two DAUs “not properly functioning.”

Human alteration to the natural movement of sediment

The effects of human land use on the natural delivery of sediment to the Mud Bay and its tributaries in the Kennedy Creek Sub-watershed were characterized using the following landscape attributes: percent bare soils, road density, and percent unstable slopes at the DAU scale. The result is a “properly functioning” and “at risk” condition for sediment.

Human alteration to the natural movement of large wood

The effects of human land use on the natural delivery and routing of large wood in the Mud Bay and its tributaries were characterized using the following landscape attributes: percent forested riparian and average number of stream crossings per kilometer of stream at the DAU scale. Results indicate that the Mud Bay Sub-watershed is primarily in a “not properly functioning” and “at risk” condition for the delivery and routing of large wood. Exceptions include two “properly functioning” DAUs.

Human alteration to the natural movement of pollutants

The effects of human land use on the natural delivery and routing of pollutants in the Mud Bay and its tributaries were characterized using the following landscape attributes: Extent of 303(d) listed water bodies for nutrients, toxicants, and bacteria and condition and extent of wetlands at the DAU scale. There is no data to rank pollutants.

Human alteration to the natural movement of heat

The effects of human land use on the natural delivery and routing of heat in the Mud Bay tributaries were characterized using the following landscape attributes: Extent of 303(d) listed water bodies for nutrients, toxicants, and bacteria, percent 67 meter riparian zone with mature canopy, road density, and percent TIA at the DAU scale. Results indicate that the Mud Bay Sub-watershed is primarily in an “at risk” condition for the delivery and routing of heat. The exception is one DAU that is “properly functioning.”

Aquatic integrity

The effects of human land use on aquatic integrity in the Mud Bay and its tributaries in the Mud Bay Sub-watershed were characterized using the following landscape attributes: percent riparian forest, percent TIA, and available B-IBI scores at the DAU scale. There is no data to rank aquatic integrity.

Habitat Connectivity

Forest covers thirty-four percent of the Mud Bay Sub-watershed. The Mud Bay Sub-watershed is considered “at risk” for habitat connectivity.

Ecological Benefit

All DAUs within the study area having ecological and biological processes that are considered “at risk” under current land use conditions were identified for further consideration. DAUs in the “at risk” category for multiple key ecological and biological processes are assumed to provide the greatest potential to maximize environmental benefits when restored. The process scores are then ranked according to the weight criteria, and converted to a high, medium, or low process rank. Mud Bay has primarily high and moderate ecological benefit, with only three DAUs ranked as low (Figure 62. Mud Bay Sub-watershed Weighted Processes).

Environmental Benefit

Once all the DAUs were ranked for their ecological benefit, all natural resource sites were ranked for their environmental benefit. Only the high and medium scoring sites were used in further evaluation to develop natural resource, fish habitat, and stormwater preservation and restoration sites.

Table 17. Mud Bay Environmental Benefit Ranking of Natural Resource Sites

Mud Bay Potential Restoration Sites				
Rank	Wetland	Riparian	Floodplain	Total
High	1	0	NA	1
Medium	2	7	NA	9
Low	10	13	NA	23

The following wetlands, riparian and floodplain sections describe the environmental benefit ranking of the natural resource sites.

Wetlands

Prior to human alteration, wetlands in the Mud Bay Sub-watershed totaled approximately 487 acres. We estimate that approximately 370 acres are currently wetlands or degraded/destroyed wetlands with some restoration potential. (Figure 63. Mud Bay Sub-Watershed Resource Sites).

Riparian condition

Development has encroached on approximately 91 acres of the 67-meter wide riparian corridors in the Mud Bay sub-watershed. Of the 202 acres, approximately 91 acres have some restoration potential (Figure 63. Mud Bay Sub-Watershed Resource Sites).

Floodplain Condition

There is no regulated floodplain in the Mud Bay sub-watershed.

Natural Resource Sites

All potential natural resource sites were evaluated for their environmental benefit and ranked high, medium, or low. Following evaluation, a total of 10 sites were of high or medium environmental benefit (Figure 64. Mud Bay Ecological Processes and Resource Site Scoring).

Fish Habitat

There were 20 sites evaluated for habitat value to salmonid fish species. These sites were then used to evaluate potential natural resource sites that have the potential to be stormwater retrofits sites. While the goal is to use natural resource sites as stormwater retrofit sites, we don't want to compromise high quality fish habitat sites.

Stormwater Retrofit

All the natural resource sites were evaluated for stormwater retrofit sites (Figure 65. Mud Bay Potential Stormwater Restoration Sites).

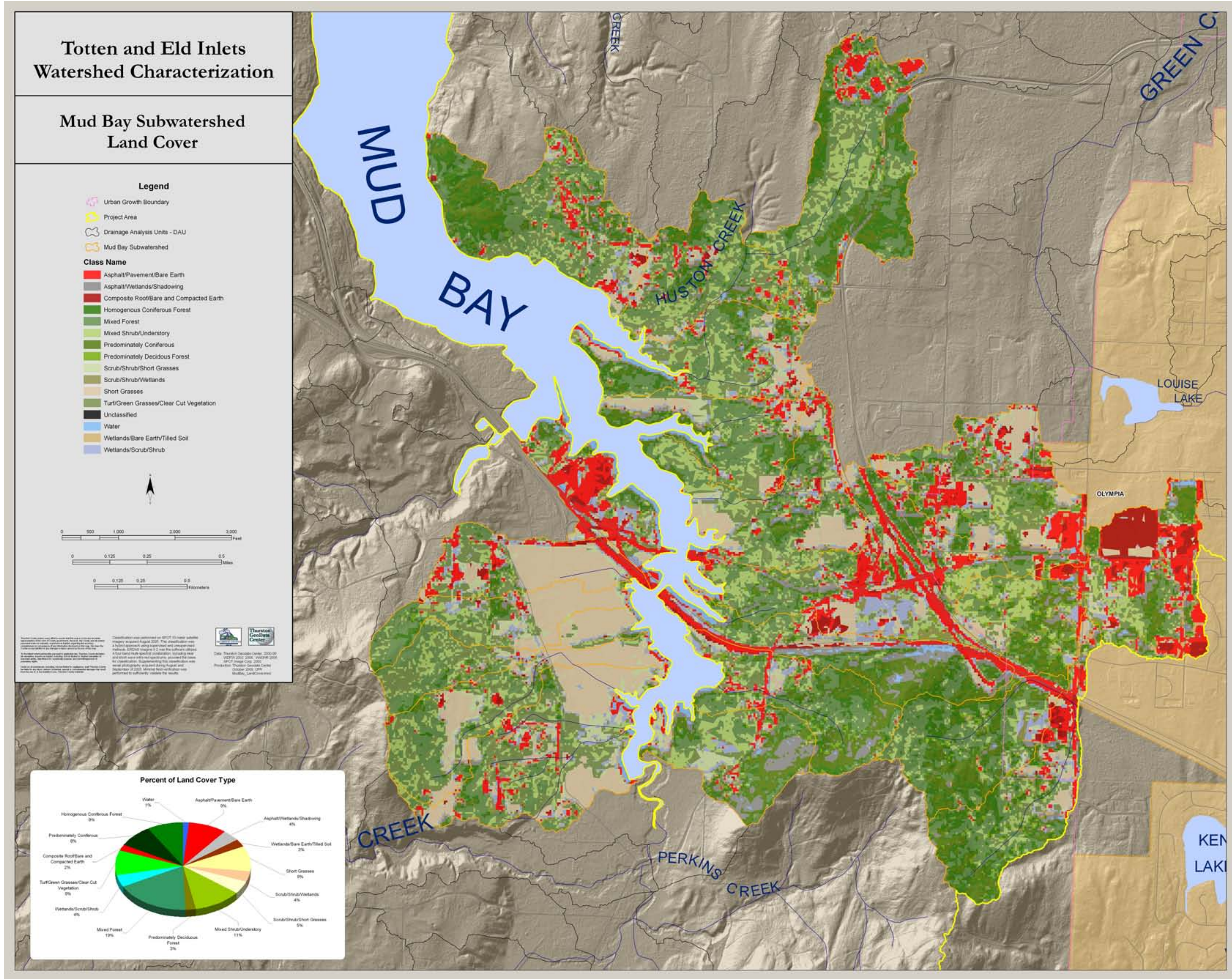
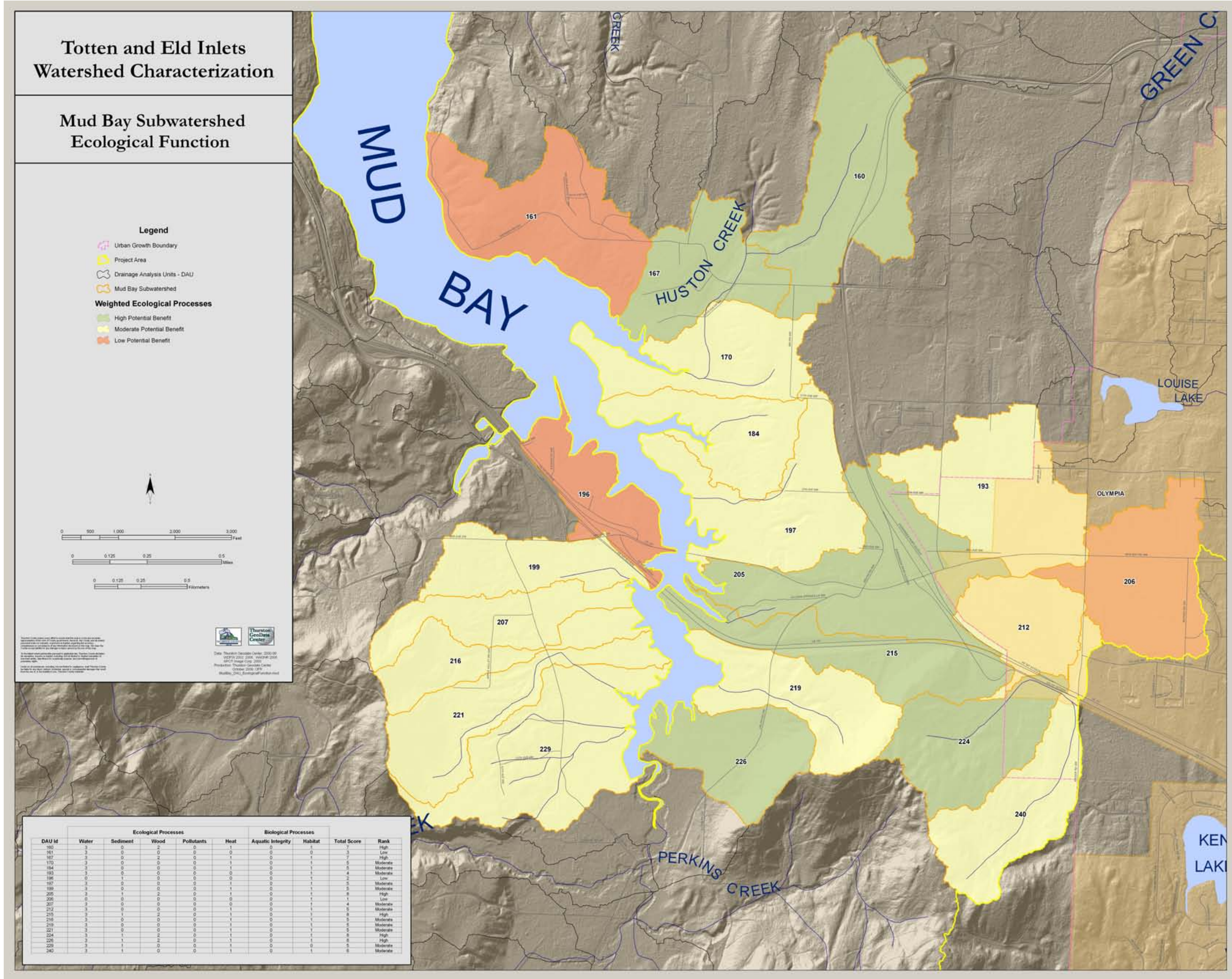


Figure 61 Mud Bay Sub-watershed Land Cover



DAU Id	Ecological Processes: Water	Sediment	Wood	Pollutants	Heat	Biological Processes: Aquatic Integrity	Habitat	Total Score	Rank
160	3	0	2	0	1	0	1	7	High
161	3	0	0	0	0	0	0	3	Low
167	3	0	2	0	1	0	1	7	High
170	3	0	0	0	1	0	1	5	Moderate
184	3	0	0	0	1	0	1	5	Moderate
193	3	0	0	0	0	0	1	4	Moderate
196	0	1	0	0	0	0	1	2	Low
197	3	0	0	0	1	0	1	5	Moderate
199	3	0	0	0	1	0	1	5	Moderate
205	3	1	2	0	1	0	1	8	High
206	0	0	0	0	0	0	1	1	Low
207	3	0	0	0	0	0	1	4	Moderate
212	3	0	0	0	1	0	1	5	Moderate
215	3	1	2	0	1	0	1	8	High
216	3	0	0	0	1	0	1	5	Moderate
219	3	0	0	0	1	0	1	5	Moderate
221	3	0	0	0	1	0	1	5	Moderate
224	3	1	2	0	1	0	1	8	High
226	3	1	2	0	1	0	1	8	High
229	3	1	0	0	1	0	0	5	Moderate
240	3	1	0	0	1	0	1	6	Moderate

Figure 62 Mud Bay Sub-watershed Weighted Processes

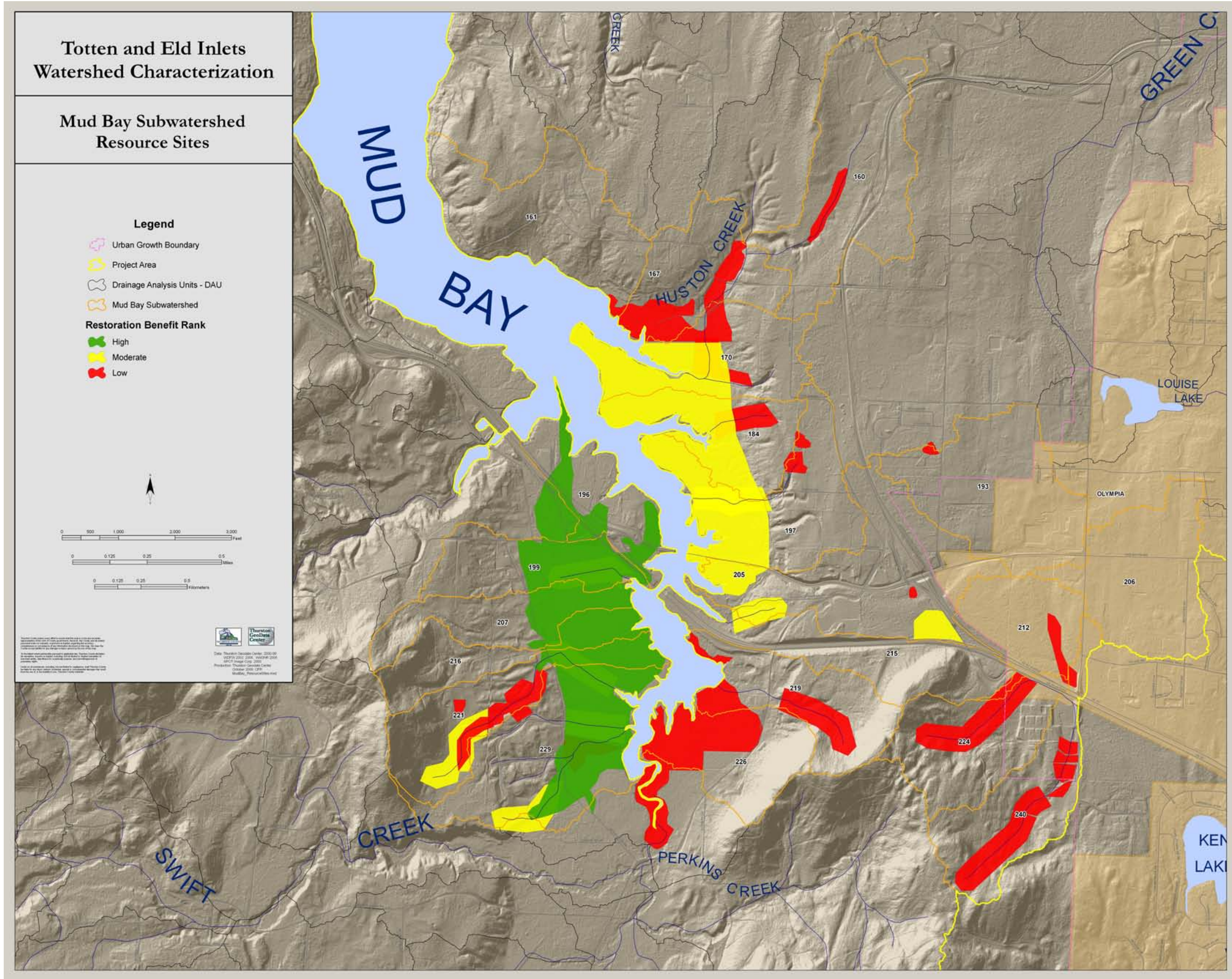


Figure 63 Mud Bay Sub-watershed Resource Sites

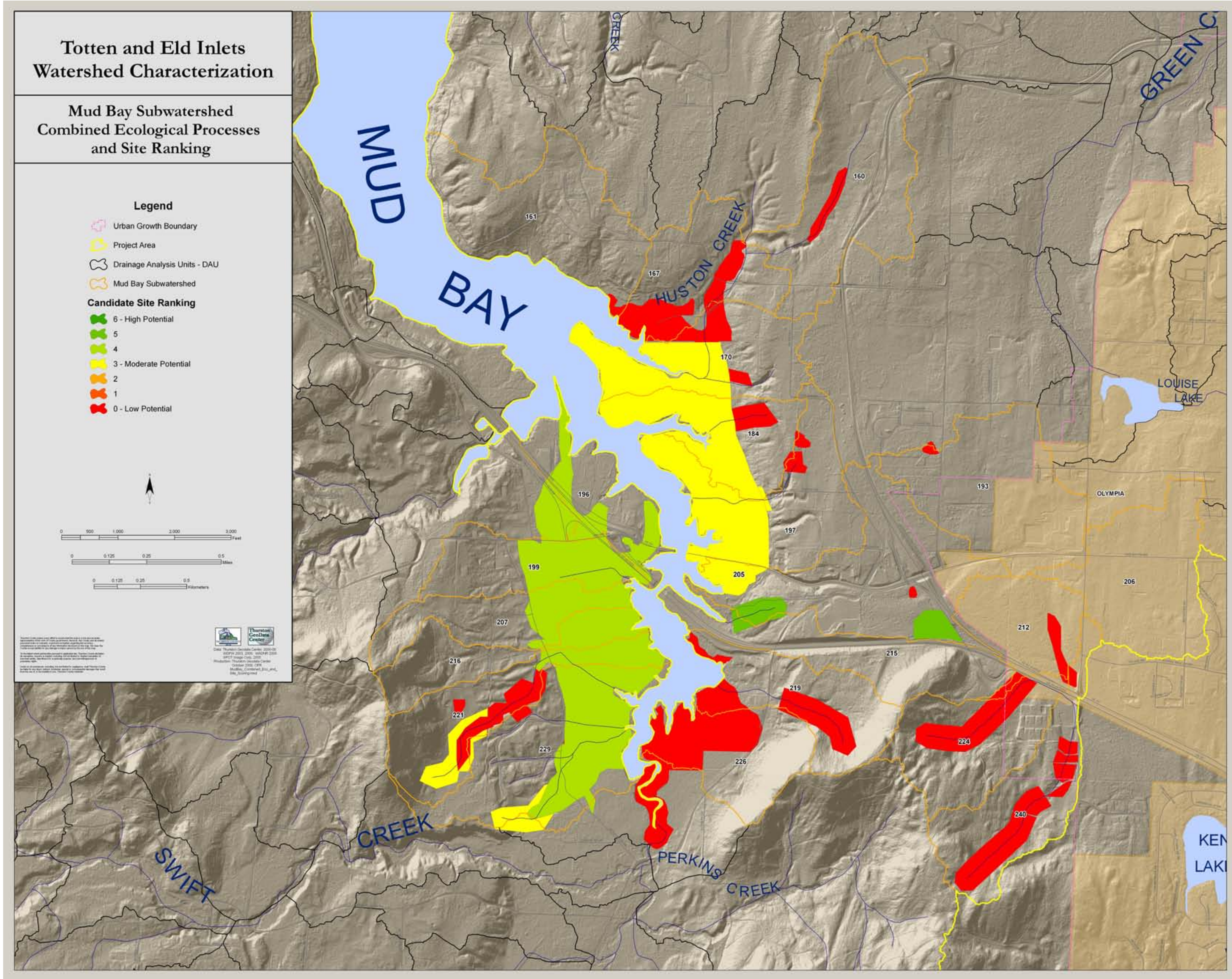


Figure 64 Mud Bay Sub-watershed Ecological Processes and Resource Site Scoring

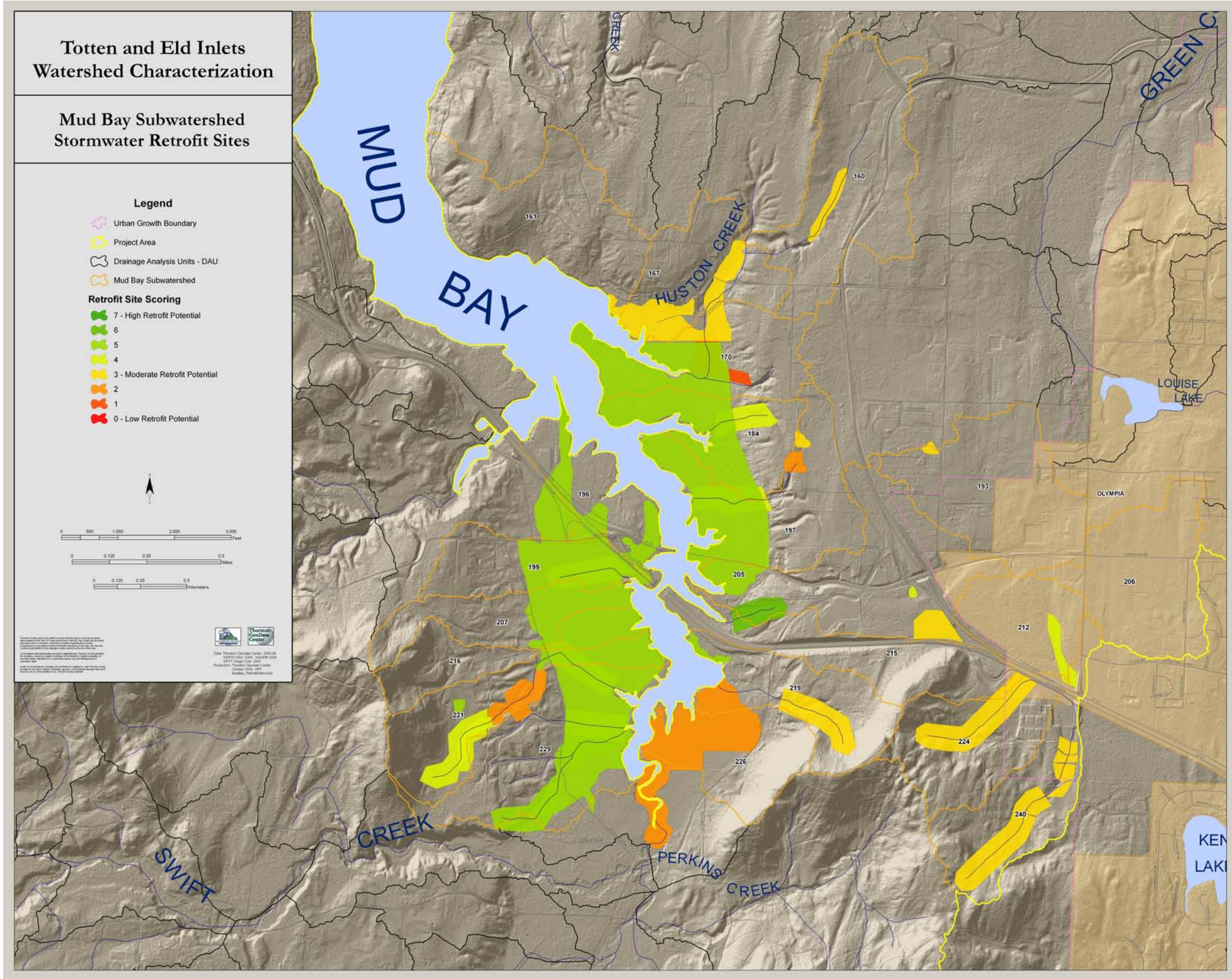


Figure 65 Mud Bay Sub-watershed Retrofit Sites

Appendix A

Methodology to a Watershed Based Approach to Federal and State Clean Water Act Regulations

Methods developed by Gersib et al., 2004 and updated in 2006 and 2008 by:

Thurston County
GeoData Center
Department of Resource Stewardship

December 29, 2009

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List of Acronyms and Abbreviations

303(d)	List of impaired water bodies specified in the Clean Water Act, Section 303(d)
ADT	Average daily traffic
Basin	1000 to 10000 acres
B-IBI	Benthic – Index of Biological Integrity
Catchment	32 to 320 acres
DAU	Drainage Analysis Unit (0.25 sq miles of 160 acres)
DBH	Diameter breast height
DEM	Digital Elevation Model
Ecology	Washington State Department of Ecology
EDT	Ecosystem Diagnosis and Treatment
EIA	Effective Impervious Area
EMC	Event mean concentration
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESB	Engrossed Senate Bill
FEMA	Federal Emergency Management Agency
FRAGSTATS	FRAGSTATS is a computer software program designed to compute a wide variety of landscape metrics
GeoData	Thurston County's GeoData Center
GIS	Geographical Information System
GLO	General Land Office
HSPF	Hydrological Simulation Program—Fortran
LID	Low Impact Development

LiDAR	Light Detecting and Ranging
LWD	Large Woody Debris
NEPA	National Environmental Policy Act
PAH	Polynuclear aromatic hydrocarbons
PHS	Priority Habitats and Species
SEPA	State Environmental Policy Act
SSHIAP	Salmon and Steelhead Habitat Inventory and Assessment Program
Sub-basin	100 to 1000 acres
Sub-watershed	320 to 19200 acres
TIA	Total Impervious Area
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
TRPC	Thurston Regional Planning Council
USDA	US Department of Agriculture
USGS	US Geological Survey
WAC	Washington Administrative Code
WADNR	Washington Department of Natural Resources
Watershed	19,200 to 320,000 acres
WDFW	Washington State Department of Fish and Wildlife
WRIA	Water Resource Inventory Area as defined in Chapter 173-500 WAC
WWHM	Western Washington Hydrologic Model
WWSMM	Western Washington Stormwater Management Manual

INTRODUCTION

This document was originally developed by Gersib et al. (2004), currently with the Washington State Department of Transportation. Thurston County staff has updated the methods in 2006 and 2008 to better reflect the needs of local government. This report summarizes a scientific framework for watershed characterization and describes a set of methods developed at the watershed scale to assist in better land use decisions. As a conceptual framework, this document serves as the key deliverable to Puget Sound Partnership (formally Puget Sound Action Team) and Thurston County summarizing watershed characterization methods and developing key recommendations that other County departments, local jurisdictions, and other entities may use to help meet current and future environmental assessment and planning needs.

Watershed based methods will be most effective when the approach is driven by landscape need and condition rather than an individual site needs. These methods will help to refine and provide new data to meet the needs of the Clean Water Act (CWA), Safe Drinking Water Act (SDWA), Endangered Species Act (ESA), Shoreline Management Act (SMA), and Critical Area Ordinance updates. It represents a transition from a site-driven to landscape-driven approach to assessing current ecological processes of the watershed.

Despite dramatic increases in effort, legal mandates, and expenditures for environmental protection and restoration over the past 20 years, the overall condition of natural ecosystems continues to decline (Karr 1995, Montgomery et al. 1995). A growing body of work indicates that declines in ecosystem integrity are perpetuated by existing policies and traditional techniques that tend to treat local symptoms of resource degradation and fail to address the root biological and physical causes of ecosystem degradation and population decline. These policy and traditional techniques perpetuate a narrow "site" review and analysis that often results in restoration that treat symptoms of localized habitat/resource degradation rather than addressing the systemic causes of ecosystem degradation (Frissell 1996, Angermeier and Schlosser 1995, Montgomery et al. 1995, Reeves et al. 1995, Ebersole et al. 1997).

Thurston County was designated a National Pollutant Discharge Elimination (NPDES) Phase II jurisdiction in 2000 census. Thurston County submitted a NPDES Phase II permit to Ecology in March 2003. With the issuance of the NPDES Permit for Phase II communities in February 2007, Thurston County determined that a more holistic approach was needed to incorporate all the required regulations at the watershed level to promote efficiency in monitoring, analyzing, and reporting on the health of our water bodies. Current government efforts are segmented and have not proven to provide protection to Thurston County's streams and the Puget Sound.

This study process provides substantial opportunity to blend developing watershed approaches with new modeling and assessment tools to develop outcome-based approaches that Thurston County Water and Waste Management, Long Range Planning, Roads and Transportation Services, to make better land use decisions and management.

The Need for a Watershed Approach

A conventional site-specific approach to environmental protection and recovery has failed to stem the decline in water quality, base flow, fish and wildlife habitat at landscape scales. Despite the expenditure of hundreds of millions of dollars on required mitigation and voluntary recovery efforts, Puget Sound continues to decline in health.

Clearly, the scale of assessment is not the only factor in this decline, but it appears to be a key one. There is a growing awareness that the scale of assessment needs to, at least initially, match the scale of the problem (Naiman et al. 1992, Doppelt et al. 1993, Montgomery 1995, Frissell and Doppelt 1996). If water quality problems are associated with one identifiable point-source, then a site-specific scale of assessment is appropriate. However, if water quality problems are associated with many non-point sources of pollutants distributed throughout a watershed, then a watershed-scale assessment is needed to identify, understand, and prioritize management options.

Natural systems are complex. Understanding cause and effect relationships within a very complex natural system will be key to realizing measurable success in creating natural resource management plans that protect the natural resources and lend to the identification of potential environmental recovery sites. Discerning how present, past, and future land use affects physical elements of landscape pattern formation and maintenance will be an essential part of understanding cause and effect relationships and identifying core environmental problems, as well as opportunities. Navigating through this complex web of human land use impacts and associated symptoms of environmental degradation will require watershed tools that help us understand the interrelated nature of natural systems (Gersib et al 2004).

Guiding Principles

The following guiding principles serve as the fundamental building blocks on which landscape-scale assessment methods are developed. All of the guiding principles listed below have an established policy and/or technical rationale. As other watersheds within Thurston County are characterized, many of the rules and assumptions could be changed to better reflect the watershed being studied.

Major initiatives intended to aid in the recovery of salmon stocks listed as “threatened” or “endangered” under the ESA and to restore polluted water bodies in the Pacific Northwest have embraced watershed-scale planning and implementation. Further, stormwater management efforts are now beginning to explore the applicability of watershed assessment tools.

Indian Tribes of the State of Washington are guaranteed the right to protection of the fish habitat within their Usual and Accustomed Areas (Orrick Decision). Development impacts to fish habitat and all associated management plans will result in consultation with the appropriate Tribe or Tribes to ensure that no net loss of the Tribal Usual and Accustomed Area will occur.

Watershed characterization efforts seek to use landscape-scale planning and analysis to maximize environmental, social, and economic benefits of natural resource and environmentally sensitive area management plans.

Watershed characterization will help ensure that Tribal concerns regarding fish habitats are identified. Watershed characterization seeks to understand human effects on ecological processes that create and maintain the unique structure elements (habitat) that support all aquatic and terrestrial wildlife species.

Any analyses of watershed conditions need to assess the variability of watershed functions and characteristics over time and space (Euphrat and Warkentin 1994). Communities and landscapes form the ecological and evolutionary context for populations and species; preserving integrity at a landscape-scale is critical to species persistence (Angermeier and Schlosser 1995). Watershed characterization seeks to better understand the effect of human land use on ecological processes at different spatial and temporal scales.

Establishment of Technical Team

Understanding the cumulative effects of land use impacts on ecological processes at landscape scales requires expertise in hydrology, hydrogeology, ecology, biology, and many other scientific disciplines (Reid 1993). This dictates the formation of a technical team that works together to develop an interdisciplinary understanding of watershed processes. To meet this need, an interdisciplinary technical team should be formed consisting of a hydrologist, hydrogeologist, ecologist, biologist, and water quality specialist. Essential technical support from a GIS analyst and GIS technician is also required. The technical team will be responsible for conducting the watershed characterization, with regular input from all stakeholders during the process. It is Thurston County's goal to work jointly with all regulatory agencies to ensure a successful application of a watershed based approach to clean water efforts.

Local Watershed Coordination between Government Agencies

The Cities of Olympia, Lacey, and Tumwater, as well as the Squaxin, Nisqually, and Chehalis tribes, share natural resource management responsibilities within Thurston County. Successful management at the landscape scale will require the coordination of responsible local and tribal governments. While the methods described are to be developed for Thurston County, our goal is to provide the data to all stakeholders to be considered in their management decisions, where appropriate.

Local watershed planning efforts are considered to be a fundamental mechanism for natural resource and environmentally sensitive area management. Watershed councils and planning groups bring stakeholders together to develop plans that consider all local interests and concerns. For this reason, local planning initiatives are assumed to be most effective at understanding and addressing the needs and priorities of local residents and the natural resources on which they depend. Local watershed planning groups often acquire and compile local or regional data sets that can be of substantial value to watershed characterization efforts.

Thurston County was an active participant in Watershed Resource Inventory Areas (WRIA) planning efforts under Engrossed Substitute House Bill (ESHB) 2515, as well as ongoing Salmon Recovery Efforts under ESHB 2496. Incorporating the results of local watershed planning efforts at the earliest stages of environmental planning creates additional opportunities for the collection of locally developed data that are needed for watershed characterization. Watershed characterization assists local governments in achieving watershed management goals and objectives.

General Framework for Watershed Characterization

1. Define appropriate spatial scales to be used in watershed characterization;
2. Compile land use/land cover information for pre-development and current conditions and estimate the type and extent of future growth/development;
3. Develop an understanding of the ecological processes within drainages occurring in the area, identify key drivers for those processes, and begin to understand how past and present land use has altered processes and disturbance regimes;
4. Assess landscape sensitivity to process alteration and identify areas most sensitive and most resistant to development;
5. Characterize the general condition of ecological processes within the largest acceptable landscape scale;
6. Identify landscape areas having specific levels of degradation to targeted ecological processes under current conditions;
7. Assess the probability that processes within target landscape areas will be maintained over the long-term using the future build-out scenario; and
8. This framework employs and adapts the five-step strategy outlined by Beechie and Bolton (1999). A complete, detailed scientific framework for watershed characterization is presented in this document.

See Figure 1 which outlines the process of conducting a watershed characterization

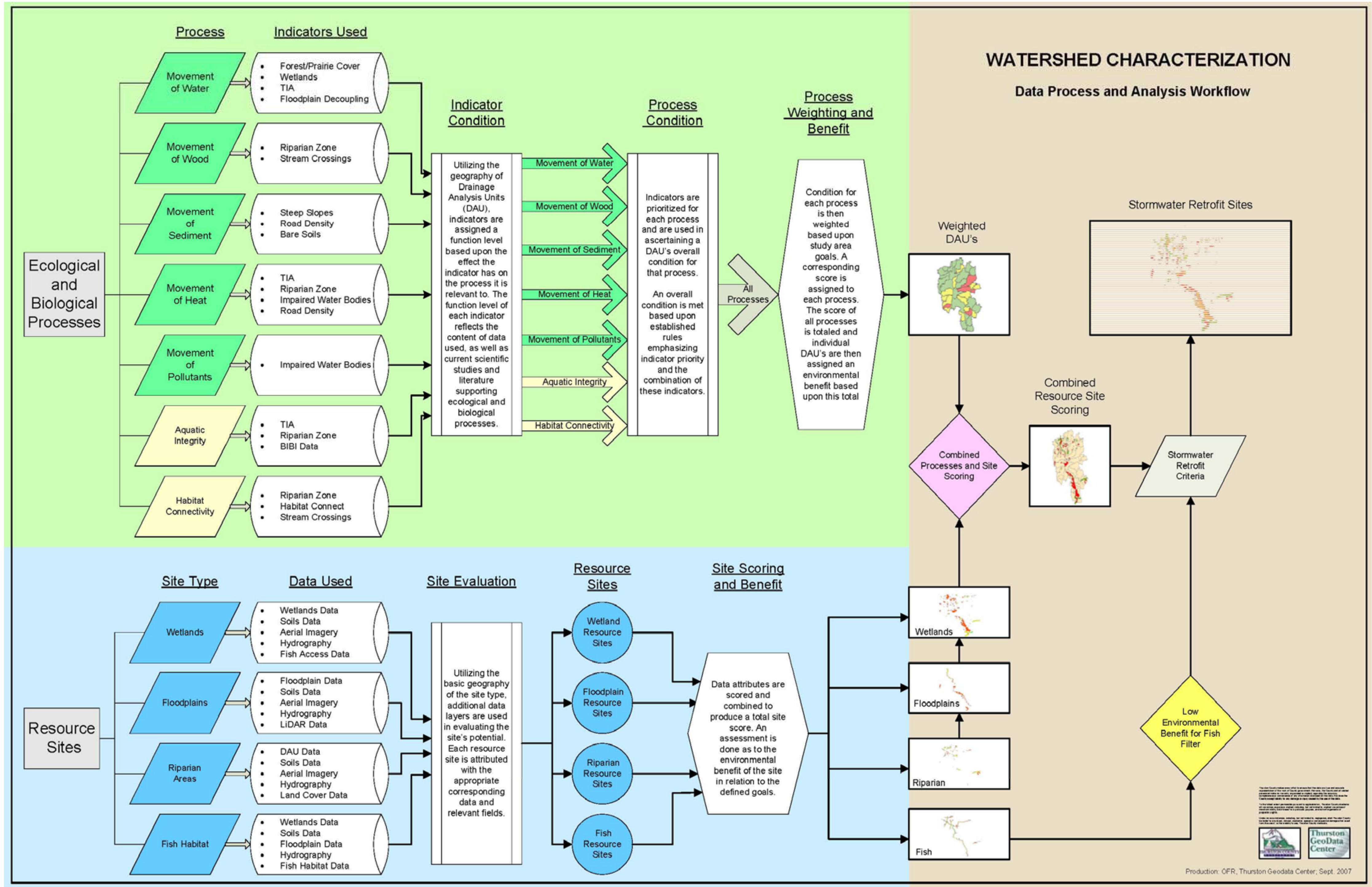


Figure 1. Process flowchart

PART I. LANDSCAPE CHARACTERIZATION

The Approach

This first step seeks to characterize the effects of human land use on ecological and biological processes within the basin area. The ecological and biological processes focused on in this work include:

Physical processes:

- Delivery and routing of water
- Delivery and routing of sediment
- Delivery and routing of nutrients/toxicants/bacteria
- Delivery and routing of large wood
- Delivery and routing of heat

Biological processes:

- Aquatic integrity
- Upland habitat connectivity

The alteration of these core ecological processes (or pathways) by human land uses result in a change in physical structure or biological elements that will, in turn, result in a change in how a site functions. Many ecological processes operate over large spatial and temporal scales. To address core problems that often exist miles from the site where functions are degraded, it is imperative that protection efforts focus on reversing the effects of human land use on ecological processes.

The watershed characterization approach seeks to better understand the relationship between land use change and the resulting change in ecological processes. This approach also seeks to understand the relationship between a change in ecological processes and the resulting change in site functions.

Step 1. Establish Spatial Scales of Analysis

Purpose

Omernik (1995) has developed a hierarchically based tool to stratify the landscape into more homogeneous units. Ecology (R. Gersib, personal communication, as cited in Gersib et al., 2004) has used the fourth level eco-regions developed by Omernik to assist in characterizing wetland resources in the Nooksack River Basin in northwestern Washington State. These tools are used in creation of some spatial layers. Step 1 primarily establishes the necessary spatial data layers for watershed characterization: assessment and analysis. It also establishes the necessary spatial data layers for the assessment and analysis of shoreline regions within the characterized watershed.

Step 1A. Establish Study Area

Definition

The study area is the sum of all the sub-watersheds that fall within the watershed to be characterized.

Purpose

To create a spatial layer that will represent the boundaries of the study area.

Methods

1. The study area is established through a GIS process of displaying the drainage areas data layer and dissolving all interior polygons.

Data Needs

Sub-watersheds data layer.

Product

A GIS data layer of the study area.

Step 1B. Establish Drainage Analysis Units Areas

Definition

The study area is divided into manageable units for characterization. Drainage analysis units (DAU)s are developed based on the needs of the study. Table 1 provides guidance on the minimize size of the DAU. For this study, the 0.25 square mile DAU scale was used. This scale was used because one of the main focuses of this study was stormwater retrofits using natural resource sites (wetlands, riparian, and floodplain restoration).

Purpose

The DAU scale has potential for assessing direct impacts and cumulative impacts of existing and future land uses. This scale was established using the Center for Watershed Protection guidance, and the need to assess and address storm water impacts on an individual stream basis. Second, the DAU scale is the fundamental spatial scale for characterizing the condition of larger spatial scales.

Methods

1. Acquire Digital Elevation Model (DEM) data of the study area.
2. Establish scale for assessment and planning needs. Use Table 1 as guidance.
3. Use the automated DEM analysis to develop drainage boundaries.

Table 1: Description of the Various Watershed Management Units

Watershed Management Unit	Typical Area (square miles)	Influence of Impervious Cover	Sample Management Measures
Catchment (Drainage Analysis Unit (DAU))	0.05 to 0.5 32 to 320 acres	very strong	stormwater management and site design
Sub-watershed	0.5 to 30 320 to 19,200 acres	strong	stream classification and management
Watershed	30 to 100 19,200 to 320,000	moderate	watershed-based zoning
Sub-basin	100 to 1,000	weak	basin planning
Basin	1,000 to 10,000	very weak	basin planning

Zielinski, Center for Watershed Protection, 2002

Data Needs

1. DEM data
2. Topographic data

Product

1. A GIS data layer of DAUs within the study area.

Step 1C. Establish Watershed Areas.

Definition

Watershed is the catchment area of a stream or streams comprising 20 to 50 square miles and equivalent to a Washington Department of Natural Resources (WADNR) Watershed Administrative Unit ("WAU") or US Geological Survey 5th field Hydrologic Unit Code ("HUC"). The Center for Watershed Protection Institute (Zielinski 2002 has defined a watershed to be 30 to 100 square miles (see Table 1). This methods document utilizes the definitions in Table 1.

Purpose

Establish a spatial scale for analysis of potential restoration and preservation sites. The goal is to analyze the appropriate scale to address the needs of the watershed characterization.

Methods

1. Identify and acquire available spatial data from local, state, tribal, and federal sources.

   Use Table 1 as a guideline to the scale(s) to be analyzed.

Data Needs

1. Available local, state, tribal, and federal spatial data.

Product

2. The GIS data layer of the spatial scales to be analyzed.

Step 1D. Establish Lithotopo Units

Definition

Lithotopo Unit is that part of the study area having a common 4th level eco-region and surficial geology as the project area. Lithotopo units were not used in this study.

Purpose

Compared to surface water catchment based spatial scales, lithotopo units are geology/ topography based means of stratifying the landscape. Because of this difference, it is assumed that lithotopo units have potential to increase success in the in-kind replacement of functions needed to compensate for past development of the landscape.

The Environmental Protection Agency (EPA) has completed a 4th level eco-region data layer for much of the United States. Montgomery (1999) uses the term lithotopo units to define finer-scale areas with similar topography and geology, within which similar suites of geomorphic processes influence gross habitat characteristics and dynamics. Further, unpublished data on watershed-scale wetland restoration assessment and planning in the Nooksack Basin, Washington (R. Gersib personal communication, as cited in Gersib et al., 2004) indicate that the stratification of 4th level eco-regions by surficial geology appears to substantially reduce variability in wetland size, hydrogeomorphic class, and functions provided. Lithotopo unit area was chosen as an experimental spatial scale that will be evaluated throughout watershed characterization methods development.

Methods

1. Acquire Levels III and IV eco-regions data layer from the EPA Spatial Data Library System.
2. Clip ecoregions data layer to the boundary of the study area.
3. Subdivide the study area level IV eco-regions.
4. Overlay the Level IV ecoregions and geology onto the project sub-watershed.
5. Refine the 1:250,000 Level IV eco-region boundaries based on 1:100,000 geology units.
6. Use surficial geology units to further subdivide Level IV ecoregions.
7. Each polygon represents a lithotopo unit. Name each mapping unit and create that lithotopo data layer.

Data Needs

1. EPA 4th level ecoregion GIS data layer
2. Surficial geology

Product

1. A GIS data layer of the lithotopo units within the study area.

Step 2. Establish Temporal Scales of Analysis

Cumulative impact assessment and an assessment of water quality loading rates under a build-out scenario require multiple temporal scales. Pre-development and current land use conditions are needed to assess cumulative impacts. Current and future build-out conditions are needed to understand potential future cumulative impacts in a build-out scenario and assess the potential for the watershed to maintain its essential ecosystem processes and functions over time, including those unique to the shoreline regions of the watershed.

Step 2A. Create a Pre-Development Data Layer

Purpose

A pre-development land use data layer is the reference point for assessing the current and future state of natural resources. In turn, an assessment of landscape condition requires an understanding of the extent of change in ecological processes from a pre-development to present and future land use conditions.

Methods

1. Acquire available data on the pre-development land cover condition of the study area.
2. Access General Land Office (GLO) data from the Washington State Department of Natural Resources website and compile land cover vegetation information GLO vegetation data include tree/shrub species and tree/shrub diameter breast height (DBH) for each section corner, and each half- and quarter-mile section line. For small areas, all vegetation data should be compiled and entered in a spreadsheet. For larger areas, a sample of vegetation data by geologic unit can be compiled.
3. Develop a database that groups diameter at breast height (DBH) size into 1-12 inch, 13-24 inch, 24-36 inch, and greater than 36 inch.
4. Compile available historic maps of stream systems and when available add to the pre-development land cover data layer.
5. For predevelopment grassland areas, follow the same process using grassland communities.

Data Needs

1. Available pre-development land cover data for the watershed.

Product

1. A narrative characterization or GIS data layer of pre-development land cover.

Step 2B. Select a Current Land Use/Land Cover Data layer

Purpose

Current land use/land cover data are used in two ways. First, this data set is used with the pre-development data layer to gain perspective on the extent of change in land cover. Second, this data layer is used to calculate key landscape attributes used to characterize the extent of alteration in the five ecological processes.

Methods

1. Contact local, state, federal, and tribal sources of land use/land cover data to determine available data options for the study area.
2. Select the most current land use/land cover data set. Thurston County used 2005 SPOT imagery.

Data Needs

1. Current land use/land cover data.

Product

1. A GIS data layer of current land use/land cover.

Step 2C. Create a Future Build-Out Land Use Data layer

Purpose

Future build-out data will be used to assess the natural resource sites ability to maintain long-term success if restored.

Methods

1. Compile comprehensive plans from local jurisdictions in the study area. Use plans developed under the Growth Management Act to determine future land-use. Thurston County is developing a method to calculate future build-out using alternative methods to GMA future zoning. Much of Thurston County was short platted in the late 1800s and early 1900s, especially around the shorelines. This includes the marine, river, and lake shoreline areas.

Data Needs

1. Current land cover.
2. GIS data layers for all local comprehensive plans.

Product

1. A GIS data layer of future build-out land use.

Step 2D. Estimate Total Impervious Area for Existing and Future Build-Out Conditions

Purpose

Total Impervious Area (TIA) is used in watershed characterization to describe the degree of hydrologic alteration within drainage basins. It is defined as the percentage of land within an area that is impervious to water, and includes rooftops, paved surfaces, and compacted earth. TIA is derived from land use/land cover data, and is a key indicator of ecological condition.

Methods

1. Estimate TIA within each drainage basin for existing conditions. Currently, Thurston County has 10 meter satellite data that will be used to determine TIA. TIA values for land cover categories can then be assigned based on relationships described by Booth and Jackson (1997), Azous and Horner (1997), and Booth et al. (2001), a shown in Table 2.
2. Estimate TIA for future build-out land use. TIA can then be estimated using literature-derived values for common land use classes, as shown in Table 3.

Table 2. Total Impervious Area values for land cover categories.

Land Cover Class	% TIA	Source
Forested (deciduous, coniferous, mixed)	3	Booth et al. (2001)
Grass, pasture, bare earth, recent clear cuts, scrub/shrub, herbaceous	5	Booth et al. (2001)
Mixed urban/low density (assumed to be equivalent to suburban)	35	Booth and Jackson (1997)
Urban/high density (assumed to include commercial, industrial, office space, high density residential)	75	Midpoint of range from Azous and Horner (1997)

Although open water is often treated as impervious in hydrologic modeling, we assign it a TIA value of 0 to reflect our use of TIA as a surrogate for developed area.

Table 3. Total Impervious Area estimates for common land use classes.

Land Use	% TIA	Source
Agricultural	5	Azous and Horner (1997)
Commercial, light industrial, downtown	75	Midpoint of range from Azous and Horner (1997)
Forestry, forested open space	3	Booth et al. (2001)
Industrial	80	Azous and Horner (1997)
Mining	80	Azous and Horner (1997) value for industrial
Schools, parks, golf courses, non-forested open space	5	Booth et al. (2001) value for grasses and shrubs
Residential High (>10 dwelling unit/acre)	60	Booth and Jackson (1997)
Residential Medium (1 to 10 dwelling units /acre)	35	Booth and Jackson (1997)
Residential Low (<1 dwelling unit /acre)	10	Booth and Jackson (1997)

Table 4. Total Impervious Area estimates for common land use classes.

Land Cover Type	% Impervious	Source
Agriculture	0	Karr 1998
Forest	5	Karr 1998
Grasslands	5	Karr 1998
Transitional	10	Karr 1998
Dirt Road	15	Karr 1998
Light Intensity Residential	30	Karr 1998
High Intensity Residential	44	Karr 1998
Commercial/Industrial	80	Karr 1998
Transportation	50	Karr 1998

Data Needs

1. Existing land use/land cover.
2. Future land use/land cover

Products

1. TIA within each DAU for existing conditions
2. TIA within each DAU for future build-out conditions

PART II. CHARACTERIZE CONDITION OF ECOLOGICAL AND BIOLOGICAL PROCESSES IN STUDY AREA

Purpose

Methods that characterize the condition of important ecological and biological processes produce results that can be used to:

- Help understand the landscape-scale condition of and constraints on aquatic and terrestrial resources and fish and wildlife habitats
- Establish a landscape context for assessing restoration options and alternatives
- Help identify where landscape-scale indicators of natural resource degradation exist at multiple scales, further providing context for understanding project impacts and restoration opportunities
- Help understand core problems that influence a site's capability to provide and maintain functions
- Establish the condition of habitat connectivity within stream basins.

Methods

1. Use appropriate landscape scale information in the analysis to determine the condition ("properly functioning," "at risk," or "not properly functioning") of ecological processes (such as delivery and routing of water, sediment, pollutants, large wood, and heat) and biological processes (aquatic integrity and upland habitat connectivity).
2. Characterize the condition of selected landscape attributes for each key ecological and biological process. Characterization work should occur at the DAU scale, unless justification exists and is documented.
3. The following text is derived from the Table 7 that details the landscape attributes and conditions appropriate for the analysis.

Delivery of Water

- Calculate percent TIA for each DAU. Assign a condition of "properly functioning," "at risk," or "not properly functioning" for this landscape indicator using criteria provided in Table 7.
- Calculate percent forest and prairie land cover for each DAU. Assign a condition of "properly functioning," "at risk," or "not properly functioning" for this landscape indicator using criteria provided in Table 7.
- Determine the condition and extent of wetlands within each DAU. Calculate percent of wetlands hydrologically altered (drained or filled) within each DAU where wetlands represent five percent of more of the drainage basin. Assign a condition of "properly functioning," "at risk," or "not properly functioning" for this landscape indicator using criteria provided in Table 7.

- Calculate percent change in drainage network for each DAU. The hydrologist on the technical team evaluates available data to determine the best attributes for assessing this landscape indicator. Examples of land uses that increase the drainage network include wetland drainage, floodplain drainage ditches, storm drains, and roadside ditches. Assign a condition of "properly functioning," "at risk," or "not properly functioning" for this landscape indicator using criteria provided in Table 7.
- When appropriate, use the Rain on Snow Zone data available through WDNR. Assign a condition of "properly functioning," "at risk," or "not properly functioning" for this landscape indicator using criteria provided in Table 7.

Routing of Water

- Calculate percent channel length straightened for each DAU. Overlay hydrography datasets onto the drainage basin coverage and visually identify stream reaches that have potentially been straightened. Highlight potentially straightened stream reaches, overlay land use/land cover, and identify potentially straightened stream reaches with native vegetation and those with altered vegetation. Stream reaches with native vegetation should be assumed to have a natural stream configuration and were eliminated from further consideration. Stream reaches with agricultural, high density residential, or commercial/industrial land uses should be assumed to have an artificially straightened stream reach. Use aerial photography to support decision-making when uncertainty exists. Use GIS tools to calculate the percentage of stream channel that has been straightened. Assign a condition of "properly functioning," "at risk," or "not properly functioning" for this landscape indicator using criteria provided in Table 7.
- Calculate percent of floodplain decoupled from the river channel for each DAU. Acquire available data on the location and extent of floodplain dikes and levees. Develop a GIS dataset that identifies that part of the floodplain that lies behind dikes and levees and has reduced opportunity to store and desynchronize flood flows and sediment. Use GIS tools to calculate the percentage of floodplain area decoupled. Assign a condition of "properly functioning," "at risk," or "not properly functioning" for this landscape indicator using criteria provided in Table 7.

Delivery of Sediment

- Calculate percent bare soil areas in long-term agricultural and forestry designated lands for each DAU. Urban areas are not included in the analysis of sediment transport because they have best management practices in place and are typically paved shortly after disturbance. A primary source of fine sediment in the Puget Lowland is assumed to be un-vegetated or disturbed soil areas. Evaluate available land use/land cover datasets and identify land uses that are considered to have bare or disturbed soils. In general, all agricultural areas, including fallow, orchards / vineyards, pasture, row crops, and small grain crops are assumed to meet these criteria. Previous clear cut areas are also assumed to have the potential to deliver sediment to streams until the stands are established. Use GIS tools to calculate the percentage of bare soil areas within each DAU, sub-watershed, and watershed. Assign a condition of "properly functioning," "at risk," or "not properly functioning" for this landscape indicator using criteria provided in Table 7.

- Calculate road density (road miles per square mile) for each drainage basin. Assign a condition of "properly functioning," "at risk," or "not properly functioning" for this landscape indicator using criteria provided in Table 7.
- Refer to previously calculated results for percent channel length straightened and percent floodplain decoupled from a stream.
- Calculate the percent of unstable slopes in each DAU. Assign a condition of "properly functioning," "at risk," or "not properly functioning" for this landscape indicator using criteria provided in Table 7.

Delivery and Routing of Nutrients and Toxicants

- Determine the number of 303(d) listed water bodies for each drainage basin. Because of the potential of limited ambient monitoring data, this landscape indicator should be used with caution. This information is excellent at indicating what sub-watersheds are "not properly functioning." However, many streams do not have ambient monitoring data and we can't assume that streams without data are "properly functioning." If 303(d) data is limited for the study area, it should not be used as an indicator of condition for this ecological process. When adequate information is available, assign a condition of "properly functioning," "at risk," or "not properly functioning" for this landscape indicator using criteria provided in Table 7.

Delivery of Large Wood

- Determine the percent of 67 meter riparian zone in mature forest for each drainage basin. Assign a condition of "properly functioning," "at risk," or "not properly functioning" for this landscape indicator using criteria provided in Table 7.

Routing of Large Wood

- Determine the average number of stream crossings per kilometer of stream for each analysis unit. Assign a condition of "properly functioning," "at risk," or "not properly functioning" for this landscape indicator using criteria provided in Table 7.
- Using available data, determine the average stream bed width and size of crossing, including the number of piers in the active channel. Assign a condition of "properly functioning," "at risk," or "not properly functioning" for this landscape indicator using criteria provided in Table 7.

Delivery and Routing of Heat

- Refer to previously calculated results for 303(d) listed water bodies, percent of 67 meter riparian zone in mature canopy, road density, and percent TIA.

Aquatic Integrity

- Plot and evaluate available Benthic - Index of Biological Integrity (B-IBI) scores within the study area.
- Use previously calculated condition results of percent riparian area in forest land cover by drainage basin.
- Use previously calculated condition results of percent total impervious area by DAU.

Snyder et al. (2003) synthesized results of existing studies relating to the influence of upland and riparian land use patterns on stream biotic integrity. This paper notes that in studies where scale influences were tested, whole catchment land use patterns were found to be better predictors of stream biological integrity in some studies, while others suggest riparian land use patterns were more influential. This information was used to support the use of both percent riparian area in forest land cover and percent total impervious area as landscape attributes for aquatic integrity.

Booth and others (2001) suggest that biological measures provide better information about environmental quality than chemical or physical measures because biological measures are one step closer to the factors that constitute environmental quality for living things. As a result of this work, B-IBI data were compiled and used when available, with best professional judgment, to modify the final condition rank of each drainage basin for aquatic integrity. Table 5 shows criteria for assigning aquatic integrity condition rank to drainage basins.

Table 5. Criteria for Assigning Aquatic Integrity Condition Rank to Drainage Basins.

Attribute	Attribute Priority	Condition Rank
Benthic – Index of Biological Integrity	Primary	Scores of: 10-22 – Not Properly Functioning 24-40 – At Risk 42-50 – Properly Functioning
Percent Riparian Area in Forest	Secondary	As noted in Table 7
Percent Total Impervious Area	Secondary	As noted in Table 7

Habitat Connectivity

- Clip the satellite derived land cover data to the sub-watershed boundaries
- In raster format, create a layer of forest, non-forest and water classifications from the satellite imagery, labeled per stream catchment. Forest and water are defined in Hill et al. (2003), and all other classifications will be referred to as non-forested. Grain size should be appropriate for the precision of the imagery and the size of the study area.
- Under an 8-neighbor rule, to encompass the most area per patch and include riparian systems, run FRAGSTATS with the metrics found in Table 7:

Table 6. FRAGSTATS-calculated landscape metrics used for this project.

Metric	Name	Description
AREA	Area	Area of each patch (ha)
CA	Class Area	Total class area within a landscape (ha)
TA	Total Area	Total landscape area (ha)
PLAND	Percent of Landscape	Percentage of landscape in class (%)
GYRATE_AM	Area-weighted Mean Radius of Gyration	The area-weighted mean radius of gyration, correlation length, the average distance traversed from a random starting point in a random direction with in a landscape, its traversability.
COHESION	Patch Cohesion Index	Physical connectedness of patches in a class, approaches 0 as class becomes less aggregated (comparative value)

- Use FRAGSTATS to calculate the total forested area per stream catchment. This creates an approximation of habitat condition and forested area within the study area and individual stream catchments.
- Rank the stream catchments by PLAND value, weighted by GYRATE_AM, and compare it to the COHESION index.

    Properly functioning -- Catchments with a COHESION index > 90% and a PLAND > 41%

    At risk -- Catchments with greater than 90 % COHESION but a PLAND of < 41 %

    Not properly functioning -- All other catchments, below 90 % COHESION are catchments with a large GYRATE_AM score that are near either border of the "at risk" category should be assessed individually, and reassigned if appropriate. This creates a baseline rating of habitat connectivity for each DAU.

Table 7. Matrix of Landscape-scale Pathways and Indicators.

Ecological Process	Landscape Indicator	Effect	Properly Functioning	At Risk	Not Properly Functioning
Delivery of Water to a Stream System	1) Percent change in Drainage Network [i]	Reduces Delivery Time; Habitat Degradation	Zero or minimal increases (<5%) in drainage network density due to development	Moderate increases (5% to 20%) in drainage network density due to development	Substantial increase (>20%) in drainage network density due to development
	2) Percent TIA [ii]	Reduces Delivery Time; Increases Amount of Water Delivered; Habitat Degradation	10% or less TIA	>10% and <25% total imperious area	≥25% TIA
	3) Percent Forest Land Cover and/or prairie cover[iii]	Reduces Delivery Time; Increases Amount of Water Delivered; Habitat Degradation	>65% of area in hydrologically mature forested land cover or native prairie	50% to 65% of area in hydrologically mature forested land cover or native prairie	<50% in hydrologically mature forested land cover or native prairie
	4) Condition and Extent of Wetland Resources [iv]	Loss of assimilative capacity	>95% of all historic connecting wetland capacity present and unaltered	70-95% of historic connecting wetland capacity present and unaltered	<70% of historic connecting wetland capacity present and unaltered
Routing of Water Through a Stream System	5) Percent of Stream Channel Length Straightened	Reduced Routing Time; Habitat Degradation	Zero or minimal increases (<5%) of natural drainage network straightened	Moderate increases (5% to 20%) in natural drainage network straightening	Substantial increase (>20%) in drainage network straightening
	6) Percent of Flood-plain Decoupled from Stream [v]	Reduced Routing Time; Habitat Degradation	Zero or minimal increases (<5%) in decoupled flood-plain	Moderate increases (5% to 40%) in decoupled flood-plain	Substantial increase (>40%) in decoupled flood-plain
Delivery of Sediment to a Stream System	7) Percent of Bare Soil Areas in agricultural and forest Areas	Increased Fine Sediment Inputs; Habitat Degradation	<5% of area in land uses having bare soils	5-15% of area in land uses having bare soils	>15% of area in land uses having bare soils
	8) Road Density [vi]	Increased Fine and Coarse Sediment Inputs; Habitat Degradation	Road densities < 2 miles/square mile	Road densities of 2-3 miles/square mile	Road densities > 3 miles/square mile
	9) Unstable Slopes	Increased Inputs of Fine and Course Sediment	≥5% of DAU in > 30 percent slope and <10 percent of high slope area in non-forest land cover	≥5% of DAU in > 30 percent slope and ≥10%< 25% of high slope area in non-forest land cover	≥5% of DAU in > 30 percent slope and ≥25% of high slope area in non-forest land cover
Routing of Sediment Through a Stream System	10) Percent of Stream Channel Length Straightened	Reduced Routing Time; Habitat Degradation	Zero or minimal increases (<5%) of natural drainage network straightened	Moderate increases (5% to 20%) in natural drainage network straightening	Substantial increase (>20%) in drainage network straightening
	11) Percent of Flood-plain Decoupled from Stream [vii]	Reduced Routing Time; Reduced Access to Habitat	Zero or minimal increases (<5%) in decoupled flood-plain	Moderate increases (5% to 40%) in decoupled flood-plain	Substantial increase (>40%) in decoupled flood-plain
Delivery and Routing of Nutrients, Toxicant, and Bacteria to a Stream System	12) Extent of 303(d) Listed Water Bodies for Nutrients, Toxicants, and Bacteria [viii]	Documented Water Quality Problem	Water quality in the stream meets water quality standards for all parameters. No excess nutrients or toxicity.	Water quality in the stream has one parameter that exceeds water quality criteria by 10 percent or greater	More than one parameter exceeds water quality criteria by 10 percent or greater.
	13) Condition and	Loss of assimilative	Historic wetland area	Historic wetland area 25%	Historic wetland area

Ecological Process	Landscape Indicator	Effect	Properly Functioning	At Risk	Not Properly Functioning
	Extent of Wetlands [ix]	capacity	>5% and <25% of wetlands have been drained or hydrologically altered	to 40% of wetlands have been drained or hydrologically altered	>40% of wetlands have been drained or hydrologically altered
Delivery of Large Wood to a Stream System	14) Percent of 67 meter Riparian Zone in Mature Condition [x]	Source of Large Wood to the Stream System; Habitat Degradation	85% of overall riparian zone in forest or wetland cover	50-85% of overall riparian zone in forest or wetland cover	<50% of overall riparian zone in forest or wetland cover
Routing of Large Wood Through a Stream System	15) Stream Crossings/Kilometer [xi]	Blocks Routing of Large Wood and Facilitates Removal from System; Habitat Degradation	< 2 –stream crossings per kilometer of stream and ratio of culvert width to channel width is >1	2 to 4 stream crossings per kilometer of stream and ratio of culvert width to channel width is 0.5 to 1	> 4 stream crossings per kilometer of stream and ratio of culvert width to channel width is <0.5
Delivery and Routing of Heat to a Stream System	16) Extent of 303(d) Listed Water Bodies for Temperature [xii]	Identifies Problem Areas but Does Not Address Causes; Habitat Degradation	Area meets water quality standards for temperature	One parameter that exceeds temperature criteria 10 percent or more of the time	More than one parameter exceed temperature criteria 10 percent or more of the time
	17) Percent of 67 meter Riparian Zone with Mature Canopy [xiii]	Increase in Solar Energy to Stream; Habitat Degradation	85 percent or more of channel with riparian canopy intact and no large continuous stretches of open canopy	50 to 85 percent of riparian canopy intact but having some continuous stretches of open canopy	Riparian canopy fragmented, > 50 percent and contains large continuous stretches with no canopy
	18) Road Density [xiv]	Reduced Stream ; Habitat Degradation Depth	Road densities < 2 miles/square mile	Road densities of 2-3 miles/square mile	Road densities > 3 miles/square mile
	19) Percent TIA [xv]	Change in Groundwater Recharge/Discharge; Habitat Degradation	10% or less TIA	>10% and <25% total imperious area	≥25% TIA
Aquatic Integrity	20) Benthic – Index of Biological Integrity	Overall Habitat Condition	Benthic – Index of Biological Integrity score ≥42	Benthic – Index of Biological Integrity score of 24 to 40	Benthic – Index of Biological Integrity score < 24
	21) Percent of 67 meter Riparian Zone in Mature Condition [xvi]	Buffers Effects of Upland Disturbance	85% of overall riparian zone in forest or wetland cover	50-85 % of overall riparian zone in forest or wetland cover	<50% of overall riparian zone in forest or wetland cover
Upland Habitat Connectivity	22) Level of Habitat Connectivity	Risk of Habitat Isolation	Use methods described elsewhere using Fragstats	Use methods described elsewhere using Fragstats	Use methods described elsewhere using Fragstats
	23) Percent of 67 meter Riparian Zone in Mature Condition [xvii]	Buffers Effects of Upland Disturbance	85% of overall riparian zone in forest or wetland cover	50-85 % of overall riparian zone in forest or wetland cover	<50% of overall riparian zone in forest or wetland cover
	24) Road Density [xviii]	Reduced Stream ; Habitat Degradation Depth	Road densities < 2 miles/square mile	Road densities of 2-3 miles/square mile	Road densities > 3 miles/square mile

Tables 8 through 14 contain the rules and assumptions developed to complete the ranking of the five ecological and two biological processes. These assumptions are based on the goal of identifying sites that have the potential to mitigate past and future impacts from development.

Table 8. Rule Examples and Rule Assumptions Used to Establish an Overall Condition Rank for the Delivery and Routing of Water

Process	Indicator Priority	Landscape Indicator	Condition	Final Rank
Water	Primary	% TIA	When % TIA is PF and % forest/prairie cover are PF, and wetlands are not an indicator, the final rank is PF	PF
	Secondary	% Forest cover/Prairie cover	When % TIA is PF and % forest/prairie cover are AR or NPF, and wetlands are not an indicator, the final rank is AR	AR
	Tertiary	Condition/extent of wetlands when used as a landscape indicator. Assimilative capacity	When % TIA is AR and % forest/prairie cover is PF, and wetlands are not an indicator, the final rank is AR	AR
	Tertiary	% Floodplain decoupled from the channel	When % TIA is NPF and % forest/prairie cover is AR or NPF, and wetlands are not an indicator, the final rank is NPF	NPF
	Secondary (with complete infrastructure data)	% Change in the drainage network	When % TIA is PF, % forest/prairie cover is PF, and wetlands are PF, the final rank is PF	PF
			When % TIA is PF, % forest/prairie cover is PF, and wetlands are AR or NPF, the final rank is AR	AR
			When % TIA is AR, % forest/prairie cover is AR or NPF, wetlands are AR or NPF, and a large lake/wetland system existing in the drainage basin, the final rank is AR	AR
			When % TIA is NPF, % forest/prairie cover is AR or NPF, wetlands are AR or NPF, the final rank is NPF	NPF
			When % TIA is PF, % forest/prairie cover is AR or NPF, and wetlands are AR or NPF, the final rank is AR	AR
			When % TIA is AR, % forest/prairie cover is AR or NPF, wetlands are AR or NPF, the final rank is NPF	NPF
			When % TIA is AR, % forest/prairie cover is AR or NPF, wetlands are PF, the final rank is AR	AR
			When % TIA is AR and % forest/prairie cover is AR, and wetlands are not an indicator, the final rank is AR	AR

Table 9. Rule Examples and Rule Assumptions Used to Establish an Overall Condition Rank for the Delivery and Routing of Sediment

Process	Indicator Priority	Landscape Indicator	Condition	Final Rank
Sediment	Primary	% Bare soil	When road density and bare soils are PF and unstable slopes are either PF or not evaluated, the final rank is PF	PF
	Secondary	Unstable slopes	When two indicators are PF and one is AR, the final rank is AR	AR
	Secondary	Road density	When two indicators are PF and one is NPF, the final rank is AR	AR
			When road density is NPF, bare soils are either PF or AR, and unstable slopes is not an indicator, the final rank is AR	AR
			When any combination of indicators has a different condition rank (i.e., PF, AR, and NPF), the final rank is AR	AR

Table 10. Rule Examples and Rule Assumptions Used to Establish an Overall Condition Rank for the Delivery and Routing of Wood

Process	Indicator Priority	Landscape Indicator	Condition	Final Rank
Wood	Primary	% of 67 m riparian zone in mature condition	When % riparian is PF, and stream crossings are PF, the final rank is PF	PF
	Secondary	Stream crossings/kilometer	When % riparian is PF, and stream crossings are AR, the final rank is AR	AR
			When % riparian is AR, and stream crossings are PF or AR, the final rank is AR	AR
			When % riparian is AR, and stream crossings are NPF, the final rank is NPF	NPF
			When % riparian is NPF, and stream crossings are either PF, AR or NPF, the final rank is NPF	NPF
			When % riparian is PF, and stream crossings are not an indicator, the final rank is PF	PF
			When % riparian is AR, and stream crossings are not an indicator, the final rank is AR	AR
			No riparian indicators	N/A

Table 11. Rule Examples and Rule Assumptions Used to Establish an Overall Condition Rank for the Delivery and Routing of Pollutants, Nutrients, and Bacteria

Process	Indicator Priority	Landscape Indicator	Condition	Final Rank
Pollutants, Nutrients, and Bacteria	Primary	CWA 303(d) list for toxicants (sub-lethal and lethal to fish)	If the stream is listed, then regardless of rank, the final rank will be AR because of the legal requirement to meet WQ standards	AR
	Secondary	CWA 303(d) list for bacteria	No Riparian Zone	N/A
	Secondary	CWA 303(d) list for nutrients		

Table 12. Rule Examples and Rule Assumptions Used to Establish an Overall Condition Rank for the Delivery and Routing of Heat

Process	Indicator Priority	Landscape Indicator	Condition	Final Rank
Heat	Primary	CWA 303(d) list for temperature	If the stream is listed, then regardless of rank, the final rank will be AR because of the legal requirement to meet WQ standards	AR
	Primary	% 67 meter riparian mature canopy	When % riparian is PF, road density is PF, %TIA is PF, the final rank is PF	PF
	Secondary	Road density	When % riparian is PF, and either road density or %TIA is AR or NPF, the final rank is AR	AR
	Secondary	%TIA	When % riparian is AR, and both road density and %TIA is either PF or AR, the final rank is AR	AR
			When % riparian is AR, and one of the two secondary indicators is NPF, with the other being PF or AR, the final rank is AR	AR
			When % riparian is AR, and both road density and %TIA is NPF, the final rank is NPF	NPF
			When % riparian is NPF, road density is PF or AR, %TIA is PF or AR, the final rank is AR	AR
			When % riparian is NPF, and either road density or %TIA is AR or NPF, the final rank is NPF	NPF
			When % riparian is NPF, and both road density and %TIA is NPF, the final rank is NPF	NPF
			No Riparian Zone	N/A

Table 13. Rule Examples and Rule Assumptions Used to Establish an Overall Condition Rank for Aquatic Integrity

Process	Indicator Priority	Landscape Indicator	Condition	Final Rank
Aquatic Integrity	Primary	B-IBI	When B-IBI score is PF, and both % riparian and %TIA are PF, the final rank is PF	PF
	Secondary	% 67 meter riparian forest cover	When B-IBI score is PF, and either or both % riparian and %TIA are AR, the final rank is AR	AR
	Secondary	%TIA (value either above 30 or below 30)	When B-IBI score is AR, and either or both % riparian and %TIA are PF or AR, the final rank is AR	AR
			When B-IBI score is AR, and % riparian is NPF and %TIA is either PF or AR, the final rank is AR	AR
			When B-IBI score is NPF, and either or both % riparian and %TIA are AR, the final rank is NPF	NPF
			When %TIA is NPF, % riparian is AR of NPF, and B-IBI is AR or NPF, the final rank is NPF	NPF
			No Riparian Zone	N/A
			No BIBI Data	N/A

Table 14. Rule Examples and Rule Assumptions Used to Establish an Overall Condition Rank for Habitat Connectivity

Process	Indicator Priority	Landscape Indicator	Condition	Final Rank
Habitat Connectivity	Primary	FRAGSTATS Metrics	When metrics, % riparian and road crossings are PF, the final rank is PF	PF
	Secondary	% 67 meter riparian forest cover	When metrics are PF, and % riparian is PF, and road crossings are AR, the final rank is PF	PF
	Tertiary	Road crossings	When metrics are PF, with no riparian zone, and road crossings are PF, the final rank is PF	PF
			When metrics are PF, and % riparian is AR, and road crossings are PF or AR, the final rank is AR	AR
			When metrics are PF, and % riparian is NPF, and road crossings are PF or AR, the final rank is AR	AR
			When metrics, % riparian and road crossings are AR, the final rank is AR	AR
			When metrics are AR, with no riparian zone, and road crossings are PF or AR, the final rank is AR	AR
			When metrics are AR, and both riparian zone and road crossings are PF, the final rank is AR	AR
			When metrics are AR, and riparian zone is AR, and road crossings are PF or AR, the final rank is AR	AR
			When metrics are AR, and % riparian is NPF, and road crossings are PF, the final rank is AR	AR
			When metrics are AR, and % riparian is NPF, and road crossings are AR or NPF, the final rank is NPF	NPF
			When metrics, % riparian and road crossings are NPF, the final rank is NPF	NPF
			When metrics are NPF, and riparian zone is AR or NPF, and road crossings are PF, AR or NPF, the final rank is NPF	NPF
			When metrics are NPF, with no riparian zone, and road crossings are PF, AR or NPF, the final rank is NPF	NPF

PART III. CHARACTERIZE NATURAL RESOURCES IN STUDY AREA

Purpose

This step develops an understanding of the natural resources within the study area. The purpose is to determine natural resource sites that can be preserved or restored in the watershed that will provide the greatest ecological benefit.

Methods

The following natural resources will be evaluated: wetlands, floodplains, and riparian corridors. The results will then be assessed in context of each DAU condition.

Step 1. Determine Location, Extent, and Condition of Wetland Resources.

Purpose

Identifying the location, extent, and condition of wetlands provides valuable insight into a landscape's capacity to store surface water, sediment, nutrients, toxics, and bacteria. This information is used to help characterize the condition of ecological processes within drainage basins in the study area. The location and extent of existing, degraded, and destroyed wetlands serve as the pool of preservation sites and potential restoration sites for development impacts to wetlands. The methodology discussed below assumes access to GIS resources, and references steps to be taken in ArcMap or ArcView. Some of this analysis can be conducted with paper maps and recent aerial photographs, but the final product is a GIS coverage or layer of existing wetlands and potential wetland restoration sites.

> ***NOTE****: A clear distinction must be made between a wetland inventory and an inventory of potential wetland restoration sites. Wetland inventories identify the location and extent of <u>existing</u> wetland resources, whether degraded or pristine. An inventory of potential wetland restoration sites identifies the location, extent and condition of existing and historical wetlands that have been altered by human activity but could be reestablished through restoration actions. For example, a wetland might have been converted to agricultural uses and dewatered (drained), and may no longer meet criteria for designation as a jurisdictional wetland, but it may provide an opportunity for restoring wetland functions in a watershed.*

Methodology

1. <u>Identify and compile available wetland datasets</u> showing the location, extent, and condition of historic and existing wetlands within the study area. Ideally, these will be digital datasets from resource management agencies (federal, state, and local) with documented metadata, known mapping methods and written analysis. Data that has been mapped at a scale of 1:24,000 or greater should used for this analysis. Within Washington State, potential data sets include National Wetland Inventory (NWI), WADNR hydrography coverage (codes

111 and 421), Washington State Department of Fish and Wildlife (WDFW) Priority Habitats and Species (PHS) data, and local wetland inventories.

2. Gather additional datasets that provide supporting natural resource information within the study area. These datasets should include hydrology, elevation and local relief, and soil survey maps and descriptions at the county/local level. Digital orthophotos, developed from aerial photographs and corrected to a geographic coordinate system, provide the link between printed resources and the digital dataset. Use recent orthophotos as the basemap for the GIS layers you create, since most digital datasets will not have been referenced to the same base layer. Historical aerial photographs, whether rectified or not, can help clarify wetland signatures from disturbed sites in the study area.

3. Create a single ArcMap polygon layer named *Existing Wetlands*. Clip all GIS wetland inventory layers to the study area boundary, then overlay them in order of assumed accuracy. Copy polygons and their attributes from different inventories into a single layer. If a site is identified in more than one inventory, chose the polygon from the most accurate inventory for the composite layer.

   The updated *Existing Wetlands* layer is the starting point for a new wetlands restoration data set. Save a copy of *Existing Wetlands* as *Potential Wetlands*, then evaluate its attribute table for applicability to restoration projects. The table will likely need additional fields to support results of the photo interpretation and wetlands analysis that follow. Suggested fields and attributes are detailed at the end of this Methodology section.

4. Create a *Hydric Soils* polygon layer. By definition, hydric soils develop under long term anoxic conditions caused by prolonged inundation or saturation with water. De-watering and clearing vegetation can quickly remove some criteria by which a jurisdictional wetland is delineated, but soils will retain hydric characteristics for many years. This layer provides a strong indication of the pre-development location and extent of wetlands in the study area. Soils surveys and data are available from the National Resource and Conservation Service (NRCS) website. Clip the county soils map to the study area, then query, select and export hydric soil polygons to a new layer named *Hydric Soils*. There are three types of soils polygons to include in your dataset: hydric soils with no upland soil inclusions, hydric soils with upland soil inclusions, and non-hydric soils with hydric inclusions.

   Read the full description/definition of each soil that is considered hydric for information about any alterations such as drain tiles or ditches that were observed while the mapping work was done. Hydric soil definitions often include slope restrictions; a particular mapped soil can be non-hydric in steeper areas, but can develop hydric properties in low-slope regions. The low slopes in the definitions may be subdivided, for example: 0%-3%, 3%-5% and >5%. In the layer's symbology window, assign different colors to the types of hydric soils, then vary each color with patterns according to any slope criteria. Delete all slope values greater than the hydric criteria from the value list in the layer's symbology table. This will leave only polygons that could be considered hydric in the layer.

5. Develop *Elevation*, *Slope*, *Low-Slope* and *Hillshade* layers. These GIS layers are derived from LiDAR, Radar or other elevation raster data. These may be used to further clarify local

relief on the orthophotos, or as stand-alone layers. Depressional and flow-through sites adjacent to mapped wetland polygons can provide expanded restoration opportunities in the study area. Create an additional *Low Slope* layer by selecting and exporting only low slopes (0-5%), then ramping the color from darker (0%) to lighter (5%).

6. Photo Interpretation. Display the *Potential Wetland*, *Hydric Soils*, and *Low-Slope* GIS layers on recent orthophotos and DEM layers (base maps). Polygons from these layers logically indicate potential restoration wetland sites. Darker soils and slope areas readily show where additional wetland and potential restoration sites are located on the orthophotos. Systematically examine and interpret each section of land within the study area. Using the *Potential Wetland* and *Hydric Soils* polygons as starting points, compare the location and extent of wetland and hydric soil polygons to the orthophotos, DEMs or other aerial photographs. Different layers can be displayed or hidden to provide maximum information for the photo interpretation process.

   If photo interpretation indicates that the shape, size or location of a restoration site is substantially different (greater than 25 percent) from the *Potential Wetland* polygon, modify the polygon to reflect the new interpreted boundary and location.

   After the polygons within a section are evaluated and recorded in the data table, the photo interpreter should scan the remaining area to identify wetland signatures that don't coincide with a wetland or hydric soil polygon. These signatures include clusters or lines of deciduous trees within conifer forests, rough marsh vegetation, or sudden changes in vegetation type. When additional wetland signatures are identified, add a new polygons to the *Potential Wetland* data layer and record their attributes in the data table.

   Consult any written data associated with existing wetland inventories, local and regional planning reports when available to support determinations made during photo interpretation.

7. Wetland Assessment. Using best professional judgment, a wetland scientist should examine the *Potential Wetland* data and attribute table, then make a series of determinations for each site and enter the results into additional fields in the attribute table. These determinations include the Hydrogeomorphic Wetland Classification and Code, the relative value of each site on its own and within the landscape to fisheries, stormwater amelioration and detention and other ecosystem services. These values are all used in determining the Wetland Category for the site. The Wetland Category is a rating system developed by Washington State's Department of Ecology (Ecology), and assigns relative values of I, II, III, and IV to wetlands. Category IV often represents the most altered sites, which can offer the greatest opportunities for restoration projects. Suggested attribute fields and values for Wetland Assessment follow this Methodology Section.

8. After the *Potential Wetland* layer and its data table are completed, add them to the Watershed Characterization process.

We suggest the following fields be added to the *Existing* and *Potential Wetland* layers attribute table. The attribute data can be derived either through photo interpretation, or from historical documents and reports associated with the digital datasets.

- **Potwet -** This attribute represents the photo interpreter's opinion of the site's potential to be either an existing wetland **OR** a historical wetland area that has restoration potential. This attribute is used to distinguish between wetland and potential wetland areas and upland and historic wetland areas having no restoration potential.

  Y - site is an existing wetland or has restoration potential

  N - site is not an existing wetland and has no restoration potential due to site or surrounding human land use/alteration.

- **RestPoten** – This attribute is the photo interpreter's opinion of a wetland or upland site's need and ability to be restored to a natural wetland condition. This attribute is used to distinguish between potential wetland sites that have potential to be used as a restoration site and wetlands that have minimal restoration site potential.

  0 – no/minimal potential for restoration; this can include both high quality wetlands and degraded or destroyed wetlands with substantial development that precludes reasonable options to restore the wetland

  1 – wetland has some level of restoration potential based on signatures from aerial photos indicating some level of hydrologic and/or vegetative alteration

  2 – the wetland site has sufficient restoration potential to serve as a viable restoration option

- **MitiPoten** – This attribute is the photo interpreter's opinion of a site's potential to be used in a mitigation or restoration project. Considerations used to determine restoration potential include the size of the site, the extent of hydrologic and vegetative alteration, indications of many separate landowners, and major infrastructure development, such as high power transmission lines or major water conveyances.

  0 – site may have limited potential as a mitigation or restoration site due to one or more site conditions observed during photo interpretation

  1 – site has good potential for serving as a mitigation or restoration site

- **HG_Class** – This attribute is the site's existing Hydrogeomorphic Code, as described in **Table 15**. It represents the photo interpreter's opinion of the hydrogeomorphic wetland classification under existing site conditions.

Table 15. Hydrogeomorphic wetland types used to classify wetlands

Hydrogeomorphic Code	Hydrogeomorphic Type	General Description
RI	Riverine Impounding	Topographic depressions on a valley bottom
RF	Riverine Flow-through	Wetland systems associated with rivers and streams where water tends to flow through rather than pond
DC	Depressional Closed	Topographic depressions outside of valley bottoms having no surface water connection to a stream
DF	Depressional Flow-through	Topographic depressions outside of valley bottoms having a surface water connection to a stream
LF	Lacustrine Fringe	Wetlands occurring at the margins of deepwater lakes
LC	Lacustrine Open Water Lake	A lake system >20 acres in area and >2 meters deep
SL	Slope Wetland	Wetlands occurring on a slope where water tends to sheet flow across
UN	Unknown	Unable to determine hydrogeomorphic type from photos
NW	Non-wetland	Site is upland area
MM	Man made	Stormwater ponds and other artificial impoundments
ES	Estuary	Direct connection to marine waters

- **HG_Poten -** This attribute is the site's potential Hydrogeomorphic Code (**Table 15**) *following* restoration. It represents the photo interpreter's opinion of the wetland's Hydrogeomorphic Classification *after* restoration activities.

- **Hyd_Alter -** This attribute represents the photo interpreter's opinion of the extent of human induced hydrologic alteration for the site based on photo interpretation and available locally developed information.

  0 – no or minimal hydrologic alteration

  1 – some hydrologic alteration evident, but portions of the site appear to be providing reasonable levels of wetland functions

  2 – extensive hydrologic alteration is evident from surface drains and ditches, grading or filling, or is presumed to exist because of human land uses

- **Veg_Alter** - This attribute represents the photo interpreter's opinion of the extent of human-induced vegetative alteration to the site based on photo interpretation and available local information.

  0 – no or minimal vegetation alteration

  1 – some vegetation alteration/clearing is evident from aerial photos and/or LiDAR datasets

  2 – extensive vegetation alteration/clearing is evident from aerial photos and/or LiDAR

- **SurLandUse** - This attribute represents the photo interpreter's evaluation of the general type of land use that surrounds the potential wetland site. Suggested land use codes are presented in Table 16.

Table 16. Land use types recorded during wetland photo interpretation.

Land Use Code	Land Use Type
RES	Residential
OPEN	Park/Open Space
FOR	Forest
COM	Commercial/Business
IND	Industrial
AGR	Agriculture

If the characterization will provide information on a specific development action, include the following fields. <u>They represent the opinion and best professional judgment of a wetland scientist</u>.

- **SiteAvoid –** This is the wetland scientist's opinion of the site-scale resource value of the wetland. It indicates the need to avoid and/or minimize impacts to the site. Use Ecology's Wetland Rating System (2004) to assign a value of High, Medium or Low to each site.

  H – High Avoidance: the wetland is an Ecology Category I or Category II (Ecology, 2004) and warrants the highest consideration for avoidance and minimization of impacts.

  M – Medium Avoidance: the wetland is an Ecology Category III or IV (Ecology, 2004) and warrants moderate consideration for avoidance and minimization of impacts.

L – Low Avoidance: the wetland is an Ecology Category III or IV (Ecology, 2004) and warrants low consideration for avoidance and minimization of impacts.

- **LandAvoid** – This is the wetland scientist's opinion of the landscape-scale resource value of the wetland in relation to the surrounding landscape and natural resources. Use Ecology's Wetland Rating System (2004) to assign a value of High, Medium or Low to each site.

  H – High Avoidance: the wetland warrants the highest consideration for avoidance and minimization of impacts based on its relationship to the landscape and natural resources around it.

  M – Medium Avoidance: the wetland warrants moderate consideration for avoidance and minimization of impacts based on its relationship to the natural resources around it.

  L – Low Avoidance: the wetland warrants low consideration for avoidance and minimization of impacts based on its relationship to the natural resources around it.

- **FinalAvoid** – This is the wetland scientist's opinion of the overall resource value of the wetland based on averaging the site and landscape-scale rankings. Use Ecology's Wetland Rating System (2004) to assign a value of High, Medium or Low to each site.

  H – High Overall Avoidance: the wetland warrants the highest consideration for avoidance and minimization based on averaging its site-scale and landscape-scale ranks.

  M – Medium Overall Avoidance: the wetland warrants moderate consideration for avoidance and minimization based on averaging its site-scale and landscape-scale ranks.

  L – Low Overall Avoidance: the wetland warrants low consideration for avoidance and minimization based on averaging its site-scale and landscape-scale ranks.

- **ECY_Categ** – Ecology's Wetland Category for the site, according to the wetland scientist's opinion. Use the Washington State Wetlands Rating System (Ecology, 2004) to determine the proper Category, then assign a value of High, Medium or Low accordingly.

  H – High Value: the wetland is a Category I or Category II (Ecology, 2004). A high quality or rare wetland that warrants the highest consideration for avoidance and minimization of impacts.

  M – Medium Value: the wetland is a Category III or IV (Ecology, 2004). These may provide ecosystem services not provided by Categories I or II wetlands, and warrant moderate consideration for avoidance and minimization of impacts.

  L - Low Value: the wetland is a Category III or IV (Ecology, 2004), and may be small, isolated or degraded sites. These wetlands warrant low consideration for avoidance and minimization, but may provide restoration opportunities.

The following attributes can be used to prioritize potential wetland restoration sites:

- **Rare_Type** – This attribute identifies wetland fens and bogs considered to be rare, unique, and/or irreplaceable. Hydric soils with > 25 % organic matter have the greatest potential of supporting peat bogs or fens.
  - **0** – potential wetland sites where ≤33% of the polygon area is a hydric soil series containing >25% organic matter
  - **1** – potential wetland sites where > 33% of the polygon area is a hydric soil series containing > 25% organic matter

- **RechrgPot** – This attribute identifies wetland sites having the greatest potential to recharge groundwater aquifers. Hydrologic code attributes within the soils data layer identify soil types having moderate to high percolation.
  - **0** – potential wetland sites with ≤50% or less of the polygon intersecting soil mapping units with a Hydrologic Code of A or B
  - **1** – potential sites with > 50% of the wetland polygon intersecting soil mapping units with a Hydrologic Code of A or B

- **SWconnect** – This attribute identifies potential wetland sites having a surface water connection as defined by wetland hydrogeomorphic (HGM) classification. Surface water connection is defined as surface water movement from the wetland to a stream or lake for all or part of the year.
  - **0** – potential wetland sites with a potential wetland classification (HG_Class) of Depressional Closed (DC)
  - **1** – wetland sites with a potential wetland classification (HG_Class) of Depressional Flow-through (DF), Riverine Flow-through (RF), Riverine Impounded (RI), Lacustrine Fringe (LF), Lacustrine Open Water (LC), or Slope (SL).

- **SWflood** – This attribute identifies wetland sites having a direct surface water connection to a perennial stream or lake. Look for the intersection of a wetland site and a stream or lake on a 1:24,000 hydrography map or GIS layer.
  - **0** – no direct intersection exists between the wetland site and a stream or lake
  - **1** – a direct intersection exists between the wetland site and a stream or lake

- **FishAccess** – This attribute identifies wetland sites having a direct surface water connection to a perennial stream or lake, where one or more species of fish have potential to access the wetland.

0 – no direct intersection exists between the wetland site and a stream or lake, **OR** a direct intersection exists, but fish do not have access to that portion of the stream or lake

1 – a direct intersection exists between the wetland site and a fish bearing stream or lake

- **Adjpublic** – This attribute identifies wetland sites located on or adjacent to public lands. Publicly owned lands include all parcels that have permanent protections or easements. These include, but are not limited to: land trust properties, parks, reserves, schools, and green belts. To identify all potential public properties, query ownership parcels that pay no real estate tax.

  0 – the potential wetland site is not on or adjacent to publicly-owned land

  1 – the potential wetland site is on or adjacent to publicly-owned land

- **LocalPrior** – This attribute identifies potential wetland restoration sites that are identified as priority restoration projects in one or more locally developed natural resource plans. Compare the plans with the potential wetland restoration site dataset for matches.

  0 – the potential wetland site is not included in a local watershed plan **OR** has not been prioritized in some manner for restoration

  1 – the potential wetland sites is on a local watershed plan or a prioritized wetland restoration list

Data Needs

In most cases, use the most recent and highest resolution datasets that your computer can process easily. Older and historical data can be helpful in determining where wetlands have been altered or potential for restoration exists.

1. All available wetland GIS coverages and datasets that provide wetland information. National Wetlands Inventory (NWI) digital data are available free of charge at

1. Soil survey digital data by County and State: digital maps and descriptions. Free digital datasets of county-level soil maps can be downloaded from USDA (NRCS) websites, or through local County Agricultural Extension websites. http://soils.usda.gov/survey
2. Hydric soils lists and descriptions by State: http://soils.usda.gov/use/hydric
3. Digital orthophotos: color or black & white
4. Digital Elevation Models (DEM) developed from LiDAR or other sources, 30 meter and 90 meter dadta are available from WADNR
5. Government Land Office data from early land survey records
6. Hydrography data by County; available from WADNR and other sources
7. Fish access data
8. Public land ownership data
9. Local natural resource planning documents

Products

1. A GIS polygon layer of existing and potential wetland restoration sites within the study area.

2. Attribute table populated with photo-interpreted data and natural resource information for each existing and potential wetland restoration site that can be used to assess the extent of wetland alteration at both the site and landscape scales, and the suitability of the site for preservation and restoration.

Step 2. Determine Location, Extent, and Condition of Floodplain Resources.

Purpose

Identifying the location, extent, and condition of floodplain resources provides valuable insight into a landscape's capacity to store surface water, sediment, large wood, and nutrients, toxicants, and bacteria. The proportion of functioning versus non-functioning floodplains provides additional insight into potential restoration sites.

Methods

1. Identify the location and extent of riparian and floodplain areas using available coverages and data.
2. Evaluate historic (Holocene) floodplain conditions. Holocene floodplain is delineated using topographic data combined with GIS coverage of alluvial soil deposits.
3. Establish condition of current floodplains within the study area. Using the Federal Emergency Management Agency (FEMA) floodplain coverage and orthophotos, identify the proportion of floodplain that is decoupled from the stream (area behind dikes or levees or affected by a road crossing), confined (channel locked in place by dredging, rip-rap etc), and free-flowing (channel is free to migrate across floodplain).
4. Evaluate floodplain restoration potential using the following methodology focused on the potential for storage restoration, stemming from analysis of floodplain decoupling. Floodplain storage areas become decoupled due to development activities that involve the construction of dikes, revetments, and filled terraces and dredging of the river channel. In order to identify these landscape changes LiDAR (Light Detecting And Ranging) data is assembled for the watershed. From those data, produce two GIS coverages. The first is a shaded relief topographic layer, which allows for rapid and accurate identification of changes in elevation, especially involving linear features (such as dikes, roads, etc.). The second GIS coverage is a 2-foot contour topographic coverage used to quantify the extent of vertical relief for the decoupling features being analyzed. Lay these coverages over the orthophoto coverage to generate a base map for geospatial analysis of floodplain decoupling. Additional coverages for FEMA floodplains, wetlands, and riparian zones are used to help identify coupled and decoupled floodplain features.
5. Each decoupled feature is then tied to the adjacent topographic features and/or the valley wall floodplain margin. From this a storage polygon is developed for each feature, depicting the spatial extent of the lost storage areas.

6. Each decoupled polygon is then analyzed for potential for restoration. To accomplish this several additional field attributes are identified and evaluated. These include land use, channel migration potential, development surrounding the site, and soils data.
7. Orthophotos are used to identify land uses for decoupled floodplain polygons. Each polygon is sorted into categories including residential, industrial/commercial, agriculture and open space. Because of the expense involved in acquiring developed land and removing the structures, only lands in agriculture and open space are identified as having restoration potential.
8. The polygons are then evaluated to determine the extent of surrounding development (to ascertain the relative fragmentation of polygons with floodplain restoration potential). Those polygons that have less development surrounding them are deemed to have higher potential restoration value. This determines the relative level of fragmentation for each polygon and its potential to reconnect adjacent undeveloped floodplain polygons.
9. Analysis of the floodplain reveals some polygons that had been removed from the jurisdictional floodplain, probably through Letters of Map Revision ("LOMR"), etc. that are adjacent to floodplain polygons with restoration potential. Those that share attributes with the adjacent floodplain polygons are identified and categorized as non-FEMA floodplain polygons in proximity to potential restoration sites. Land use for these is examined and those that were undeveloped were deemed to have restoration potential, however they were categorized as "non-jurisdictional" polygons.
10. Next, the polygons are evaluated to determine the potential for restoration of channel migration or channel complexity. This is done by identifying remaining vestiges of channel geomorphology, most notably mender bends and confluences. Polygons adjacent to these remainder geomorphic features receive a higher value in terms of restoration potential. This is done to identify the most likely locations for restoration activities to be augmented by remaining aspects of riverine geomorphic processes.
11. The coverage showing type A and B soils is then applied to each decoupled floodplain polygon to determine the potential for restoring riparian, wetland, aquifer recharge and nutrient exchange functions for the polygon, based on the extent to which the coverages overlap.

    - L - < 25 % of the polygon.
    - M - 25 – 50 % overlap of polygon
    - H - 50 % overlap of polygon

Attributes used include:

- **Mend_fdpln** – This attribute represents the photo interpreter's opinion if the site can mend isolated patches of floodplain

    Y – site can mend floodplain

    N – site can't mend floodplain

- **Chinmig_pot** – This attribute is a measure of the polygon's ability to migrate across the floodplain

  Y – the site could migrate

  N – the site could not migrate

- **Confined** – This attribute represents the photo interpreter's opinion if the site has been confined from the active floodplain

  Y – site has been confined

  N – site is not confined

- **Decoupled** – This attribute represents the photo interpreter's opinion if the site has been decoupled from the active floodplain

  Y – site has been decoupled.

  N – site has not been decoupled

- **Rechrg_pot** – This attribute identifies floodplain sites having the greatest potential to recharge groundwater aquifers. Hydrologic code attributes within the soils data layer are used to identify soil types having moderate to high percolation.

  0 – potential floodplain sites with 50 percent or less of the polygon intersecting soil mapping units with a Hydrologic Code of A or B

  1 – potential floodplain sites with > 50 % of the polygon intersecting soil mapping units with a Hydrologic Code of A or B

- **Rest_Pot** – This attribute represents the photo interpreter's opinion of a floodplain site's need and ability to be restored to a natural wetland condition. This attribute is used to distinguish between potential wetland sites that have potential to be used as a restoration site and wetlands that have minimal restoration site potential.

  0 – no/minimal potential for restoration; this can include both high quality floodplain and degraded or destroyed floodplain with substantial development that precludes reasonable options to restore the wetland

  1 – floodplain has some level of restoration potential based on signatures from aerial photos indicating some level of hydrologic and/or vegetative alteration

  2 –the floodplain site has adequate restoration potential to serve as a viable restoration option

- **Mit_pot** – This attribute represents the photo interpreter's opinion of a floodplain site's potential. This attribute is based soling on the signatures observed during photo interpretation. Considerations used to determine restoration potential include the size of the potential restoration site, the extent of hydrologic and vegetative alteration, indications of many separate landowners, and major infrastructure development, such as high power transmission lines or major water conveyances.

0 – site may have restoration potential but limited potential to serve as a high natural resource restoration site do to one or more site attributes observed during photo interpretation

1 – site has restoration potential and potential for serving as a development restoration site

- **SLU** - This attribute represents the photo interpreter's evaluation of the general type of land use that surrounds the potential site. Suggested land use codes are presented in Table 17.

Table 17. Land use types recorded during photo interpretation.

Land Use Code	Land Use Type
res	Residential
par	Park/Open Space
for	Forest
com	Commercial/Business
ind	Industrial
agr	Agriculture

- **Adjpub** – This attribute identifies floodplain sites located on or adjacent to public lands. Publicly owned lands include all parcels that have permanent protections or easements, and include, but not limited to: land trust properties; parks; reserves; schools; and green belts. To account for all potentially properties, query parcels that pay no real estate tax. Using the best available public ownership data, a determination of adjacency was made.

  0 – the potential floodplain site does not occur on or adjacent to publicly-owned land

  1 – the potential floodplain site occurs on or adjacent to publicly-owned land

- **Local_prio** – This attribute identifies potential floodplain restoration sites that have also been identified as being a priority restoration project in one or more locally developed natural resource plans. Available watershed plans and recovery projects were compared with the potential floodplain restoration site dataset for matches.

  0 – the potential floodplain site does not occur on a local watershed plan or is not prioritized in some manner for restoration

  1 – the potential floodplain sites does occur on a local watershed plan or is on a prioritized wetland restoration list

- **Notes** – This attribute provides more detail on a polygon's site information beyond what was given in the other attributes.

Data Needs

1. Current orthophoto GIS coverage
2. LiDAR or other accurate topographic data
3. GIS riparian coverage
4. GIS wetland coverage
5. GIS type A and B soils coverage
6. GIS coverage of dikes, levees, and riprap
7. GIS FEMA floodplain coverage
8. Hydrography
9. Background information on flood control activities most notably channel dredging, levee construction and flow control structures
10. Current land use/land cover

Products

1. Information on the floodplain systems.

Step 3. Determine Location, Extent, and Condition of Riparian Resources

Purpose

Identifying the extent, location, and condition of riparian resources provides valuable insight into a landscape's capacity to store and transport surface water, sediment, large wood, nutrients, toxicants, and bacteria (Hyatt et al. 2004, Morley and Karr 2002, Sweeney et al. 2004). This information is used to help characterize the condition of ecological processes, or aquatic integrity, within in the study area. The location and extent of existing deforested riparian areas also serves as a pool of potential restoration sites for past impacts to riparian areas.

Methods

1. Clip the hydrography layer to the study area boundary.
2. Identify the extent of riparian areas using available GIS data layers. Apply a 67-meter buffer to a 1:24,000 scale hydrography layer within the study area, creating a riparian buffer layer around all rivers and streams. The buffer is based on established minimum shade requirements and site potential tree height (SPTH) for large woody debris recruitment, respectively.
3. Using available riparian coverage, current land cover and digital orthophotos, create polygons around all non-forested areas within the riparian buffer.

4. Add attributes to this new layer of non-forested riparian areas according to existing land cover data.

Attributes used include:

- **Mend_rip** – This attribute is a measure of the polygon's ability to link two disjunct forest patches, if it was chosen for riparian restoration.

  Y – the site would link two forest patches

  N – the would not link two forest patches

- **Add_rip** – This attribute is a measure of the polygon's proximity to forest patches, whether the polygon would add forest to the existing forest if it were chosen as a restoration site and restored.

  Y – the site would add forest to the existing forest

  N – the site would not add forest to the existing forest

- **CTS** – This attribute represents the range of forest cover within the polygon, how much of the area is Cleared To Stream on a scale of 0 to 2, based on the 67-meter buffer distance from the stream.

  0 - <25% cover

  1 – 25 to 50% cover

  2 - >50% cover

- **CDsoils** – Overlay the soils layer and assess how much of the potential restoration area per polygon contains C or D soil types. If a large percentage of the polygon contains C or D soils, the site will provide more benefit from restoration than a site with A or B soils.

  1 - > 50 percent C or D soils

  0 - < 50 percent C or D soils

- **Rest_Pot** – This attribute represents the photo interpreter's opinion of a site's need and ability to be restored to a natural condition. This attribute is used to distinguish between potential sites that have potential to be used as a restoration site and riparian that have minimal restoration site potential.

  0 – no/minimal potential for restoration; this can include both high quality and degraded or destroyed sites with substantial development that precludes reasonable options to restore the riparian area.

  1 – Riparian has some level of restoration potential based on signatures from aerial photos indicating some level of hydrologic and/or vegetative alteration

  2 –the site has adequate restoration potential to serve as a viable restoration option

- **Mit_pot** – This attribute represents the photo interpreter's opinion of a site's potential. This attribute is based solely on the signatures observed during photo interpretation. Considerations used to determine restoration potential include the size of the potential restoration site, the extent of hydrologic and vegetative alteration, indications of many separate landowners, and major infrastructure development, such as high power transmission lines or major water conveyances.

0 – no/minimal potential for restoration; this can include both high quality and degraded or destroyed sites with substantial development that precludes reasonable options to restore the riparian zone.

1 – site may have restoration potential but limited potential to serve as a high natural resource restoration site do to one or more site attributes observed during photo interpretation

2 – site has restoration potential and potential for serving as a development restoration site

- **SLU -** This attribute represents the photo interpreter's evaluation of the general type of land use that surrounds the potential site. Suggested land use codes are presented in Table 18.

Table 18. Land use types recorded during photo interpretation.

Land Use Code	Land Use Type
res	Residential
open	Park/Open Space
for	Forest
com	Commercial/Business
ind	Industrial
agr	Agriculture

- **Adj_pub** – This attribute identifies sites located on or adjacent to public lands. Publicly owned lands include all parcels that have permanent protections or easements, and include, but not limited to: land trust properties; parks; reserves; schools; and green belts. To account for all potentially properties, query parcels that pay no real estate tax. Using the best available public ownership data, a determination of adjacency was made.

  0 – the potential site does not occur on or adjacent to publicly-owned land

  1 – the potential site occurs on or adjacent to publicly-owned land

- **Local_prio** – This attribute identifies potential restoration sites that have also been identified as being a priority restoration project in one or more locally developed natural resource plans. Available watershed plans and recovery projects were compared with the potential floodplain restoration site dataset for matches.

  0 – the potential site does not occur on a local watershed plan or is not prioritized in some manner for restoration

1 – the potential sites does occur on a local watershed plan or is on a prioritized wetland restoration list

- **Notes** – This attribute provides more detail on a polygon's site information beyond what was given in the other attributes.

After the entire study area has been evaluated for non-forested riparian areas, merge the DAU layer with the non-forested riparian area layer. There should now be an attribute for each polygon stating its DAU designation.

The remaining area in the riparian buffer is the forested area per DAU. Create a new layer of forested polygons within the riparian buffer.

Add the following attributes to each layer, calculating the area of each polygon.

- Area – square feet of each polygon
- Acres – acreage of each polygon

The forested and non-forested layers tables can now be exported to a spreadsheet and the data compiled for the study area, the individual stream catchments, and the individual drainage basins to determine the condition of the riparian area.

Select only the non-forested polygons with restoration potential and create a new layer. Additional attributes to help with characterization of the potential riparian restoration sites may be included. Suggestions for useful attributes include:

Potential riparian restoration polygons that intersect potential wetland or floodplain areas should be clipped to the border of the wetland or floodplain and their area and acreage recalculated.

A copy of the layer should be made and the potential riparian restoration polygons less than three acres in area removed from the new layer, creating a layer of potential riparian restoration sites greater than three acres in size.

Data Needs

1. Hydrography layer.
2. Available riparian coverages, current land cover, digital orthophotos, stereo-paired if available.
3. Study area, Stream Catchments, and drainage basin boundary layers.
4. Soil survey layer, C and D soils.
5. Land ownership layer or maps of publicly owned lands.
6. Local priority sites.
7. Wetland and floodplain potential restoration sites (when available).

Products

1. An approximation of riparian condition and forested riparian area within the study area, DAUs and sub-watersheds.

2. A GIS data file of potential riparian restoration sites within the study area, DAUs and sub-watersheds.

Step 4. Determine Location, Extent, and Condition of Fish Habitat Resources

Purpose

This landscape method has been developed to prioritize potential wetland, floodplain, and riparian restoration sites for maximizing habitat benefits for salmonid fish species. The results will then be used in the identification of stormwater retrofits sites. Those sites with high salmonid habitat value will be avoided.

Introduction

Natural resource mitigation efforts have often focused on a projects ability to provide functions at the site scale. These functions are assessed by evaluating key physical features, such as pool riffle ratios and channel complexity in streams or open water to emergent plant ratios and snags per acre in wetlands. However, there is growing evidence that significant stressors within individual watersheds play an important role in how a site will function and must be identified and evaluated before natural resource improvements 'are initiated (Booth et al. 2001). Further, not all watersheds are created equal (Booth 1991) when human land use intensity increases. Because of the diverse physical and biological influences on watershed processes and conditions, aspects of the regional and local geology must be understood for stream restoration or rehabilitation to be successful (Booth et al. 2003). Likewise, stormwater treatment and control infrastructure has typically been an engineered system to store and convey surface stormwater. Watershed characterization is a tool to evaluate using the natural landscape to mitigate stormwater treatment and runoff, vs. the traditional engineered attempts to mimic the natural runoff characteristics of a drainage area.

Geology, climate, and gross reach morphology are ultimate controls over the landscape processes and are independent of land-use management over the long-term (centuries to millennia), act over large areas (> 1 km2), and shape the range of possible processes and habitat conditions in a watershed (Naiman et al. 1992; Beechie and Bolton 1999).

Proximate controls are affected by land management over the short term (i.e., years to decades), act over smaller areas, and determine habitat conditions expressed at any point in time (Naiman et al. 1992, as cited in Beechie et al. 2003).

Given the enormous area over which anadromous salmonid species complete their freshwater life-history stages, it is not surprising that landscape processes have a profound influence on populations (Feist et al. 2003). A landscape's regional topography, climate, geological substrate, soil, vegetation types, and biogeography define, in large part, the biota of the region (Booth et al. 2001).

We apply this understanding through the development of the following criteria used to prioritize potential wetland, floodplain, and riparian restoration sites. Our purpose is to prioritize potential natural resource restoration sites based on each site's opportunity to maximize habitat benefits to salmonid fish species

Methods

Criteria used to rank natural resource restoration sites for potential to provide important habitat for salmonid fish species is presented in Table 17. Rationale for each criterion follows.

The priority ranking process follows the five steps outlined in Table 17. Potential floodplain, wetland, and riparian restoration site datasets, detailed in this methods document, were used as the starting point for this ranking process.

Table 19. Fish Habitat Ranking Criteria

Ranking Step	Criteria	Rating	Rationale
Step 1. Identify key habitat areas for salmonids at a landscape scale	Number of salmonid species spawning in a Drainage Analysis Unit (DAU) under past or present conditions Note: Spawning and rearing areas were determined through the Washington Lakes and Rivers Information System (WLRIS) that includes the Salmon and Steelhead Inventory (SaSi) database. Because WLRIS contains historic data on spawning and rearing, the DAU may or may not currently maintain the number of spawning or rearing salmonid species identified in WLRIS.	High -three or more salmonid species spawning or rearing in a DAU. Moderate -one or two salmonid species spawning or rearing in a DAU. USE TYPE 2 = known spawning and 3 = known juvenile rearing Low -no salmonid species are known to spawn or rear in the DAU	Habitat occupied by multiple salmonid species is assumed to have higher environmental benefit than areas with fewer species. Known spawning areas are key habitat areas that provide one or more critical life stages for salmonid species. Studies in the Pacific Northwest (PNW) have documented that native trout remain close to their spawning areas (Moore and Gregory 1988,as cited in Montgomery et al., 1999), implying that distribution of juvenile fish closely reflects the species spawning distribution (Montgomery et al.,1999).
Step 2. Identify landscape areas where restoration actions have the greatest potential for measurable environmental benefits	Ecological process condition rank	High, Moderate, or Low -based on the number of ecological processes in an "At Risk" condition Only sites having a High or Moderate ecological process condition rank are considered in prioritizing sites.	A high ecological process condition rank indicates that a majority of ecological processes evaluated within the DAU, both physical and biological, are in an "At Risk" condition. A core premise of watershed characterization is that targeting restoration actions within DAUs having ecological processes in an "At Risk" condition provides the greatest opportunity for maximizing environmental benefits.
Step 3. Identify DAUs having high groundwater recharge potential and resulting strong summer baseflows	Percent of DAU in advance and recessional outwash areas As determined by the United States Geological Service and Washington State department of Natural Resources geological mapping	High ->30% advance and recessional outwash in the DAU Moderate -<30% advance and recessional outwash in the DAU	Outwash geology provide essential phreatic and hyporheic functions that salmonid species rely on to provide spawning habitat and maintenance of summer baseflow (Booth et al. 2003)

Ranking Step	Criteria	Rating	Rationale
Step 4. Identify sites having important habitat characteristics for salmonids	Riparian areas -stream gradient and channel confinement Floodplains -surrounding development and potential to restore channel migration Wetlands -fish access and potential for open water during high flow events (100 year)	High -riparian restoration sites having 0-2% stream gradient unconfined channel and <1% moderately confined channel High -floodplain restoration sites with slu = 0-1 and Ch_Mig_Pot = y High -wetland restoration sites with fish access and potential for open water (Fish_acces = 1 and DF, Rl and RF) Moderate -All sites not ranking High	<2% unconfined channels are key habitat to five species of salmonid species Floodplains (0-1%) are key habitat to four salmonid species Open water ponds are key habitat for three salmonid species (Beechie et al. 2003; Pess et al. 2002)
Step 5. Rank sites by size	Site area	Larger site prioritized over smaller	Final rank to separate sites with identical habitat criteria.

Riparian: 1V = GCDESC <1% unconfined, 2V = GCDESC 1-2% unconfined, 1M = GCDESC <1% moderately confined

Floodplain: slu = surrounding land use

O = no development on any side

1 = one side is developed

Cha_Mig_Pot = channel migration potential is based on photo interpretation of remnant geomorphic features such as meander bends, confluences, etc.

Wetland: Fish_acces –This attribute identifies wetland sites having a direct connection to a perennial stream or lake and one or more species of fish have potential to access the wetland.

O = no direct intersection exists between the wetland site and a stream or lake or a direct intersection exists but fish do not have access to that portion of the stream or lake

1 = a direct intersection exists between the wetland site and a fish bearing stream or lake

DF = Depressional flow through wetland

Rl = Riverine impounding wetland

RF = Riverine flow through

Step 1. Identify key habitat areas for salmonids at a landscape scale.

The first criterion is based on the number of salmonid species known to historically spawn or rear in, or is currently spawning or rearing in the DAU. We rated potential restoration sites High if the Drainage Analysis Unit (DAU) contained three or more known spawning species, Moderate for one or two species, and Low for no species. Spawning and rearing distribution data was acquired through the use of Washington Lake and Rivers Information System (WLRIS) that contains existing Salmon and Steelhead Inventory (SaSi) data compiled by the Washington State Department of Fish and Wildlife (WDFW). Information contained in the database on spawning and rearing areas contain historic and current information on salmonid species and bull trout. It should be noted that the current number of spawning species may or may not be currently present. However, we assume that DAUs capable of supporting multiple salmonid species in the past have important physical attributes at landscape scales capable of supporting diverse aquatic habitats if restored.

The first proposed criterion is based on the premise that fish presence and distribution is dependent upon the physical attributes of the watershed that are formed and maintained by the ecological processes and the underlying geology. Increasing survival during freshwater residency may have the greatest likelihood of reversing population declines (Kareiva, et al. 2000, as cited in Feist, et al., 2003), addressing habitat locations possessing the physical attributes associated with high salmon abundance is a logical first step (Feist, et al. 2003). The goal is to identify where there are known spawning and rearing areas, and then use that information to identify other potential sites (Feist, et al. 2003). Thus, the first step of method development is to determine where aquatic habitat historically supported, or currently supports spawning and rearing in the study area.

High salmon spawning begins with the adult spawner homing to their natal habitats. Population structure begins at spawning for all species, however, species mobility during subsequent life phases and the organization of habitats may also influence the spatial structure of the population (Martin, et al. 2004). The criteria for identifying core areas are focused on spawning because spawning is the geographic starting point for structuring populations and we have the most knowledge of this life stage (Martin, et al. 2004).

Spawning reaches were chosen as key areas based on studies in the Pacific Northwest that have documented that native trout tend to remain close to their spawning areas (e.g., June 1981; Moore and Gregory 1988), implying that distribution of juvenile fish closely reflects the species spawning distribution (Montgomery, et al. 1999).

King County, with multiple partners completed a watershed assessment, including a Viable Salmon Population model to determine potential high usage areas by chinook that they labeled Core areas and Satellite areas. King County has also recently published a framework document for identifying critical habitat for salmon (Martin et al. 2004) based on known chinook spawning areas. While our method took into account the King County et al. methods, our key habitat areas focused on catchments that have the potential to support multiple salmonid species, and thus diversity, compared to focusing on one species over another.

Our approach more closely resembles methods developed by Dr. Chris May, Battelle (May and Peterson 2003) in the development of two refugia studies for Kitsap and Jefferson counties, and methods in the Ecosystem Recovery Planning for Listed Salmon: An Integrated Assessment Approach for Salmon Habitat (2003) published by the U.S. Department of Commerce National Oceanic And Atmospheric Administration National Marine Fisheries Service, in that restoring specific salmon populations is sub-ordinate to the goal of restoring the ecosystem that supports multiple salmon species.

Step 2. Identify landscape areas where restoration actions have the greatest potential for measurable environmental benefits

One of the tasks in this watershed characterization was to determine the appropriate scale to identify potential fisheries habitat resource restoration sites. Habitat areas should be classified at a relatively coarse level of resolution (e.g., estuary, main stem, overwintering habitats), because the information available for evaluating which habitats limit salmon recovery is very sparse and the certainty of answers is very low (Beechie et al. 2003). Our approach uses the condition of ecological processes at the DAU scale as a foundational component when ranking candidate sites for salmonid fish habitat potential. Key ecological processes characterized including physical processes; movement of water, wood, and sediment, and biological processes; aquatic integrity and habitat connectivity

The second criterion is based on the ecological process rank completed for the five ecological processes. Each of the five ecological processes was determined to be "Properly Functioning", "At Risk", or "Not Properly Functioning" condition. An ecological process rank of High or Moderate was assigned each DAU based on the number of ecological processes in an "At Risk" condition. We believe this approach is consistent with Beechie et al. (2003) where they note that an ecosystem approach includes analysis of landscape and habitat features to help set recovery goals, and analysis of disrupted ecosystem processes to identify watershed and aquatic restoration actions (Beechie et al. 2003). The goal of watershed characterization is to contribute to recovery planning by providing environmental benefit by offsetting impacts in areas where ecological processes can be enhanced or restored to facilitate recovery efforts of all salmonid and trout species (Federally or State listed and not listed).

Step 3. Identify DAUs having high groundwater recharge potential and resulting strong summer base flows

Note: This criterion requires an new evaluation for every watershed characterization because of the varied geology in Thurston County.

The third step involves the amount of advance and recessional outwash geology that were present in each DAU studied. A histogram of the varying amounts of each type of geology and AB soils were analyzed. Within a study in the 1-405 / SR-520 study area, there was an obvious break at 30%, and thus it was determined that DAUs with greater than 30% of the geology types would be classified as high, while less than 30% would be classified moderate.

At the landscape scale, available literature suggests that geology plays a large role in determining the suitability of a stream system to be used by salmonid species. Because of the diverse physical and biological influences on watershed processes and conditions, aspects of the regional and local geology must be understood for stream restoration or rehabilitation to be successful (Booth et al. 2003).

Glacial deposits have a wide range of physical properties. From the perspective of hydrologic processes and stream-channel response, two of these properties, permeability and consolidations are particularly important (Booth et al. 2003). Outwash deposits (both recessional and advance) compose the majority of permeable sediments found across the Puget Lowland. In contrast, consolidation is associated not with depositional environment, but with stratigraphic position (Booth et al. 2003).

Subsurface geology becomes critical where natural erosion or human disturbance has thinned, compacted, or stripped the surficial soil. Precipitation typically would result in a subsurface flow regime if the surficial soil layers were present, however when soils are removed or compacted, the runoff becomes Horton overland flow. This can lead to changes in peak discharges, sediment delivery, and water chemistry (Booth et al. 2003).

Conversely, where deep permeable deposits, such as glacial outwash are present, erosion of the surficial soils is unlikely to impose significant hydrologic changes. But if urban development covers these areas of once permeable substrate with pavement, tremendous relative increases in discharges can result (Booth, et al. 2003). In the Pacific Northwest, the fundamental hydrologic effect of urban development is the loss of water storage in the soil column (Booth 2000).

In addition to geology contributing to maintaining base flow, outwash and alluvial geology has been investigated as areas that salmon cue into to spawn. Geist and Dauble (1998) proposed that geomorphic features promotes groundwater-surface water interactions within hyporheic habitats and may play a role in spawning site selection by fall chinook in the Colombia River. Upwelling in spawning areas contained more oxygen and was composed of a higher proportion of river water than upwelling in non-spawning areas. These upwelling characteristics could provide cues that adult fall Chinook salmon used to locate preferred spawning habitats.

Berman and Quinn (1991) determined that spring chinook was found to cue in to pools and banks receiving cool water inputs. The majority of the fish were associated with islands (67%) and pools and rock outcroppings (33%) along the bank (Berman and Quinn, 1991). Although energy benefits may be derived from inhabiting thermal refugia areas, costs may also be incurred. Refuge areas supplied by groundwater or subsurface seeps may have low dissolved oxygen concentrations (Bilby 1984, as cited in Berman and Quinn). It is possible that smaller fish with decreased oxygen requirements relative to large fish could maintain themselves in a thermal refuge supplied with oxygen poor groundwater for a longer period of time. Thus, smaller fish may be able to inhabit a broader range of refuge areas.

Geist (2000) evaluated the relationship between hyporheic discharge and fall salmon spawning site selection in the Hanford Reach, an alluvial floodplain section of the Columbia River. Hyporheic discharge includes a mix of phreatic ground water and river water that discharges from the hyporheic zone into the river channel (e.g., Verier et al., 1992; Harvey and Bencala 1993; Brunke and Gonser 1997, as cited in Geist (2000). Phreatic ground water is beneath land areas and contains a significant component of dissolved solutes derived from a long residence time in the subsurface (Freeze and Cherry 1979, as cited in Geist 2000). Fall Chinook salmon spawning locations were highly correlated with hyporheic discharge that was composed of mostly river water and not phreatic ground water (Geist 2000)

Geomorphic bed features (i.e., islands, gravel bars, riffles) of alluvial rivers are able to create hydraulic gradients sufficient to direct surface water into the bed (Standford et al. 1996; Brunke and Gonser 1997, as cited in Geist 2000). The more permeable the alluvium, the more the physicochemical characteristics of the hyporheic waters will resemble surface water rather then ground water (Geist 2000).

Leman, 1993 determined the hydraulic features of a river channel and its form result in differential hydrostatic pressures in the subsurface flow whereby, in certain sites, positive pressure causes an upwelling through the substrate. It is such sites that are selected by the salmon for spawning.

Step 4. Identify sites having important habitat characteristics for salmonids

At the reach scale we ranked key habitat types that are critical habitats for one or more life stages of salmon as listed in Beechie et al. (2003). Beechie et al. (2003) defined reach-level habitat types for anadromous salmonid species in the Skagit River as either "key" or "secondary" based on literature and local studies. The following three key habitat types were rated high for providing essential habitat for multiple salmonid species; riparian <1-2% unconfined pool-riffle and forced pool riffle provide key habitat for five species, floodplains, where the floodplain had the potential to be restored to some function, can provide key habitat to four species, and open water wetlands that currently provide access to fish or had the potential to provide access to fish if restored, provide habitat for three species.

We used information cited in Beechie et al. (2003), and extrapolated their approach to streams in our study area. We assume that the distinction between large and small rivers is arbitrary since the geometry and hydraulic aspects of rivers are often similar in small shallow streams and large deep rivers (Stalnaker et al. 1989, as cited in Geist and Dauble 1998).

Step 5. Rank sites by size

Lastly, when all the criteria was applied to the current list of natural resource sites, and multiple sites met all the criteria, larger sites were prioritized over smaller sites. The result is a list of riparian, floodplain, and wetland sites that have the potential to directly or indirectly provide benefit to salmonid species.

PART IV. IDENTIFY AND ASSESS POTENTIAL SITES

Drainage Analysis Units in the study area were evaluated based on their potential to maintain natural processes, thus to promote habitat that can support aquatic species. Following a watershed characterization of the five ecological and two biological processes, DAUs were identified as "not properly functioning", "at risk," and "properly functioning" for each of the five ecological processes based on rules and assumptions developed in Tables 8-14.

1. Compile available results on the current condition of the five core ecological processes and two biological processes.

Data Needs

1. Characterization results for all available ecological and biological processes.

Products

1. A map that details the current state of the five ecological processes in each DAU within the study area.

2. A narrative report summarizing the current state of aquatic habitat in the study area.

Step 1. Identify Drainage Analysis Units Having "At Risk" Ecological Processes

Purpose

This step seeks to identify DAUs within the study area having ecological and biological processes that are considered "at risk" under current and future land use conditions. To maximize environmental benefit, there is growing evidence (Booth et al. 2001, Booth et al. In Press update) that mitigation efforts should target areas where ecological processes have been altered at a low to moderate level, rather than targeting "the worst first" or a random selection of mitigation sites. Further, DAUs in the "at risk" category for multiple key ecological and biological processes are assumed to provide the greatest potential to maximize environmental benefits when restored.

Methods

All results from the characterization of ecological and biological processes should be used in the creation of an ecological process score and rank. The following processes will be used in characterizing landscape condition:

- Delivery and Routing of Water
- Delivery of Sediment
- Delivery of Pollutants
- Delivery and Routing of Large Wood
- Delivery and Routing of Heat
- Aquatic Integrity
- Habitat Connectivity

1. Using the condition rank assigned to the DAU in which a potential mitigation site occurs, identify which ecological and biological processes are considered "At Risk". Use the local planning theme identified earlier to identify a single ecological or biological process as the local recovery priority. Then weight ecological and biological processes based on the following criteria:

In the Totten and Eld Inlets characterization, the following weighting criteria were used.

Table 20. Weighted criteria to rank DAUs.

Ecological / Biological Process in "At Risk" Condition	Score Weight	Total Score
Movement of Water	1 X 3	3
Local Theme – Movement of Large Wood	1 X 2	2
Movement of Pollutants	1 X 1	1
Movement of Heat	1 X 1	1
Movement of Sediment	1 X 1	1
Aquatic Integrity	1 X 1	1
Upland Habitat Connectivity	1 X 1	1
Maximum score for a DAU when all processes are "at risk"		**10**

Note: based on potential to contribute ecological and biological benefits at landscape scales when five ecological and biological processes were characterized.

To calculate the ecological/biological process score follow these rules:

Score one point for each ecological/biological process that is in an "At Risk" condition,
If water is "At Risk" add two additional points; and
If the local theme is "At Risk" add one additional point

Final process score is the sum of scores from 1-7, above.

All DAUs are assigned an ecological process score. This score is then used to develop an ecological process rank using technical team best professional judgment. Under this scenario, a final process rank was established using the conversion shown in Table 19.

Table 21. Convert Ecological Process Score to Ecological Process Rank

Ecological/Biological Process Score	Ecological/Biological Process Rank
7, 8, 9, 10 points	High
3, 4, 5, or 6 points	Moderate
0, 1, or 2 points	Low

Following the ranking of each DAU, all potential sites are given an environmental benefit ranking score to be evaluated within each DAU. Calculate an environmental benefit score and rank for each potential wetland, riparian, and floodplain restoration site using Table 22, Table 23, and Table 24, respectively. The environmental benefit score is used to establish environmental benefit ranks of high, moderate, and low.

Table 22. Potential Wetland Restoration Site Environmental Benefits Ranking Criteria

Scoring Criteria	Points	Rationale
Site has restoration potential and:		
1) Site has extensive hydrologic alteration (Hydro_alt = 2) (If criteria for #1 are met, skip #2)	3	Loss of hydrology can mean the total conversion of the site from wetland to upland. Sites with extensive hydrologic alteration have the greatest potential to restore many of the recognized wetland functions. Restoring hydrologic alteration results in added flood storage desynchronization and flow control, as well as other functions specific to the site.
2) Site has some hydrologic alteration (Hydro_alt = 1)	2	Sites with some hydrologic alteration still function as a wetland, at some level. Mitigation credits are gained for only the functions restored, not maintained. Restoring natural hydrology results in an increase in flood storage /flow control function.
3) Site has extensive vegetation alteration (Veg_alt = 2) (If criteria for #3 are met, skip #4)	2	Sites with extensive forest clearing have potential to restore some flood storage/flow control, water quality, temperature maintenance, and organic export functions.
4) Site has experienced some vegetation alteration (Veg_alt = 1)	1	Sites with some forest clearing have potential to re-store that portion of the flood storage / flow control, water quality, temperature maintenance, and organic export functions affected by forest clearing.
5) More than 50 percent of site has Hydro Code A or B soils	1	Site has increased potential to provide groundwater recharge function.
6) Site has surface hydrology connection to river/stream Sw_connect = y	1, 2, or 3	Improves site's ability to provide impacted functions and priorities from City Comprehensive Plans. One point if site has surface water connection, 2 points for regular surface water flooding, and 1 additional point if the site's stream reach supports fish species.
7) > More than 33 percent of site on Orcas peat, Seattle muck, Shalcar muck, Mukilteo muck, Tukwila muck, etc	1	Site has bog or fen characteristics that make it a unique wetland type.
Ranking Criteria:	**Maximum Score**	
Environmental Benefit Criteria	13	

Table 23. Potential Riparian Restoration Site Environmental Benefits Ranking Criteria

Scoring Criteria	Points	Rationale
Site has restoration potential <u>and</u>:		
1) Site reconnects two large forest patches (If criteria for #1 are met, skip #2) Mend_rip = y	2	Maximizes potential to reduce habitat fragmentation/increase connectivity.
2) Site adds to an existing forest patch Add_rip = y	1	Has potential to reduce habitat fragmentation/increase connectivity.
3) Site has 67 meter buffer cts (If criteria for #3 are met, skip #4, 5, and 6) CTS = 3	3	Reforestation of 67 meter buffer has potential to provide maximum temperature attenuation, water quality treatment, fish habitat value, and wood recruitment.
4) More than 50 percent of site has Hydro Code C or D soils	1	The recharge potential of outwash soils precludes substantial increase in flow control if the site is reforested. Riparian reforestation on till or bedrock areas are assumed to provide greater flow control potential.
Ranking Criteria:	**Maximum Score**	
Environmental Benefit Criteria	7	

Table 24. Potential Floodplain Restoration Site Environmental Benefits Ranking Criteria

Scoring Criteria	Points	Rationale
1) Site is decoupled from floodplain Decoupled = y	3	Sites having lost connectivity to the floodplain provide maximum potential for the recovery of floodplain functions.
2) Site has riparian restoration potential Rip_pot = y	1	Sites that can restore riparian areas have potential to provide flow control and improve floodplain function.
3) Site hydrologically reconnects two large floodplain patches (If criterion for #3 are met, skip #4) Mend_fdpln = y	2	Reestablishes floodplain hydrologic connectivity.
4) Site adds to an existing floodplain patch Confined = n	1	Adds to floodplain hydrologic connectivity.
5) Site has wetland restoration potential Potwet = y and Hydro_alt = 1 or 2	1	Sites that can also restore wetland areas have potential to improve floodplain function.
6) Channel migration potential Ch_mig_pot = y	2	Sites with channel migration potential have greater potential to restore and maintain diverse floodplain functions.
Ranking Criteria:	**Maximum Score**	
Environmental Benefit Criteria	10	

Table 25. Potential Fish Habitat Environmental Benefits Ranking Criteria

Scoring Criteria	Points	Rationale
Site has restoration potential <u>and</u>:		
1) Number of species spawning or rearing in the DAU 3 or more species = 2 1-2 species = 1 Zero species = 0 USE-TYPE = 2 or 3 in Washington Lakes and Rivers Information System (WLRIS) database	2	Habitat occupied by multiple salmonid species is assumed to have higher environmental benefit than areas with fewer species. Known spawning areas are key habitat areas that provide one or more critical life stages for salmonid species. Studies in the Pacific Northwest (PNW) have documented that native trout remain close to their spawning areas (Moore and Gregory 1988), implying that distribution of juvenile fish closely reflects the species spawning distribution (Montgomery et al. 1999).
2) DAUs that have high groundwater recharge potential >30% advance and recessional outwash = 1 <30% advance and recessional outwash = 0	1	Outwash geology provide essential phreatic and hyporheic functions that salmonid species rely on to provide spawning habitat and maintenance of summer baseflow (Booth et al. 2003)
3) Identify sites having important habitat characteristics for salmonids Riparian reaches having 0-2% stream gradient unconfined channel and <1% moderately confined channel Gradient = 0-2% = 1 Gradient >2% = 0 Confin = unconfined or moderate = 1 Confin = confined = 0	2	<2% unconfined channels are key habitat to five species of salmonid species
Floodplain sites with Cha_MigPot = y = 1 Cha_MigPot = n = 0	1	Floodplains (0-1%) are key habitat to four salmonid species
Wetland restoration sites with fish access and potential for open water (Fish_acces = 1 and DF, Rl and RF) = 1 All other sites = 0	1	Wetlands - fish access and potential for open water ponds are key habitat for three salmonid species (Beechie et al. 2003; Pess et al. 2002)
4) Rank sites by size		Final rank to separate sites with identical habitat value
Ranking Criteria:	**Maximum Score**	
Environmental Benefit Criteria	7	

Table 26. Potential Stormwater Retrofit Site Environmental Benefits Ranking Criteria

Scoring Criteria	Points	Rationale
1) More than 50 percent of site on SCS Hydro A or B soils >50% A or B soils = y	1	Infiltration contributes to stream base flow and hyporheic exchange.
2) More than 50 percent "Qgos, Qgo, Qga, Qa" surficial geology	2	Infiltration contributes to stream base flow and hyporheic exchange.
3) Site has the ability to divert stormwater from existing stormwater infrastructure Stormwater infrastructure within 300 feet of site	1	Breaking conveyance where possible will improve water quality and recharge groundwater supplies
4) Site avoids habitat with high potential to support anadromous fish. Fish habitat environmental benefit ranking No connect = 3 L = 2 M = 1	3	Stormwater conveys many chemical constituents that are harmful to fish and high volumes can cause erosion to the streambanks, thus the goal is to avoid high quality fish habitat.
5) Stormwater retrofit area is on or adjacent to public lands	1	Site has increased potential for cost savings.
Ranking Criteria:	**Maximum Score**	
Environmental Benefit Criteria - #1 - #5	8	

Sites having an environmental benefit rank of low are removed from further consideration. Starting with the sites having an ecological process rank of high, subdivide these sites into two groups. Group one has an ecological process rank of high and an environmental benefit rank of high. All sites in group one rank above sites in group two, which have an ecological process rank of high and an environmental benefit rank of moderate. This same sorting process is done again for sites with an ecological process rank of moderate, and then again for sites with an ecological process rank of low.

3. Within sites occurring having a common ecological process rank and a like environmental benefit rank, sort each common group by resource in this order: floodplains, wetlands, riparian, stormwater retrofit.

4. Within each common group established in Step #3, order by each sites rank score for contributing to wildlife mobility. Ranks sites scoring 3 above sites having a score of 2, and so on.

5. Within each common group established in Step #4, order all local priority sites ahead of non-local priorities.

6. Within each common group established in Step #5, order all sites on or adjacent to public lands ahead of those not adjacent to public lands.

7. Within each category established in Step #6, order by size, largest area first. Delete sites less than 3.0 acres in size.

Stormwater Priority Ranking Criteria

All Steps for natural resource ranking except #2

Priority ranking criteria for stormwater flow control uses the identical 7-step process described above with one major exception. That exception relates to Step #2 and the use of a proximity score to help meet regulatory stormwater requirements. Step #2 below replaces that step in the natural resource mitigation criteria with specific stormwater criteria to prioritize stormwater flow control sites.

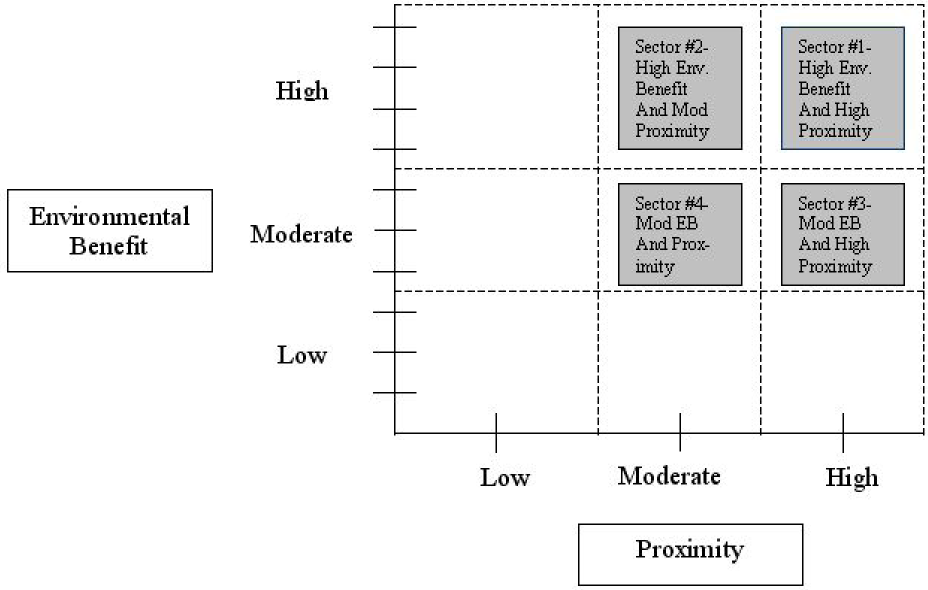
Step #2 for Stormwater Retrofit Site Ranking

Chart potential sites by proximity and environmental benefit rank and establish a sector score for each site, as shown in Figure 2. Then order potential mitigation sites within each process rank, by sector rank.

Establish a priority rank for each site based on the site's upslope distance from the project area (Tables 20 to 23). Establish a sector score for each site using proximity rank and environmental benefit rank and ordering according to Figure 2.

Starting with the sites having an ecological process rank of high, subdivide these sites into four groups based on sector score. All sites with a high ecological process rank and a sector score of 1 are ranked above those with a sector score of 2, and so on. Repeat this same sorting process with sites having an ecological process rank of moderate and then with sites having an ecological process rank of low.

Figure 2. Sector Score for Stormwater Mitigation Sites



Note: Based on Potential Environmental Benefits and Site Proximity to Development Area.

Within each category established in Step #5, order all sites on or adjacent to public lands ahead of those sites that are not on or adjacent.

Step 2. Identify Drainage Analysis Units Having the Greatest Potential to Maintain Function in the Long-term

Purpose

This step identifies DAUs that have the greatest potential to maintain and potentially improve target ecological processes over the long-term. Too often, mitigation sites are selected for their ability to provide needed functions under existing conditions at the site. If substantial growth or development is planned for the surrounding landscape, some functions may not be maintained, leading to environmental degradation. By considering both current and anticipated future land use pressure on each potential mitigation site, managers have the greatest potential to select sites providing functions capable of being maintained in the future. NOTE: This is a future task following the outcome of any future zoning changes.

Methods

1. Identify "at risk" DAUs for target ecological processes developed. .

2. Develop a table that compares current and future land use/land cover.

3. Assess the effects of change in land use intensity on ecological processes through the threshold criteria established in the matrix of landscape pathways and

indicators. One important effect of a change in land cover relates to percent TIA used in the characterization of the delivery of water. Identify DAUs in which percent TIA changes from a "properly functioning" condition under current conditions to "at risk" under future build-out conditions and DAUs that change for an "at risk" condition under current conditions to "not properly functioning" under future build-out conditions. Determine the effect of this change on the overall rank condition for the delivery of water. Identify the DAUs in which a change in the condition rank for percent TIA results in a change in the delivery of water from "properly functioning" to "at risk." Under this situation, consider all potential mitigation sites within these DAUs as "at risk" and revise the ecological condition rank accordingly. Likewise, identify the DAUs in which a change is indicated in the condition rank from an "at risk" condition under current conditions to "not properly functioning" under future build-out condition. Under this situation, consider all potential mitigation sites within these DAUs as "not properly functioning" and revise the ecological condition rank accordingly.

Data Needs

1. Data on the condition of target ecological processes within DAUs under both current and future land use conditions.
2. Current and future land use/land cover layers.

Products

1. A GIS coverage of DAUs in the "at risk" condition for ecological and biological processes under both current and future land use conditions.
2. Revised potential floodplain, wetland, and riparian restoration site databases with the condition rank of all ecological and biological processes assigned to the DAU in which the site resides.

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[vi] Narrative and numeric criteria for indicator condition taken from NOAA-Fisheries (1996)

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Appendix B

Ecological

and

Biological

Processes Ranking

PROJECT AREA

	Ecological Processes					Biological Processes			
DAU Id	Water	Sediment	Wood	Pollutants	Heat	Aquatic Integrity	Habitat	Total Score	Rank
96	3	1	2	1	1	1	1	10	High
203	3	1	2	1	1	1	1	10	High
69	3	1	2	1	1	0	1	9	High
183	3	1	2	0	1	1	1	9	High
195	3	0	2	1	1	1	1	9	High
202	3	1	2	0	1	1	1	9	High
209	3	1	2	0	1	1	1	9	High
247	3	1	2	1	1	0	1	9	High
258	3	1	2	1	1	0	1	9	High
300	3	1	2	0	1	1	1	9	High
27	3	0	2	1	1	0	1	8	High
39	3	0	2	1	1	0	1	8	High
41	3	0	2	1	1	0	1	8	High
47	3	1	2	0	1	0	1	8	High
55	3	1	2	0	1	0	1	8	High
57	3	0	2	1	1	0	1	8	High
84	3	1	2	0	1	0	1	8	High
89	3	1	2	0	1	0	1	8	High
92	3	1	2	0	1	0	1	8	High
93	3	1	2	0	1	0	1	8	High
99	3	1	2	0	1	0	1	8	High
101	3	1	2	0	1	0	1	8	High
102	3	1	2	0	1	0	1	8	High
109	3	1	2	0	1	0	1	8	High
111	3	0	2	0	1	1	1	8	High
117	3	1	2	0	1	0	1	8	High
131	3	1	2	0	1	0	1	8	High
132	3	1	2	0	1	0	1	8	High
135	3	1	2	0	1	0	1	8	High
153	3	1	2	0	1	0	1	8	High
205	3	1	2	0	1	0	1	8	High
208	3	1	2	0	1	0	1	8	High
214	3	1	2	0	1	0	1	8	High
215	3	1	2	0	1	0	1	8	High
224	3	1	2	0	1	0	1	8	High
226	3	1	2	0	1	0	1	8	High
227	3	1	2	0	1	0	1	8	High
230	3	1	2	0	1	0	1	8	High
250	3	1	2	0	1	0	1	8	High
252	3	1	2	0	1	0	1	8	High
259	3	1	2	0	1	0	1	8	High
267	3	1	2	0	1	0	1	8	High
270	3	1	2	0	1	0	1	8	High
278	3	1	2	0	1	0	1	8	High
283	3	1	2	0	1	0	1	8	High
285	3	0	2	0	1	1	1	8	High
10	3	0	2	0	1	0	1	7	High
14	3	0	2	0	1	0	1	7	High
18	3	0	2	0	1	0	1	7	High
23	3	1	0	1	1	0	1	7	High
31	3	0	2	0	1	0	1	7	High
33	3	0	2	0	1	0	1	7	High
35	3	0	2	0	1	0	1	7	High
36	3	0	2	0	1	0	1	7	High
42	3	0	2	0	1	0	1	7	High

PROJECT AREA

	Ecological Processes					Biological Processes			
DAU Id	Water	Sediment	Wood	Pollutants	Heat	Aquatic Integrity	Habitat	Total Score	Rank
44	3	0	2	0	1	0	1	7	High
46	3	0	2	0	1	0	1	7	High
48	3	1	0	1	1	0	1	7	High
56	3	0	2	0	1	0	1	7	High
62	3	1	0	1	1	0	1	7	High
63	3	0	2	0	1	0	1	7	High
68	3	0	2	0	1	0	1	7	High
72	3	0	2	0	1	0	1	7	High
73	3	0	2	0	1	0	1	7	High
74	3	0	2	0	1	0	1	7	High
77	3	0	2	0	1	0	1	7	High
81	3	0	2	0	1	0	1	7	High
82	3	0	2	0	1	0	1	7	High
94	3	0	2	0	1	0	1	7	High
95	3	0	2	0	1	0	1	7	High
113	3	0	2	0	1	0	1	7	High
115	3	0	2	0	1	0	1	7	High
119	3	0	2	0	1	0	1	7	High
124	3	0	2	0	1	0	1	7	High
133	3	0	2	0	1	0	1	7	High
139	3	0	2	0	1	0	1	7	High
140	3	0	2	0	1	0	1	7	High
147	3	0	2	0	1	0	1	7	High
149	3	0	2	0	1	0	1	7	High
151	3	0	2	0	1	0	1	7	High
156	3	0	2	0	1	0	1	7	High
157	3	0	2	0	1	0	1	7	High
160	3	0	2	0	1	0	1	7	High
162	3	0	2	0	1	0	1	7	High
167	3	0	2	0	1	0	1	7	High
172	3	0	2	0	1	0	1	7	High
177	3	0	2	0	1	0	1	7	High
179	3	0	2	0	1	0	1	7	High
198	3	0	2	0	1	0	1	7	High
200	3	0	2	0	1	0	1	7	High
228	3	0	2	0	1	0	1	7	High
232	3	1	0	1	1	0	1	7	High
238	3	0	2	0	1	0	1	7	High
243	3	1	0	1	1	0	1	7	High
254	3	1	0	1	1	0	1	7	High
274	3	0	2	0	1	0	1	7	High
275	3	0	2	0	1	0	1	7	High
276	3	0	2	0	1	0	1	7	High
277	3	0	2	0	1	0	1	7	High
282	3	0	2	0	1	0	1	7	High
284	3	0	2	0	1	0	1	7	High
295	3	1	0	0	1	1	1	7	High
299	3	1	0	0	1	1	1	7	High
303	3	0	2	0	1	0	1	7	High
20	3	0	0	1	1	0	1	6	Moderate
40	3	0	0	1	1	0	1	6	Moderate
45	3	1	0	1	0	0	1	6	Moderate
60	3	1	0	0	1	0	1	6	Moderate
70	3	1	0	0	1	0	1	6	Moderate
71	3	1	0	0	1	0	1	6	Moderate

PROJECT AREA

	Ecological Processes					Biological Processes			
DAU Id	Water	Sediment	Wood	Pollutants	Heat	Aquatic Integrity	Habitat	Total Score	Rank
75	3	1	0	0	1	0	1	6	Moderate
76	3	1	0	0	1	0	1	6	Moderate
78	3	1	0	1	0	0	1	6	Moderate
79	3	1	0	0	1	0	1	6	Moderate
80	3	1	0	0	1	0	1	6	Moderate
83	3	1	0	0	1	0	1	6	Moderate
85	3	1	0	0	1	0	1	6	Moderate
87	3	1	0	0	1	0	1	6	Moderate
88	3	1	0	0	1	0	1	6	Moderate
97	3	1	0	0	1	0	1	6	Moderate
98	3	1	0	0	1	0	1	6	Moderate
100	3	1	0	0	1	0	1	6	Moderate
104	3	1	0	0	1	0	1	6	Moderate
106	3	1	0	0	1	0	1	6	Moderate
110	3	1	0	0	1	0	1	6	Moderate
112	3	1	0	0	1	0	1	6	Moderate
114	3	1	0	0	1	0	1	6	Moderate
120	3	1	0	0	1	0	1	6	Moderate
127	3	1	0	0	1	0	1	6	Moderate
129	3	1	0	0	1	0	1	6	Moderate
138	3	1	0	0	1	0	1	6	Moderate
141	3	1	0	0	1	0	1	6	Moderate
143	3	1	0	0	1	0	1	6	Moderate
145	3	1	0	0	1	0	1	6	Moderate
148	0	1	2	0	1	1	1	6	Moderate
150	3	1	0	0	1	0	1	6	Moderate
152	3	1	0	0	1	0	1	6	Moderate
154	3	1	0	0	1	0	1	6	Moderate
158	3	1	0	0	1	0	1	6	Moderate
164	3	1	0	0	1	0	1	6	Moderate
166	3	1	0	0	1	0	1	6	Moderate
171	3	1	0	0	1	0	1	6	Moderate
174	3	1	0	0	1	0	1	6	Moderate
178	3	1	0	0	1	0	1	6	Moderate
180	3	1	0	0	1	0	1	6	Moderate
189	3	1	0	0	1	0	1	6	Moderate
192	3	1	0	0	1	0	1	6	Moderate
204	3	1	0	0	1	0	1	6	Moderate
213	3	1	0	0	1	0	1	6	Moderate
218	3	1	0	0	1	0	1	6	Moderate
223	3	1	0	0	1	0	1	6	Moderate
225	3	1	0	0	1	0	1	6	Moderate
231	3	1	0	0	1	0	1	6	Moderate
233	3	1	0	0	1	0	1	6	Moderate
235	3	1	0	0	1	0	1	6	Moderate
239	3	1	0	0	1	0	1	6	Moderate
240	3	1	0	0	1	0	1	6	Moderate
244	3	1	0	0	1	0	1	6	Moderate
251	3	1	0	0	1	0	1	6	Moderate
253	3	1	0	0	1	0	1	6	Moderate
255	3	1	0	0	1	0	1	6	Moderate
264	3	1	0	0	1	0	1	6	Moderate
266	3	1	0	0	1	0	1	6	Moderate
268	3	1	0	0	1	0	1	6	Moderate
269	3	1	0	0	1	0	1	6	Moderate

PROJECT AREA

	Ecological Processes					Biological Processes			
DAU Id	Water	Sediment	Wood	Pollutants	Heat	Aquatic Integrity	Habitat	Total Score	Rank
273	3	1	0	0	1	0	1	6	Moderate
280	3	1	0	0	1	0	1	6	Moderate
281	3	1	0	0	1	0	1	6	Moderate
286	3	1	0	0	1	0	1	6	Moderate
287	3	1	0	0	1	0	1	6	Moderate
289	3	1	0	0	1	0	1	6	Moderate
291	3	1	0	0	1	0	1	6	Moderate
293	3	1	0	0	1	0	1	6	Moderate
297	3	0	0	0	1	1	1	6	Moderate
298	3	1	0	0	1	0	1	6	Moderate
302	3	1	0	0	0	1	1	6	Moderate
5	3	0	0	0	1	0	1	5	Moderate
7	3	0	0	0	1	0	1	5	Moderate
8	3	0	0	0	1	0	1	5	Moderate
13	3	0	0	0	1	0	1	5	Moderate
29	3	0	2	0	0	0	0	5	Moderate
30	3	0	0	0	1	0	1	5	Moderate
32	3	0	0	0	1	0	1	5	Moderate
34	3	0	0	0	1	0	1	5	Moderate
37	3	0	0	0	1	0	1	5	Moderate
38	3	0	0	0	1	0	1	5	Moderate
43	3	0	0	0	1	0	1	5	Moderate
50	3	0	0	0	1	0	1	5	Moderate
54	3	0	0	0	1	0	1	5	Moderate
58	3	0	0	0	1	0	1	5	Moderate
59	3	0	0	0	1	0	1	5	Moderate
61	3	0	0	0	1	0	1	5	Moderate
64	3	0	0	0	1	0	1	5	Moderate
65	3	0	0	0	1	0	1	5	Moderate
86	3	0	0	0	1	0	1	5	Moderate
91	3	0	0	0	1	0	1	5	Moderate
103	3	0	0	0	1	0	1	5	Moderate
105	3	0	0	0	1	0	1	5	Moderate
107	3	0	0	0	1	0	1	5	Moderate
108	3	0	0	0	1	0	1	5	Moderate
116	3	1	0	0	1	0	0	5	Moderate
118	3	1	0	0	0	0	1	5	Moderate
122	3	1	0	0	0	0	1	5	Moderate
123	3	0	0	0	1	0	1	5	Moderate
128	3	0	0	0	1	0	1	5	Moderate
130	3	0	0	0	1	0	1	5	Moderate
134	3	0	0	0	1	0	1	5	Moderate
137	3	0	0	0	1	0	1	5	Moderate
142	3	0	0	0	1	0	1	5	Moderate
155	3	0	0	0	1	0	1	5	Moderate
163	3	0	0	0	1	0	1	5	Moderate
165	3	0	0	0	1	0	1	5	Moderate
168	3	0	0	0	1	0	1	5	Moderate
169	3	0	0	0	1	0	1	5	Moderate
170	3	0	0	0	1	0	1	5	Moderate
176	3	0	0	0	1	0	1	5	Moderate
181	3	0	0	0	1	0	1	5	Moderate
182	3	1	0	0	1	0	0	5	Moderate
184	3	0	0	0	1	0	1	5	Moderate
186	3	0	0	0	1	0	1	5	Moderate

PROJECT AREA

	Ecological Processes					Biological Processes			
DAU Id	Water	Sediment	Wood	Pollutants	Heat	Aquatic Integrity	Habitat	Total Score	Rank
188	3	1	0	0	0	0	1	5	Moderate
190	3	0	0	0	1	0	1	5	Moderate
191	3	0	0	0	1	0	1	5	Moderate
197	3	0	0	0	1	0	1	5	Moderate
199	3	0	0	0	1	0	1	5	Moderate
201	3	0	0	0	1	0	1	5	Moderate
210	3	0	0	0	1	0	1	5	Moderate
211	3	1	0	0	0	0	1	5	Moderate
212	3	0	0	0	1	0	1	5	Moderate
216	3	0	0	0	1	0	1	5	Moderate
217	3	0	0	0	1	0	1	5	Moderate
219	3	0	0	0	1	0	1	5	Moderate
220	3	0	0	0	1	0	1	5	Moderate
221	3	0	0	0	1	0	1	5	Moderate
222	3	1	0	0	0	0	1	5	Moderate
229	3	1	0	0	1	0	0	5	Moderate
234	3	0	0	0	1	0	1	5	Moderate
236	3	0	0	0	1	0	1	5	Moderate
237	3	0	0	0	1	0	1	5	Moderate
242	3	0	0	0	1	0	1	5	Moderate
245	3	0	0	0	1	0	1	5	Moderate
246	3	0	0	0	1	0	1	5	Moderate
249	3	0	0	0	1	0	1	5	Moderate
256	0	1	2	0	1	0	1	5	Moderate
257	3	0	0	0	1	0	1	5	Moderate
260	3	0	0	0	1	0	1	5	Moderate
261	0	1	2	0	1	0	1	5	Moderate
262	0	1	2	0	1	0	1	5	Moderate
263	0	1	2	0	1	0	1	5	Moderate
265	3	0	0	0	1	0	1	5	Moderate
271	3	0	0	0	1	0	1	5	Moderate
279	3	0	0	0	1	0	1	5	Moderate
288	3	0	0	0	1	0	1	5	Moderate
290	3	0	0	0	1	0	1	5	Moderate
301	0	0	2	0	1	1	1	5	Moderate
304	3	0	0	0	1	0	1	5	Moderate
305	3	1	0	0	1	0	0	5	Moderate
308	3	1	0	0	0	0	1	5	Moderate
12	3	0	0	1	0	0	0	4	Moderate
15	3	0	0	1	0	0	0	4	Moderate
16	3	0	0	1	0	0	0	4	Moderate
17	3	1	0	0	0	0	0	4	Moderate
26	3	1	0	0	0	0	0	4	Moderate
28	3	0	0	1	0	0	0	4	Moderate
49	3	0	0	0	0	0	1	4	Moderate
53	3	0	0	0	0	0	1	4	Moderate
66	3	1	0	0	0	0	0	4	Moderate
121	3	1	0	0	0	0	0	4	Moderate
146	0	0	2	0	1	0	1	4	Moderate
159	3	1	0	0	0	0	0	4	Moderate
175	3	1	0	0	0	0	0	4	Moderate
185	3	0	0	0	1	0	0	4	Moderate
187	0	0	2	0	1	0	1	4	Moderate
193	3	0	0	0	0	0	1	4	Moderate
207	3	0	0	0	0	0	1	4	Moderate

PROJECT AREA

	Ecological Processes					Biological Processes			
DAU Id	Water	Sediment	Wood	Pollutants	Heat	Aquatic Integrity	Habitat	Total Score	Rank
241	0	0	2	0	1	0	1	4	Moderate
248	0	0	2	0	1	0	1	4	Moderate
272	0	0	2	0	1	0	1	4	Moderate
296	3	0	0	0	1	0	0	4	Moderate
307	3	1	0	0	0	0	0	4	Moderate
2	0	1	0	1	0	0	1	3	Low
3	3	0	0	0	0	0	0	3	Low
4	3	0	0	0	0	0	0	3	Low
6	3	0	0	0	0	0	0	3	Low
9	3	0	0	0	0	0	0	3	Low
11	3	0	0	0	0	0	0	3	Low
19	3	0	0	0	0	0	0	3	Low
21	3	0	0	0	0	0	0	3	Low
22	3	0	0	0	0	0	0	3	Low
24	0	0	0	1	1	0	1	3	Low
25	3	0	0	0	0	0	0	3	Low
51	3	0	0	0	0	0	0	3	Low
52	3	0	0	0	0	0	0	3	Low
67	3	0	0	0	0	0	0	3	Low
90	0	1	0	0	1	0	1	3	Low
125	3	0	0	0	0	0	0	3	Low
126	3	0	0	0	0	0	0	3	Low
136	3	0	0	0	0	0	0	3	Low
144	3	0	0	0	0	0	0	3	Low
161	3	0	0	0	0	0	0	3	Low
173	3	0	0	0	0	0	0	3	Low
194	3	0	0	0	0	0	0	3	Low
292	0	0	2	0	0	0	1	3	Low
306	3	0	0	0	0	0	0	3	Low
1	0	1	0	1	0	0	0	2	Low
196	0	1	0	0	0	0	1	2	Low
294	0	0	0	0	1	0	1	2	Low
206	0	0	0	0	0	0	1	1	Low

KENNEDY CREEK

	Ecological Processes					Biological Processes			
DAU Id	Water	Sediment	Wood	Pollutants	Heat	Aquatic Integrity	Habitat	Total Score	Rank
92	3	1	2	0	1	0	1	8	High
93	3	1	2	0	1	0	1	8	High
99	3	1	2	0	1	0	1	8	High
101	3	1	2	0	1	0	1	8	High
102	3	1	2	0	1	0	1	8	High
117	3	1	2	0	1	0	1	8	High
132	3	1	2	0	1	0	1	8	High
135	3	1	2	0	1	0	1	8	High
208	3	1	2	0	1	0	1	8	High
214	3	1	2	0	1	0	1	8	High
227	3	1	2	0	1	0	1	8	High
230	3	1	2	0	1	0	1	8	High
250	3	1	2	0	1	0	1	8	High
252	3	1	2	0	1	0	1	8	High
267	3	1	2	0	1	0	1	8	High
278	3	1	2	0	1	0	1	8	High
119	3	0	2	0	1	0	1	7	High
124	3	0	2	0	1	0	1	7	High
139	3	0	2	0	1	0	1	7	High
156	3	0	2	0	1	0	1	7	High
238	3	0	2	0	1	0	1	7	High
71	3	1	0	0	1	0	1	6	Moderate
75	3	1	0	0	1	0	1	6	Moderate
76	3	1	0	0	1	0	1	6	Moderate
79	3	1	0	0	1	0	1	6	Moderate
80	3	1	0	0	1	0	1	6	Moderate
87	3	1	0	0	1	0	1	6	Moderate
88	3	1	0	0	1	0	1	6	Moderate
97	3	1	0	0	1	0	1	6	Moderate
98	3	1	0	0	1	0	1	6	Moderate
100	3	1	0	0	1	0	1	6	Moderate
104	3	1	0	0	1	0	1	6	Moderate
110	3	1	0	0	1	0	1	6	Moderate
112	3	1	0	0	1	0	1	6	Moderate
127	3	1	0	0	1	0	1	6	Moderate
145	3	1	0	0	1	0	1	6	Moderate
158	3	1	0	0	1	0	1	6	Moderate
171	3	1	0	0	1	0	1	6	Moderate
178	3	1	0	0	1	0	1	6	Moderate
213	3	1	0	0	1	0	1	6	Moderate
218	3	1	0	0	1	0	1	6	Moderate
225	3	1	0	0	1	0	1	6	Moderate
233	3	1	0	0	1	0	1	6	Moderate
244	3	1	0	0	1	0	1	6	Moderate
253	3	1	0	0	1	0	1	6	Moderate
264	3	1	0	0	1	0	1	6	Moderate
268	3	1	0	0	1	0	1	6	Moderate
280	3	1	0	0	1	0	1	6	Moderate
59	3	0	0	0	1	0	1	5	Moderate
61	3	0	0	0	1	0	1	5	Moderate
64	3	0	0	0	1	0	1	5	Moderate
65	3	0	0	0	1	0	1	5	Moderate
103	3	0	0	0	1	0	1	5	Moderate
130	3	0	0	0	1	0	1	5	Moderate
134	3	0	0	0	1	0	1	5	Moderate
155	3	0	0	0	1	0	1	5	Moderate

KENNEDY CREEK

	Ecological Processes					Biological Processes			
DAU Id	Water	Sediment	Wood	Pollutants	Heat	Aquatic Integrity	Habitat	Total Score	Rank
165	3	0	0	0	1	0	1	5	Moderate
169	3	0	0	0	1	0	1	5	Moderate
176	3	0	0	0	1	0	1	5	Moderate
188	3	1	0	0	0	0	1	5	Moderate
190	3	0	0	0	1	0	1	5	Moderate
201	3	0	0	0	1	0	1	5	Moderate
210	3	0	0	0	1	0	1	5	Moderate
217	3	0	0	0	1	0	1	5	Moderate
220	3	0	0	0	1	0	1	5	Moderate
222	3	1	0	0	0	0	1	5	Moderate
236	3	0	0	0	1	0	1	5	Moderate
246	3	0	0	0	1	0	1	5	Moderate
249	3	0	0	0	1	0	1	5	Moderate
265	3	0	0	0	1	0	1	5	Moderate
241	0	0	2	0	1	0	1	4	Moderate
272	0	0	2	0	1	0	1	4	Moderate
52	3	0	0	0	0	0	0	3	Low
90	0	1	0	0	1	0	1	3	Low
194	3	0	0	0	0	0	0	3	Low

NORTH SCHNEIDER

	Ecological Processes					Biological Processes			
DAU Id	Water	Sediment	Wood	Pollutants	Heat	Aquatic Integrity	Habitat	Total Score	Rank
69	3	1	2	1	1	0	1	9	High
55	3	1	2	0	1	0	1	8	High
57	3	0	2	1	1	0	1	8	High
109	3	1	2	0	1	0	1	8	High
153	3	1	2	0	1	0	1	8	High
44	3	0	2	0	1	0	1	7	High
62	3	1	0	1	1	0	1	7	High
74	3	0	2	0	1	0	1	7	High
82	3	0	2	0	1	0	1	7	High
133	3	0	2	0	1	0	1	7	High
149	3	0	2	0	1	0	1	7	High
157	3	0	2	0	1	0	1	7	High
162	3	0	2	0	1	0	1	7	High
60	3	1	0	0	1	0	1	6	Moderate
78	3	1	0	1	0	0	1	6	Moderate
85	3	1	0	0	1	0	1	6	Moderate
114	3	1	0	0	1	0	1	6	Moderate
141	3	1	0	0	1	0	1	6	Moderate
166	3	1	0	0	1	0	1	6	Moderate
50	3	0	0	0	1	0	1	5	Moderate
105	3	0	0	0	1	0	1	5	Moderate
107	3	0	0	0	1	0	1	5	Moderate
118	3	1	0	0	0	0	1	5	Moderate
49	3	0	0	0	0	0	1	4	Moderate
53	3	0	0	0	0	0	1	4	Moderate
66	3	1	0	0	0	0	0	4	Moderate
67	3	0	0	0	0	0	0	3	Low

SOUTH SCHNEIDER

	Ecological Processes					Biological Processes			
DAU Id	Water	Sediment	Wood	Pollutants	Heat	Aquatic Integrity	Habitat	Total Score	Rank
84	3	1	2	0	1	0	1	8	High
89	3	1	2	0	1	0	1	8	High
70	3	1	0	0	1	0	1	6	Moderate
83	3	1	0	0	1	0	1	6	Moderate
106	3	1	0	0	1	0	1	6	Moderate
120	3	1	0	0	1	0	1	6	Moderate
108	3	0	0	0	1	0	1	5	Moderate
122	3	1	0	0	0	0	1	5	Moderate
123	3	0	0	0	1	0	1	5	Moderate

EAST TOTTEN

	Ecological Processes					Biological Processes			
DAU Id	Water	Sediment	Wood	Pollutants	Heat	Aquatic Integrity	Habitat	Total Score	Rank
27	3	0	2	1	1	0	1	8	High
39	3	0	2	1	1	0	1	8	High
41	3	0	2	1	1	0	1	8	High
23	3	1	0	1	1	0	1	7	High
20	3	0	0	1	1	0	1	6	Moderate
40	3	0	0	1	1	0	1	6	Moderate
45	3	1	0	1	0	0	1	6	Moderate
30	3	0	0	0	1	0	1	5	Moderate
54	3	0	0	0	1	0	1	5	Moderate
58	3	0	0	0	1	0	1	5	Moderate
12	3	0	0	1	0	0	0	4	Moderate
15	3	0	0	1	0	0	0	4	Moderate
16	3	0	0	1	0	0	0	4	Moderate
17	3	1	0	0	0	0	0	4	Moderate
28	3	0	0	1	0	0	0	4	Moderate
2	0	1	0	1	0	0	1	3	Low
9	3	0	0	0	0	0	0	3	Low
19	3	0	0	0	0	0	0	3	Low
24	0	0	0	1	1	0	1	3	Low
1	0	1	0	1	0	0	0	2	Low

SUMMIT LAKE

	Ecological Processes					Biological Processes			
DAU Id	Water	Sediment	Wood	Pollutants	Heat	Aquatic Integrity	Habitat	Total Score	Rank
131	3	1	2	0	1	0	1	8	High
177	3	0	2	0	1	0	1	7	High
198	3	0	2	0	1	0	1	7	High
143	3	1	0	0	1	0	1	6	Moderate
150	3	1	0	0	1	0	1	6	Moderate
154	3	1	0	0	1	0	1	6	Moderate
164	3	1	0	0	1	0	1	6	Moderate
163	3	0	0	0	1	0	1	5	Moderate
168	3	0	0	0	1	0	1	5	Moderate
186	3	0	0	0	1	0	1	5	Moderate
191	3	0	0	0	1	0	1	5	Moderate
306	3	0	0	0	0	0	0	3	Low

MCLANE CREEK

	Ecological Processes					Biological Processes			
DAU Id	Water	Sediment	Wood	Pollutants	Heat	Aquatic Integrity	Habitat	Total Score	Rank
247	3	1	2	1	1	0	1	9	High
258	3	1	2	1	1	0	1	9	High
300	3	1	2	0	1	1	1	9	High
259	3	1	2	0	1	0	1	8	High
270	3	1	2	0	1	0	1	8	High
283	3	1	2	0	1	0	1	8	High
285	3	0	2	0	1	1	1	8	High
232	3	1	0	1	1	0	1	7	High
243	3	1	0	1	1	0	1	7	High
254	3	1	0	1	1	0	1	7	High
274	3	0	2	0	1	0	1	7	High
275	3	0	2	0	1	0	1	7	High
276	3	0	2	0	1	0	1	7	High
277	3	0	2	0	1	0	1	7	High
282	3	0	2	0	1	0	1	7	High
284	3	0	2	0	1	0	1	7	High
295	3	1	0	0	1	1	1	7	High
299	3	1	0	0	1	1	1	7	High
239	3	1	0	0	1	0	1	6	Moderate
251	3	1	0	0	1	0	1	6	Moderate
255	3	1	0	0	1	0	1	6	Moderate
266	3	1	0	0	1	0	1	6	Moderate
269	3	1	0	0	1	0	1	6	Moderate
273	3	1	0	0	1	0	1	6	Moderate
281	3	1	0	0	1	0	1	6	Moderate
286	3	1	0	0	1	0	1	6	Moderate
287	3	1	0	0	1	0	1	6	Moderate
289	3	1	0	0	1	0	1	6	Moderate
291	3	1	0	0	1	0	1	6	Moderate
293	3	1	0	0	1	0	1	6	Moderate
297	3	0	0	0	1	1	1	6	Moderate
298	3	1	0	0	1	0	1	6	Moderate
302	3	1	0	0	0	1	1	6	Moderate
234	3	0	0	0	1	0	1	5	Moderate
237	3	0	0	0	1	0	1	5	Moderate
242	3	0	0	0	1	0	1	5	Moderate
245	3	0	0	0	1	0	1	5	Moderate
257	3	0	0	0	1	0	1	5	Moderate
260	3	0	0	0	1	0	1	5	Moderate
263	0	1	2	0	1	0	1	5	Moderate
271	3	0	0	0	1	0	1	5	Moderate
279	3	0	0	0	1	0	1	5	Moderate
288	3	0	0	0	1	0	1	5	Moderate
290	3	0	0	0	1	0	1	5	Moderate
301	0	0	2	0	1	1	1	5	Moderate
296	3	0	0	0	1	0	0	4	Moderate
292	0	0	2	0	0	0	1	3	Low
294	0	0	0	0	1	0	1	2	Low

WEST ELD

	Ecological Processes					Biological Processes			
DAU Id	Water	Sediment	Wood	Pollutants	Heat	Aquatic Integrity	Habitat	Total Score	Rank
47	3	1	2	0	1	0	1	8	High
10	3	0	2	0	1	0	1	7	High
14	3	0	2	0	1	0	1	7	High
18	3	0	2	0	1	0	1	7	High
31	3	0	2	0	1	0	1	7	High
35	3	0	2	0	1	0	1	7	High
36	3	0	2	0	1	0	1	7	High
42	3	0	2	0	1	0	1	7	High
46	3	0	2	0	1	0	1	7	High
56	3	0	2	0	1	0	1	7	High
63	3	0	2	0	1	0	1	7	High
68	3	0	2	0	1	0	1	7	High
73	3	0	2	0	1	0	1	7	High
77	3	0	2	0	1	0	1	7	High
81	3	0	2	0	1	0	1	7	High
129	3	1	0	0	1	0	1	6	Moderate
138	3	1	0	0	1	0	1	6	Moderate
152	3	1	0	0	1	0	1	6	Moderate
5	3	0	0	0	1	0	1	5	Moderate
7	3	0	0	0	1	0	1	5	Moderate
8	3	0	0	0	1	0	1	5	Moderate
13	3	0	0	0	1	0	1	5	Moderate
29	3	0	2	0	0	0	0	5	Moderate
32	3	0	0	0	1	0	1	5	Moderate
34	3	0	0	0	1	0	1	5	Moderate
37	3	0	0	0	1	0	1	5	Moderate
38	3	0	0	0	1	0	1	5	Moderate
43	3	0	0	0	1	0	1	5	Moderate
91	3	0	0	0	1	0	1	5	Moderate
137	3	0	0	0	1	0	1	5	Moderate
159	3	1	0	0	0	0	0	4	Moderate
3	3	0	0	0	0	0	0	3	Low
4	3	0	0	0	0	0	0	3	Low
6	3	0	0	0	0	0	0	3	Low
11	3	0	0	0	0	0	0	3	Low
22	3	0	0	0	0	0	0	3	Low
25	3	0	0	0	0	0	0	3	Low
51	3	0	0	0	0	0	0	3	Low
173	3	0	0	0	0	0	0	3	Low

SOUTH ELD

	Ecological Processes					Biological Processes			
DAU Id	Water	Sediment	Wood	Pollutants	Heat	Aquatic Integrity	Habitat	Total Score	Rank
72	3	0	2	0	1	0	1	7	High
95	3	0	2	0	1	0	1	7	High
113	3	0	2	0	1	0	1	7	High
115	3	0	2	0	1	0	1	7	High
86	3	0	0	0	1	0	1	5	Moderate
116	3	1	0	0	1	0	0	5	Moderate
128	3	0	0	0	1	0	1	5	Moderate
142	3	0	0	0	1	0	1	5	Moderate
146	0	0	2	0	1	0	1	4	Moderate
125	3	0	0	0	0	0	0	3	Low
136	3	0	0	0	0	0	0	3	Low
144	3	0	0	0	0	0	0	3	Low

NORTH ELD

	Ecological Processes					Biological Processes			
DAU Id	Water	Sediment	Wood	Pollutants	Heat	Aquatic Integrity	Habitat	Total Score	Rank
21	3	0	0	0	0	0	0	3	Low
26	3	1	0	0	0	0	0	4	Moderate
33	3	0	2	2	1	0	1	7	High
48	3	1	0	0	1	0	1	7	High

PERRY CREEK

	Ecological Processes					Biological Processes			
DAU Id	Water	Sediment	Wood	Pollutants	Heat	Aquatic Integrity	Habitat	Total Score	Rank
203	3	1	2	1	1	1	1	10	High
183	3	1	2	0	1	1	1	9	High
195	3	0	2	1	1	1	1	9	High
202	3	1	2	0	1	1	1	9	High
209	3	1	2	0	1	1	1	9	High
200	3	0	2	0	1	0	1	7	High
228	3	0	2	0	1	0	1	7	High
174	3	1	0	0	1	0	1	6	Moderate
180	3	1	0	0	1	0	1	6	Moderate
189	3	1	0	0	1	0	1	6	Moderate
192	3	1	0	0	1	0	1	6	Moderate
204	3	1	0	0	1	0	1	6	Moderate
223	3	1	0	0	1	0	1	6	Moderate
231	3	1	0	0	1	0	1	6	Moderate
235	3	1	0	0	1	0	1	6	Moderate
181	3	0	0	0	1	0	1	5	Moderate
211	3	1	0	0	0	0	1	5	Moderate
256	0	1	2	0	1	0	1	5	Moderate
261	0	1	2	0	1	0	1	5	Moderate
262	0	1	2	0	1	0	1	5	Moderate
175	3	1	0	0	0	0	0	4	Moderate
187	0	0	2	0	1	0	1	4	Moderate
248	0	0	2	0	1	0	1	4	Moderate

GREEN COVE CREEK

	Ecological Processes					Biological Processes			
DAU Id	Water	Sediment	Wood	Pollutants	Heat	Aquatic Integrity	Habitat	Total Score	Rank
96	3	1	2	1	1	1	1	10	High
111	3	0	2	0	1	1	1	8	High
94	3	0	2	0	1	0	1	7	High
140	3	0	2	0	1	0	1	7	High
147	3	0	2	0	1	0	1	7	High
151	3	0	2	0	1	0	1	7	High
172	3	0	2	0	1	0	1	7	High
179	3	0	2	0	1	0	1	7	High
303	3	0	2	0	1	0	1	7	High
148	0	1	2	0	1	1	1	6	Moderate
182	3	1	0	0	1	0	0	5	Moderate
304	3	0	0	0	1	0	1	5	Moderate
305	3	1	0	0	1	0	0	5	Moderate
308	3	1	0	0	0	0	1	5	Moderate
121	3	1	0	0	0	0	0	4	Moderate
185	3	0	0	0	1	0	0	4	Moderate
307	3	1	0	0	0	0	0	4	Moderate
126	3	0	0	0	0	0	0	3	Low

MUD BAY

	Ecological Processes					Biological Processes			
DAU Id	Water	Sediment	Wood	Pollutants	Heat	Aquatic Integrity	Habitat	Total Score	Rank
205	3	1	2	0	1	0	1	8	High
215	3	1	2	0	1	0	1	8	High
224	3	1	2	0	1	0	1	8	High
226	3	1	2	0	1	0	1	8	High
160	3	0	2	0	1	0	1	7	High
167	3	0	2	0	1	0	1	7	High
240	3	1	0	0	1	0	1	6	Moderate
170	3	0	0	0	1	0	1	5	Moderate
184	3	0	0	0	1	0	1	5	Moderate
197	3	0	0	0	1	0	1	5	Moderate
199	3	0	0	0	1	0	1	5	Moderate
212	3	0	0	0	1	0	1	5	Moderate
216	3	0	0	0	1	0	1	5	Moderate
219	3	0	0	0	1	0	1	5	Moderate
221	3	0	0	0	1	0	1	5	Moderate
229	3	1	0	0	1	0	0	5	Moderate
193	3	0	0	0	0	0	1	4	Moderate
207	3	0	0	0	0	0	1	4	Moderate
161	3	0	0	0	0	0	0	3	Low
196	0	1	0	0	0	0	1	2	Low
206	0	0	0	0	0	0	1	1	Low

Appendix C

Natural Resource Site Ranking

Kinnedy Creek Wetlands

Hydro_Alt	Veg_Alt	Hydric_Soi	Surface_Hy	Muck_Score	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strm_Re	Sq_Ft
2	2	1	1	0	6	High	4	0	0	0	2	0	2	789884
2	2	1	1	0	6	High	4	0	0	0	2	0	2	762219
2	2	1	1	0	6	High	4	0	0	0	2	0	2	458180
2	1	1	1	1	6	High	4	0	0	0	2	0	2	211711
2	1	1	1	0	5	Moderate	3	1	0	0	1	0	2	16413498
2	1	1	1	0	5	Moderate	3	1	0	0	1	0	2	5150014
2	1	1	1	0	5	Moderate	5	0	0	0	2	0	2	2943939
2	1	1	1	0	5	Moderate	3	1	0	0	2	0	3	363318
2	1	0	1	0	4	Moderate	3	0	0	0	2	0	2	2551337
2	1	1	0	0	4	Moderate	3	1	0	0	0	0	1	846817
2	0	1	1	0	4	Moderate	3	0	0	0	0	0	0	5443723
0	1	1	1	0	3	Low	0	0	0	0	2	0	2	862950
0	1	1	1	0	3	Low	0	0	2	0	3	0	5	81546
0	1	1	1	0	3	Low	0	1	0	0	2	0	3	751037
0	1	1	1	0	3	Low	0	0	2	0	3	0	5	242535
0	1	1	1	0	3	Low	0	1	2	0	1	0	4	475050
0	0	1	1	0	2	Low	0	0	2	0	1	0	3	249413
0	0	1	1	0	2	Low	0	0	0	0	2	0	2	184819
0	0	1	1	0	2	Low	0	1	2	0	1	0	4	550524
0	0	1	1	0	2	Low	0	1	2	0	1	0	4	530799
0	0	1	1	0	2	Low	0	1	2	0	1	0	4	123482
0	0	1	1	0	2	Low	0	1	2	0	2	0	5	121362
0	0	1	1	0	2	Low	0	1	0	0	2	0	3	171612
0	1	1	0	0	2	Low	0	0	0	0	3	0	3	114853
0	0	1	0	0	1	Low	0	0	0	0	2	0	2	462430
0	0	1	0	0	1	Low	0	1	0	0	2	0	3	47315
0	0	1	0	0	1	Low	0	0	0	0	3	0	3	65951
0	0	0	0	0	0	Low	0	0	0	0	0	0	0	6332985

Kinnedy Creek Riparian

Mend_Score	Addition_S	CTS_	Soils_	Adjacency_	LocalPrior	Score	Rank	Combined_D	AorB_	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
2	0	2	0	0	1	5	High	4	1	0	0	2	0	3	341299
0	1	2	0	0	1	4	High	4	1	0	0	2	0	3	1276084
0	1	2	0	1	0	4	High	4	1	0	0	2	0	3	223461
0	1	1	0	0	1	3	Moderate	3	1	0	0	2	0	3	800071
0	1	1	0	0	1	3	Moderate	3	1	0	0	2	0	3	1981758
0	1	1	0	0	1	3	Moderate	3	1	0	0	2	0	3	486928
2	0	0	0	1	0	3	Moderate	3	1	0	0	2	0	3	636172
2	0	0	0	1	0	3	Moderate	3	1	0	0	2	1	4	594001
2	0	0	0	1	0	3	Moderate	3	1	0	0	2	0	3	1037512
2	0	1	0	0	0	3	Moderate	3	1	0	0	0	0	1	1965017
2	0	1	0	0	0	3	Moderate	3	1	0	0	2	0	3	1506696
0	1	1	0	0	0	2	Moderate	3	1	0	0	2	0	3	1068305
2	0	0	0	0	0	2	Moderate	5	1	0	0	1	0	2	552537
0	1	1	0	0	0	2	Moderate	3	1	0	0	2	0	3	301061
0	0	0	1	0	1	2	Moderate	3	0	0	0	2	0	2	501022
0	1	1	0	0	0	2	Moderate	3	1	2	0	2	0	5	877764
0	1	1	0	0	0	2	Moderate	3	1	0	0	2	0	3	500137
0	1	0	0	1	0	2	Moderate	5	1	0	0	3	0	4	187289
0	1	0	0	1	0	2	Moderate	3	1	0	0	2	0	3	2592405
0	1	0	0	1	0	2	Moderate	3	1	0	0	2	0	3	216742
0	1	0	1	0	0	2	Moderate	3	0	0	0	2	0	2	121710
2	0	0	0	0	0	2	Moderate	3	1	0	0	0	0	1	4854467
0	1	1	0	0	0	2	Moderate	3	0	0	0	2	0	2	117962
0	0	0	0	0	1	1	Low	0	1	0	0	2	0	3	541791
0	1	0	0	0	0	1	Low	0	1	2	0	2	0	5	430106
0	0	0	0	0	1	1	Low	0	1	0	0	2	0	3	356658
0	0	0	0	0	1	1	Low	0	1	0	0	2	0	3	2041639
0	1	0	0	0	0	1	Low	0	1	0	0	2	0	3	1124614
0	1	0	0	0	0	1	Low	0	1	0	0	2	0	3	1123310
0	0	0	0	1	0	1	Low	0	1	0	0	2	0	3	271676
0	0	0	0	1	0	1	Low	0	1	0	0	2	1	4	862020
0	0	0	0	1	0	1	Low	0	1	0	0	2	1	4	441950
0	0	1	0	0	0	1	Low	0	1	0	0	2	0	3	7656621
0	0	0	0	1	0	1	Low	0	1	0	0	2	1	4	4490145

Kinnedy Creek Riparian

Mend_Score	Addition_S	CTS_	Soils_	Adjacency_	LocalPrior	Score	Rank	Combined_D	AorB_	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
0	1	0	0	0	0	1	Low	0	1	0	0	2	0	3	208921
0	0	0	0	0	0	0	Low	0	1	0	0	1	0	2	5272092
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	7613907
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	388242
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	244189
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	493660
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	7971588
0	0	0	0	0	0	0	Low	0	1	0	0	1	0	2	4679167
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	599296
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	223130
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	231138
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	554503
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	329219
0	0	0	0	0	0	0	Low	0	1	2	0	1	0	4	11580476
0	0	0	0	0	0	0	Low	0	0	2	0	3	0	5	675799
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	762600
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	1494752
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	8175510
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	1284374
0	0	0	0	0	0	0	Low	0	1	2	0	1	0	4	6293972
0	0	0	0	0	0	0	Low	0	1	2	0	0	0	3	9332861
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	4077052
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	3114552
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	7417683
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	1215872
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	2724485
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	1860202
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	1251555
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	9594812
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	252366
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	762467
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	2347190
0	0	0	0	0	0	0	Low	0	1	2	0	2	0	5	429474
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	267441
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	399742

Kinnedy Creek Riparian

Mend_Score	Addition_S	CTS_	Soils_	Adjacency_	LocalPrior	Score	Rank	Combined_D	AorB_	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	598284
0	0	0	0	0	0	0	Low	0	0	0	0	0	0	0	3577394
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	1964211
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	515841

North Schneider Wetlands

Hydro_Alt_	Vegetation	Hydric_Soi	Surface_Hy	Muck_Score	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
2	1	1	1	1	6	High	6	0	0	0	1	0	1	2248252
2	1	1	1	1	6	High	6	0	2	0	0	0	2	620128
3	2	0	1	0	6	High	4	0	2	0	0	0	2	3808101
3	1	1	1	0	6	High	4	0	2	0	0	0	2	364405
2	1	1	1	0	5	Moderate	5	1	0	0	0	0	1	2123762
2	1	1	1	0	5	Moderate	5	1	2	0	0	0	3	399284
3	1	1	0	0	5	Moderate	5	0	2	0	0	0	2	688939
2	1	1	1	0	5	Moderate	3	0	0	0	0	0	0	316371
2	2	1	0	0	5	Moderate	3	1	0	0	3	0	4	29220
2	2	0	0	0	4	Moderate	3	0	0	0	3	0	3	13867
2	2	0	0	0	4	Moderate	5	0	0	0	3	0	3	49613
2	2	0	0	0	4	Moderate	3	0	2	0	0	0	2	90664
2	1	0	0	0	3	Low	0	0	0	0	3	0	3	377719
2	0	0	1	0	3	Low	0	0	0	0	0	0	0	193131
0	2	1	0	0	3	Low	0	1	0	0	3	0	4	41017
2	1	0	0	0	3	Low	0	0	0	0	3	0	3	3978
0	0	1	0	1	2	Low	0	0	0	0	0	0	0	1288105
0	0	1	0	1	2	Low	0	0	0	0	2	0	2	270853
0	0	1	1	0	2	Low	0	0	2	0	0	0	2	489298
0	2	0	0	0	2	Low	0	0	0	0	3	0	3	67942
0	0	1	0	1	2	Low	0	0	2	0	0	0	2	365409
0	0	1	1	0	2	Low	0	0	0	0	0	0	0	341998
0	0	1	1	0	2	Low	0	0	0	0	0	0	0	120980
0	0	1	1	0	2	Low	0	1	0	0	0	0	1	529337
0	0	1	1	0	2	Low	0	1	0	0	0	0	1	112488
0	0	0	1	0	1	Low	0	0	0	0	3	0	3	1166501
0	0	1	0	0	1	Low	0	0	0	0	0	0	0	933047
0	0	1	0	0	1	Low	0	1	0	0	0	0	1	345271
0	0	0	1	0	1	Low	0	0	0	0	0	0	0	670809
0	0	1	0	0	1	Low	0	0	0	0	3	0	3	212573
0	0	1	0	0	1	Low	0	0	0	0	3	0	3	388960
0	0	0	1	0	1	Low	0	0	2	0	0	0	2	385077
0	0	0	1	0	1	Low	0	0	2	0	0	0	2	1473009
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	188983

North Schneider Wetlands

Hydro_Alt_	Vegetation	Hydric_Soi	Surface_Hy	Muck_Score	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	205422
0	0	0	0	0	0	Low	0	0	2	0	3	0	5	60138
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	475191

North Schneider Riparian

Mend_Score	Addition_S	CTS_	Soils_Scor	Adjacency_	LocalPrior	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
0	1	1	0	0	1	3	Moderate	3	0	2	0	0	0	2	305062
0	1	1	0	0	1	3	Moderate	5	0	2	0	0	0	2	268559
0	1	1	0	0	1	3	Moderate	5	1	2	0	0	0	3	220463
0	1	1	0	0	1	3	Moderate	3	0	0	0	0	0	0	149612
0	1	1	0	0	1	3	Moderate	3	0	0	0	0	0	0	294453
0	1	1	0	0	1	3	Moderate	3	0	0	0	0	0	0	508791
0	1	0	1	0	1	3	Moderate	3	0	0	0	0	0	0	234133
0	1	1	0	0	1	3	Moderate	5	0	2	0	0	0	2	206184
0	1	0	1	0	1	3	Moderate	5	0	0	0	0	0	0	992616
2	0	1	0	0	0	3	Moderate	3	1	0	0	2	0	3	314599
0	0	0	1	0	1	2	Moderate	5	0	0	0	0	0	0	967304
0	1	0	1	0	0	2	Moderate	3	0	2	0	3	0	5	500382
0	1	0	1	0	0	2	Moderate	5	0	2	0	3	0	5	168608
0	1	0	1	0	0	2	Moderate	5	0	2	0	3	0	5	311364
0	1	1	0	0	0	2	Moderate	5	1	2	0	0	0	3	231949
0	1	1	0	0	0	2	Moderate	3	1	0	0	0	0	1	270846
0	1	0	0	0	1	2	Moderate	3	1	2	0	0	0	3	301740
0	1	0	1	0	0	2	Moderate	3	0	2	0	3	0	5	35235
0	0	0	1	0	1	2	Moderate	3	0	2	0	0	0	2	72361
0	1	0	1	0	0	2	Moderate	3	0	2	0	3	0	5	307438
0	1	1	0	0	0	2	Moderate	3	1	0	0	1	0	2	339791
0	1	1	0	0	0	2	Moderate	5	1	0	0	0	0	1	734956
0	0	0	1	0	0	1	Low	0	0	2	0	3	0	5	257184
0	0	0	1	0	0	1	Low	0	0	2	0	3	0	5	344745
0	0	0	1	0	0	1	Low	0	0	2	0	3	0	5	414678
0	0	0	1	0	0	1	Low	0	0	2	0	0	0	2	1583324
0	0	0	1	0	0	1	Low	0	0	2	0	0	0	2	875258
0	0	0	1	0	0	1	Low	0	0	0	0	0	0	0	705769
0	0	0	1	0	0	1	Low	0	0	0	0	0	0	0	339770
0	0	0	1	0	0	1	Low	0	0	0	0	3	0	3	103064
0	0	0	1	0	0	1	Low	0	0	2	0	3	0	5	182682
0	0	0	1	0	0	1	Low	0	0	0	0	0	0	0	487840
0	0	0	0	0	1	1	Low	0	1	0	0	0	0	1	3887081
0	0	0	1	0	0	1	Low	0	0	0	0	1	0	1	378665

North Schneider Riparian

Mend_Score	Addition_S	CTS_	Soils_Scor	Adjacency_	LocalPrior	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
0	0	0	1	0	0	1	Low	0	0	0	0	1	0	1	233702
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	549616
0	0	0	0	0	0	0	Low	0	1	0	0	0	0	1	2383220
0	0	0	0	0	0	0	Low	0	1	0	0	3	0	4	456360
0	0	0	0	0	0	0	Low	0	1	0	0	0	0	1	198338
0	0	0	0	0	0	0	Low	0	1	2	0	1	0	4	727238
0	0	0	0	0	0	0	Low	0	1	0	0	3	0	4	436355
0	0	0	0	0	0	0	Low	0	1	0	0	1	0	2	3307548
0	0	0	0	0	0	0	Low	0	1	0	0	0	0	1	462593
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	657184
0	0	0	0	0	0	0	Low	0	1	0	0	1	0	2	5580399
0	0	0	0	0	0	0	Low	0	0	0	0	0	0	0	210413

South Schneider Wetlands

Hydro_Alt_	Vegetation	Hydric_Soi	Surface_Hy	Muck_Score	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
2	2	1	1	0	6	High	4	1	0	0	2	0	3	172949
2	0	1	1	0	4	Moderate	3	0	2	0	2	0	4	393862
0	2	0	1	0	3	Low	0	0	0	0	3	0	3	194446
2	0	0	1	0	3	Low	0	0	0	0	1	0	1	1663230
0	0	1	0	1	2	Low	0	0	0	0	3	0	3	116277
0	0	1	1	0	2	Low	0	0	2	0	2	0	4	167329
0	0	0	1	0	1	Low	0	0	0	0	1	0	1	270526
0	0	0	1	0	1	Low	0	0	0	0	2	0	2	83323
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	528536

South Schneider Riparian

Mend_Score	Addition_S	CTS_	Soils_Scor	Adjacency_	LocalPrior	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
2	0	1	0	1	0	4	High	4	1	2	0	2	0	5	3279993
2	0	1	0	1	0	4	High	4	1	0	0	2	0	3	562329
2	0	0	0	1	0	3	Moderate	3	1	0	0	2	0	3	487744
0	1	1	0	0	0	2	Moderate	3	0	0	0	1	0	1	433783
0	0	0	1	0	0	1	Low	0	0	0	0	1	0	1	601895
0	0	0	1	0	0	1	Low	0	0	0	0	1	0	1	5017398
0	0	0	0	0	0	0	Low	0	1	0	0	0	0	1	791645
0	0	0	0	0	0	0	Low	0	1	2	0	1	0	4	1296417
0	0	0	0	0	0	0	Low	0	1	2	0	1	0	4	1079717
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	2445883
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	2494390
0	0	0	0	0	0	0	Low	0	1	0	0	1	0	2	6346202
0	0	0	0	0	0	0	Low	0	0	0	0	1	0	1	1078273

East Totten Wetlands

Hydro_Alt_	Vegetation	Hydric_Soi	Surface_Hy	Muck_Score	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
2	2	0	1	0	5	Moderate	3	0	2	0	2	0	4	136966
2	2	0	0	0	4	Moderate	3	0	2	0	3	0	5	230178
2	2	0	0	0	4	Moderate	3	0	2	0	3	0	5	545279
2	1	0	1	0	4	Moderate	3	0	0	0	2	0	2	325359
0	2	0	0	0	2	Low	0	0	0	0	3	0	3	65168
0	2	0	0	0	2	Low	0	0	2	0	3	0	5	120112
0	2	0	0	0	2	Low	0	0	0	0	3	0	3	88719
0	2	0	0	0	2	Low	0	0	0	0	3	0	3	160668
0	0	1	1	0	2	Low	0	0	2	0	2	0	4	285303
0	1	0	0	0	1	Low	0	0	0	0	3	0	3	88909
0	1	0	0	0	1	Low	0	0	2	0	3	0	5	242614
0	0	1	0	0	1	Low	0	1	2	0	3	0	6	41150
0	1	0	0	0	1	Low	0	0	0	0	3	0	3	49917
0	0	0	1	0	1	Low	0	0	0	0	2	0	2	379044
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	71773
0	0	0	0	0	0	Low	0	0	2	0	3	0	5	403323
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	63008
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	101391
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	166299
0	0	0	0	0	0	Low	0	0	2	0	3	0	5	79346
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	129374
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	21241
0	0	0	0	0	0	Low	0	0	0	0	2	0	2	192266
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	448088
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	24555
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	96156
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	149542
0	0	0	0	0	0	Low	0	0	0	0	2	0	2	1153997
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	83534
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	210998

East Totten Riparian

Mend_Scc	Addition_S	CTS_	Soils_Scor	Adjacen	Local Prior	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Stormwtr_Re	Sq Ft
0	1	0	1	0	0	2	Moderate	3	0	2	0	2	0	4	290418
0	0	0	1	0	0	1	Low	0	0	0	0	2	0	2	143967
0	0	0	1	0	0	1	Low	0	0	0	0	2	0	2	50614
0	0	0	1	0	0	1	Low	0	0	0	0	2	0	2	768269
0	0	0	1	0	0	1	Low	0	0	0	0	2	0	2	607035
0	0	0	1	0	0	1	Low	0	0	0	0	2	0	2	968776
0	0	0	1	0	0	1	Low	0	0	2	0	2	0	4	362672
0	0	0	1	0	0	1	Low	0	0	0	0	2	0	2	1245350
0	0	0	1	0	0	1	Low	0	0	0	0	2	0	2	730605
0	0	0	1	0	0	1	Low	0	0	0	0	2	0	2	461305
0	0	0	1	0	0	1	Low	0	0	0	0	2	0	2	341909
0	0	0	1	0	0	1	Low	0	0	0	0	2	0	2	181596
0	0	0	1	0	0	1	Low	0	0	0	0	2	0	2	425569
0	0	0	1	0	0	1	Low	0	0	0	0	2	0	2	400912
0	0	0	1	0	0	1	Low	0	0	0	0	2	0	2	510017
0	0	0	1	0	0	1	Low	0	0	0	0	2	0	2	256823
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	126252
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	152873

Summit Lake Wetlands

Hydro_Alt_	Vegetation	Hydric_Soi	Surface_Hy	Muck_Score	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
2	2	1	1	0	6	High	6	0	0	0	2	0	2	53066
0	0	1	0	1	2	Low	0	0	2	1	2	0	5	1339164
0	0	1	1	0	2	Low	0	1	0	0	3	0	4	58079
0	0	1	1	0	2	Low	0	1	0	0	3	0	4	43184
0	0	1	1	0	2	Low	0	0	0	0	2	0	2	536136
0	0	1	1	0	2	Low	0	0	0	0	2	0	2	56190
0	0	1	1	0	2	Low	0	0	2	0	3	0	5	622666

Summit Lake Riparian

Mend_Score	Addition_S	CTS_	Soils_Scor	Adjacency_	LocalPrior	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
0	1	0	0	1	1	3	Moderate	5	1	0	0	2	1	4	263869
0	1	1	0	1	0	3	Moderate	3	1	0	1	2	0	4	647160
0	1	1	0	0	0	2	Moderate	3	1	0	0	2	0	3	496285
0	1	1	0	0	0	2	Moderate	3	1	0	0	2	0	3	433170
0	0	0	1	0	0	1	Low	0	1	0	0	2	0	3	544442
0	0	0	1	0	0	1	Low	0	0	0	0	2	0	2	194025
0	0	0	0	1	0	1	Low	0	1	2	0	2	1	6	1882737
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	464429
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	219745
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	574062
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	599658
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	330744
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	426181
0	0	0	0	0	0	0	Low	0	1	0	1	2	0	4	654156
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	359948
0	0	0	0	0	0	0	Low	0	1	0	1	2	0	4	315423
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	502008
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	1382435
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	339488
0	0	0	0	0	0	0	Low	0	1	0	0	3	0	4	816968

McLane Creek Wetlands

Hydro_Alt_	Vegetation	Hydric_Soi	Surface_Hy	Muck_Score	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
2	2	1	1	0	6	High	4	0	2	0	0	0	2	2807846
2	1	1	1	1	6	High	6	0	2	0	3	0	5	624276
2	2	1	1	0	6	High	4	0	2	0	2	0	4	475386
2	2	1	1	0	6	High	4	1	2	0	0	0	3	519516
2	1	1	1	0	5	Moderate	3	0	0	0	2	0	2	1348010
2	1	1	1	0	5	Moderate	3	0	2	0	0	0	2	722417
2	1	1	1	0	5	Moderate	5	1	0	0	0	0	1	696716
2	2	0	1	0	5	Moderate	5	0	0	0	3	0	3	578200
2	1	1	1	0	5	Moderate	5	1	0	0	0	0	1	188255
2	2	1	0	0	5	Moderate	3	0	0	0	3	0	3	36568
0	2	1	1	0	4	Moderate	5	0	2	0	0	0	2	10712213
0	0	1	1	1	3	Low	0	0	2	0	0	0	2	6216508
0	1	1	1	0	3	Low	0	0	2	0	0	0	2	356553
0	1	1	1	0	3	Low	0	1	0	0	3	0	4	40301
0	1	1	1	0	3	Low	0	0	0	0	2	0	2	310869
0	0	1	1	0	2	Low	0	0	0	0	2	0	2	2237028
0	0	1	1	0	2	Low	0	0	0	0	0	0	0	1021700
0	1	0	1	0	2	Low	0	0	2	0	0	0	2	278500
0	0	1	1	0	2	Low	0	1	2	0	0	0	3	161963
0	2	0	0	0	2	Low	0	0	0	0	3	0	3	161223
0	0	1	1	0	2	Low	0	0	2	0	1	0	3	823125
0	0	1	1	0	2	Low	0	0	2	0	1	0	3	507946
0	2	0	0	0	2	Low	0	0	2	0	3	0	5	14433
0	2	0	0	0	2	Low	0	0	2	0	3	0	5	339907
0	1	0	1	0	2	Low	0	0	2	0	3	0	5	82306
0	1	0	1	0	2	Low	0	0	2	0	0	0	2	68833
0	1	1	0	0	2	Low	0	0	0	1	3	0	4	62840
0	0	1	1	0	2	Low	0	1	0	0	1	0	2	62197
0	0	1	1	0	2	Low	0	0	0	0	2	0	2	43364
0	0	0	1	0	1	Low	0	0	2	0	1	0	3	324102
0	0	0	1	0	1	Low	0	0	0	1	1	0	2	207595
0	0	1	0	0	1	Low	0	1	0	0	3	0	4	24120
0	0	1	0	0	1	Low	0	1	0	0	3	0	4	10909
0	0	0	0	0	0	Low	0	0	2	0	3	0	5	629491

McLane Creek Wetlands

Hydro_Alt_	Vegetation	Hydric_Soi	Surface_Hy	Muck_Score	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	750968
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	90642
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	44104
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	30374

McLane Creek Riparian

Mend_Score	Addition_S	CTS_Score	Soils_Scor	Adjacency_	LocalPrior	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
0	1	0	1	0	1	3	Moderate	3	0	2	0	0	0	2	1108332
2	0	0	1	0	0	3	Moderate	5	0	0	0	3	0	3	692324
0	1	1	0	0	1	3	Moderate	3	0	2	0	0	0	2	196167
0	1	1	0	0	1	3	Moderate	5	0	2	0	0	0	2	364402
0	1	0	1	0	1	3	Moderate	3	0	2	0	0	0	2	566436
0	1	1	0	0	1	3	Moderate	5	0	2	0	0	0	2	377391
0	1	1	0	0	1	3	Moderate	3	0	2	0	2	0	4	522656
0	1	1	0	1	0	3	Moderate	3	1	0	0	3	0	4	347520
2	0	0	0	1	0	3	Moderate	3	1	2	0	2	0	5	727442
0	1	0	1	1	0	3	Moderate	3	0	2	0	2	0	4	332838
0	1	1	0	0	0	2	Moderate	3	0	0	0	0	0	0	275542
0	1	1	0	0	0	2	Moderate	5	0	2	0	3	0	5	539145
0	0	0	1	0	1	2	Moderate	5	0	2	0	0	0	2	871454
0	1	0	0	0	1	2	Moderate	5	1	2	0	0	0	3	477510
0	1	1	0	0	0	2	Moderate	5	1	0	0	2	0	3	93413
0	1	1	0	0	0	2	Moderate	5	0	2	0	0	0	2	413454
0	0	0	1	0	1	2	Moderate	3	0	2	0	0	0	2	4275778
0	1	1	0	0	0	2	Moderate	3	0	2	0	3	0	5	114863
0	0	0	1	0	1	2	Moderate	5	0	2	0	1	0	3	400773
0	0	0	1	0	1	2	Moderate	3	0	2	0	1	0	3	4287651
0	1	0	1	0	0	2	Moderate	3	0	2	0	2	0	4	425662
0	1	1	0	0	0	2	Moderate	3	0	2	0	2	0	4	321452
0	1	0	0	1	0	2	Moderate	3	1	0	0	3	0	4	282696
0	1	0	0	1	0	2	Moderate	5	1	0	0	2	0	3	281179
0	0	0	1	0	1	2	Moderate	5	0	0	0	0	0	0	7148933
0	1	0	0	1	0	2	Moderate	3	1	0	0	2	0	3	281648
0	0	0	1	0	0	1	Low	0	0	2	0	0	0	2	2341725
0	0	0	1	0	0	1	Low	0	0	2	0	0	0	2	376446
0	0	0	1	0	0	1	Low	0	0	2	0	0	0	2	2579345
0	0	0	1	0	0	1	Low	0	0	2	0	2	0	4	593649
0	0	0	1	0	0	1	Low	0	0	0	1	0	0	1	2766720
0	0	0	1	0	0	1	Low	0	0	0	0	1	0	1	1902376
0	0	0	1	0	0	1	Low	0	0	0	0	0	0	0	305223
0	0	0	1	0	0	1	Low	0	0	0	0	1	0	1	418160

McLane Creek Riparian

Mend_Score	Addition_S	CTS_Score	Soils_Scor	Adjacency_	LocalPrior	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
0	0	0	1	0	0	1	Low	0	0	0	0	1	0	1	761618
0	0	0	1	0	0	1	Low	0	0	0	0	1	0	1	509306
0	0	0	1	0	0	1	Low	0	0	0	0	1	0	1	706795
0	0	0	1	0	0	1	Low	0	0	0	0	2	0	2	339255
0	0	0	1	0	0	1	Low	0	0	0	0	2	0	2	5097003
0	0	0	1	0	0	1	Low	0	0	0	0	1	0	1	1033873
0	0	0	0	0	0	0	Low	0	1	0	0	1	0	2	5731019
0	0	0	0	0	0	0	Low	0	1	0	0	3	0	4	955887
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	2558573
0	0	0	0	0	0	0	Low	0	1	0	0	3	0	4	1223909
0	0	0	0	0	0	0	Low	0	0	2	0	0	0	2	692202
0	0	0	0	0	0	0	Low	0	1	0	0	0	0	1	636768
0	0	0	0	0	0	0	Low	0	1	0	0	0	0	1	261353
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	2839782
0	0	0	0	0	0	0	Low	0	1	0	0	1	0	2	12000897
0	0	0	0	0	0	0	Low	0	1	2	0	1	0	4	7540789
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	13084055

McLane Creek Floodplains

Mend_Score	ChannelMig	Confine_Sc	Decoupled_	Recharge_S	LocalPrior	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
0	0	0	0	0	0	0	Low	0	0	0	0	1	0	1	858851
0	0	0	0	0	0	0	Low	0	0	0	1	0	0	1	2959220
0	2	0	0	0	0	2	Low	0	0	0	0	0	0	0	430503
0	2	0	0	0	0	2	Low	0	0	0	0	1	0	1	530177
0	0	0	2	0	0	2	Low	0	0	0	0	0	0	0	3917390
0	2	0	0	0	0	2	Low	0	0	0	0	0	0	0	5829755

West Eld Wetlands

Hydro_Alt_	Vegetation	Hydric_Soi	Surface_Hy	Muck_Score	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
2	1	1	1	1	6	High	6	0	0	0	3	0	3	929874
2	2	0	1	0	5	Moderate	3	0	0	0	1	0	1	813793
2	1	0	1	1	5	Moderate	5	0	0	0	3	0	3	3689080
2	2	0	1	0	5	Moderate	3	0	0	0	3	0	3	43176
2	2	1	0	0	5	Moderate	5	1	0	0	3	0	4	163565
2	2	0	0	0	4	Moderate	5	0	0	0	3	0	3	16709
2	2	0	0	0	4	Moderate	5	0	0	0	3	0	3	178710
2	1	0	1	0	4	Moderate	5	0	0	0	1	0	1	368243
2	1	1	0	0	4	Moderate	5	1	0	0	3	0	4	1174362
2	2	0	0	0	4	Moderate	3	0	0	0	3	0	3	48207
2	2	0	0	0	4	Moderate	5	0	0	0	3	0	3	15044
2	1	0	1	0	4	Moderate	3	0	2	0	1	0	3	209758
0	1	1	1	1	4	Moderate	5	0	0	0	3	0	3	826336
2	2	0	0	0	4	Moderate	3	0	0	0	3	0	3	16949
2	2	0	0	0	4	Moderate	3	0	0	0	3	0	3	199792
2	1	1	0	0	4	Moderate	5	1	2	0	3	0	6	39094
2	2	0	0	0	4	Moderate	1	0	0	0	3	0	3	745078
2	2	0	0	0	4	Moderate	1	0	0	0	3	0	3	618493
2	2	0	0	0	4	Moderate	5	0	0	0	3	0	3	550637
2	1	0	1	0	4	Moderate	5	0	0	0	3	0	3	93352
2	2	0	0	0	4	Moderate	5	0	0	0	3	0	3	95547
2	1	0	0	0	3	Low	0	0	0	0	3	0	3	95991
2	1	0	0	0	3	Low	0	0	0	0	3	0	3	58005
2	1	0	0	0	3	Low	0	0	0	0	1	0	1	263268
0	2	0	1	0	3	Low	0	0	0	0	3	0	3	210741
0	2	0	1	0	3	Low	0	0	0	0	2	0	2	327422
2	1	0	0	0	3	Low	0	0	0	0	3	0	3	216554
0	1	0	1	0	2	Low	0	0	0	0	1	0	1	211352
0	1	0	1	0	2	Low	0	0	2	1	2	0	5	146766
0	1	0	1	0	2	Low	0	0	0	0	1	0	1	605694
0	1	0	1	0	2	Low	0	0	2	0	1	0	3	2976380
0	1	1	0	0	2	Low	0	0	0	0	3	0	3	470095
0	0	1	1	0	2	Low	0	1	0	0	2	0	3	356566
0	1	0	1	0	2	Low	0	0	0	0	1	0	1	243876

West Eld Wetlands

Hydro_Alt_	Vegetation	Hydric_Soi	Surface_Hy	Muck_Score	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
0	2	0	0	0	2	Low	0	0	0	0	3	0	3	154043
0	2	0	0	0	2	Low	0	0	0	0	3	0	3	130741
0	0	0	1	1	2	Low	0	0	0	0	3	0	3	351322
0	2	0	0	0	2	Low	0	0	2	0	3	0	5	163680
0	1	0	1	0	2	Low	0	0	0	0	3	0	3	52831
0	1	0	1	0	2	Low	0	0	0	0	1	0	1	358763
0	0	0	1	0	1	Low	0	0	0	0	2	0	2	900911
0	1	0	0	0	1	Low	0	0	0	0	3	0	3	148093
0	1	0	0	0	1	Low	0	0	0	0	3	0	3	68288
0	1	0	0	0	1	Low	0	0	0	0	3	0	3	32241
0	1	0	0	0	1	Low	0	0	0	0	3	0	3	26861
0	0	0	1	0	1	Low	0	0	0	0	3	0	3	4602189
0	0	0	1	0	1	Low	0	0	0	0	1	0	1	1075943
0	1	0	0	0	1	Low	0	0	0	0	3	0	3	45520
0	0	0	1	0	1	Low	0	0	0	0	1	0	1	182755
0	0	0	1	0	1	Low	0	0	0	0	3	0	3	69418
0	0	0	1	0	1	Low	0	0	0	0	2	0	2	264076
0	1	0	0	0	1	Low	0	0	0	0	3	0	3	48711
0	1	0	0	0	1	Low	0	0	0	0	3	0	3	1487326
0	0	1	0	0	1	Low	0	0	2	0	3	0	5	901765
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	185008
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	51231
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	4966
0	0	0	0	0	0	Low	0	0	0	0	2	0	2	5776
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	55993
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	104878
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	1262865
0	0	0	0	0	0	Low	0	0	0	0	3	1	4	71132
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	168261
0	0	0	0	0	0	Low	0	0	0	0	2	0	2	95094
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	24330
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	105484
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	45434
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	77076
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	2549607

West Eld Wetlands

Hydro_Alt_	Vegetation	Hydric_Soi	Surface_Hy	Muck_Score	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	65033
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	112917
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	178326
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	116130
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	48358
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	777990
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	225622
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	157390
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	206947
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	57822
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	239693

West Eld Riparian

Mend_Score	Addition_S	CTS_Score	Soils_Scor	Adjacency_	LocalPrior	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Strmwtr_Re	Sq Ft
2	0	0	1	0	1	4	High	6	0	2	0	1	3	613580
2	0	1	0	0	0	3	Moderate	3	0	0	0	3	3	40136
2	0	0	1	0	0	3	Moderate	3	0	0	0	2	2	83858
2	0	0	1	0	0	3	Moderate	3	0	0	0	3	3	340407
0	1	1	0	1	0	3	Moderate	3	0	0	0	1	2	882534
0	1	1	0	1	0	3	Moderate	3	0	0	0	1	2	527395
0	1	1	0	0	1	3	Moderate	3	0	0	1	2	3	920291
2	0	1	0	0	0	3	Moderate	3	0	0	0	2	2	1519842
2	0	1	0	0	0	3	Moderate	5	0	0	0	3	3	1060631
0	1	1	0	0	0	2	Moderate	3	0	0	0	2	2	78282
0	1	0	1	0	0	2	Moderate	3	0	0	0	2	2	77732
0	0	2	0	0	0	2	Moderate	3	0	0	0	2	2	55286
0	0	0	1	1	0	2	Moderate	3	0	0	0	2	3	301767
0	0	0	1	1	0	2	Moderate	5	0	0	0	1	2	244045
0	1	1	0	0	0	2	Moderate	3	0	0	0	1	1	122350
0	1	0	1	0	0	2	Moderate	5	0	0	0	1	1	290495
0	1	1	0	0	0	2	Moderate	5	0	0	0	1	1	640240
0	1	1	0	0	0	2	Moderate	5	0	2	0	2	4	345009
0	0	0	1	0	1	2	Moderate	5	0	2	0	1	3	540463
0	1	0	1	0	0	2	Moderate	5	0	0	0	1	1	399480
0	1	1	0	0	0	2	Moderate	5	0	0	0	1	1	271288
0	0	0	1	0	0	1	Low	0	0	0	0	2	2	117207
0	0	0	1	0	0	1	Low	0	0	0	0	2	2	825708
0	0	0	1	0	0	1	Low	0	0	0	0	2	2	807100
0	0	1	0	0	0	1	Low	0	0	0	0	2	2	55172
0	0	0	1	0	0	1	Low	0	0	0	0	2	2	139101
0	0	0	1	0	0	1	Low	0	0	0	0	2	2	48576
0	0	0	1	0	0	1	Low	0	0	0	0	2	2	53137
0	0	0	1	0	0	1	Low	0	0	0	0	2	2	36622
0	0	0	1	0	0	1	Low	0	0	0	0	2	2	23074
0	0	0	1	0	0	1	Low	0	0	0	0	2	2	67630
0	0	0	1	0	0	1	Low	0	0	0	0	2	2	510620
0	0	0	1	0	0	1	Low	0	0	0	0	2	2	778396
0	0	0	1	0	0	1	Low	0	0	0	0	2	2	356302

West Eld Riparian

Mend_Score	Addition_S	CTS_Score	Soils_Scor	Adjacency_	LocalPrior	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Strmwtr_Re	Sq Ft
0	0	0	1	0	0	1	Low	0	0	0	0	3	3	316226
0	0	0	1	0	0	1	Low	0	0	0	0	2	2	245506
0	0	0	1	0	0	1	Low	0	0	0	0	2	2	395938
0	0	0	1	0	0	1	Low	0	0	0	0	1	1	492400
0	0	0	1	0	0	1	Low	0	0	0	0	2	2	255817
0	0	0	1	0	0	1	Low	0	0	0	0	2	2	90968
0	0	0	1	0	0	1	Low	0	0	0	0	2	2	758754
0	0	0	1	0	0	1	Low	0	0	0	0	2	2	154286
0	0	0	1	0	0	1	Low	0	0	0	0	3	3	933634
0	0	0	1	0	0	1	Low	0	0	0	0	3	3	563373
0	0	0	1	0	0	1	Low	0	0	0	0	3	3	896771
0	0	0	1	0	0	1	Low	0	0	0	0	1	1	1411745
0	0	0	1	0	0	1	Low	0	0	0	0	2	2	318504
0	0	0	1	0	0	1	Low	0	0	0	0	1	1	461150
0	0	0	1	0	0	1	Low	0	0	0	0	1	1	831150
0	0	0	1	0	0	1	Low	0	0	0	0	3	3	434661
0	0	0	1	0	0	1	Low	0	0	0	0	2	2	803320
0	0	0	1	0	0	1	Low	0	0	2	0	2	4	774344
0	0	0	1	0	0	1	Low	0	0	2	0	2	4	124295
0	0	0	1	0	0	1	Low	0	0	0	1	2	3	1917856
0	0	0	1	0	0	1	Low	0	0	0	0	3	3	517938
0	0	0	1	0	0	1	Low	0	0	0	0	2	2	294256
0	0	0	1	0	0	1	Low	0	0	0	0	1	1	532425
0	0	0	1	0	0	1	Low	0	0	0	0	2	2	357250
0	0	0	0	0	0	0	Low	0	1	0	0	2	3	764633
0	0	0	0	0	0	0	Low	0	1	0	0	2	3	133801

South Eld Wetlands

Hydro_Alt_	Vegetation	Hydric_Soi	Surface_Hy	Muck_Score	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
2	2	0	1	1	6	High	6	0	0	0	3	0	3	800753
2	0	0	1	0	3	Low	0	0	0	0	3	1	4	224403
0	0	1	1	0	2	Low	0	1	0	0	2	1	4	887538
0	0	1	1	0	2	Low	0	1	0	0	2	1	4	1363676
0	0	0	1	0	1	Low	0	0	0	0	3	0	3	200105
0	0	0	1	0	1	Low	0	0	0	0	2	0	2	136427
0	0	1	0	0	1	Low	0	0	0	0	3	1	4	1269659
0	0	1	0	0	1	Low	0	1	0	0	3	1	5	461700
0	0	1	0	0	1	Low	0	0	0	1	3	1	5	764820
0	0	1	0	0	1	Low	0	1	0	0	3	0	4	17149
0	0	0	1	0	1	Low	0	0	0	0	2	1	3	274078

South Eld Riparian

Mend_Score	Addition_S	CTS_Score	Soils_Scor	Adjacency_	LocalPrior	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
0	0	0	1	1	0	2	Moderate	3	0	0	0	2	1	3	2374689
0	0	0	1	1	0	2	Moderate	5	0	0	0	2	1	3	556778
0	0	0	1	1	0	2	Moderate	5	0	0	0	3	1	4	289289
0	0	0	1	1	0	2	Moderate	5	0	0	0	2	1	3	676954
0	0	0	1	0	0	1	Low	0	0	0	0	3	0	3	118357
0	0	0	1	0	0	1	Low	0	0	0	0	2	0	2	920710
0	0	0	1	0	0	1	Low	0	0	0	1	2	0	3	749449
0	0	0	0	1	0	1	Low	0	1	0	0	3	1	5	1366441
0	0	0	1	0	0	1	Low	0	0	0	0	2	0	2	947204
0	0	0	1	0	0	1	Low	0	0	0	0	3	0	3	293375
0	0	0	1	0	0	1	Low	0	0	0	0	3	0	3	240732

North Eld Riparian

Hydro_Alt_	Vegetation	Hydric_Soi	Surface_Hy	Muck_Score	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
2	2	0	0	0	4	Moderate	1	0	0	1	3	0	4	47971
2	2	0	0	0	4	Moderate	3	0	0	1	3	0	4	122616
2	1	0	0	0	3	Low	0	0	0	1	3	0	4	62307
2	1	0	0	0	3	Low	0	0	0	1	3	0	4	40637
2	0	0	0	0	2	Low	0	0	0	1	3	0	4	718847
0	0	1	1	0	2	Low	0	0	0	1	3	0	4	1402336
2	0	0	0	0	2	Low	0	0	0	1	3	0	4	135030
0	2	0	0	0	2	Low	0	0	0	1	3	0	4	144769
0	2	0	0	0	2	Low	0	0	0	1	3	0	4	37074
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	40328
0	0	0	0	0	0	Low	0	0	0	1	3	0	4	101865

North Eld Riparian

Mend_Score	Addition_S	CTS_Score	Soils_Scor	Adjacency_	LocalPrior	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
0	1	1	0	0	0	2	Moderate	5	0	0	1	3	0	4	83515
0	0	0	1	0	0	1	Low	0	0	0	1	2	0	3	494513
0	0	0	1	0	0	1	Low	0	0	0	1	2	0	3	209245
0	0	0	1	0	0	1	Low	0	0	0	1	3	0	4	250280
0	0	0	1	0	0	1	Low	0	0	0	1	2	0	3	366715
0	0	0	1	0	0	1	Low	0	0	0	1	3	0	4	94667

Perry Creek Wetlands

Hydro_Alt_	Vegetation	Hydric_Soi	Surface_Hy	Muck_Score	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
2	2	1	1	1	7	High	4	0	0	0	2	0	2	331292
3	2	0	1	0	6	High	4	0	0	0	2	0	2	298358
2	2	1	1	0	6	High	6	0	0	0	3	0	3	251818
2	2	1	1	0	6	High	4	0	0	0	2	0	2	435359
2	2	1	0	1	6	High	6	0	2	1	3	0	6	83035
2	1	1	1	0	5	Moderate	5	0	0	0	1	0	1	33777
2	2	1	0	0	5	Moderate	3	1	0	0	3	0	4	71438
2	2	0	0	0	4	Moderate	3	0	0	0	3	0	3	108394
0	1	1	1	0	3	Low	0	0	0	0	2	1	3	345207
0	2	1	0	0	3	Low	0	0	0	0	3	1	4	95423
0	1	1	1	0	3	Low	0	0	0	0	2	1	3	76631
0	1	1	1	0	3	Low	0	0	2	0	0	0	2	121373
2	0	1	0	0	3	Low	0	0	0	0	3	0	3	21666
0	1	1	1	0	3	Low	0	0	0	0	2	1	3	539820
0	1	1	1	0	3	Low	0	0	0	0	2	0	2	156190
0	1	1	0	0	2	Low	0	0	0	0	3	0	3	117945
0	0	1	1	0	2	Low	0	1	0	0	2	0	3	88248
0	0	1	1	0	2	Low	0	0	0	0	2	0	2	217124
0	0	1	0	0	1	Low	0	1	0	0	3	0	4	43164
0	0	1	0	0	1	Low	0	1	0	0	3	0	4	18686
0	0	1	0	0	1	Low	0	1	2	0	3	0	6	43665
0	0	0	1	0	1	Low	0	0	2	0	0	0	2	205476
0	0	0	1	0	1	Low	0	0	0	0	1	0	1	542164
0	0	0	0	0	0	Low	0	0	2	0	3	0	5	9672

Perry Creek Riparian

Mend_Score	Addition_S	CTS_Score	Soils_Scor	Adjacency_	LocalPrior	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
0	1	1	0	0	1	3	Moderate	5	0	2	0	0	0	2	199289
0	1	1	0	0	1	3	Moderate	3	0	0	0	2	0	2	452638
0	1	1	0	0	1	3	Moderate	3	0	0	0	2	0	2	535573
0	1	0	1	0	1	3	Moderate	3	0	0	0	2	0	2	453875
0	1	1	0	0	1	3	Moderate	3	1	0	0	2	0	3	329448
2	0	0	0	1	0	3	Moderate	3	0	0	0	2	1	3	309560
2	0	0	0	1	0	3	Moderate	3	1	0	0	2	0	3	423677
0	1	0	1	0	1	3	Moderate	3	0	0	0	2	0	2	828160
2	0	0	0	1	0	3	Moderate	5	1	0	0	2	0	3	259547
2	0	0	0	1	0	3	Moderate	3	1	0	0	2	0	3	209687
0	0	0	1	0	1	2	Moderate	3	0	0	0	2	0	2	347123
0	1	1	0	0	0	2	Moderate	3	1	0	0	2	0	3	538097
0	0	0	0	1	1	2	Moderate	3	1	0	0	2	1	4	1894118
0	0	0	1	0	0	1	Low	0	0	2	0	0	0	2	1201317
0	0	0	1	0	0	1	Low	0	0	0	0	0	0	0	2279877
0	0	0	1	0	0	1	Low	0	0	0	0	1	0	1	3219881
0	0	0	1	0	0	1	Low	0	0	2	0	1	0	3	932833
0	0	0	0	0	1	1	Low	0	1	0	0	2	0	3	827202
0	1	0	0	0	0	1	Low	0	1	0	0	2	0	3	775864
0	0	0	0	0	0	0	Low	0	1	0	0	1	0	2	1257269
0	0	0	0	0	0	0	Low	0	1	0	0	3	0	4	345841
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	191305
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	2363492
0	0	0	0	0	0	0	Low	0	1	0	0	2	1	4	1031784
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	5732854
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	2906319
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	2752566
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	413363
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	666968
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	1628932
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	2456136
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	2317893
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	409732
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	235403

Perry Creek Riparian

Mend_Score	Addition_S	CTS_Score	Soils_Scor	Adjacency_	LocalPrior	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
0	0	0	0	0	0	0	Low	0	1	0	0	3	0	4	689651

Green Cove Wetlands

Hydro_Alt_	Vegetation	Hydric_Soi	Surface_Hy	Muck_Score	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
3	2	1	0	0	6	High	6	0	0	0	3	0	3	1522068
2	1	1	1	0	5	Moderate	5	0	0	1	0	0	1	3648737
2	1	1	0	0	4	Moderate	5	0	0	0	3	0	3	557722
2	2	0	0	0	4	Moderate	5	0	0	1	3	0	4	76342
2	0	0	1	0	3	Low	0	0	0	1	0	0	1	2254121
2	1	0	0	0	3	Low	0	0	2	0	3	1	6	649926
2	0	0	1	0	3	Low	0	0	0	0	3	0	3	64620
2	0	1	0	0	3	Low	0	0	0	1	3	1	5	344868
0	0	1	0	1	2	Low	0	0	0	0	3	0	3	145202
0	0	1	1	0	2	Low	0	0	0	1	1	1	3	4237828
2	0	0	0	0	2	Low	0	0	0	0	3	1	4	386729
0	1	0	1	0	2	Low	0	0	2	0	3	0	5	73421
0	0	0	1	1	2	Low	0	0	0	1	0	1	2	5909668
0	2	0	0	0	2	Low	0	0	0	1	3	0	4	51185
0	1	0	0	0	1	Low	0	0	0	0	3	0	3	2757737
0	0	1	0	0	1	Low	0	1	0	1	3	1	6	2384762
0	0	0	0	0	0	Low	0	0	0	1	3	0	4	625416
0	0	0	0	0	0	Low	0	0	0	0	3	1	4	367316
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	39233
0	0	0	0	0	0	Low	0	0	0	0	3	1	4	375123
0	0	0	0	0	0	Low	0	0	0	1	3	0	4	126241
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	14980

Green Cove Riparian

Mend_Score	Addition_S	CTS_Score	Soils_Scor	Adjacency_	LocalPrior	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
0	1	0	1	1	0	3	Moderate	3	0	0	0	1	1	2	327828
0	1	0	1	0	1	3	Moderate	5	0	0	0	0	0	0	223915
0	1	1	0	0	0	2	Moderate	3	1	0	0	3	0	4	72625
0	0	0	1	1	0	2	Moderate	3	0	2	0	1	1	4	1575175
0	0	0	1	0	1	2	Moderate	5	0	0	0	0	0	0	2697682
0	1	1	0	0	0	2	Moderate	5	0	0	0	1	0	1	162504
0	0	0	1	0	0	1	Low	0	0	0	1	3	0	4	259194
0	0	0	1	0	0	1	Low	0	0	0	0	3	0	3	83285
0	0	0	1	0	0	1	Low	0	0	0	0	1	0	1	837582
0	0	0	1	0	0	1	Low	0	0	0	0	2	0	2	166462
0	0	0	1	0	0	1	Low	0	0	0	0	2	0	2	472476
0	0	0	0	1	0	1	Low	0	0	0	0	1	1	2	550477
0	0	0	1	0	0	1	Low	0	0	0	1	0	0	1	797441
0	0	0	1	0	0	1	Low	0	0	0	1	0	0	1	744699
0	0	0	1	0	0	1	Low	0	0	0	1	0	0	1	1157983
0	0	0	1	0	0	1	Low	0	0	0	1	0	0	1	875195
0	0	0	0	0	0	0	Low	0	0	0	0	1	0	1	216563

Green Cove Floodplains

Mend_Scc	ChannelMig	Confine_Sc	Decoupled_	Recharge_S	Adjacency_	LocalPrior	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
0	2	0	0	0	0	0	4	Moderate	5	0	0	0	0	0	0	542862
0	2	0	0	0	0	0	4	Moderate	5	0	2	0	2	0	4	873438
0	2	0	0	0	0	0	2	Low	0	0	0	0	0	0	0	530095
0	2	0	0	0	0	0	2	Low	0	0	2	0	2	1	5	908394
0	0	0	2	0	0	0	2	Low	0	0	2	0	3	1	6	353032
0	0	0	0	0	0	0	0	Low	0	0	0	1	2	1	4	962578

Mud Bay Wetlands

Hydro_Alt_	Vegetation	Hydric_Soi	Surface_Hy	Muck_Score	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
3	2	1	1	0	7	High	4	0	2	1	2	0	5	8953880
2	1	0	0	1	4	Moderate	5	0	0	0	3	0	3	328344
2	1	0	1	0	4	Moderate	3	0	2	1	1	1	5	6836446
2	1	0	0	0	3	Low	0	0	0	1	3	0	4	251392
0	2	0	1	0	3	Low	0	0	2	0	2	0	4	233972
0	0	1	1	0	2	Low	0	0	2	0	0	0	2	2604020
0	1	0	1	0	2	Low	0	0	0	0	2	1	3	1505917
0	2	0	0	0	2	Low	0	0	2	0	3	0	5	44407
0	0	1	1	0	2	Low	0	0	0	0	2	1	3	237498
0	1	1	0	0	2	Low	0	0	2	0	3	0	5	101426
0	0	1	0	0	1	Low	0	0	0	0	3	0	3	56711
0	0	0	0	0	0	Low	0	0	0	0	3	0	3	42696
0	0	0	0	0	0	Low	0	0	0	1	3	0	4	23805

Mud Bay Riparian

Mend_Score	Addition_S	CTS_Score	Soils_Scor	Adjacency_	LocalPrior	Score	Rank	Combined_D	AorB_Soils	Surficial_	Infrastruc	Fish_Avoid	Public_Adj	Strmwtr_Re	Sq Ft
0	1	0	1	0	0	2	Moderate	3	0	2	0	2	0	4	594895
0	1	0	1	0	0	2	Moderate	3	0	2	0	2	0	4	552133
0	1	0	1	0	0	2	Moderate	3	0	2	0	2	0	4	510650
0	0	0	1	1	0	2	Moderate	5	0	2	0	3	1	6	402515
0	1	1	0	0	0	2	Moderate	3	0	2	0	2	0	4	592362
0	1	0	1	0	0	2	Moderate	3	0	2	0	2	0	4	715724
0	1	1	0	0	0	2	Moderate	3	0	2	1	2	0	5	607830
0	0	0	1	0	0	1	Low	0	0	0	0	2	0	2	501282
0	0	0	1	0	0	1	Low	0	0	0	0	2	0	2	119997
0	0	0	1	0	0	1	Low	0	0	2	0	2	0	4	431860
0	0	0	1	0	0	1	Low	0	0	0	0	1	0	1	427309
0	0	0	1	0	0	1	Low	0	0	0	0	3	0	3	79064
0	0	0	1	0	0	1	Low	0	0	0	0	3	0	3	63390
0	0	0	1	0	0	1	Low	0	0	0	0	3	0	3	108459
0	0	0	1	0	0	1	Low	0	0	0	0	3	0	3	57329
0	0	0	1	0	0	1	Low	0	0	0	0	3	0	3	81546
0	0	0	1	0	0	1	Low	0	0	0	0	3	0	3	904047
0	0	0	1	0	0	1	Low	0	0	0	0	3	0	3	1060602
0	0	0	1	0	0	1	Low	0	0	2	1	2	0	5	313757
0	0	0	0	0	0	0	Low	0	1	0	0	2	0	3	681222