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Acknowledgments

We would like acknowledge the Environmental Protection Agency (EPA) for providing grant funds (Grant #WS-96073601) to complete this important work for Thurston County and the South Puget Sound.

Watershed Characterization Technical Team

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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	A hydrologic unit linked to the movement of water with a geographic area of 1,000 to 10,000 acres
B-IBI	Benthic – Index of Biological Integrity
Catchment	A hydrologic unit linked to the movement of water with a geographic area of 32 to 320 acres
DAU	Drainage Analysis Unit (approximately 0.25 sq mile or 160 acres)
DBH	Diameter breast height
DEM	Digital Elevation Model
Ecological benefit	The ability of a DAU to maintain ecological processes
Ecology	Washington State Department of Ecology
EIA	Effective Impervious Area
Environmental benefit	The ability of a natural resource site to maintain function within a DAU
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	A hydrologic unit linked to the movement of water with a geographic area of 100 to 1,000 acres
Sub-watershed	A hydrologic unit linked to the movement of water with a geographic area of 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	A hydrologic unit linked to the movement of water with a geographic area of 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

The Nisqually Watershed Characterization described in this document presents the work of the technical team using a modified version of 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 the culmination of refinements made by our technical team and a 2010 peer review by Derek Booth and Rich Horner, and a 2011 review by David Montgomery, to meet the needs of local governments. The report provides a scientific approach to analyzing the ecological processes that maintain a healthy watershed.

One of the goals of the watershed characterization is to identify natural resource areas that could serve as restoration and enhancement sites to mitigate past and future urban development in the Nisqually River watershed. Another goal of the watershed characterization is to provide a list of natural resource sites for preservation and/or protection. Preservation and/or protection sites have not been clearly defined or presented in previous watershed characterization reports (Reynolds, O. and B. Wood 2006; Reynolds, O. and B. Wood 2009; and Reynolds, O. and B. Wood 2009). For purposes of this report, Thurston County, is using the following definitions (Horner, 2010);

> **Restoration—**any level of improvement in the state, with no connotation of necessarily returning the system to its original state, i.e., pre-human influence, although such an objective is a theoretical possibility (some literature terms partial restoration as "rehabilitation" or "enhancement"); and
>
> **Preservation** (or protection)**—**retaining the ecological state at its existing level, whatever that may be, without diminishment of any indicators of the health of that state, terrestrial or aquatic, structural or functional.

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.

The Nisqually Watershed Project Area is subdivided into 191 drainage analysis units (DAU) and eight study areas. Landscape attributes were used to characterize the condition of key ecological processes (movement of water, sediment, large wood debris, pollutants, and heat) and upland habitat connectivity that have been affected by the built out environment. 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 Project Area.

In the Project Area, it was determined that McAllister Creek and Nisqually Bluff Study Areas were most altered by development with total impervious area (TIA) at 21% and 20%, respectively. These two Study Areas include portions of the City of Lacey, as well as unincorporated Thurston County. The Powell Creek Study Area is least impacted by the built environment with only 1% TIA.

The watershed characterization identifies the state of ecological processes and habitat connectivity of each DAU and also identifies altered wetland, floodplain, and riparian resources with restoration potential. Each potential restoration site was evaluated in the context of the existing landscape and then prioritized for restoration and/or enhancement.

The study identified a total of 2199 wetland areas, 344 riparian areas, and 41 floodplain areas for a total of 2584 potential restoration sites. Of these sites, 1071 potential wetland, floodplain and riparian restoration sites met the minimum criteria for restoration and/or enhancement potential. Those sites were prioritized for optimizing overall ecosystem function within the DAU and sub-watersheds. The remaining sites are either high preservation value, or sites that are located in a highly built environment and would provide little or no environmental benefit if restored.

At the landscape scale, it was determined that the entire Project Area had a total impervious area (TIA) value of 7%, a coniferous forest value of 29%, a mixed forest value of 19%, and a grasses value of 9%. It should be noted that the TIA values include other landscape attributes (e.g., shadowing) where it couldn't be distinguished from impervious cover without current high quality aerials and field verification. 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 to distinguish EIA from TIA, such as stormwater infrastructure, is difficult to acquire on a large scale. Thus, by default TIA is used to determine the delivery and routing of water.

Background

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 report presents the results of a watershed characterization of landscape conditions in the Nisqually River watershed that identified natural resources sites (wetlands, riparian areas, flood plains) for restoration, mitigation, and enhancement at the watershed scale rather than the smaller scale of jurisdictional boundaries used in traditional approaches. In addition, natural resource sites are identified for preservation and/or protection.

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 provide refined existing data in support of CWA, SDWA, Endangered Species Act (ESA), Shoreline Management Act (SMA), and Critical Area Ordinance (CAO) 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.

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 treat only local symptoms of resource degradation and fail to address the root biological and physical causes of ecosystem degradation. (Frissell 1996, Angermeier and Schlosser 1995, Montgomery et al. 1995, Reeves et al. 1995, Ebersole et al. 1997).

The approximately 30-year history of stormwater management in the United States has been organized, almost invariably, according to local jurisdictional (city, county) boundaries. This organizational principle extends, for the most part, to management of other pollutant-bearing discharges as well. Early in this decade United States Environmental Protection Agency (USEPA) began to take note of the disadvantages of this practice and the potential benefits of an alternative; in a policy statement (USEPA 2003a) USEPA recommends embracing, "... a detailed, integrated, and inclusive watershed planning process ...," with a basis in, "... clear watershed goals ..." Subsequent to the policy statement, USEPA published two guidance documents laying out a general process for setting up Clean Water Act permits on a watershed basis (USEPA 2003b, 2007).

The Natural Resource Council (NRC) committee recognized the benefits of and general principles applying to USEPA's concept but concluded that its guidance did not go far enough toward bringing it to fruition. The committee developed an approach fitting within the general framework outlined by USEPA but greatly expanding it in scope and detail. It is intended to replace the present structure, instead of being an adjunct to it, and to be uniformly applied nationwide (Horner, 2010).

The USEPA guidance does not specify how to implement a watershed-based permit; however, the Natural Resource Council has recently published *Urban Stormwater Management in the United States* (NRC, 2009). This document, specifically chapter six details how NPDES permit holders could implement EPA's Watershed-Based NPDES Permitting.

Watershed characterization provides a scientific basis for specific land-use planning. That specification is a function of objectives, which must be determined by policy makers informed by science. Guidance has been added to counsel users of the procedure on how to develop comprehensive, achievable objectives. As the NRC (2009) framework is strongly predicated on such objectives, and its report provides rationale and background for their development. In that framework and in Thurston County's methodology also, those objectives would generally be in biological terms (e.g., communities, species, and/or life stages to preserve or restore and at what target levels) (Horner, 2010).

One element in the NRC (2009) report is the, "**efficient, advanced scientific and technical watershed analysis to identify negative impact sources and set objectives and strategies."** That element represents Thurston County's approach and shows its place in the overall watershed-based framework. It is essential to clarify that watershed-based strategy formulation in the NRC committee's framework, and seemingly in the County's methodology, differs sharply from what has been termed watershed (or basin) planning. Drawing up such a plan is a timeconsuming process, which has often become an end in itself, instead of a means to an end. Many, perhaps most, such plans completed over the last 40 years have not been successfully implemented. Davenport (2003), drawing heavily on a survey of practitioners by the Center for Watershed Protection, presented and commented on 12 reasons for these failures (Horner, 2010).

The process recommended by the NRC (2009) does not anticipate completing a watershed plan, as usually construed in the past, as a prerequisite to watershed-based strategy development. Rather, the anticipated process would spring much more from comprehensive, advanced scientific and technical analysis of the water resources to be managed and their contributing catchment areas than from a planning framework. It would be cognizant of the pitfalls identified in traditional planning and seek to avoid them. The County's approach appears to comply with this principle, but it is reiterated to add emphasis to its importance (Horner, 2010). The NRC report can be acquired at http://www.nap.edu/catalog.php?record_id=12465

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 informed land use decisions and management.

What is in this document?

This document presents the work of the technical team using Gersib et al. (2004) landscape characterization methods and refinements made by our technical team to meet the needs of Thurston County. The report describes the scientific approach used to analyze the ecological processes that maintain a healthy watershed. The goal of the watershed characterization work is to identify resource sites for mitigation, restoration, and enhancement as a result of past alterations to the landscape. In addition, preservation sites are identified to assist in improving watershed function in Nisqually River watershed. One of the goals in identifying priority preservation sites is to guide sound decision-making to purchase natural resource parcels.

The methods characterize the condition of key ecological processes (movement of water, sediment, large wood, pollutants, and heat) and the biological elements upland habitat connectivity that have been affected by past urban and rural development. This is accomplished by interpreting existing land cover and natural resource data and developing databases that identify the location and condition of current and historical wetland, riparian, and floodplain resources. Once the baseline conditions are assessed, sites 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.

The priority site list identifies wetland, riparian, and floodplain restoration sites that have potential to mitigate water quality and quantity impacts of the built environment. The priority site list identifies sites where restoration would maximize overall ecosystem function.

Identification of sites for preservation is another important product of the watershed characterization.

General Framework for Watershed Characterization

The following is a 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.

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 current conditions;
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 based on the future build-out scenario; and

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.

Figure 1.0 outlines the process of conducting a watershed characterization.

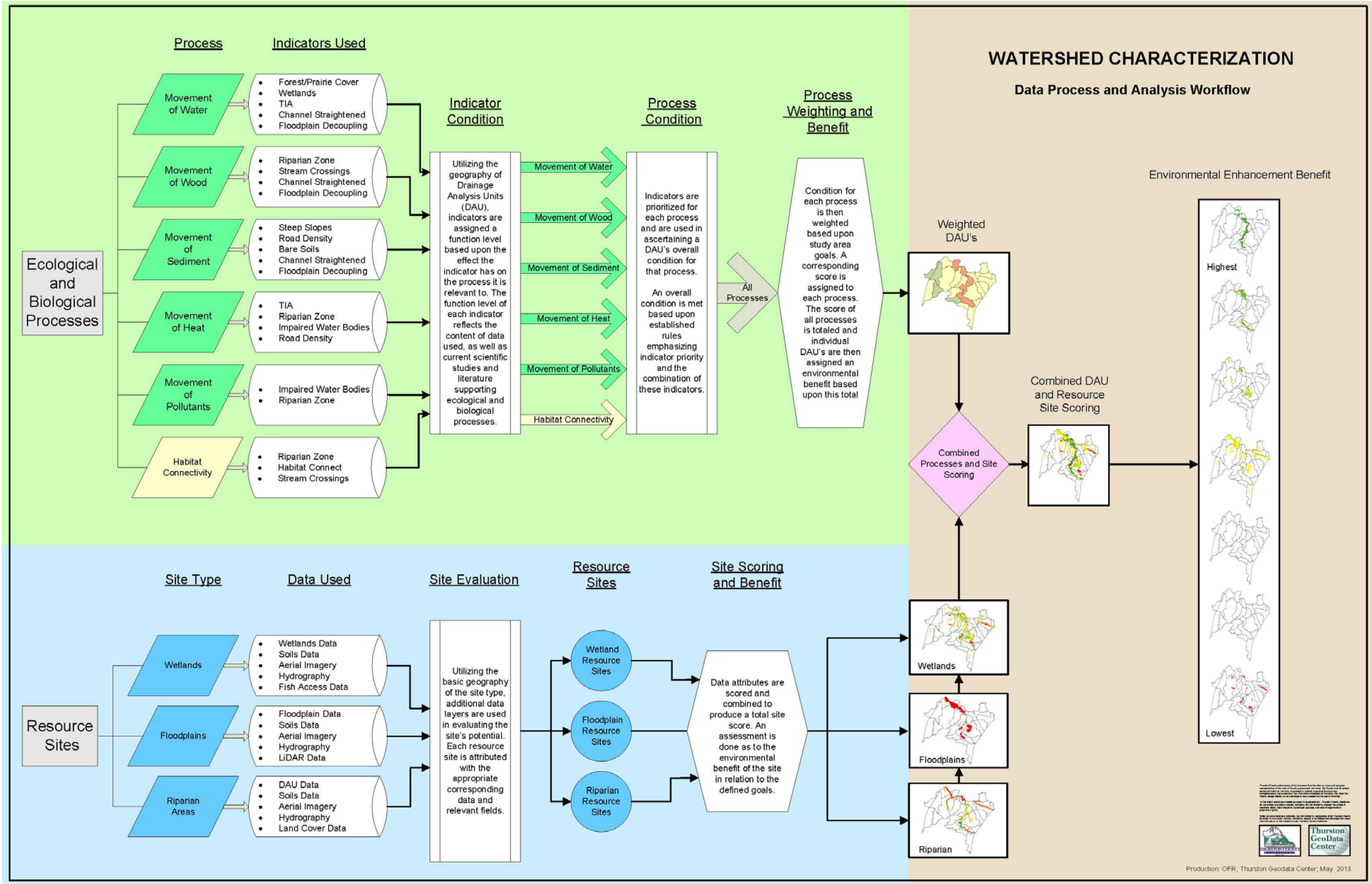

Figure 1.0 Process flowchart

What are the general findings of this study?

The Nisqually Watershed Project area is subdivided into 191 drainage analysis units (DAU) and eight study areas. Landscape attributes were used to characterize the condition of key ecological processes (movement of water, sediment, large wood debris, pollutants, and heat) and upland habitat connectivity that have been affected by the built out environment. 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.

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At the landscape scale, it was determined that the entire Project Area had a total impervious area (TIA) value of 7%, a coniferous forest value of 29%, a mixed forest value of 19%, and a grasses value of 9%. It should be noted that the TIA values include other landscape attributes (e.g., shadowing) where it couldn't be distinguished from impervious cover without current high quality aerials and field verification. 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 to distinguish EIA from TIA, such as stormwater infrastructure, is difficult to acquire on a large scale. Thus, by default TIA is used to determine the delivery and routing of water.

Table 1.0 contains the values of major land cover categories of the study areas. Impervious area is a total of asphalt/pavement/bare earth and composite roof, bare and compacted earth.

Coniferous forest is the total of predominately coniferous and homogenous coniferous forest. Mixed forest is mixed coniferous and deciduous forest. Grasses are a total of turf/grasses and short grasses.

Wetlands, deciduous forest, shrubs, scrub shrubs, and water are listed in the table under "Other."

Table 1.0 Land Cover Values in the Study Areas

Sub-Watershed	Impervious Area (%)	Coniferous Forest (%)	Mixed Forest (%)	Grasses (%)	Other
Project Area	7	29	19	9	36
Powell Creek	1	52	21	3	23
Lacamas Creek	5	24	23	10	38
Yelm Creek	9	11	19	16	45
Thompson Creek	6	35	19	9	31
Lake St. Clair	4	45	19	6	26
McAllister Creek	21	8	17	10	44
Delta Bluff	18	9	9	8	56
Nisqually Bluff	20	26	23	6	25

Introduction to Watershed Characterization

What is a watershed characterization?

Watershed characterization is a series of steps that identify, screen, and prioritize hundreds of potential wetland, riparian, and floodplain sites for restoration and/or enhancement opportunities and identifies sites for preservation and protection. 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 restore the landscape to a higher function level through the restoration of wetland, riparian, and floodplain areas, which have the greatest potential to mitigate past development's impact on stormwater runoff and result in measurable environmental benefits. This is done by assessing the condition of ecological processes, such as the movement of water, sediment, pollutants, large wood, and heat. In addition, upland habitat connectivity is assessed.

How is a watershed characterization conducted?

Watershed characterization consists of three primary key parts:

Part I. Characterize Condition of Ecological Processes in Study Area

Step 1 – Establish Drainage Analysis Units & Assess Landscape Attributes

The Nisqually River Watershed Project Area (Figure 1.1) was delineated into 191 drainage analysis units (DAU) catchments and eight study areas. The Study Areas and DAUs were derived using ArcHydro and 2011 LiDAR imagery (Figure 1.2 and 1.3). It should be noted that the delineations derived for this study may not align with other published watershed boundaries. Watershed delineations are varied based on the data and methods used to delineate a watershed, and the intended applications, such as hydrological modeling.

Land cover values were derived from SPOT 2011 satellite imagery (Figure 1.2). Twelve landscape indicators were evaluated (see 1.5 Landscape Indicators). The following landscape attributes were used to characterize how land use change has altered the natural movement of water, sediment, pollutants, and large wood, along with upland habitat connectivity. Each indicator was evaluated within each DAU (Figure 1.5):

1. Forest /Prairie Land Cover
2. Wetlands-Assimilative capacity and hydro alteration
3. Total Impervious Surface (TIA)
4. Riparian Zones
5. Steep Slopes
6. Habitat Connectivity
7. Road Density
8. Stream Crossings
9. Stream Channel Straightening
10. Floodplain Decoupling
11. Bare Soils
12. Pollutants and Heat

This information was used to target restoration efforts within landscapes that have the greatest potential to restore and maintain a site's environmental benefits over the long-term.

Step 2 – Establish Condition of Drainage Analysis Units (PF, AR, NPF)

Using the landscape attributes estimated from each study area analysis, the Matrix of Pathways and Indicators (MPI) Table 2 of the Methods document, and the Rules and Assumptions (Tables 3 through 8 of the Methods document) are used to evaluate each ecological process and habitat connectivity at the DAU scale and provide a ranking of Properly Functioning (PF), At Risk (AR), or Not Properly Functioning (NPF) for each DAU. Appendix A of this document contains the Methods document.

The following list includes the landscape indicators that are used for each ecological process assessed, as well as habitat connectivity.

Human alteration to the movement of water

- Percent TIA
- Percent forest and/or prairie land cover
- Percent wetlands cover
- Percent of stream channel straightened
- Percent of floodplain decoupled

Human alteration to the natural movement of large wood

- Percent of 67 meter riparian zone in mature canopy
- Percent of stream channel straightened
- Percent of floodplain decoupled
- Number of stream crossings per kilometer of stream

Human alteration to the natural movement of sediment

- Percent bare soils
- Road density
- Percent unstable slopes
- Percent of stream channel straightened
- Percent of floodplain decoupled

Human alteration to the natural movement of pollutants

- Extent of 303(d) listed water bodies for nutrients, toxicants, and bacteria
- Condition and extent of wetlands
- Percent of 67 meter riparian zone in mature canopy

Human alteration to the natural movement of heat

- Extent of 303(d) listed water bodies for temperature
- Percent 67 meter riparian zone with mature canopy

Habitat Connectivity

FRAGSTATS was utilized to determine habitat connectivity for forest and prairie landscapes. FRAGSTATS is a computer software program designed to compute a wide variety of landscape metrics for categorical map patterns. The original software (version 2) was released in the public domain in 1995 in association with the publication of a USDA Forest Service General Technical Report (McGarigal and Marks 1995). For more information, go to http://www.umass.edu/landeco/research/fragstats/fragstats.html

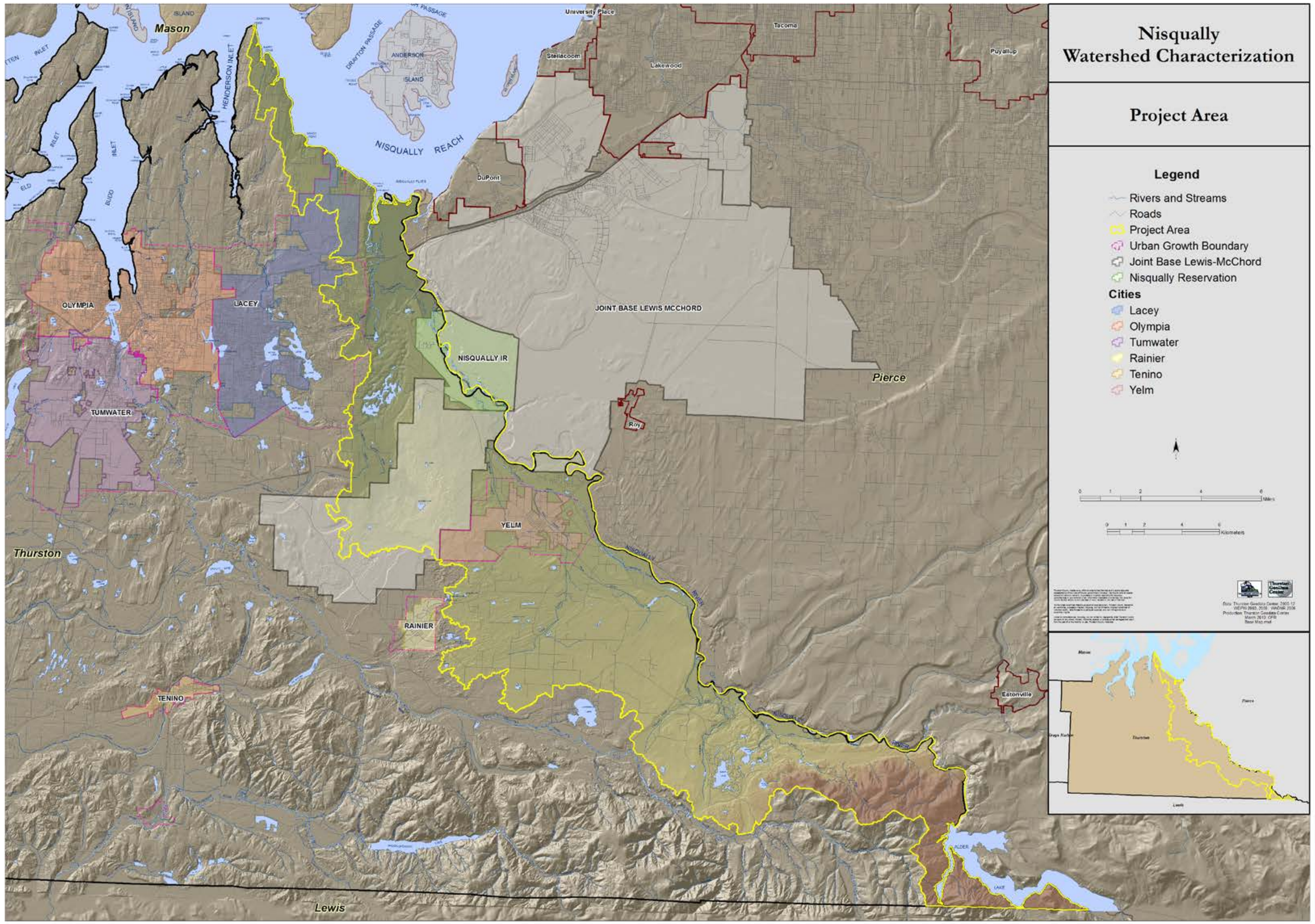


Figure 1.1 Nisqually River Watershed Project Area

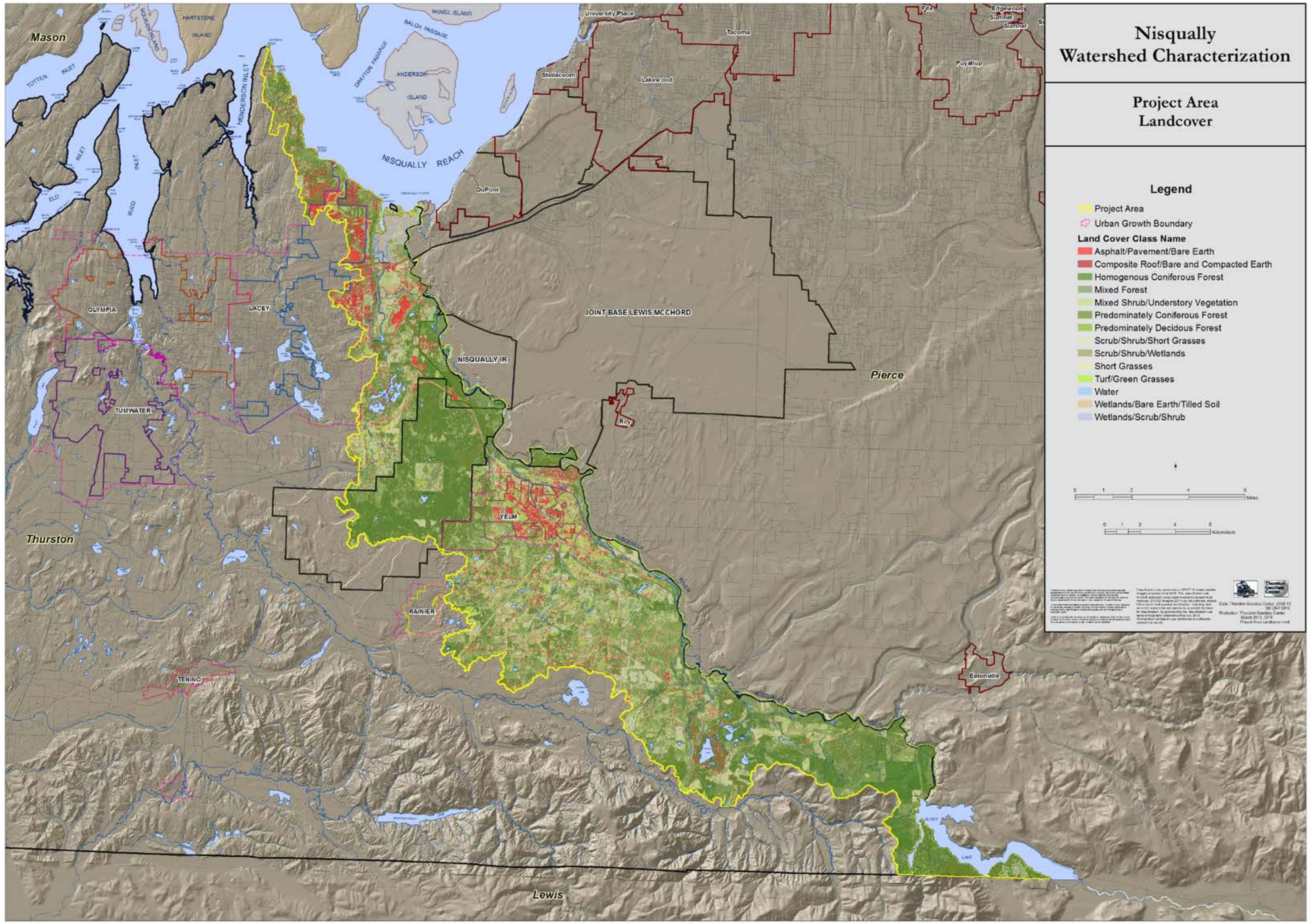


Figure 1.2 Nisqually River Watershed Project Area Land Cover

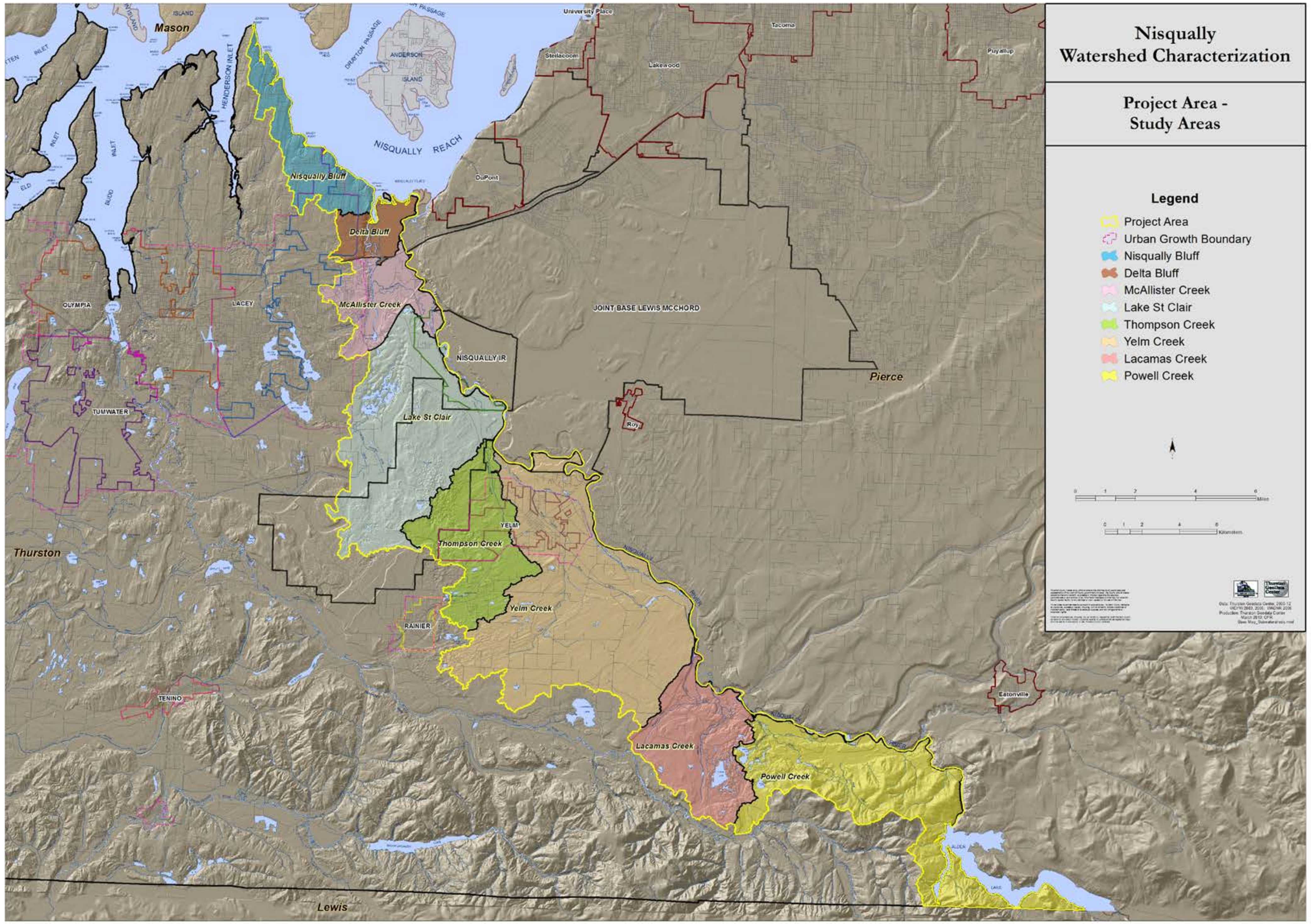


Figure 1.3 Nisqually River Watershed Study Areas

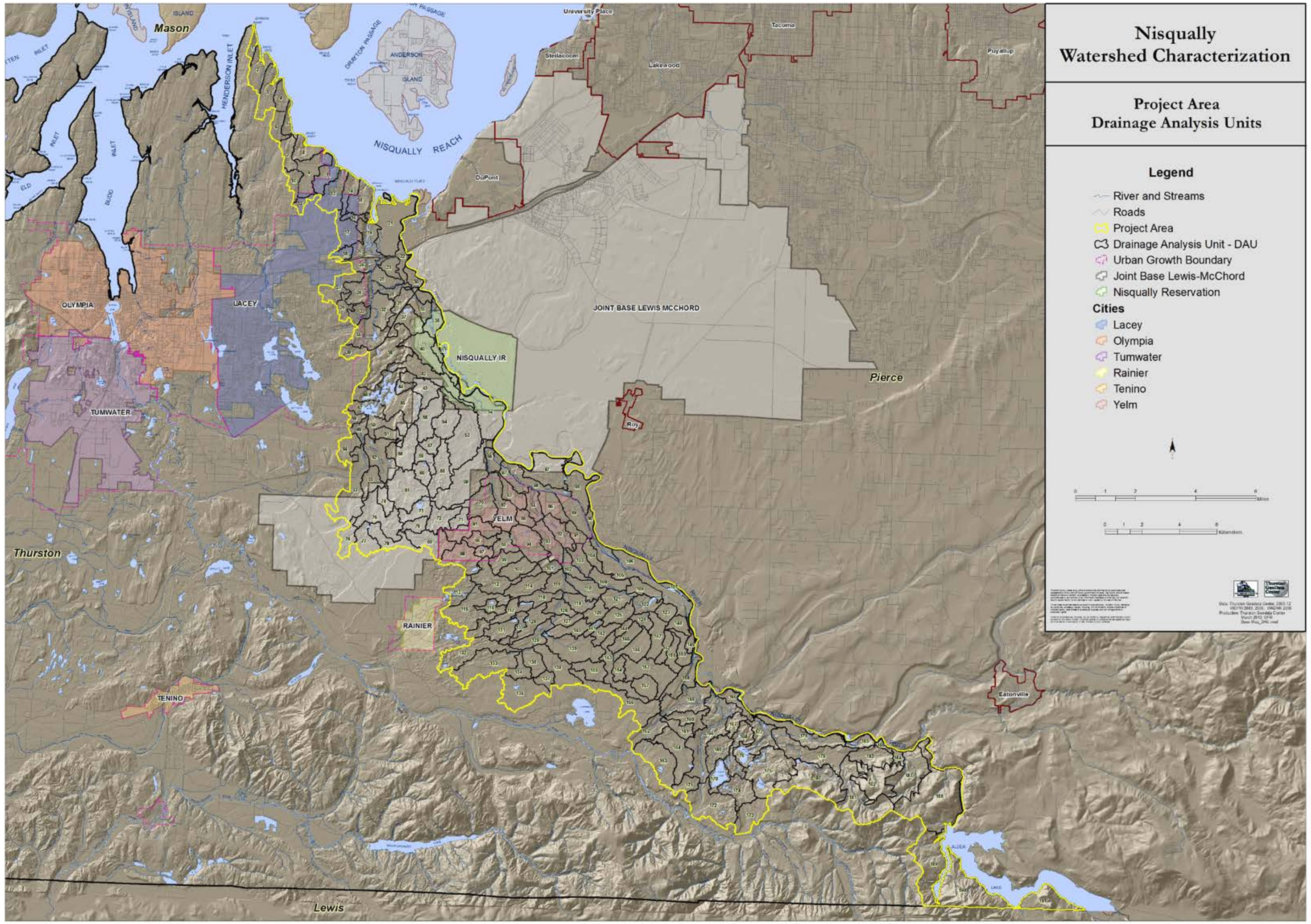
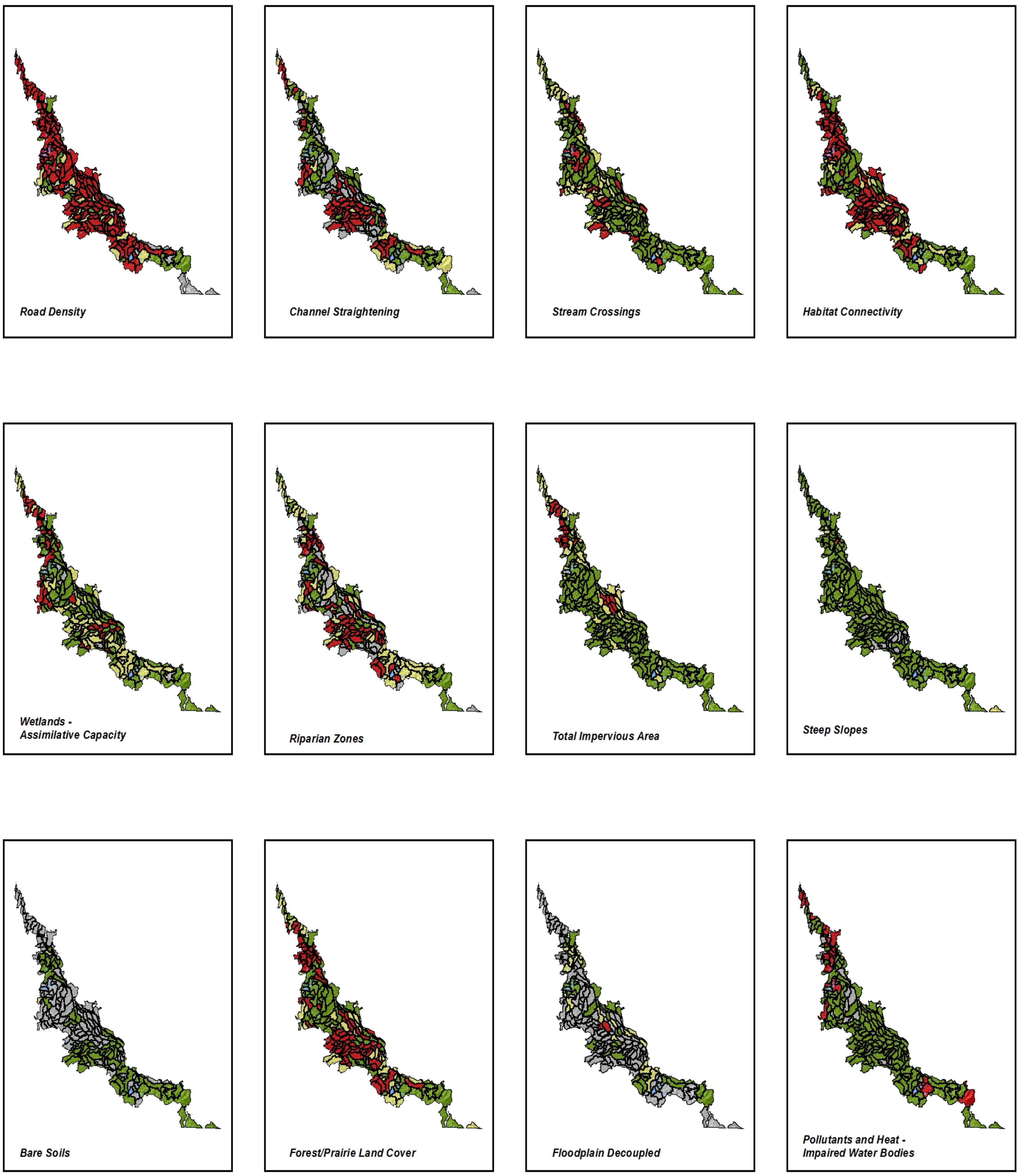


Figure 1.4 Nisqually River Watershed Project Area Drainage Analysis Units



Nisqually
Watershed Characterization

Landscape Indicators

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

Legend

FunctionLevel

- Properly Functioning
- At Risk
- Not Properly Functioning
- No Feature Data

Figure 1.5 Nisqually River Watershed Study Area Landscape Indicators

Step 3 - Determine the Ecological Benefit Ranking of the DAU

The final ranking of each DAU establishes a baseline condition of ecological health for each DAU. Considering the ranking of each DAU within a study area, the baseline ecological health of the study area is also established. All DAUs within the study area with ecological processes considered "At Risk" (AR) under current land use conditions are identified for further consideration. DAUs in the AR category for multiple key ecological processes are assumed to provide the greatest potential to maximize environmental benefits when natural resource sites are restored. DAUs that are ranked PF would be where entities should focus on preserving sites. DAUs in a NPF category would indicate that engineering solutions may be the best option to maintain/improve water flow and pollutant loading.

Using the function condition assigned to the DAU in which a potential mitigation site occurs, identify which ecological processes and biological elements are considered “At Risk”. Identify a single ecological process or biological element that is the local recovery priority.

In the Nisqually River Project Area, Nisqually Tribal habitat specialists identified the processes of the movement of wood, sediment, pollutants, and heat as being equally important because their data identifies different reaches having different restoration needs. However, the movement of water remained a weight of three.

All DAUs are assigned an ecological process score of 0 to 8 based on the number of ecological/biological indicators considered “At Risk” within the DAU (Table 1.1). Ecological processes and habitat connectivity that have been identified as "At Risk” are further evaluated based upon the potential for enhancement from restored/rehabilitated marginal function levels. The movement of water is weighted the highest because of the importance of that ecological process in a built landscape.

Table 1.1 Weight criteria for Ecological Process Scoring of DAUs.

Ecological Process/Biological Indicator in “At Risk” Condition	Score Weight	Total Score
Movement of Water	1 X 3	3
Movement of Large Wood	1 X 1	1
Movement of Sediment	1 X 1	1
Movement of Pollutants	1 X 1	1
Movement of Heat	1 X 1	1
Upland Habitat Connectivity	1 X 1	1
Maximum Ecological Process Score for a DAU when all processes are “At Risk”		**8**

The ecological process score (0 to 8) is then used to develop an ecological process ranking of low, moderate, or high for the DAU, as detailed in Table 1.2. The low, moderate or high ecological process rank of a DAU represents whether restoration actions are more or less likely to provide an environmental lift, DAU’s ranked “high” should have a higher priority for restoration and mitigation actions.

Table 1.2 Convert Ecological Process Score to Ecological Process Rank

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

Part II. Characterize Natural Resource Sites in Study Area

Natural resource sites (wetlands, riparian, and floodplain) were identified that have the potential to mitigate the built environment if restored.

Existing datasets available for wetlands, riparian areas, and floodplains were used as a starting point. New GIS data was obtained and processed from 2011 LiDAR and 2009 aerials to further develop wetland, riparian, and floodplain datasets.

The resulting datasets differ significantly from existing natural resource data, such as local and state agencies might provide, 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 restoration and/or enhancement needs of the sub-watershed. The technical team relied on existing data and both site and landscape criteria to evaluate and rank of potential floodplain, wetland, and riparian restoration sites, as detailed in the Methods document. The existing wetland datasets including the National Wetland Inventory (NWI) and the updated NWI completed by Thurston Regional Planning Council (2002) for the Nisqually River Project Area varied widely in quality.

Each of the natural resource sites identified above was evaluated based on the attributes assigned during site assessment. Some specific attributes including; vegetation alteration, hydrologic alteration, and adjacency to public lands, were included in the assessment of all three natural resource site types. For specific details, please refer to Tables 13 to 16 in the Methods document.

Once all the attributes have been scored, the following criteria are used to rank the sites High, Moderate, and Low for restoration potential, as detailed in Tables 1.3 to 1.5.

NOTE: The three point classes were determined using Jenk’s natural breaks in the data range points specific for the Nisqually Watershed.

Table 1.3 Convert Wetland Environmental Process Score to Process Rank

Environmental Process Score	Environmental Process Rank
7 to 12 points	High
4 to 6 points	Moderate
0 to 3 points	Low

Table 1.4 Convert Riparian Environmental Process Score to Process Rank

Environmental Process Score	Environmental Process Rank
6 to 10 points	High
3 to 5 points	Moderate
0 to 2 points	Low

Table 1.5 Convert Floodplain Environmental Process Score to Process Rank

Environmental Process Score	Environmental Process Rank
9 to 10 points	High
7 to 8 points	Moderate
6 points	Low

Part III. Assess Potential Sites within the DAU

This section presents the results of a ranking process for all potential natural resource restoration sites combines the site ranking with the DAU ranking. This final ranking of a natural resource restoration site is based on a combination of each sites individual environmental process rank (site score) (Part II above) combined with the ecological process ranking of the DAU (see Part I above) within which the restoration site is located. The result of this combination is a final score for each restoration site from 0 to 6, with a score of 6 representing those sites with the greatest potential for environmental benefit if restored. Table 1.6 is used to score the natural resource sites in the context of the DAU.

Table 1.6 Combined DAU and Site Score Ranking

DAU Ecological Processes Rank	Resource Site Environmental Process Rank	Total Score
High	High	6
High	Moderate	5
Moderate	High	4
Moderate	Moderate	3
Low	High	2
Low	Moderate	1
N/A	Low	0

For complete details on methods used in watershed characterizations, please refer to the Methods Document included as Appendix A of this report.

Updates and Modifications to the Methods

As the Gersib et al., 2004 methods were applied, it was determined that the methodology needed to be updated and refined to reflect a methodology that was more tailored to local government needs. The original methods focused on meeting avoidance and mitigation needs for transportation projects. In addition to avoidance and mitigation needs, local governments can use the data to prioritize riparian and wetland restoration projects, and high quality habitat to be preserved through conservation easements or acquisition using conservation future funds. In applying the Gersib et al (2004) methods, the following modifications and/ or clarifications have been made:

- The indicator “percent change in drainage network” in the MPI was not used because there is currently not sufficient stormwater infrastructure data.
- Further defined “mature forest” to mean “hydrologically mature forest” (Douglas fir 25 years old (DNR, 2009).
- A “prairie landscape” was added to the MPI. 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 MPI was developed for habitat conservation plans on forest lands. In an urban environment, with required stormwater best management practices (BMP), cleared earth is typically paved, replanted, or replaced by roof area within a limited amount of time, thus there are minimal bare soils in the DAU. The exception would be agricultural activities, but they are also just temporarily exposed prior to replanting.

- There was a lack of data for the condition process "movement of pollutants" thus only DAUs that had water quality data were analyzed.
- Buffers of 67 meter were applied throughout the analysis vs. 33 meter, as stated in the MPI for the movement of heat. The 67 meter buffer reflects an aquatic buffer that provides pollutant removal, shade, the recruitment of large woody debris, and habitat connectivity for migration. In addition, the 67 meter buffer assures that the stream channel is included given that current stream layers are not always accurate.
- The rules and assumptions were updated and developed based on best available science.
- Attributes for initial natural resource site identification and condition descriptions were standardized (e.g., a value given for adjacency to public lands, etc.).
- In 2012, Thurston County's FEMA maps were updated using 2011 LiDAR data. This update was then applied to Federal Insurance Rate Maps (FIRM). It should be noted that the updated FIRM maps were based on elevation data only.
- 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 data, Benthic Indicator Biotic Indicators (B-IBI), is limited in the number of sites sampled. Thurston County added sites in study areas to better assess aquatic integrity. In the Nisqually watershed characterization, B-IBI data was not directly utilized in the ranking, but used as a reference to compare to the results derived from other landscape indicators.
- Habitat connectivity data had been limited in life stage information for multiple species. However, in 2010, the Washington State Department of Fish and Wildlife released a multiple species matrix that contains life history data in GIS format to study a species of interest. Depending on the species of interest, there may be sufficient data to evaluate different habitat for different life stages.
- In 2010, Thurston County contracted with Derek Booth, Ph.D., Richard Horner, PhD, and Dave Montgomery, PhD to complete a peer review of the Methods. Comments were received in late summer, 2010 and early 2011. Peer review comments were incorporated into the Methods in late 2011 and early 2012. The Nisqually River Watershed characterization utilized the updated Methods.

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. As a result of discussions with stakeholders in the Nisqually Project Area, four of the ecological processes were weighted the same, while the movement of water remained with a weight of three.

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. The locally identified recovery sites/areas are incorporated into the watershed characterization analysis to prioritize candidate restoration sites and sites of high quality identified for preservation and/or protection.

What are the project deliverables?

Watershed characterization deliverables for the Nisqually River Watershed Study are:

- Documentation of technical methods, assumptions, and results of watershed characterization in a manner that is comprehensive and understandable.
- Information on the landscape condition of key ecological processes.
- Potential wetland, floodplain, riparian 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.

The goal is to make this report clear and understandable to the average person with some background in science, resource management or planning, 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 Project Area.
- The technical methods are detailed in Appendix A.
- Results of the ecological processes are provided in Appendix B.
- Results of the natural resource site analysis are provided in Appendix C.

- Attribute tables for the natural resource sites are provided in Appendix D.
- Map packages of the natural resource sites are provided in Appendix E.
- The GIS data, modeling assumptions, and other technical details are available electronically upon request. Excel spreadsheets of the land cover, ecological processes, and natural resource sites are posted on the website at http://www.co.thurston.wa.us/waterresources/chara/chara-nisqually.html

It is hopeful that this approach 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 2009 and LiDAR 2011), other state, tribal, and local data were also used in the analysis of the ecological processes and natural resource site development. Much of this data is outdated. The National Wetlands Inventory (NWI) that was updated by the Thurston Regional Planning Council (TRPC) in 2002 and was used as the base data to evaluate potential historical wetlands. If historic wetlands were not obvious, the analysts used other supporting data including: 2011 LiDAR; 2009 aerials; General Lands Office; soils and slope to delineate potential wetlands.

> **NOTE:** This methodology identifies sites at a coarse GIS scale. All sites need to be field verified and delineated using the most recent guidance published by Washington State Department of Ecology (Ecology) and the US Army Corp of Engineers. Further work is required to assess sites for actual restoration, mitigation, and/or preservation opportunities. This report and the data within it, should generally be considered as an initial site screening resource.

Another caveat is the Department of Natural Resources (DNR) stream hydro layer used in this 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, a 67 meter buffer was applied vs. a 33 meter buffer as detailed in the original Gersib et al (2004) methods. As part of this work, the Wild Fish Conservancy was contracted to survey Spurgeon and Yelm creeks to update DNR's stream classifications in those study areas.

Description of the Nisqually Watershed Study Area

The following excerpts are taken from the Nisqually Tribe Chinook Recovery Plan, 2001.

The Nisqually River Basin, Water Resource Inventory Area (WRIA) 11, is located in Washington State approximately 20 miles south of the City of Tacoma and five miles east of the City of Olympia. The total area of the basin is approximately 761 square miles. The Nisqually River originates from the Nisqually Glacier on the southern slope of Mt. Rainier and flows west-northwest for approximately 78 miles until it enters south Puget Sound River. River flow is determined primarily by rainfall, snow, and glacial melt, as well as the actions of dams located in the upper reaches of the river.

The Nisqually River and its tributaries are the primary streams in WRIA 11. Also included in WRIA 11 are two independent streams: McAllister Creek, which discharges into the Nisqually estuary on the west side of the Nisqually delta, and Red Salmon Creek (Mounts Creek), which discharges into the east side of the delta. WRIA 11 contains 332 individual streams, covering a linear distance of approximately 714 miles (Williams et al. 1975).

The LaGrande Canyon, at river mile (RM) 42, divides the watershed into two distinct physiographic areas. Below the canyon, the watershed consists of low hills and plains of glacial outwash. Above the canyon, volcanic rocks and steeper mountainous terrain dominate the area. The canyon itself contains sheer cliffs extending upwards of 200 feet.

LaGrande Dam, located at RM 42.5 on the Nisqually River, is the likely upper extent of the historic distribution of anadromous salmonids in the basin. LaGrande Dam definitely is the upstream: limit of current anadromous ·fish usage in WRIA 11 today. Consequently, only 382 linear miles of the 714 miles of stream in WRIA 11 (the "lower Nisqually Basin") have the potential for anadromous fish use. However, much of the length is comprised of streams with insufficient flow to accommodate Chinook utilization or is above natural migration barriers. We identified a total linear distance of 98 miles of freshwater/estuarine habitat in the Nisqually as being the most likely to have-or have had significant use by fall Chinook.

The Thurston County side of the Nisqually River Project Area drains approximately 134 sq miles, as delineated using the 2011 LiDAR. The project area represents approximately 18% of the entire watershed. The following Study Areas (sub-watershed level) are included in the Project Area: Powell Creek, Lacamas Creek, Yelm Creek, Thompson Creek, Lake St. Clair, McAllister Creek, Delta Bluff, and the Nisqually Bluff, as well as various unnamed tributaries (see *Figure 1.3 Study Areas*).

Pre-development land cover

The historic Nisqually River estuary contained a total area of approximately 5.8 sq miles (Bartleson et al. 1980). It is by far the largest estuary in southern Puget Sound, but only a mid-size estuary compared with others in the Puget Sound region. The total size of the estuary is constrained by steep bluffs along both sides of the delta area and a steep drop off at the outer edge of the delta.

The historic estuary included four habitat types: mudflat/delta (approximately 2 sq miles), emergent salt marsh (approximately 2.3 sq miles) transition fresh/salt (approximately 1.2 sq mile), and riverine tidal (approximately 0.31 sq mile). Historic reconstruction by zone based on map provided in Bartleson et al. 1980).

The habitat of the Nisqually River estuary today has been changed substantially, primarily by the historic dikes installed in the early 1900’s to convert salt marsh into pasture. The fill associated with the Interstate-5 crossing of the estuary also has resulted in the loss of historic estuarine habitat. According to a preliminary analysis of estuarine habitat by the Nisqually Tribe, the estuary size today has been reduced to 3.0 sq miles including reductions in all four habitat types: mudflat/delta (now approximately 1.8 sq mile), emergent salt marsh (approximately 0.5 sq mile), transition fresh/salt (approximately 0.46 sq mile), and riverine tidal (approximately 0.23 sq mile).

Most of the estuary north of Interstate-5 is now the Nisqually National Wildlife Refuge. However, despite that status, a substantial portion of the historic estuarine habitat remains behind historic farm dikes."

The following is taken from the Nisqually Delta Restoration website. http://www.nisquallydeltarestoration.org/about.php

"After a century of diking off tidal flow, the Brown Farm Dike was removed to inundate 761 acres of the Nisqually National Wildlife Refuge (Refuge) on 11 November 2009. Along with 141 acres wetlands restored by the Nisqually Indian Tribe, the Nisqually Delta represents the largest tidal marsh restoration project in the Pacific Northwest to assist in recovery of Puget Sound salmon and wildlife populations. Over the past decade, the Refuge and close partners, including the Tribe and Ducks Unlimited, have restored more than 21.8 miles of the historic tidal slough systems and re-connected historic floodplains to Puget Sound, increasing potential salt marsh habitat in the southern reach of Puget Sound by 50%. Estuarine restoration of this magnitude and the potential contribution to restoration science is unprecedented in Puget Sound. Because the mosaic of estuarine habitats, this large-scale restoration is expected to result in a considerable increase in regional ecological functions and services, representing one of the most significant advances to date towards the recovery of Puget Sound. The US Geological Survey is the lead science agency providing science support to document habitat development and ecosystem function with large-scale restoration."

The nearshore habitat on the Pierce County side of the Nisqually Reach was substantially impacted by railroad construction beginning in 1912. Most of the shoreline is armored to prevent erosion of the railroad bed. The armoring and the bed itself have severely limited sediment contribution to the beach.

The Thurston County side of the Nisqually Reach is in better condition, with significant portions remaining undeveloped. However, bulkhead construction and other armoring associated with home development is more regulated but is ongoing in the county, resulting in continued degradation of the nearshore habitat.

Water Quantity and Water Quality

Water Quantity

The major sources of water in the Nisqually River are rainfall, snow, and glacial melt. River flow is generally highest from November through February due to rainfall and rain-on-snow events. Although river flow is generally lowest during the late summer months (August-October), flows remain relatively high during summer because of glacial melt. In addition, the Centralia Power Company must maintain a base flow during the late summer to assure andromous fish have sufficient flow for migration and spawning.

Fine sediment (rock flour) in glacial melt causes the river to run a milky green during the summer and early fall months. Flash flooding events occur in the upper basin as a result of Jokulhlaups. A Jokulhlaups is a flash flood caused by glacial melt water collecting behind an ice dam and then being released suddenly as the dam collapses. In the Nisqually River, these flood events occur every 3 to 10 years. Each event results in large deposits of sediment and debris in the mainstem of the Nisqually River. Historically, these flood events would have impacted the entire river to a much greater extent than they do today, adding significantly to the amount of fine sediment in the mainstem throughout its length.

Since construction of the Nisqually Hydroelectric Project, glacial flour is not as evident in the lower river (RM 10-42.5) due to the presence of Alder Reservoir. The reservoir stores the glacial melt throughout the summer. Consequently, water clarity in the lower river is much higher during the summer months than it was historically. Some glacial flour settles out in the reservoir; the portion that remains suspended finally enters the lower river by September and is present throughout the fall and winter. Furthermore, the Alder Reservoir generally contains the most significant sediment impacts of Jokulhlaups events.

As a condition of its Federal Energy Regulatory Commission (FERC) license, Tacoma Power is required to meet certain minimum flows downstream of the Nisqually Project. Tacoma is also required to provide water to meet a portion of Centralia's water rights at the Yelm Project Diversion Dam. As a result, flows in the lower Nisqually River often exceed the fisheries habitat minimum flow required by the FERC license.

Water Quality

The Nisqually River is designated by Washington State as a Class AA stream (extraordinary water quality) above the Alder-LaGrande Hydroelectric Project (RM 44.2) and a Class A stream (excellent water quality) below RM 44.2. Most of the major tributaries to the Nisqually in the lower basin are designated as Class A streams. A recent water quality study conducted by the Nisqually Tribe (Whiley and Walter 2000) suggests that water quality in the river meets the Class AA and Class A standards most of the time. Elevated water temperatures were detected in the Centralia Diversion bypass reach of the mainstem although they did not chronically exceed the Washington state water quality standards. The study recommends further monitoring of temperature in areas of concern as well as expanded research on nutrient concentrations and their relationship to land use activities.

The primary source of water in the tributary streams in the lower Nisqually Basin is rainfall; snowmelt is a significant contributor in only the upper portions of the Mashel, Ohop, and (to a lesser extent) Powell sub-basins. Spring flows are a significant contributor to the lower portions of most tributary streams (i.e., where streams down cut through deposits to reach the level of the Nisqually River), and are the main driver of stream flows in McAllister Creek, where spring flows makes up approximately 40% of the discharge at the mouth (AGI Technologies 1999).

The Nisqually River, Nisqually Reach, and McAllister and Ohop creeks are on the 303(d) list of waterbodies that do not meet water quality standards. These are all listed for fecal coliform bacteria, with McAllister Creek listed for dissolved oxygen as well. In addition, review of historical data on Red Salmon Creek, a tributary to Nisqually Reach, shows that Red Salmon Creek does not meet water quality standards for fecal coliform bacteria.

Table 1.7 lists the waterbodies in the Nisqually Reach and basin that are on the 303(d) list or do not meet water quality standards. The table also shows the water quality parameters of concern for each waterbody (Sargent et al., 2005).

Table 1.7 Nisqually River on the 303(d) list or not meeting water quality standards

Waterbody	Parameter	Location	New ID #	Old ID #
Marine Water – WRIA 11 Nisqually Reach	Fecal coliform bacteria	*Latitude/Longitude* 47.115, 122.695	390KRD	OE72JI WA-PS-08 0290
Freshwater – WRIA 11 Nisqually River	Fecal coliform bacteria	*Township/Range/Section*	18N 01E	WA-11-1010
McAllister Creek	Fecal coliform bacteria and dissolved oxygen	18N 01E 37 and 18N 01E 38	LD26OX	WA-11-2000
Ohop Creek Fecal	Fecal coliform bacteria	16N 03E 25	MW64EV	WA-11-1024
Red Salmon Creek	Fecal coliform bacteria	19N 01E 01 and 19N 01E 09	No ID	WA-PS-0290

WRIA – Water Resource Inventory Area

Fish Resources

Chinook Salmon

The Salmon and Steelhead Stock Inventory (SASSI) lists the Nisqually Chinook as a summer/fall Chinook stock (WDF et al. 1993). Adults enter the river from July through September. Peak spawning is mid-October. Historically, there was a spring component in the Nisqually. This component was last observed in the early 1950s and is now considered extinct.

Migration of Nisqually Chinook is assumed to be predominantly in the spring and summer of the first year of freshwater residence (ocean type life history). However, Tyler (1980) reported catches of some juvenile Chinook in the Nisqually River as late as December, suggesting that at least a portion of the stock migrates in the fall or the following spring as yearling smolts. Age at return is primarily age-3 and age-4 fish.

Since the mid 1970s, Nisqually Chinook have been managed as a single stock for the purpose of supporting treaty and non-treaty fisheries. Native Nisqually Chinook have been extirpated as a consequence of hydro power, habitat loss, hatchery introductions, and high harvest rates.

Current production consists primarily of on-station hatchery releases with some natural spawning in the mainstem and the lower reaches of major tributaries. Natural spawners are derived from prior outplants with continuing contributions from hatchery strays.

The status of salmon stocks is sometimes expressed in terms of biological significance and viability. The biological significance of the present Nisqually Chinook stock is relatively low due to the extirpation of the native population components and the mixed hatchery origin of the remaining population. The viability of this stock in nature is as yet unknown; but, as a hatchery population, variability could be relatively high, especially given the recent management shift toward the use of local broodstock.

Basin is managed for natural production. Hatchery plants of both winter and summer steelhead have occurred historically in the basin, but they have been eliminated to protect the native wild stock. Spawning occurs from April through June, with fry emerging from late May through August. From 1982 through 1992 adult returns to the basin have ranged from approximately 650 to over 7,000 fish.

Coho Salmon

The Nisqually River coho population likely consists of both a wild and a hatchery component. However, the majority of the coho returning to the basin are of hatchery origin. An average of 700,000 hatchery coho smolts are released from the Clear Creek and Kalama Creek hatcheries each year. Wild coho juveniles rear in freshwater for more than a year and migrate to the estuary in the spring and early summer.

Nisqually hatchery coho are an early spawning population, returning to the river in October and November. The Nisqually tribal staff has reported observations of late spawning coho in some smaller tributaries. These fish likely are part of a wild component of the run, but genetic data does not exist to determine whether they are a distinct population. Adult coho returns to the Nisqually River from 1961-1991 have ranged from 600 to 13,000 fish (FERC 1994 as cited in the Nisqually Chinook Recovery Plan, 2001).

Chum Salmon

The Nisqually River is a major producer of wild chum salmon. Adult chum escapement to the river from 1968- 1991 has ranged from 10,000 to over 100,000 fish Joan Miniken, NIT, (personal communication, as cited in the Nisqually Chinook Recovery Plan, 2001).

Chum salmon are generally found in the lower Nisqually River downstream of the Centralia Diversion Dam and in portions of Muck and Yelm creeks. A minor amount of hatchery production of the species occurred historically in the basin, but has been eliminated. Adult chum salmon enter the Nisqually River during the months of November through January. Fry emerge in the early spring and migrate immediately to the estuary.

Pink Salmon

Pink salmon return to the Nisqually River Basin in every odd year. The pink salmon run is native to the Nisqually and is not influenced by hatchery production. Adult escapement to the basin has ranged from a few hundred fish in recent years to over 10,000 fish for runs in the late 1980s.

Adult pink salmon spawn from September through November. As is the case with chum salmon, fry emerge in early spring and migrate immediately to the Nisqually River estuary.

Sea-Run Cutthroat

There is a sea-run cutthroat population in the Nisqually River. However, little information is available regarding the run size or distribution of this species in the basin. This stock is assumed to exhibit a life-history pattern similar to other Puget Sound stocks.

Native Resident and Non-Native Fish

The most prominent resident fish species found in the Nisqually River Basin are listed in Table 1.8 below. Many of the non-native fish species were introduced to provide sport-fishing opportunities in local lakes.

Table 1.8 Nisqually Native and Non-native fish

Native Resident Species		Non-Native Resident Species
Bullhead		Largemouth Bass
Cutthroat Trout		Bluegill
Rainbow Trout		Black Crappie
Dace		Brook Trout
Large-scale Sucker		Catfish
Sculpin		Kokanee
		Yellow Perch

Native Rainbow and Cutthroat Trout are found throughout the mainstem Nisqually River and its tributaries. These species, as well as Kokanee, are also found in Alder Lake. The Alder Lake Kokanee population is self-sustaining; and, for the most part, these fish inhabit stream reaches above the Nisqually Hydroelectric Project.

Bull Trout

There is no definitive evidence of Bull Trout in the Nisqually River Basin. One juvenile captured in a trap in the early 1980s was tentatively identified as a Dolly Varden trout. However, the sample has been lost, and its identification cannot be confirmed. Recent stream habitat surveys in the upper Nisqually River have shown no evidence of bull trout. The Bull Trout Recovery Unit Team has decided that the Nisqually is not a core population watershed for Puget Sound Bull Trout. However, the team has designated the Nisqually as "core habitat" due to the possibility that Bull Trout from other South Puget Sound watersheds may use the Nisqually estuary for habitat.

Shellfish Resources

In 1992, the Washington State Department of Health (DOH) reclassified 1,000 acres of commercial shellfish growing areas in the Nisqually Reach from Approved to Conditionally Approved, with closures occurring after 0.50" of rain in 24 hours. One year later DOH adjusted the closure criterion to 1" in 24 hours based on improvements seen in water quality. In 1999, in response to declining water quality and after consultation with local shellfish growers, DOH established a one-year voluntary "no harvest zone" in the vicinity of the eastern-most water quality monitoring stations of the growing area (Sargent et al., 2005).

In 2000, improved conditions at the western end of the Conditionally Approved area allowed DOH to upgrade 20 acres of geoduck tracts there to the Approved status. At the same time, however, conditions at the east end of the area continued to decline. In November 2000, DOH reclassified about 74 acres at the east end of the area from Conditionally Approved to Restricted.

In 2002, DOH upgraded 960 acres from Conditionally Approved and Restricted to Approved (Washington State Department of Health, 2004). This change in classification was prompted by the results of a comprehensive review of shoreline sanitary conditions and marine water quality data (Sargent et al., 2005).

In early 2000, about 40 acres of the commercial shellfish growing area currently remain Restricted; these 40 acres are located west of the mouth of McAllister Creek. Also, recreational shellfish beds located in the mouth of McAllister Creek continue to be unsafe for consumption (Thurston County, 2002).

In 2012, the Thurston County Board of Health and Board of County Commissioners adopted an Operation and Maintenance on-site septic program that was developed by a citizen advisory group, including input from residents in the The purpose of the program is to assure that on-site sewage systems are properly operated and maintained to protect the health of county residents and to preserve the water quality of Nisqually Reach.

This program is modeled after the successful program that was started in Henderson Inlet in 2007. The program includes septic system inspection and monitoring requirements, incentives, funding mechanisms and enforcement elements.

Findings of the Nisqually Watershed Characterization

All the candidate floodplain, wetland, and riparian restoration sites have been identified and analyzed using aerial photo interpretation; however, no field verification has been conducted. 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 with support. This approach recognizes 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 the built landscape. The results of a watershed characterization could be used to eliminate or reduce the need for hard stormwater infrastructures, such as a conveyance system to engineered ponds, and restore or enhance the natural function of the resources to mitigate the current built environment.

Current Conditions

The Nisqually Watershed Project area is subdivided into 191 drainage analysis units (DAU) and eight study areas. Landscape attributes were used to characterize the condition of key ecological processes (movement of water, sediment, large wood debris, pollutants, and heat) and upland habitat connectivity that have been affected by the built out environment. 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.

In the Project Area, it was determined that McAllister Creek and Nisqually Bluff Study Areas were most altered by development with total impervious area (TIA) at 21% and 20%, respectively.. These two Study Areas include portions of the City of Lacey, as well as unincorporated Thurston County. The Powell Creek Study Area is least impacted by the built environment with only 1% TIA.

The watershed characterization identifies the state of ecological processes and habitat connectivity of each DAU and also identifies altered wetland, floodplain, and riparian resources with restoration potential. Each potential restoration site was evaluated in the context of the existing landscape and then prioritized for restoration and/or enhancement.

At the landscape scale, it was determined that the entire Project Area had a total impervious area (TIA) value of 7%, a coniferous forest value of 29%, a mixed forest value of 19%, and a grasses value of 9%. It should be noted that the TIA values include other landscape attributes (e.g., shadowing) where it couldn't be distinguished from impervious cover without current high quality aerials and field verification. 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 to distinguish EIA from TIA, such as stormwater infrastructure, is difficult to acquire on a large scale. Thus, by default TIA is used to determine the delivery and routing of water.

The study identified a total of 2199 wetland areas, 344 riparian areas, and 41 floodplain areas for a total of 2584 potential restoration sites. Of these sites, 1071 potential wetland, floodplain and riparian restoration sites met the minimum criteria for restoration and/or enhancement potential. Those sites were prioritized for optimizing overall ecosystem function within the DAU and study areas. The remaining sites are either high preservation value, or sites that are located in a highly built environment and would provide little or no environmental benefit if restored.

The current condition of the Nisqually River Watershed Project Area, as identified in this watershed characterization, indicate that approximately 7% percent of the Project Area within the jurisdictions of Thurston County, the City of Lacey, and the City of Yelm is impervious land cover. As detailed in Figure 1.2, the majority of impervious surface is within the two cities.

In contrast, a large percentage of tree/prairie cover is within Joint Base Lewis McCord. (see Figure 1.2. Nisqually River Watershed Project Area Land Cover). Figure 1.6 illustrates the categories of land cover.

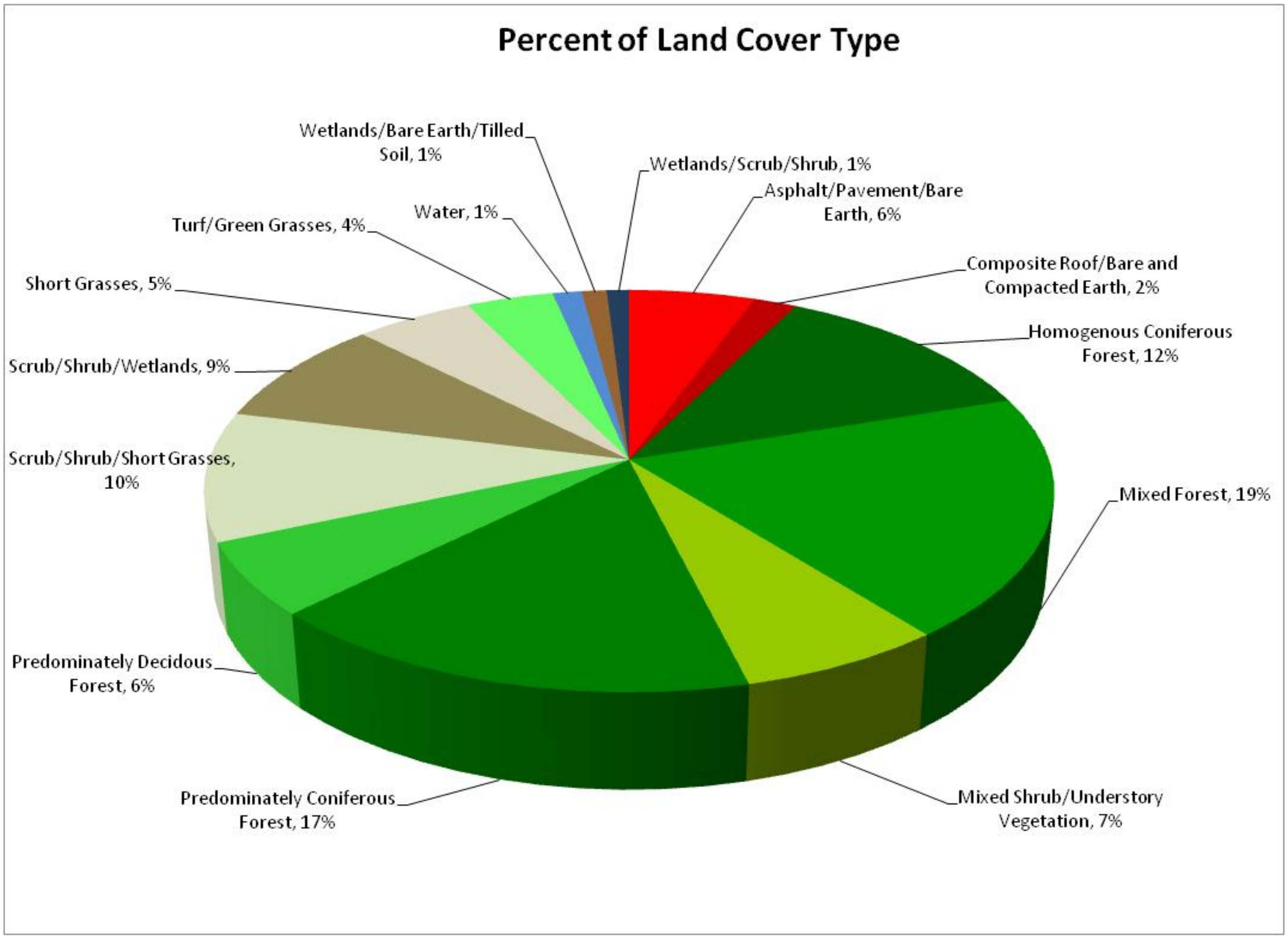


Figure 1.6 Classification Percent Totals for Nisqually Project Area
Land cover data derived from 2009 SPOT imagery.

The current condition of each DAU was determined to be “properly functioning”, “at risk” or “not properly functioning” based on the values detailed in the MPI (see Appendix A, Table 3 for complete details).

The Study Area

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

The Nisqually River Project Area is shown in *Figure1.1 Nisqually River Project Area*. The study area was delineated using 2011 LiDAR data. Multiple scales were established including 191 approximately 0.25 sq mile DAUs, eight study areas, and the delineation of the Thurston County side of the Nisqually River watershed. These scales were based on the Center for Watershed Protection definitions (Zielinski, 2002). The analysis used the 0.25 sq mile DAUs (stormwater management and site design scale), sub-watersheds (stream classification and management scale, referred to as "Study Areas" in the Nisqually Watershed characterization) , and the watershed (watershed-based zoning scale). Because much of the Nisqually Project Area is relatively flat, the DAUs will vary in size, with the tendency to be larger than the target of 0.25 sq miles. The eight study areas were created for ease of presenting the data in eight chapters instead of attempting to describe the 191 DAUs. (*Figure 1.3 Study Area and Figure 1.4 Study Area Drainage Analysis Units*).

Potential Restoration Opportunities

Natural resource sites were assessed for restoration opportunities following the assessment of several ecological and biological landscape indicators at the DAU scale.

Step One: Apply the Matrix and Pathways Indicators (MPI) to assess ecological processes and habitat connectivity at the DAU scale.

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

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

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

How were 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 and ultimately the Study Area to mitigate past disturbances, specifically the movement of water. All natural resource sites not ranked Moderate or High for restoration can be assumed to be of high ecological value for avoidance and preservation or sites that are located in a highly built out environment, and would provide little to no environmental benefit if restored.

There are two essential steps to identify and assess natural resource sites; 1) Determine the ecological processes at the DAU scale using the MPI; and 2) Identify all natural resource sites in the study area. These two data sets are the foundation of the watershed characterization.

The MPI 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). 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 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 because they have a high avoidance and preservation value. In addition, there are sites that would have little environmental benefit if restored because of their location in the landscape e.g. surrounded by a highly built-out environment.

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

- Ecological 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. The Ecological Processes' results are detailed in Appendix B; the detailed natural resource sites are presented in Appendix B; and the natural resource site attributes are presented in Appendix 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 ranked remaining sites. The resulting potential natural resource site lists are presented in Table 1.9.

The natural resource site database consists of 2584 polygons that were created in ArcMap as a data layer, including:

- 2199 unique wetland sites
- 344 unique riparian sites
- 41 unique floodplains sites

Table 1.9 Potential Natural Resource Sites

Study Areas	Wetlands	Riparian	Floodplain	Total Sites in Each Study Area
Powell Creek	176	90	2	**269**
Lacamas Creek	376	49	6	**431**
Yelm Creek	666	79	21	**766**
Thompson Creek	272	26	3	**301**
Lake St. Clair	260	33	3	**296**
McAllister Creek	163	24	5	**192**
Delta Bluff	195	16	0	**211**
Nisqually Bluff	91	27	1	**120**
Total	**2199**	**344**	**41**	**2584**

All potential riparian, wetland, and floodplain sites were evaluated for restoration opportunities. Attributes of each candidate site were then evaluated using established criteria. This process eliminated sites ranked Low from further consideration. Sites ranked Low are either of high quality avoidance and/or preservation sites, or if restored would provide little environmental benefit.

After applying the criteria to the initial site database, the number of sites that warranted further evaluation were reduced to 1071 sites (see Table 1.10).

Table 1.10 Actual Natural Resource Restoration Opportunities

Study Area	Wetlands	Riparian	Floodplain	Total Sites in Each Study Area
Powell Creek	53	37	0	**90**
Lacamas Creek	115	38	0	**153**
Yelm Creek	326	65	5	**396**
Thompson Creek	118	37	0	**155**
Lake St. Clair	66	18	1	**85**
McAllister Creek	78	17	1	**96**
Delta Bluff	39	10	0	**49**
Nisqually Bluff	31	16	0	**47**
Total	**826**	**238**	**7**	**1071**

What are the restoration opportunities within the study area?

Based on the site's environmental ranking (high, moderate or low) and the ecological process rank of the DAU (high, moderate or low) that it resides in, a total of 1466 potential wetland, riparian, and floodplain restoration sites met minimum ranking criteria and were prioritized.

These prioritized lists and the data used in the prioritization process are presented for each Study Area in chapters two through nine.

How should this information be used?

The science of watershed processes is relatively new and it requires a new paradigm of thinking. Most decisions within Thurston County Resource Stewardship Land-Use Permitting are site based and have limited information on what Thurston County now knows about the ecological functions of each watershed in Thurston County. To protect and restore water and upland resources in these watersheds, the information from the characterization should be used in the county's permitting and planning processes because it will enable a broader review of the potential ecological impacts. Following are several county programs where the watershed characterization results can be used.

These recommendations are modified from the Pierce County Biodiversity Network Assessment (Brooks, et al. 2004) on potential uses of the data resulting from watershed characterizations:

Policy and Programmatic Actions

Thurston County Comprehensive Plan

The Thurston County Comprehensive Plan contains an Important Greenspaces Map that identifies areas throughout the County for high priority open space. These areas are a combination of natural hazards (such as wetlands and floodplains), significant wildlife habitat areas, and existing parks and preserves (such as the Nisqually and Black River Wildlife Refuges). It includes both public lands and private properties where a land trust holds a conservation easement. The Comprehensive Plan provides the overarching guidance for other County programs described below. It also includes policies and definitions about what natural features and habitats warrant County regulations or implementation actions. At the present time, it lacks a policy regarding watershed characterization identified restoration or preservation sites. Comprehensive Plan updates relating to critical areas require substantive consideration of supporting science that meets the GMA's Best Available Science criteria (WAC 365-195-900 through 365-195-925)

Potential Actions:

1) The Thurston County Comprehensive Plan, Natural Environment Chapter, should be amended to include a definition of watershed characterization restoration sites, an objective regarding the management approach appropriate for these areas, and specific policies for County implementation actions.

2) The Important Greenspaces Map in the Comprehensive Plan should be amended to include the watershed characterization identified restoration sites.

Conservation Futures Program

The Thurston County Conservation Futures Program was established as a mechanism to protect open space, timber lands, wetlands, fish and wildlife habitat, and agricultural lands of Thurston County. Conservation Futures funds are used by Thurston County or a local land trust to acquire the land or the rights to future development of the land for permanent protection. Currently, applications are reviewed and ranked in terms of high to low priority based on a point system.

Potential Actions:

1) The Conservation Futures ranking process should be amended to recognize watershed characterization restoration and preservation sites as priority habitat areas, including upland forested areas with an added point value.

2) The DAU ranking should be considered in weighting projects for funding using Conservation Futures or other available conservation/mitigation funds.

Open Space Tax Program

The Thurston County Current Use Assessment Program was established to provide deferral of property tax to properties maintained in agriculture, forestry or other open space uses. Properties are evaluated under a point system, called a Public Benefit Rating System, which is similar to the Conservation Futures Program. The existing Current Use Assessment Program does not specifically recognize the watershed characterization results but does give points for the presence of Significant Wildlife Habitat that includes wetlands, streams, floodplain, shoreline, and fish habitat.

Potential Actions:

1) The Current Use Assessment Program could be amended to recognize watershed characterization restoration sites as priority natural resource areas with an added point value.

2) The DAU ranking should be considered in the Public Benefit Rating System.

Compensatory Mitigation Program

Compensatory mitigation could address cumulative unavoidable development impacts through three distinct mechanisms. These include: 1) Permittee Responsible Mitigation (currently done in Thurston County Resource Stewardship through the Critical Areas Ordinance and through SEPA); 2) Mitigation Banking; and 3) In-Lieu Fee Mitigation.

Permittee responsible mitigation maintains the liability for the construction and long-term success of the site. Whereas mitigation banking and in-lieu fee mitigation are forms of "third party" compensation, where the liability for project success is transferred to the mitigation bank or in-lieu fee sponsor. At the present, Thurston County does not have offsite compensatory mitigation programs such as wetland banking or fee-in-lieu, although a pilot in-lieu fee program is underway in the Nisqually and Deschutes watersheds, funded by the Puget Sound Partnership.

The Puget Sound Partnership provided the grant to undertake pre-capitalization activities that included: a feasibility study, preliminary design plans, and an appraisal. Watershed Characterization could inform future banking or fee-in-lieu programs regarding which sites provide restoration opportunities. Critical Area Ordinance updates require supporting science that meets the GMA's Best Available Science criteria (WAC 365-195-900 through 365-195-925)

Potential Actions:

1) Thurston County should consider adopting a compensatory mitigation program that uses the results of the Watershed Characterization to identify restoration sites. This would need to identify the type of mechanism to be used (permittee responsible, program is mandatory and any areas where it would be optional).

<u>Purchase or Transfer of Development Rights Program</u>

In the mid-1990's Thurston County adopted a Purchase of Development Rights (PDR) and a Transfer of Development Rights Program (TDR) for selected agricultural lands within the County. The PDR program purchased the development potential on 940 acres of farm land within the Nisqually Valley. The TDR program was applied to all other long-term agricultural areas.

The intent of the Transfer of Development Rights program is to provide an opportunity for working-land owners to sell their development rights without having to sell their property for development. Under this approach, the rural character and agricultural economy of Thurston County is preserved, and working-land owners have the opportunity to realize some of the true market value of their land without having to sell the land.

Under a TDR program watershed characterization preservation and restoration sites could be identified. Under such an approach, watershed characterization preservation or restoration sites may have the option to transfer the residential development rights to an appropriate receiving location.

Potential Actions:

1) Thurston County should consider adopting a Transfer of Development Rights Program which includes the identification of watershed characterization preservation and restoration sites, as priority features.

<u>Watershed or Salmon Recovery Plans</u>

Thurston County has been involved in various types of watershed and salmon recovery planning since 1999 for non-point source pollution efforts, water resource planning, or other localized needs.

The Nisqually Indian Tribe is lead for water resource planning under ESHB 2514 (watershed planning) and ESHB 2496 (salmon recovery planning). Both of these efforts continue to be active.

Potential Actions:

1) The salmon recovery plans for WRIAs 11, 13 and 14 could be updated to include watershed characterization restoration sites as potential properties for restoration or long-term protection.

Thurston County Capital Facilities Plan

Thurston County adopts a Capital Facilities Plan (CFP) identifying those facilities where the County will fund projects within the next six or twenty years. Transportation projects are a major portion of the CFP. While most new roadway systems throughout the County are proposed by private developments, expansions of existing facilities may be included within the County CFP. New or significantly widened roadways may increase habitat fragmentation and affect high quality habitat areas.

Potential Actions:

1) The Thurston County Comprehensive Plan should consider an amendment to address watershed characterization restoration sites when considering capital improvement projects.

2) Policies could be added that projects within the Thurston County Capital Facilities Plan avoid restoration or preservation sites identified by Watershed Characterizations. If an impact cannot be avoided, then identified mitigation/restoration sites should be pursued whenever practicable.

Stormwater Basin Planning

In the past, Thurston County undertook stormwater basin planning within the urban basins of the north Thurston County urban growth area. Over time the County and the adjacent Cities of Lacey, Olympia, and Tumwater prepared a number of basin plans. All the basin plans include lists of stormwater facilities to be retrofitted. All the basin plans are outdated and do not include any watershed characterization restoration sites. The Nisqually watershed characterization provides an opportunity to partner with the City of Yelm on restoration activities in the Yelm and Thompson creek study areas.

Potential Actions:

1) The list of stormwater facilities to be retrofitted should consider, by basin, watershed characterization restoration sites.

Urban Growth Area Boundary Revision

The Thurston County Watershed Characterization results identify high quality natural resource sites that should be taken into consideration when changes to the Urban Growth Area (UGA) boundary are proposed and evaluated.

Potential Action:

1) Utilize the list of high quality natural resource sites from the Watershed Characterization results, when making boundary revisions to UGA boundaries.

Development Regulations

Critical Areas Regulations

Development regulations are means to implement the goals, objectives and policies of the Comprehensive Plan. All local jurisdictions in the state are required to have "Critical Areas" regulation under the State Growth Management Act (GMA). A Critical Areas Ordinance (CAO) covers a wide range of geographic conditions including floodplains, riparian areas, wetlands, and steep slopes. A CAO is a type of development regulation. Thurston County adopted its current CAO in 2012.

Critical Area Ordinance updates require substantive consideration of supporting science that meets the GMA's Best Available Science criteria (WAC 365-195-900 through 365-195-925).

While a Critical Area regulation can require protection of the current conditions, it lacks the ability to require substantial habitat restoration. For example, if a wetland has been ditched and now only supports monoculture of reed canary grass, (referred to by farmers as 'wet pasture') those ecological functions are what the CAO regulations would protect. This is why separate actions are needed by local governments for more ecological restoration and long-term habitat protection. CAO regulations could offer some innovative approaches for regulating critical areas; such as allowing mitigation banking, off-site mitigation, and alternative mitigation approaches. The management of watershed characterization restoration sites is more suitable for these alternative approaches than the traditional site-by site review process at the time of a development proposal. However, any proposed development that requires a SEPA review should be subject to a requirement to address restoration of sites identified by the watershed characterization results.

The CAO allows the adoption of special management plans for specific situations relating to critical areas, such as sub-watersheds or basins. When detailed studies are completed, alternative standards and requirements can be adopted which provide specific development regulations, protection, and restoration potential. Such alternative approaches could include off-site mitigation when it can be shown to provide equal or greater benefits than on-site mitigation. While such an approach is most commonly associated with wetland mitigation, it might be equally suitable for streams, riparian, or prairie areas where off-site mitigation may provide greater watershed restoration benefits. Either could be linked to the compensatory mitigation program describe above.

Potential Actions:

1) The Thurston County Critical Area Ordinance (CAO) should be amended based on completed watershed characterizations.. An alternative set of regulations could be adopted that includes requirements related to restoration of sites identified in the watershed characterization to provide equal or better watershed restoration benefits.

3) New regulations should be considered regarding aquatic and terrestrial habitats and may include:

   a) Minimum forest cover standards,
   b) Minimum patch size for various habitats,
   c) A change of allowed uses to those which are defined as ‘low intensity, and
   d) Avoidance provision for the location of new upland roads similar to those currently in place for wetlands.

3) These special regulations could be linked to the adoption of a compensatory mitigation program.

<u>Stormwater Regulations - Low Impact Development</u>

Stormwater regulations are a type of development regulation described by the Thurston County Comprehensive Plan and the State Growth Management Act. Thurston County and the Cities of Lacey, Olympia, and Tumwater are regulated by the Washington State Department of Ecology (Ecology) through a National Pollution Discharge Elimination System (NPDES) phase II permit. Thurston County and the Cities of Lacey, Olympia, and Tumwater have all adopted an equivalent to Ecology’s Stormwater Management Manual for Western Washington, as required by the NPDES permit. The recently issued 2013-2018 NPDES Phase II permit requires Low Impact Development (LID), where feasible, to minimize the impacts of new development and redevelopment on hydrology and water quality. The application of LID techniques can offer a number of advantages over traditional, engineered stormwater drainage approaches, where feasible.

Possible Actions:

1) The Thurston County Stormwater Drainage Manual should consider incorporating the restoration or preservation of high priority sites identified in the watershed characterization for projects where LID is not feasible.

Non-Regulatory Conservation Efforts

Land Trusts

There are many organizations and programs set-up to acquire properties for habitat conservation. Land trusts are one of these. They manage lands for a variety of open space and wildlife habitat purposes, and acquire properties through a fee simple purchase or a conservation easement which restricts the future use and development of the site. Within southern Puget Sound the Cascade Land Conservancy, Capital Land Trust, and Nisqually Land Trust are all active. The Nisqually Land Trust (WRIA 11) and the Capitol Land Trust (WRIA 13 and 14) have been active in acquiring parcels and conservation easements though a collaboration of funding sources including Conservation Futures, the Open Space Tax Program, and Salmon Recovery funding.

Possible Actions:

1) Thurston County should continue to support the actions of local land trusts to acquire parcels and conservation easements for the purpose of natural resource protection.

2) Encourage land trusts to participate in collaborative efforts that would include prioritizing watershed characterization restoration and preservation sites.

South Puget Sound Salmon Enhancement Group

The South Puget Sound Salmon Enhancement Group (SPSSEG) is one of fourteen Regional Enhancement Groups created by the State in 1990 to protect and restore salmon populations. By obtaining grants and donations it undertakes aquatic restoration projects. This is often done in cooperation with other conservation organizations.

Possible Actions:

1) Encourage SPSSEG to consider watershed characterization restoration sites as possible future projects.

2) List SPSSEG as a possible restoration partner in future updates of the Capitol Facilities Plan by the Thurston County Resource Stewardship Department – Water Resources Program.

Stream Team

Thurston County and the Cities of Lacey, Olympia, and Tumwater have partnered with the Thurston Conservation District to have organized citizen based volunteer stream teams assist in various education and restoration efforts within the communities. This can often involve other environmental and civic groups (such as schools, scout troops, etc.). The volunteer approach offered by the Stream Team may have a higher success rate in interacting with these property owners than other governmental techniques.

Possible Action:

1) Identify watershed characterization restoration sites that may assist in prioritizing Stream Team restoration efforts with a limited budget.

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