Guiding Growth – Healthy Watersheds: McLane Creek Basin Water Resource Protection Study

thurston regional planning council

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Guiding Growth – Healthy Watersheds

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1. Introduction

Overview: Guiding Growth – Healthy Watersheds

McLane Creek and the land surrounding it and its tributaries was one of three Thurston County basins identified for a focused study as part of the *Guiding Growth – Healthy Watersheds* program. Thurston County is located at the southern end of Puget Sound, and boasts a wealth of natural resources, including large forested areas and many streams and water bodies. In part, we owe our relatively good water quality to the fact that the county is less developed than other urbanized areas in the Puget Sound region. Thurston County also is home to the state capitol and the metropolitan area surrounding the cities of Olympia, Lacey, and Tumwater. It is one of the fastest growing counties in Washington State. According to the 2013 population forecast developed by Thurston Regional Planning Council (TRPC), we can expect an additional 110,000 people to move into our region over the next 20 years.

This growth will bring many benefits to the economy and residents of Thurston County, yet there are downsides to such a rapid increase in population and the demand for new homes, roads, and services that it entails. Development in sensitive areas can damage or disrupt important ecosystem services provided by our watersheds, including the filtering and purification of water, regulation of water flows, protection from floods, and creation of habitat for plants and animals. Careless development in these areas could lead to lakes, streams, and beaches that are unhealthy and unusable for both people and wildlife. One response is to plan for this growth by identifying ecologically important areas at a landscape scale, and considering how development can occur in a way that preserves the ecosystem services that are important within specific watersheds.

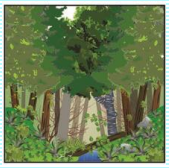
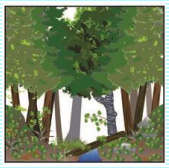
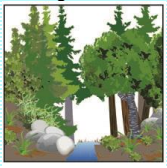
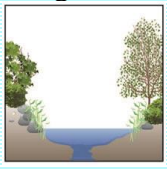
Project Background

Thurston County teamed with TRPC and the cities of Olympia, Tumwater, and Lacey to integrate watershed science into local policies. The aim of the study was to investigate ways to accommodate projected population growth while preserving water resources in areas impacted by that growth. This collaborative effort is funded by a grant from the U.S. Environmental Protection Agency, as part of that agency's efforts to protect and restore water quality in Puget Sound. The project initially focused on areas within the Totten, Eld, Budd/Deschutes, Henderson, and Nisqually Reach watersheds (

Map 1). The watershed planning process began in 2010 and includes the following stages, several of which are detailed in accompanying documents:

Evaluating Current Basin Conditions

In Phase One of this project, stream basins within the Totten, Eld, Budd/Deschutes, Henderson, and Nisqually Reach watersheds were categorized by their current conditions:

Intact 	*Intact basins have little to no impervious surfaces (<2% basin-wide), a nearly complete forest canopy (>80% basin-wide), and vegetated riparian corridors (>90%). Water bodies are in excellent condition, with no water quality violations and a high B-IBI score (>41).*
Sensitive 	*Sensitive basins have minimal impervious area (2-10% basin-wide), considerable forest cover (65-80% basin-wide), and riparian corridors with few breaks in protective buffers (75-90% vegetated). Water bodies are in good condition, meeting most water quality standards, and have a high B-IBI score (36-41).*
Impacted 	*Impacted basins are moderately urbanized (10-25% total impervious area), with some remaining forest cover (45-65%). Riparian corridors are cleared in many places (only 60-75% vegetated) and water quality is fair, with some impairments and lower B-IBI scores (28-35).*
Degraded 	*Degraded basins are urbanized (25-40% total impervious area) with limited remaining forest canopy (30-45%) or vegetated riparian areas (30-60%). Water quality is poor, with multiple impairments and very low B-IBI scores (28-35).*
Highly Degraded 	*Highly degraded stream basins generally have poor water quality and support a low diversity of aquatic species. Impervious cover is generally over 40% and forest cover is generally less than 30%. No Thurston County stream basins fall into this category.*

Project Stages

1. Evaluate basins based on current conditions and impacts from future growth. The results of this evaluation are detailed in a separate report, *Basin Evaluation and Management Strategies for Thurston County* (TRPC 2013). This report reviews recent research about the impacts of urbanization on water quality and watershed health and provides an assessment of the current condition of 69 basins that drain to Puget Sound, classifying each as intact, sensitive, impacted, or degraded (see sidebar). This assessment was based on monitoring and land cover data as well as a characterization of watershed processes. It also details the potential impacts of future growth on each of those basins, using projections of impervious surfaces and loss of forest lands.
2. Select three at-risk basins for detailed study. Based on the results of the basin evaluation and the availability of sufficient data for hydrologic modeling, the project team recommended three key basins for further attention: McLane Creek, Black Lake, and Woodard Creek basins. Section 2 of this report includes a narrative depiction of the current conditions, threats, and management goals for McLane Creek basin.
3. Analyze future land-use scenarios. Section 3 of this report includes a description of the scenarios developed and a summary of the results of the hydrologic modeling. A more detailed account of the modeling methodology and results is included in a separate report, *Hydrologic Modeling in Support of Watershed Based Land Use Planning in Thurston County* (NHC 2014).

4. Develop recommended changes to management policies. Section 4 of this report includes a set of recommended policy changes for the McLane Creek basin, based on the results of the modeling work and land use analysis.
5. Adopt and implement changes to land use practices. Although this report recommends a preferred management approach and Section 5 includes suggested next steps for making the identified policy changes, each local jurisdiction will determine how best to apply the results in their communities using their own public process. The long-term success of this effort depends on continued regional coordination as well as public outreach and support.
6. Monitoring/Adaptive management. The effectiveness of the policies developed and implemented through this project will be evaluated in future phases of this study.

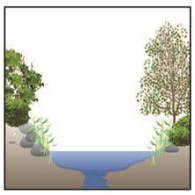
Project Goals

The *Guiding Growth – Healthy Watersheds* project was begun with the understanding that preventing damage to our watersheds is less expensive and often more effective than paying to restore natural forest cover and stream flow conditions after they have been extensively altered. Rather than focus on restoring the most degraded areas, the focus of this project is to prevent basins that are categorized as "intact" or "sensitive" from becoming "impacted," and to prevent basins that are categorized as "impacted" from becoming "degraded." The approach taken by the project team has been to look at landscape patterns from a basin-scale and determine the goals and policies that make sense based on the current conditions and future potential of that basin (Table 1).

The strategies identified for achieving these goals include:

- Focusing new development in existing urban areas
- Guiding growth away from identified sensitive or critical habitats
- Reducing the impacts of growth through low impact development and stormwater regulations

TABLE 1: SUMMARY OF MANAGEMENT GOALS BASED ON EXISTING BASIN CONDITIONS.

	Basin and In-Stream Current Conditions		
	Sensitive	**Impacted**	**Degraded**
Management Goals:			
Basin-wide Conditions to support properly functioning Water Flow and Water Quality			
Protect basin-wide conditions[1]	Yes	Functions already impacted	Functions already degraded
Restore basin-wide conditions	Yes	Possibly	Probably not achievable
Maintain existing basin-wide conditions	Yes	Yes	Yes
Critical Habitats Functions (Shorelines, Wetlands, Riparian Corridors)			
Protect critical habitats:	Yes	Yes	Yes
Restore critical habitats:	Yes	Possibly	Less likely although it is dependent on the size / uniformity of basin conditions[2]
Water Quality			
Minimize downstream pollutants from new growth:	Yes	Yes	Yes
Improve water quality – lower existing pollutant levels	Yes	Yes	Yes
Water Flow (Flooding)			
Minimize increase in peak flows	Yes	Yes	Yes
Improve water flow conditions where degraded	Yes	Yes	Yes

[1] Basin conditions – mainly related to land use and land cover characteristics such as urbanization and impervious area, forest cover, and other land uses that effect in-stream conditions.

[2] Some basins may have large patches of intact or sensitive areas where restoration will be successful. Each basin must be evaluated for local conditions.

Planning Process

This basin study was conducted by a project team that included staff from Thurston County's Long-Range Planning and Water Resources divisions, TRPC, U.S. Environmental Protection Agency, and Northwest Hydraulic Consultants. The basin scenarios and management recommendations were developed with the input and assistance of planning and public works staff from the cities of Olympia, Tumwater, and Lacey, and the Squaxin Island Tribe, as well as members of the Municipal Stormwater Technical Advisory Committee for Thurston County (StormTAC), and the WRIA 13 Salmon Habitat Workgroup.

A Scientific Advisory Team (SAT) was convened to review technical decisions and products at key points during the project, including the data used for the project, the basins selected, and the modeling results. The SAT included technical experts from Cambria Science and Communication, Washington State Department of Ecology, King County, and the Squaxin Island Tribe.

Public Engagement

Thurston County solicited input from basin residents and other interested parties throughout the course of the project. In August and September of 2013, Thurston County and TRPC distributed a survey to property owners and residents in the three basins to assess the community's awareness and interest in water resource issues, and their preferences in developing management policies that affect the future of the basins. The results of the survey for McLane Creek basin are detailed below, in Section 2.

On April 9, 2014, the County hosted a Water Resource Community Workshop for residents of the McLane Creek basin at the Black Lake Grange Hall. Those who attended were given a presentation with background on water resource issues in the McLane Creek basin and the watershed planning work. Participants provided feedback on what management goals should be prioritized for the basin, and on specific places that they considered worthy of attention.

On October 9, 2014, the County hosted a second workshop for residents and interested parties at the McLane Grange Hall. The workshop included a presentation describing the alternative future scenarios developed for the project, an overview of the preliminary modeling results, and a discussion about the draft management options discussed in Section 3 of this report.

Additional opportunities for public feedback on the project and recommendations were provided in the spring and summer of 2015 as this report was reviewed by the Thurston County Planning Commission and Board of County Commissioners.

Relationship to Regional Goals

While the results included in this study apply specifically to the McLane Creek basin, this watershed planning project also supports the goals and strategies outlined in several ongoing regional efforts, as detailed below:

Puget Sound Partnership Indicators and Targets

The Puget Sound Partnership is the state agency charged with coordinating the recovery of Puget Sound. The agency has identified a set of 21 key ecosystem indicators to help track progress toward their recovery goals, and the Partnership's Leadership Council has adopted specific targets for many of these indicators. This basin study and the management policies recommended support several of these indicators and targets.

Indicator: Freshwater Quality

- By 2020, at least 50% of all monitoring stations with suitable data have Freshwater Water Quality Index scores of 80 or higher.
- By 2020, achieve a decrease in the number of impaired waters (303(d) list) in Puget Sound freshwaters.
- By 2020, 100% of Puget Sound lowland stream drainage areas monitored with baseline B-IBI scores of 42-46 or better retain these "excellent" scores and mean B-IBI scores of 30 Puget Sound lowland drainage areas improve from "fair" to "good."

What are Urban Growth Areas?

Local cities and counties in Washington State plan under the Growth Management Act (GMA). In Thurston County, jurisdictions have worked together to designate urban growth areas (UGAs). These are the areas that already have, or are planned to receive, urban services such as sewer, in the future.

Thurston County's first urban growth boundary agreement was established in 1983 for the north county areas, and later revised in 1988. In the early 1990s growth boundaries were established county-wide. Since that time the urban growth boundaries have been adjusted slightly. Overall, the area designated for urban growth has been reduced by over 1,000 acres, or around 1.7% in the last 20 years.

Thurston County's urban growth areas include the incorporated areas (cities and towns), the unincorporated urban growth areas within and around the cities and towns, and the unincorporated Grand Mound area.

Indicator: Land Cover & Land Development

- By 2020, average annual loss of forested land cover to developed land cover in non-federal lands does not exceed 1,000 acres per year and 268 miles of riparian vegetation are restored or restoration projects are underway.
- By 2020, the proportion of basin-wide growth occurring within urban growth areas is at least 86.5% (equivalent to all counties exceeding goal by 3%) and all counties show an increase over their 2000-2010 percentage.
- Basin-wide, by 2020, loss of vegetation cover on indicator land base over a 5-year period does not exceed 0.15% of the 2011 baseline land area.

Sustainable Thurston

Thurston Regional Planning Council's Sustainable Thurston plan, *CREATING PLACES—PRESERVING SPACES: A SUSTAINABLE DEVELOPMENT PLAN FOR THE THURSTON REGION*, adapts the Puget Sound Partnership's 2020 freshwater quality target and sets the following target for the Thurston County region in 2035:

- Protect small stream basins that are currently ranked as "intact" or "sensitive," and improve and restore as many as possible "impacted" stream basins.

The Sustainable Thurston plan also set two land-use priority targets, which will help the region protect water quality, as well as reduce vehicle miles traveled and related greenhouse gas emissions:

- By 2035, 72% of all (new and existing) households in our cities, towns, and unincorporated growth areas will be within a half-mile (comparable to a 20-minute walk) of an urban center, corridor, or neighborhood center with access to goods and services to meet some of their daily needs.

- Between 2010 and 2035, no more than 5% of new housing will locate in the rural areas, and 95% will be within cities, towns, unincorporated growth areas, and tribal reservations. Rural areas include land outside of the cities, towns, unincorporated urban growth areas and tribal reservations.
    - Supporting target: No net loss of farmlands, forest lands, prairie habitats (in addition to environmentally critical areas that are currently protected) while providing for a range of densities within rural Thurston County.

2. Basin Description

Overview

The McLane Creek basin (Figure 1; Map 2) is located in northwestern Thurston County, a little more than five miles west of the city of Olympia. It encompasses more than 7,000 acres that drain into McLane Creek and into Eld Inlet, and is bounded on its northeastern side by U.S. Route 101, and on its northwestern side by the steep terrain of the Black Hills. The basin contains six major tributaries to McLane Creek, including Beatty Creek, Cedar Flats Creek, Perkins Creek, and Swift Creek. The area is one of the most ecologically intact basins within Thurston County that discharges to Puget Sound.

FIGURE 1: MCLANE CREEK BASIN.

McLane Creek basin is a rural area that is home to around 1,300 people. The population of the area is expected to grow by an estimated 29% between 2010 and 2035, to around 1,700 people.

Jurisdiction

McLane Creek basin is located entirely within rural Thurston County (Map 3).

Soils

The majority of the basin is underlain by till soils, with smaller areas of outwash, Kitsap and saturated soils (NHC 2014)[3]. Till soils include areas where glacial activity left a compacted and relatively impermeable layer of clay, silt, loam, and/or gravels; they generally allow limited drainage and have higher surface runoff. Outwash soils include glacial deposits of permeable sands and gravels. Kitsap soils include those formed by lacustrine sediment, and generally have greater moisture storage and drainage than till soils, but less than outwash. Saturated soils are poorly drained and include wetland areas.

[3] These four soil classifications were defined using NRCS soils inventory data by the US Geological Survey and were used in the HSPF modeling study for this project.

Thurston County sets some standards for development and stormwater management according to hydrologic soil group classifications. Hydrologic soil groups are defined by the Natural Resource Conservation Service and are based on estimates of surface water runoff potential determined by how fast water can be expected to infiltrate – these groups are related but do not correspond exactly to the soil classes described above. Group A soils have the highest infiltration rates (low runoff potential) even when thoroughly wetted (greater than 0.30 in/hr); Group B soils have more moderate infiltration rates (0.15-0.3 in/hr); Group C soils have slow infiltration rates (0.05-0.15 in/hr) and include fine textured soils and those with a layer that impedes downward draining of water; Group D soils have very low infiltration rates (0-0.05 in/hr) and include clay soils as well as areas with high groundwater that nears the surface (Thurston County DDEM 209). In McLane Creek basin, most of the soils have moderately high to high runoff potential (Groups C and D), with some areas with more moderate infiltration east of the East Fork of McLane and in the area around Perkins Creek (see Table 2; Map 4).

TABLE 2: SOIL TYPES IN MCLANE CREEK BASIN

USGS Soil Class	Outwash	Till	Kitsap	Saturated
	26%	61%	3%	11%
Hydrologic Soil Group (NRCS)	**Group A**	**Group B**	**Group C**	**Group D**
	5%	29%	55%	11%

Species and Habitat

The McLane Creek basin supports a variety of wildlife, including several migratory salmon runs in the freshwater streams, as well as geoduck, littleneck clam, and other harvestable shellfish species in Eld Inlet. The Washington Department of Fish and Wildlife maintains a list of Priority Habitats and Species (PHS) that identify priorities for conservation and management. Priority species include state listings of Endangered, Threatened, Sensitive, or Candidate species, as well as wildlife that are vulnerable to habitat alteration and disturbance, or that are of economic or tribal importance. The PHS catalog and map data identify the following important species and habitats within the McLane Creek basin:

TABLE 3. PRIORITY HABITATS AND SPECIES IN MCLANE CREEK BASIN

	Common Name	McLane Creek Basin Location
Species		
	Cutthroat trout	Swift, Mainstem McLane, Perkins, East Fork McLane Creeks
	Winter steelhead	Swift, Mainstem McLane, Perkins Creeks

	Coho	Swift, Mainstem McLane, Cedar Flats, Perkins, Beatty, East Fork McLane Creeks
	Fall Chinook	Swift Creek
	Chum	Swift, Cedar Flats, McLane, Beatty Creeks
	Shorebird concentrations	Shorebirds forage in Mud Bay North and South of highway bridge
	Wood duck	Breeding areas north of Swift Creek and near the confluence of McLane and Beatty Creeks
	Western (Pacific) pond turtle	Throughout basin
	Pileated woodpecker	Breeding area near Beatty Creek
	Big brown bat	Regular concentration near the mouth of McLane Creek
Habitats		
	Coastal wetlands	Coastal salt marshes, salt meadows and brackish marshes
	Palustrine wetlands	Extensive wetlands associated with Mainstem McLane Creek; there is a long wetland area connecting McLane Basin to Black Lake Basin
	Estuarine intertidal	Along marine shoreline of Mud Bay

Critical Areas

Thurston County's Critical Areas Ordinance (TCC 24) was updated in 2012; it includes protective policies for five types of critical areas: important fish and wildlife habitat areas (including riparian corridors), wetlands, critical aquifer recharge areas, frequently flooded areas, and geologically hazardous areas (including steep slopes and bluffs). A variety of critical areas are located within McLane Creek basin.

Habitat Areas

McLane Creek, and tributaries Swift, Beatty, and Cedar Flats creeks are listed as Type-F, or fish-bearing, streams under the Washington Department of Natural Resources (DNR) classification system. Thurston County's Critical Areas Ordinance assigns Type-F streams a riparian habitat area ranging from 150 to 250 feet, depending on the width of the stream.

Wetlands

There are extensive wetlands in the basin, including those associated with the mainstem and East Fork of McLane Creek, as well as estuarine wetlands and coastal salt marsh where McLane

drains into Eld Inlet. These areas qualify for protections under the Critical Areas Ordinance, with wetland buffers ranging from 50 to 300 feet, depending on the condition of the habitat.

Critical Aquifer Recharge Areas

Critical Aquifer Recharge Areas (CARAs) are locations that overlie significant groundwater resources and, based on geology and soils, are particularly susceptible to groundwater contamination. Category I CARAs are considered extremely sensitive, and include Wellhead Protection Areas, or the distance around a well through which contaminants are likely to travel within one, five, or ten years. There are eleven wellhead protection areas within or overlapping the McLane Creek basin, including those surrounding the water systems for Cougar Ridge, Maple Valley, Delphi Daubel, Camelot, Western Skies, and Alpine Hills neighborhoods. There are Category I CARAs along many of the streams in the basin, including the mainstem of McLane, Swift, and Beatty creeks. Activities that use hazardous materials or that could pose a risk to groundwater are restricted and regulated within these areas.

Frequently Flooded Areas

Flooding concerns are minimal within McLane Creek basin, though there is a potential for coastal flooding where McLane Creek exits into Mud Bay and along Eld Inlet. The FEMA designated one-hundred-year floodplain along McLane Creek is relatively narrow. There are a few identified high groundwater areas in McLane Creek basin, most falling near McLane Creek. Development must be set back and above the base flood elevation of these areas. New onsite septic systems must be located outside of the one-hundred-year floodplain, floodway, and high groundwater hazard areas.

Geologically Hazardous Areas

McLane Creek basin includes a number of areas where slopes are greater than 40%, as well as areas identified as potential landslide hazard areas, based on their soils and topography. These hazard areas are concentrated in the southwestern corner of the basin, within the Black Hills. Removal of vegetation is restricted within these hazard areas, and tree harvesting is subject to review in addition to that required under Forest Practice Permits.

Land Use

Primary uses in this basin include forestry, agriculture, and residential development. The basin contains a large section of Capitol State Forest, which is managed by the Washington Department of Natural Resources, as well as the McLane Creek Nature Trail and the Delphi Country Club golf course.

Zoning

About half the basin is zoned Rural Residential Resource 1/5 (49%), and half Long Term Forestry (46%). Small areas within the basin are zoned as Rural 1/10, Rural 1/20, or Limited Areas of More Intensive Rural Development (LAMIRD) 1/1 or 1/2. There is a small area zoned for Highway Commercial (5).

Rural Residential Resource 1/5. The purpose of this zone is to balance human uses with the natural environment, maintain rural character, and buffer environmentally sensitive areas and resource management areas from incompatible activities. Primary land uses permitted in this zone include agriculture, forestry, open space, and low-density residential. The zone allows one dwelling unit for every five acres of land. Land in this zone may have critical areas or limited groundwater, and should not require the provision of urban services. This zone is not permitted to be upland to an aquaculture management district or a "natural" shoreline designated in the Shoreline Master Program.

Within this zone, maximum impervious surface coverage is 60%, except lots that are primarily on soils with minimal infiltration capacity (hydrologic soil groups C and D) are limited to 10% impervious coverage. Maximum building coverage on a lot is 6,000 square feet for parcels between five to ten acres, and 20,000 square feet for parcels over ten acres. Within McLane Creek basin, there are no vegetation retention requirements for this zone.

Long-Term Forestry. The purpose of this zone is to conserve forest lands of long-term significance and to discourage uses incompatible with forestry. Primary land uses include forest practices and management, harvest and accessory uses, agriculture, low-intensity recreation, and limited single-family residences. The zoning designation includes area within Capitol Forest, as well as parcels owned by several large timber companies. Within this zone, residential densities are limited to one unit per 80 acres; clustering of residences is encouraged, and density can be increased to one unit per 20 acres on parcels under 640 acres, if it is clustered.

This zone has no maximum limits on impervious surface or building coverage, and no vegetation retention requirements.

Residential LAMIRD 1/1. This zone recognizes residential development in rural areas that was developed at a higher density prior to July 1990. Within the McLane Creek basin, this zoning includes the Cougar Ridge (1988) and Camelot (1970) subdivisions off Delphi Road, and the Alpine Hills neighborhood (1971). New development in these areas is limited to infill and to a density of one unit per acre. The maximum coverage limit within this zone is 60%, and there are no vegetation retention requirements.

Residential LAMIRD 1/2. This zone recognizes residential development in rural areas that was developed at a higher density prior to July 1990. Within the McLane Creek basin, this zoning includes the area developed around the Delphi Country Club (1972) and the Arnesen Place subdivision (1982). New development in these areas is limited to infill and to a density of one unit per two acres. The maximum coverage limit within this zone is 60%, and there are no vegetation retention requirements.

Rural 1/10. The purpose of this zone is to protect public health and safety by minimizing development in environmentally sensitive and hazardous areas, particularly flood prone areas and those above aquifers with elevated chloride levels. Within this zone, maximum impervious surface coverage is 60%, except lots that are primarily on soils with minimal infiltration capacity (hydrologic soil groups C and D) are limited to 10% impervious coverage.

Rural 1/20. The purpose of this zone is to protect public health and safety by minimizing development in environmentally sensitive and hazardous areas, and to protect critical areas and create open space corridors. Within this zone, maximum impervious surface coverage is 60%, except lots that are primarily on soils with minimal infiltration capacity (hydrologic soil groups C and D) are limited to 10% impervious coverage.

Highway Commercial. The purpose of this zone is to provide for the location of facilities and services needed by the traveling public (food, gas, lodging) along major highways. Within McLane Creek basin, this zone includes an area where Mud Bay is crossed by U.S. Route 101. This zone limits the maximum coverage by structures to 60% of a parcel.

Shorelines

The reaches along lower portions of Cedar Flats and McLane Creek, and along Eld Inlet up to U.S. Route 101 are considered shorelines of the state and are designated as Conservancy under Thurston County's Shoreline Master Program (1990). The SMP regulates land use and development along marine shorelines, rivers with flows greater than 20 cubic feet per second, lakes larger than 20 acres, associated floodplains and wetlands, as well as areas within 200 feet of these shorelines.

The Conservancy Environment designation applies to areas along the shoreline with low-intensity land uses, and is intended to protect and manage existing natural resources, as well as valuable historic and cultural areas, to ensure sustainable utilization of renewable forest and aquatic resources as well as limited recreational use. Permitted uses include agriculture, aquaculture, and low-intensity recreational access. Residential development of up to one unit per acre is allowed, as is clustering of development – for non-clustered developments, 100 feet is the minimum lot width. Forest Management is permitted with regulations to provide additional protections for wildlife habitat. Boat ramps, docks, buoys, and piers are allowed within this designation, subject to general regulations, as are shoreline protective measures, such as bulkheads, dikes, riprap, and berms. Mining is allowed with a conditional use permit, and industrial uses are prohibited. Utility distribution and transmission lines are permitted, but facilities such as sewage treatment plants and substations are prohibited.

Within the Conservancy Environment designation, total impervious surface coverage is limited to 30% coverage of a lot. Commercial recreation and residential structures must be set back 100 feet from the ordinary high water mark. A minimum 20-foot buffer of existing ground cover must be maintained, but there are no additional regulations related to the removal of trees and vegetation for views or other reasons.

Aquatic Habitat Conditions

McLane Creek basin is considered to be a relatively intact basin with good remaining habitat and limited impacts from development and other human alteration (see Table 4). The area is covered by 1% total impervious surfaces and has retained 64% tree canopy, using data from 2011. Streams remain vegetated along most of their lengths (TRPC 2013). Large woody debris (LWD) is somewhat limited in the basin, with a lack of key pieces, and there remain a number of fish passage barriers along Beatty Creek, Perkins Creek, and Cedar Flats Creek. Many historic wetlands within the basin have been drained or modified.

TABLE 4: CURRENT AQUATIC HABITAT CONDITIONS FOR MCLANE CREEK BASIN

Level of Urbanization	Hydrology	Riparian Corridor	In-stream Physical Conditions
• Total Impervious Area Estimate 1991: 0.6% 2006: 1.0% 2011: 1.0%	• Effective Impervious Area Estimate, 2006: 0.7% • Forest Cover 2006: 72.7% 2011: 64% • Unmodified Wetlands: 4.1% • Miles of Streams: 43.8 • Areas of high groundwater flooding: 0.2% of basin	• Coniferous forest cover in 250 foot stream riparian corridor, 2006: 14.4% • Forest, scrub/shrub vegetation and wetlands in stream riparian corridor: 150 ft: 93.9% 250 ft: 92.0% 1,000 ft: 90.8% • Number of road crossings per mile of creek: 1.1	• Good amount of LWD, poor key piece LWD • Pools: fair for both surface area and frequency • Canopy closure not sufficient to maintain water temperatures • Fair amount of fine sediment • Estuary at mouth in good condition

SOURCE: TRPC 2013

Water Quality

Overall water quality for McLane Creek is ranked *Fair* by Thurston County Environmental Health, which has monitored a station at the stream mouth since 1983 (TCEH 2012). McLane Creek and Swift Creek are both included on the federal list of impaired waters for violating standards for fecal coliform (bacteria) pollution. McLane Creek usually meets Part 1 but fails Part 2 of the fecal coliform standard, and there appears to be a pattern of higher fecal coliform results during the dry season. The average levels of nutrients in McLane Creek (nitrate+nitrite and phosphorus) are elevated, and the stream sometimes fails the turbidity standard. Stream temperature is cool and stays below the standard for protecting salmonid rearing and migration (17.5 °C) and there have been no recent violations for pH or dissolved oxygen.

The Benthic Index of Biologic Integrity is a method for evaluating and comparing the biological condition of streams by evaluating the presence and diversity of different macroinvertebrates. For McLane Creek, the average B-IBI score for 2002-2011 ranks in good condition at 39.

Eld Inlet has exhibited declining water quality, specific monitoring stations with concerns, and several shellfish growing areas are classified as "threatened" by the state Department of Health. The county currently has a program that tests failing septic systems in marine shoreline areas, but participation in Eld Inlet has been low.

Residential Development Potential

Large portions of McLane Creek basin are undeveloped and forested, but in private ownership, and zoned for rural residential development. The area around Perkins Creek in particular is likely to see residential development if water is available. Most of the recent development activity (buildings and lot subdivisions) has been along Swift Creek and the Beatty Creek/Hart Creek area (Map 6).

Threats and Concerns

- The Basin Evaluation report (TRPC 2013) identified McLane Creek basin as at risk for loss of forest lands and forest cover.
- Water quality in the basin is impacted by nonpoint pollution from agricultural activities and forest practices. McLane Creek routinely fails part 2 of the fecal coliform standard and has repeatedly failed the turbidity standard. Phosphorus levels are elevated and increasing.
- McLane Creek was placed on Washington State's 303(d) list of impaired waterbodies in 2004 for bacteria. A TMDL for Totten and Eld Inlet was approved by the Washington State Department of Ecology in 2006. According to the TMDL Water Quality Improvement report (2006), McLane Creek's highest bacteria concentrations occur in the dry season, late summer and fall, and the main human-controlled sources of bacteria identified were livestock waste, leaking onsite septic systems (OSS) and pet waste. McLane Creek contributes half the bacterial load to Eld Inlet.
- Stream segment monitoring conducted in 2006 and 2007 by Thurston County Environmental Health identified a bacteria pollutant source along McLane Creek between river mile 3 and 2.5.
- The WRIA 13 Habitat Limiting Factors report identified the following limiting factors for salmon in McLane Creek and its tributaries (excludes fish passage barriers): Lack of large woody debris (particularly key pieces), lack of pools, fine sediment, and degraded riparian corridors.
- Capitol Land Trust and the South Sound Salmon Enhancement Group have conducted several restoration projects in this basin, most notably along the marine shoreline at the mouth of McLane Creek. Landowner willingness has been identified as a limitation for restoration projects in parts of this basin.

Threats and concerns in the McLane Creek basin include (clockwise) pollution from pet waste, septic systems, and agricultural activities, lack of large woody debris in the stream corridors, and forest practices (next page.)

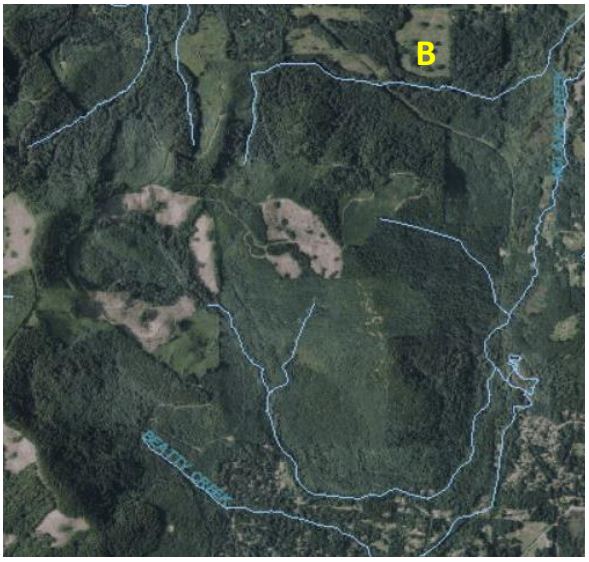
FIGURE 2: MCLANE CREEK BASIN – THREATS AND CONCERNS.

Much of McLane Basin is in Capitol State Forest, part of Washington State's forest lands. Timber in Capitol Forest is harvested regularly under forest practice permits issued by the State Department of Natural Resources. In the past, timber was harvested without leaving a forested buffer around streams (A). The current practices require stream buffers (B) to protect streams from exposed soil and other runoff from forest harvest practices.

2000

2006

2009



2012

FIGURE 3: MCLANE CREEK BASIN FOREST PRACTICES.

Public Views

In response to a survey[4] sent in August 2013, residents and property owners indicated that the things they value most about living in the McLane Creek basin are its natural environment and scenery, the opportunities it provides for a rural lifestyle and privacy, and its wildlife. Clean drinking water, private property rights, healthy salmon runs, and Puget Sound water quality are all issues that are very important to the majority of respondents. More than half of those who responded (62%) indicated that they are somewhat or very concerned about water quality in the basin. They saw the greatest risks to water quality as urban development, loss of forest cover, and pollution from stormwater runoff and septic systems. When it comes to planning for the future of the basin, residents felt that the most important issues to address were:

- Protecting wildlife and fish habitat (64%),
- Protecting water quality (57%),
- Preserving undeveloped land (47%),
- Preserving farmland and agriculture (38%), and
- Preserving working forests (31%).

When asked how they would like to describe McLane Creek basin in the future, many residents expressed hope that the area would remain much as it is today, predominantly rural in character, with clean water and healthy salmon runs, and with only limited new development at lower densities. Land stewardship is important, with some residents expressing a desire to pass their land down to a new generation. Several respondents noted that they hoped to continue or expand their access to recreation areas in the basin, such as the McLane Creek Nature Trail.

These views were emphasized at a community workshop held on April 9, 2014, at the Black Lake Grange. Participants expressed curiosity about the potential impacts of planning and growth on the watershed, as well as concerns about the impact of forestry within the basin, the impact of McLane Creek on water quality in Eld Inlet, and how zoning might impact wells and overall quality of life. Map 7 shows a summary of comments noted on an aerial map of the basin. Participants were asked to identify areas they thought should be identified for protection, or that were of special concern to them. These notes included references to areas that had served as habitat for different species in the past, including chum salmon and brown trout, areas that currently have issues with flooding, as well as areas that could serve future recreational purposes. Participants noted concerns about the lack of vegetation in the corridor under the power lines, managed by Bonneville Power, as well as the forest practices within Capitol Forest.

[4] The survey was sent to 566 homes and had a response rate of 20%.

Management Goals for McLane Creek Basin from Previous Planning Efforts

A number of previous planning efforts and analyses have identified management goals for the basin. McLane Creek basin was categorized as "sensitive" in the Basin Evaluation report (TRPC 2013). That report identifies the following management goals for sensitive basins:

- Protect, restore, and maintain basin-wide conditions
- Protect and restore critical habitats
- Minimize downstream pollutants from new growth
- Improve water quality by lowering existing pollutant levels
- Minimize increase in peak flows
- Improve water flow conditions where degraded

The Total Maximum Daily Load (TMDL) process for Eld Inlet set a 95% target reduction of bacteria during August in McLane Creek and a 77% target reduction of bacteria from June to October in Swift Creek – to be achieved by 2015. The implementation plan listed actions mainly related to outreach, education, and voluntary landowner programs.

The Habitat Limiting Factors Report (1999) and Salmon Habitat Preservation and Restoration Plan (2005) for WRIA 13 list the following recommended actions for McLane Creek and its tributaries:

- Restore pool frequency and function through introduction of functional LWD (primarily conifer) to mainstem and tributary channels
- Restore functional riparian areas (with emphasis on conifer) to address temperature and LWD concerns
- Preclude direct animal access into riparian areas that are being restored
- Improve riparian corridors, primarily in the lower basin, for increased shade and LWD recruitment. Increase LWD key piece abundance to encourage pool formation and sorting of sediments in the lower basin (Swift Creek and McLane Creek).
- Preserve intact habitat
- Maintain vegetative cover to reduce runoff and erosion that lead to fine sediment deposition.
- Encourage LID and reforest high-impact clearcut developed areas.
- Educate landowners located in the basin to increase compliance with land use regulations and voluntary implementation of BMPs
- Restore and preserve estuary shoreline through riparian plantings, livestock exclusion, and long-term conservation easements. Explore opportunities to alleviate the threat of future development.
- Protect sensitive habitat features/processes from incompatible land uses
- Protect hydrologic integrity within the basin

The McLane Creek Action Plan (2010) prioritized stream reaches for protection and restoration within the basin, with the goal of preserving salmon habitat:

- Priority Areas for Protection: Middle Fork McLane Creek, Swift Creek, Lower McLane Creek
- Priority Areas for Restoration:
    1. Beatty Creek (augment base flow , add large wood, remove obstructions, improve passage effects)
    1. Swift Creek (augment base flow, add large wood, decrease peak winter flows)
    2. Middle Fork McLane Creek (add large wood, restore riparian functions)
    3. East Fork McLane Creek (add large wood, restore riparian functions, remove obstructions, improve passage effects)
    4. Upper McLane (road maintenance)
    4. West Fork McLane/Cedar Flats Creek (add large wood)
    5. Lower McLane Creek (add large wood)
    6. Perkins Creek (augment base flows, add large wood, remove obstructions)

Watershed Characterizations

The project team considered two recently completed landscape-scale ecological analyses in the course of this study. Watershed characterizations integrate data sources to describe and relate ecological processes at a basin and watershed scale, rather than at a site scale. These analyses can provide an early filter to help identify priority areas for protection, restoration, and development.

The Washington Department of Ecology's Puget Sound Watershed Characterization Project (2010) includes assessments for water flow processes (delivery, surface storage, recharge, and discharge), water quality (sediment, nutrients, pathogens, metals), and fish and wildlife habitat (terrestrial, freshwater, marine shorelines). In its regional analysis, the project assessed the McLane Creek basin as part of the greater Deschutes watershed (WRIA 13), and identified it as a high priority area for protection because of its importance for delivery and discharge of water and relatively low level of degradation. The basin also is identified as a high priority area for the protection of sediment sources. In its assessment of freshwater lotic habitats, the McLane Creek basin is identified as a very high value habitat area, due to its use by multiple salmonid species and high functioning habitat in both upstream and downstream areas.

The project team worked with Ecology to further refine its water flow analysis within the McLane Creek basin; that analysis identified the following priorities:

- ***Swift Creek:*** this sub-area is identified as a highest priority area for restoration, particularly of surface storage and recharge processes.
- ***Beatty Creek:*** this sub-area is identified as a priority area for protection and conservation.

- ***Mainstem McLane Creek:*** the sub-area downstream of the junction with Beatty Creek is identified as a high priority area for protection, due to its importance for surface storage and discharge, and a priority restoration area.
- ***Cedar Flats Creek:*** this sub-area is identified as a priority area for protection, though it is a lower priority than other areas.
- ***East Fork McLane:*** this sub-area is identified as a potential restoration area, due to the degradation of surface storage and other water flow processes.

Thurston County's Water Resources Division conducted a separate landscape analysis of the basin as part of the Totten-Eld Inlet Watershed Characterization Report (2009). The primary purpose of this analysis was to support stormwater management planning, by assessing functional processes and identifying wetland, riparian, and floodplain areas that could provide ecological benefit if restored. The analysis considered alterations to the natural movement of wood by reviewing the percent of forested riparian areas, and judged much of the McLane Creek basin to be "not properly functioning" or "at risk" for the delivery of large wood into streams.

This assessment identified a number of priority riparian restoration areas along the stream corridors, as well as potential wetland restoration areas along the Mainstem and East Fork of McLane Creek. It also identified a priority estuarine wetland restoration area along Eld Inlet. These areas were incorporated into the restoration alternative future scenario discussed below in Section 3.

3. Analysis of Basin Alternatives

How Scenarios Were Developed

McLane Creek basin was classified as "sensitive" in the Basin Evaluation report (TRPC, 2013). "Sensitive" stream basins support a diversity of aquatic species and have good water quality. The management focus should be to protect and maintain existing conditions, and improve them where possible.

Scenarios of historic, current, and future alternatives were developed to better understand stream water quantity and quality dynamics under a variety of conditions. All scenarios were developed for a hydrologic model that gave outputs on various stream flow and water quality factors.

What are Impervious Surfaces?

Impervious surfaces are materials that prevent the infiltration of water into the soil. The most common impervious surfaces in the built environment are roads, rooftops, sidewalks, and patios. While these structures are almost 100 percent impervious; other features such as gravel roads, compacted soils, and even lawns are impervious to varying degrees, as they allow for less infiltration than natural ground cover such as forests.

The basic premise is that as land cover (forest, grass, impervious areas, etc.) and hydrology (stream network and infrastructure that modifies water flow such as ditches, pipes, and stormwater ponds) change it will have an impact on both the stream water quantity and quality. In general, as urbanization increases, so does the amount of impervious surfaces. This means less rainwater can infiltrate into the ground, and there is a greater amount of stormwater runoff (Figure 4). The runoff can scour stream beds and carry pollutants to the water. Stormwater infrastructure, such as ponds that capture runoff and release it slowly, can help mitigate some of the effects of runoff.

Using a hydrologic model[5], land cover and hydrologic conditions can be tied to stream flow and water quality where stream monitoring data is available. For this reason, the scenarios start with a Current Condition scenario to help ensure that the model is working (calibrated) correctly. The Historic Condition scenario gives an idea of how the stream flowed and functioned before the land cover and hydrology was altered. Three future scenarios were developed to evaluate potential management strategies. All future scenarios were designed to be realistic and achievable.

Scenarios were conceptualized and developed by a project team of land use, storm water, and hydrology specialists with experience in Thurston County. The scenarios were designed to answer some specific questions such as:

- Will stream health degrade with additional development under current zoning regulations, and would changing the zoning density make a difference?
- Will stream health degrade under current stormwater regulations, and will updating stormwater regulations to include low impact development techniques make a difference?
- Will stream corridor or wetland restoration lead to an improvement in stream health?

[5] The Hydrologic Simulation Program-Fortran (HSPF) was used to simulate watershed hydrology and water quality for this study. The details of this effort are reported in NHC 2014.

- Will retrofits of stormwater infrastructure in areas of existing development lead to an improvement in stream health?

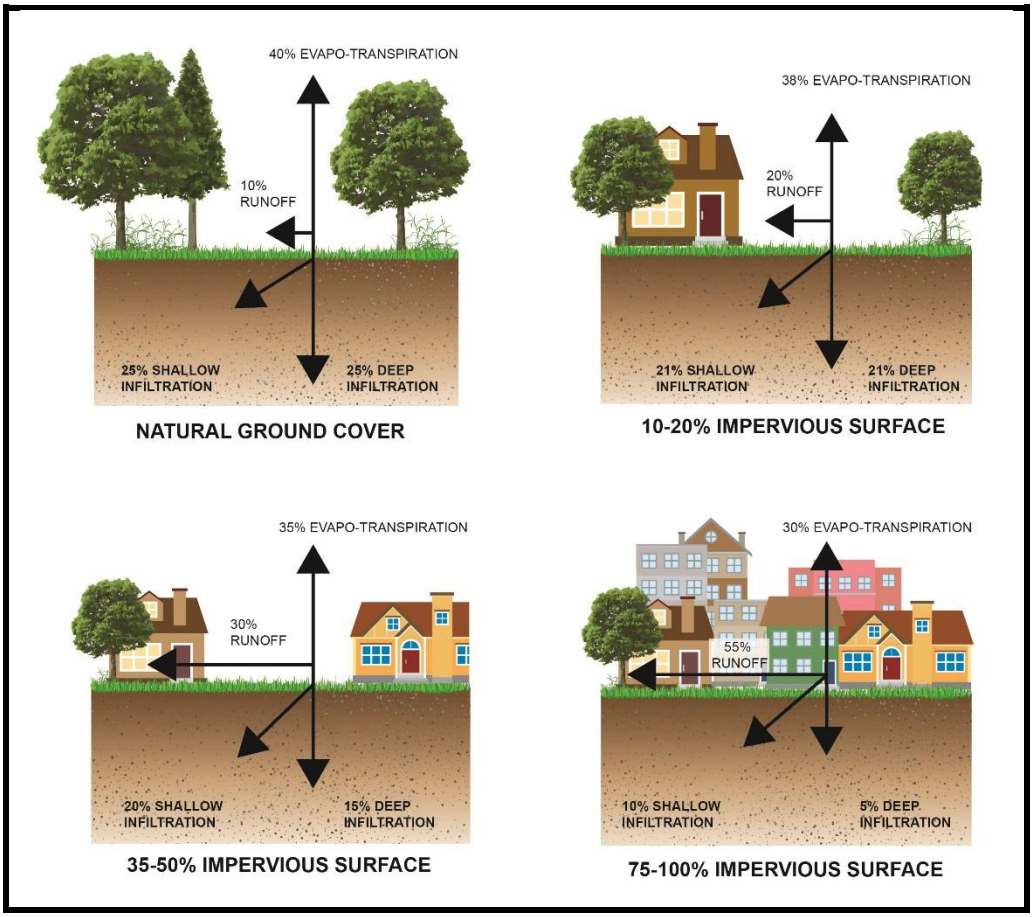


FIGURE 4: WATER CYCLE CHANGES ASSOCIATED WITH URBANIZATION.
SOURCE: GUIDANCE SPECIFYING MANAGEMENT MEASURES FOR SOURCES OF NONPOINT SOURCE POLLUTION IN COASTAL WATERS, 1993; AS SHOWN IN ARNOLD, 1996.

Current Condition

The Current Condition scenario was developed to approximate 2010-12 conditions for land cover and land use, hydrology, and stormwater treatment facilities. Sources included existing land cover and land use data, basin reports, infrastructure mapping, and air photo mapping. Each land cover was assigned a value for water infiltration and runoff, as well as the amount of pollutants it was likely to generate.

The current condition data layers were used to calibrate the hydrologic model to stream flow and water quality data.

Historic Condition

The Historic Condition scenario was developed by assuming land cover was a combination of forest, wetlands and prairie throughout the basin. A variety of sources were used to develop the land cover data, including maps of historic wetlands and prairies.

Planned Trend

The Planned Trend scenario was developed to approximate future development under adopted zoning and development regulations. Planned trend was consistent with the assumptions developed for the region's population and employment forecast and buildable lands analysis (www.trpc.org). Assumptions for future impervious area were made depending on the type or density of expected development. (see *TRPC 2013A and TRPC 2015).*

Specific assumptions for the Planned Trend scenario included:

- Current zoning and development regulations would remain in place
- Current stormwater regulations would remain in place
- Future development occurs in similar style / density as recent trends
- As development occurs, land cover would convert from existing cover to a mixture of impervious surfaces (homes, driveways, roads) and other urban land cover (lawns and cleared areas)

Alternative Future A

The Future A scenario (Map 8) examined changes to regulations as a way to protect stream health from the effects of development. The following changes were evaluated:

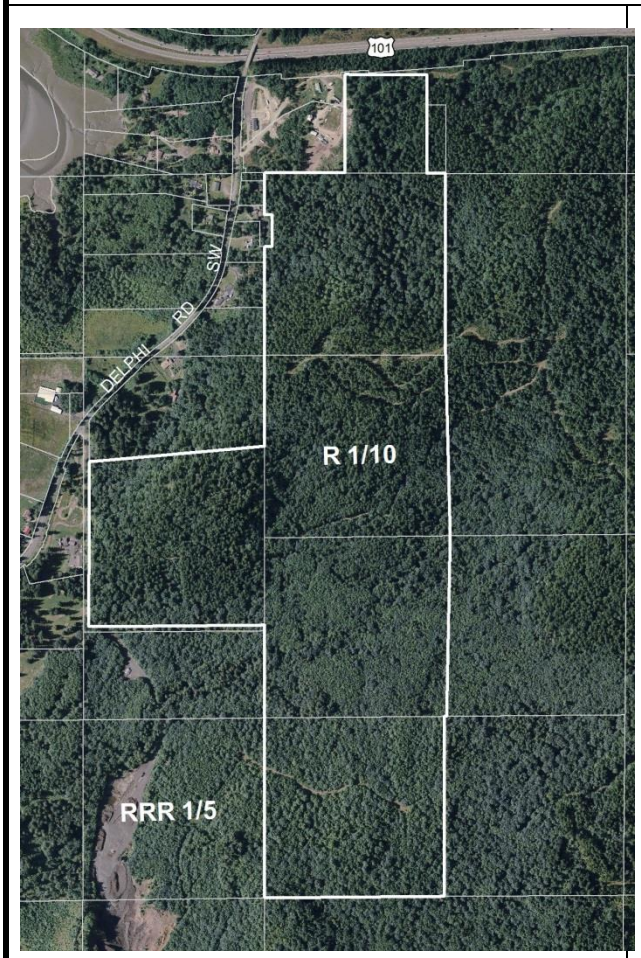
- Place public lands in long term forestry or public preserves to ensure protection
- Place large undeveloped and forested parcels in long term forestry zoning designation (Figure 5)
- Reduce zoning densities from five-acre lots to 10-acre lots (and in some limited cases 20-acre lots) along stream corridors in areas that have not yet developed.
- Assume that new development would meet low impact development requirements for stormwater control, if feasible (Figure 6)
- Set tree cover and impervious surface limits for new rural development

What are the New Low Impact Development (LID) Requirements for Stormwater Control?

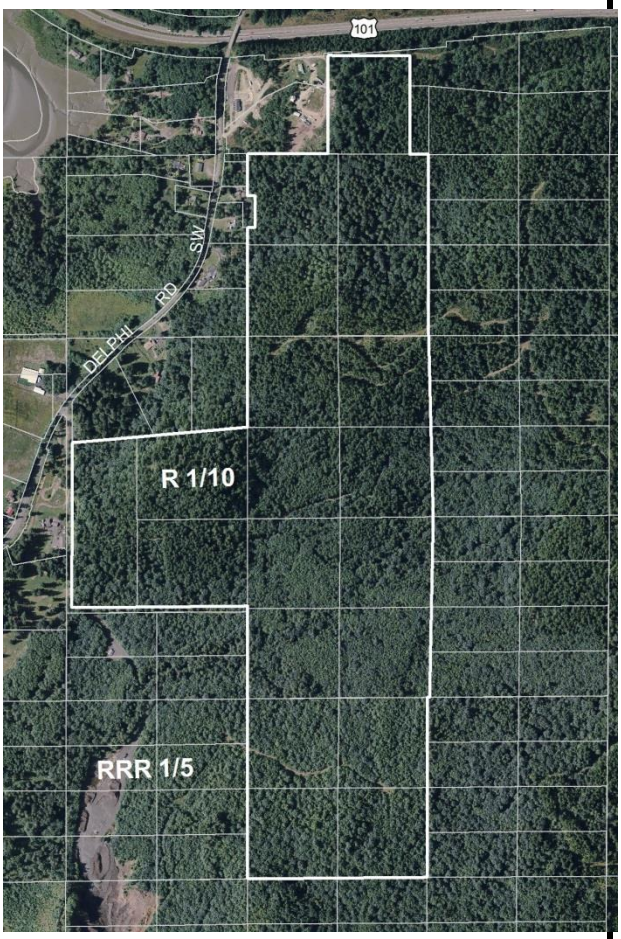
The current stormwater flow control standard only requires controlled release for infrequent, large storms (50% of 2-year = 1.4" in 24-hrs at Oly Airport) and is intended to only protect against stream bank erosion and control downstream flooding impacts. Smaller storm events are routed through stormwater facilities with little to no restrictions. This flow control standard can be met by detention ponds only, with little or no infiltration.

The new LID flow control standard (required by 2016 in parts of Thurston County) will provide control for much smaller storms (8% of 2-year = 0.22" in 24-hrs at Oly Airport). It is intended reduce the volume of stormwater runoff and limit low flows to pre-development (forested) conditions. Based on recent research, changes to these low flows can have impacts to stream quality and the increased volume of runoff increases pollutant loadings. In general to meet this standard requires extensive infiltration of stormwater into the ground through bioretention, porous pavement, infiltration ponds/trenches, etc. A detention pond in the majority of cases cannot be the only stormwater control method, mainly because they would be prohibitively large to meet the standard.

Future A includes reducing rural densities for large, undeveloped properties. Under current zoning of Rural Residential/Resource (RRR) 1/5 and 1/10 zoning (left image) properties can be subdivided into smaller properties (right image – theoretical lot configuration). Rezoning the area to lower densities such as 1 unit in 40 acres will help preserve large tracts of forest land.



Current parcel boundaries



Theoretical subdivision under current zoning

FIGURE 5: POSSIBLE SUBDIVISION UNDER CURRENT ZONING FOR LARGE, FORESTED PARCELS IN MCLANE CREEK BASIN.

What is Low Impact Development?

Low impact development (LID) is an approach to land development that works with nature to manage stormwater as close to its source as possible.

Some of the principles of low impact development are:

- Preserving and re-creating natural landscape features,
- Minimizing impervious areas and create functional and appealing site drainage that treat stormwater as a resource rather than a waste product.

By implementing low impact principles and practices, stormwater can be managed in a way that promotes the natural movement of water within an ecosystem.

At the site-level, low impact development techniques include:

- Reducing impervious area by requiring narrower streets than conventional development, Requiring smaller lots and clustering development to reduce miles of street,
- Using porous materials such as pervious sidewalks rather than impervious materials
- Maintaining native vegetation
- Using bioswales and bioretention areas to infiltrate runoff, rather than trying to capture the runoff and move it off of the site as quickly as possible

FIGURE 6: CONVENTIONAL DEVELOPMENT (LEFT) VERSUS LOW IMPACT DEVELOPMENT (RIGHT).
SOURCE: AHBL 2012.

Compact Growth as a Form of Low Impact Development

Compact growth is also a form of low impact development. Given the same amount of homes, directing growth to city centers and urban residential neighborhoods as compared to rural areas can significantly reduce the amount of impervious area within a basin. In the example below, at rural densities (A) 1,000 homes would cover the entire rural area – or 5,000 acres – resulting in 200 acres of impervious surfaces. At typical urban residential neighborhood densities, the same amount of homes would require around 125 acres (B) and result in around 55 acres of impervious surfaces. At city center densities, 1,000 apartments or condominiums would require around 10 acres (C) and result in around 6 acres of impervious surfaces. Of course actual growth will be accommodated in all three areas, but guiding growth to urban areas has less impact overall on a basin.

Type of Area	Density	Units of New Growth	Percent Impervious Area	Total Acres	Impervious Acres
City Center	100 dwellings per acre	1,000	55%	10	6
Urban Residential Neighborhood	8 dwellings per acre	1,000	44%	125	55
Rural 5 acre lots	1 dwelling per five acres	1,000	4%	5,000	200

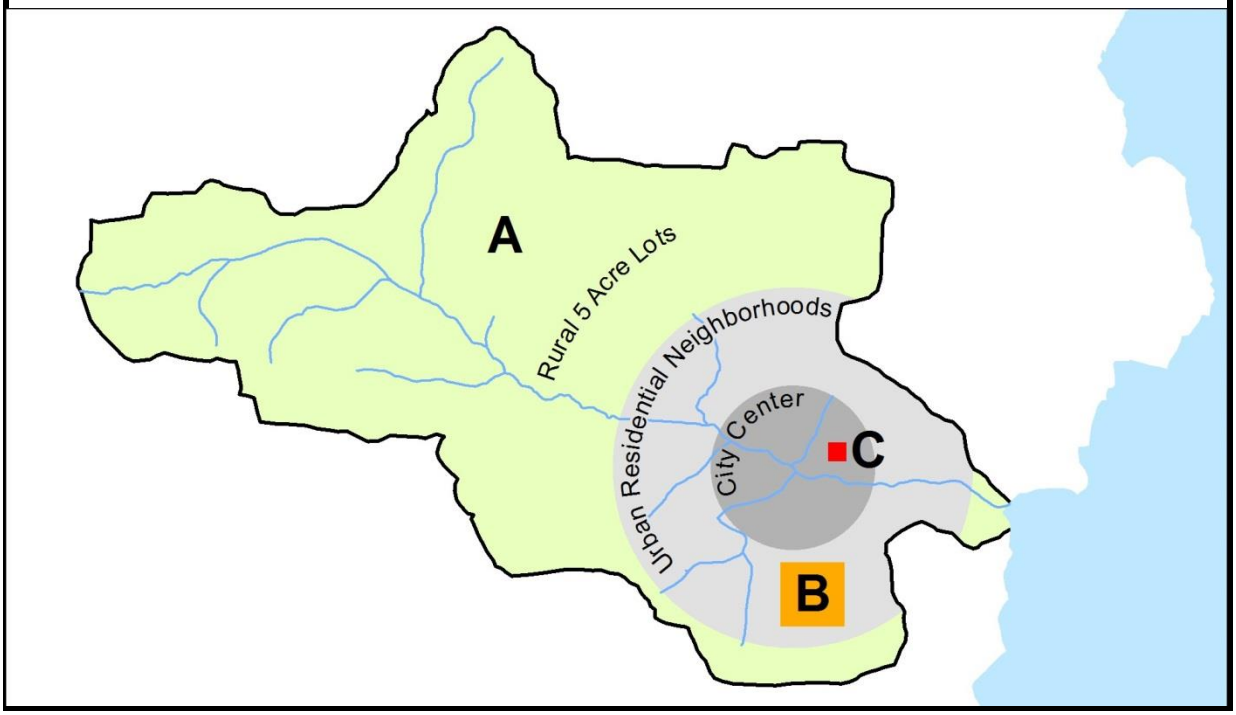


FIGURE 7: COMPACT GROWTH AS A FORM OF LOW IMPACT DEVELOPMENT.

Alternative Future B

The Future B (Map 9) scenario built on the Future A scenario and added the following:

- Restore wetland hydrology (where degraded) (Figure 8)
- Restore forest cover along major stream corridors (where altered) (Figure 8)
- Acquire or use other voluntary programs such as purchase or transfer of development rights to protect sensitive but currently developable areas that cannot be protected through other means (Figure 9)
- Implement stormwater retrofit projects for older residential subdivisions.

The large wetland site along the East Fork Creek (A) is an example of a wetland system that has been drained and ditched. Restration opportunities include restoring natural hydrology and planting trees along the stream (riparian) corridor for shade. Restoration sites were identified using a combination of data from the Thurston County Watershed Characterizations and examining stream corridors around major creeks. Many restoration opportunities are on private property, and will require working with the landowner.

FIGURE 8: EXAMPLE OF A POTENTIAL RESTORATION SITE.

Thurston County has two programs in place with the main purpose of preserving farmland: Purchase of Development Rights (PDR) and Transfer of Development Rights (TDR). The programs compensate land owners for agreeing to conserve their land. Typically, the property owner would retain ownership of the land and continue to reside and farm the property. These programs could be extended to working forest lands, or lands of ecological importance for stream quality.

Preserving land that has already been subdivided, as in the example above, will require innovative programs and tools.

FIGURE 9: DEVELOPABLE LOTS CLOSE TO STREAM CORRIDORS.

Comparison of results

Land Use and Dwelling Units

McLane Creek basin is a rural basin in Thurston County with around 570 homes in it today. It can expect moderate growth to a buildout of around 900 homes (or an increase of 58%). Under Future A and B scenarios, changes in zoning densities would lead to a buildout of approximately 740 homes.

Future A & B assume that existing but unbuilt lots will develop in the future, as changing zoning densities will not impact their development potential. Acquisition or purchase/transfer of development rights in Future B could reduce buildout by several dozen homes.

What is Buildout?

Buildout is a theoretical maximum number of homes that can be built in a specific area based on current land use, ownership, and zoning. It is unlikely that all of the possible homes that could be built will be built, as many land owners will choose to keep their properties undeveloped. Properties that are designated for parks, open space, and long term forestry are not considered to be buildable.

TABLE 5: NUMBER OF DWELLING UNITS FOR CURRENT AND FUTURE USE SCENARIOS.

	Current Condition 2010	Planned Trend Buildout	Future A & B Buildout
Dwelling Units (homes)	570	900	740
% Increase from Current Condition		58%	30%

SOURCE: THURSTON REGIONAL PLANNING COUNCIL
NOTE: DOES NOT INCLUDE REDEVELOPMENT, FAMILY MEMBER UNITS OR ACCESSORY DWELLING UNITS.

Land Cover

Development in the McLane basin has led to an estimated 12% loss of forest cover when compared to conditions that likely existed in the region prior to the 1800s. That development also contributed to the loss of around 4% of historical wetlands that may have been filled or drained and converted to grazing pastures, roads, or other uses. The total amount of impervious surfaces in the basin remains low, though the growth anticipated under current plans is estimated to increase slightly to 4% (see Table 6).

The zoning and land use changes proposed in the Future A scenario would reduce the growth of those new impervious areas, keeping them at the current level (see Map 10). The restoration activities modeled in Future B would lead to slightly less impervious area, as well as substantial increases in forest cover for the basin, bringing this important indicator back toward historic levels, particularly along streams (see Map 11).

TABLE 6: COMPARISON OF HISTORIC, CURRENT, AND FUTURE LAND COVERS

	Historic Condition	Current Condition 2010	Planned Trend Buildout	Future A	Future B
Forest	89%	77%	77%	77%	81%
Pasture/Prairie	0%	12%	11%	11%	7%
Grass	0%	2%	3%	2%	2%
Wetland	11%	7%	7%	7%	9%
High-polluting Total Impervious Area	0%	2%	2%	2%	2%
Low-polluting Total Impervious Area	0%	1%	2%	1%	1%

SOURCE: NHC, 2014

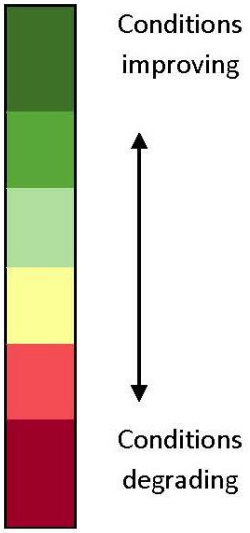
Water Flow & Water Quality

The hydrologic model tested the effects of each of the five scenarios on water flow in the basin (hydrology), as well as on several water quality parameters, including temperature, bacteria (fecal coliform), and nitrates. The results of this work show that minimum flows and hydrology remain similar to historic conditions for the basin as a whole – an expected outcome for a basin that remains relatively undeveloped. Water quality has degraded, with substantial increases in the number of days that stream temperatures are too warm for fish, as well as increased nutrient and bacteria loads.

The differences between the Planned Trend and Alternative Future scenarios were much smaller when compared with the changes from Historic to Current conditions. In general, the Planned Trend scenario holds the line at the existing level of degradation in the basin. With the land use changes proposed in Future Scenario A, water quality would improve in some local stretches of streams, particularly at the focus area, the East Fork of McLane Creek. Future Scenario B, which includes restoration of vegetation within stream corridors and the restoration of some wetlands, could lead to broader water quality benefits in the basin and would substantially lower stream temperatures. Under Future Scenario B, temperature would be restored to closely resemble conditions prior to any development in the region. A summary that compares the results from the alternative futures modeling is shown in Figure 10.

FIGURE 10: WATER FLOW AND WATER QUALITY CONDITIONS FOR FUTURE ALTERNATIVES COMPARED WITH CURRENT CONDITIONS

	Planned Trend Buildout	Future A	Future B
Hydrology	No change	No change	No change
Temperature	No change	No change	Large improvement
Fecal Coliform	No change	Local improvement	Improvement
Nitrate	No change	No change	Local improvement
Overall Benefit to Water Resources	**No change**	**Local benefit**	**Moderate benefit**



A detailed description of the model results is available in the report *THURSTON COUNTY HYDROLOGIC MODELING FOR WATERSHED BASED LAND USE PLANNING* (NHC 2014).

Interpretation and limits of results

In summary, the model results indicate that:

- Existing land use in the basin has had a significant impact on water quality in McLane Creek, when compared with historic conditions. Temperatures are frequently elevated above the 16° Celsius threshold considered safe for core summer salmonid habitat. Bacteria and nutrient loads to the streams in this basin are much higher than they would have been naturally.

- Although the analysis shows that there has been significant degradation of water quality when compared with historic conditions, this trajectory seems to have slowed, and conditions are not dramatically worse under the Planned Trend scenario. This result indicates that current regulations – including zoning and critical area protections – when properly implemented, can be effective at minimizing the impact of new development. Such an outcome is likely due in part to the fact that much of the basin is already zoned for very low-density development, as Long-term Forestry, and is unlikely to develop extensively under any future scenario.

- Lowering the dwelling unit densities allowed by downzoning by itself is unlikely to have a substantial impact on water flow or water quality, although there may be localized

improvements in some smaller areas.

- The policies identified for Future Alternative B, which pairs land use changes with a substantial restoration effort, will have the greatest benefit to water quality in McLane Creek basin. In particular, revegetating shorelines where they have been cleared will help to shade and cool streams, making temperatures significantly more hospitable to fish. Such restored riparian areas will also reduce the amount of fecal coliform bacteria and nitrogen loading into streams. Restoration of degraded wetland areas and retrofitting older stormwater infrastructure stream conditions can bring additional improvements.

- The relatively good condition of water flow and water quality for McLane Creek is likely supported by the high percentage of forested land in its uplands. A substantial loss of forest cover was not considered in any scenarios – all non-pervious land covers will contribute nutrients and bacteria through runoff at more than twice the rate of a forested area. Preservation of existing forested areas is important to maintaining the current condition of water flow and water quality.

A number of assumptions were made in the development and application of the model that should be considered when interpreting these results. The future scenarios assumed that new development would only clear and cover a minimal amount of each parcel with impervious surfaces, rather than the total amount allowed under current regulations (for example, up to 60% in areas zoned RRR 1/5). More extensive clearing and conversion could lead to additional impacts in the watershed. The model also assumed that all pasture areas have some livestock or agricultural use, and that this use would contribute a certain amount of bacteria and nutrient loads – these contributions could be lessened or mitigated through a variety of best practices. The model analysis assumed that existing regulations would effectively protect critical areas, and that stormwater facilities, including those required under the new low impact development standard, would be mostly effective at reducing and treating stormwater to mimic a pre-developed, forested condition. This assumption underlines the need for tools to ensure these facilities are properly built and maintained over time.

The model results provide a window into the potential effects of different policies, but they are limited to considering only impacts to water flow and water quality – they do not take into account many other important environmental factors that should be considered as part of the planning effort. For example, the model does not account for the many habitat benefits that would come from preserving tree cover in the basin. For this reason, the recommendations listed in Section 4 of this study are based on the full spectrum of information included in this report, rather than solely on the model results.

Public Views on Future Scenarios

On October 9, 2014, Thurston County and Thurston Regional Planning Council (TRPC) hosted a second community workshop for residents of McLane Creek basin and other interested parties. Attendees had the opportunity to view maps that showed the different future scenarios and outlined different outcomes associated with each, including the results of the modeling work.

4. Goals and Management Recommendations

This watershed study provided an opportunity to consider current conditions in the McLane Creek basin, how future growth and development may impact those conditions, and how alternative management approaches might affect that future. The following recommendations for management actions in the McLane Creek basin are based on the basin alternatives analysis outlined above in Section 3, as well as public input and other information described in this report. This section outlines seven overarching ***goals*** for the basin – these are high-level statements that outline the desired aim of any actions taken. The basin goals are grounded in the watershed-scale assessments completed in the Baseline Conditions report and Puget Sound Watershed Characterization project (see Section 2), which both emphasized the need for protection of ecological functions in this basin, as well as in the feedback received during public outreach on the preferences residents and others have for McLane Creek basin remaining a rural area. Associated with each goal are a mix of ***strategies*** intended to set the guiding direction for achieving that goal, as well as specific ***actions*** that address each strategy. Some actions have priority areas for implementation, as identified in the analyses or other planning efforts.

These actions can be taken on by Thurston County, as well as state and federal agencies, the Squaxin Island Tribe, or community organizations. A number of recommended actions were researched in more detail – these findings are included as a series of memos in the appendixes.

GOAL M.1 Protect basin-wide ecological functions, including delivery and discharge of water, and the recruitment of large woody debris into streams

McLane Creek basin was identified as a priority area for protection, both in the Baseline Evaluation report (TRPC 2013) and in the Puget Sound Watershed Characterization. The modeling work indicated that hydrology (water flow) has not been substantially degraded by development in the basin and would not be significantly impacted under future development scenarios. This result assumes, however, that there is not a substantial loss of forest cover or increase in impervious surfaces. Current regulations may not be sufficient to provide that level of protection. For residential areas in this basin (those areas not zoned as long-term forestry), the county's current zoning code provides no guidance for retaining vegetation on a site, and only minimal limits on the amount of a parcel that can be covered by impervious surfaces. In addition, several studies have indicated this basin would benefit from having more large wood in its streams, a situation that can only occur when corridors along streams remain forested, and trees are allowed to fall into streams.

Strategies & Actions

- Maintain existing tree cover
  - Establish tree retention standards for the basin to ensure canopy cover remains at current levels or increases over time
  - Review open space standards to consider additional standards for protection of existing vegetation

    - Consider ways to provide incentives to landowners who set aside and retain trees within open space areas
- Limit the installation of new impervious surfaces
    - Encourage clustering of new development (see Memo, Appendix A)
    - Limit the development of new impervious surfaces from sources such as additional family member units (see Memo, Appendix B)
    - Establish impervious surface limits through zoning in this basin (see Memo, Appendix C)
    - Consider implementing an impervious surface trading program that would shift the placement of new impervious out of sensitive areas
- Ensure protection of existing, intact riparian corridors and encourage replanting along stream where vegetation has been removed
    - Support protective shoreline regulations through update of Thurston County Shoreline Management Program
    - Develop outreach and incentive program for landowners along stream shorelines who may be interested in voluntary restoration
    - Support compliance with Critical Areas ordinance (TCC 24)
- Support preservation of high-functioning areas through fee-simple acquisition, conservation easements, or transfer of existing development rights
    - Provide priority ranking of funding for projects in this basin, including through Conservation Futures program
    - Support such acquisitions by partner organizations, such as Capitol Land Trust
- Monitor key indicators – such as impervious surfaces, water quality, and acres of forested land – to assess long-term condition of basin
    - Continue annual monitoring through TRPC's benchmark program
- Consider how climate change may affect ecological functions
    - Develop a watershed-based climate resilience plan

GOAL M.2 Protect and improve water quality

Human activities have substantially degraded water quality in McLane Creek and a number of its tributaries, resulting in streams that are warmer than is healthy for salmon habitat and that have high concentrations of bacteria and nutrients that impact both the streams and marine life in Eld Inlet. Thurston County's 2014 On-Site Sewage System Management Plan notes that water quality is declining in Eld Inlet. Residents are concerned about water quality in the basin and value clean water for a variety of uses. The hydrologic modeling study found that actions that address these impairments can improve water quality.

Strategies & Actions

- Identify sources of pollution
    - Support the designation of Eld Inlet and its watershed, including McLane Creek basin, as a Marine Recovery Area to enable more resources be brought to the identification of pollution issues
    - Implement a Pollution Identification and Control (PIC) program for McLane Creek
- Minimize and reduce pollution from agricultural activities

- Work with landowners to educate and encourage best management practices for agriculture

- Minimize and reduce pollution from septic systems
  - Implement a focused Operation and Maintenance program for septic systems in high risk areas of the McLane Creek basin
- Minimize and reduce pollution from stormwater runoff
  - Update stormwater regulations to encourage low impact development, where feasible, in accordance with state guidelines
  - Investigate and prioritize stormwater retrofit opportunities within this basin in Thurston County's Capital Facilities Plan (CFP)
- Mitigate for impacts to water quality from new development
  - Prioritize wetland areas in this basin for restoration through the county's In-Lieu Fee mitigation program, to offset impacts in other areas

GOAL M.3 Protect critical habitat for wildlife and fish

McLane Creek basin ranked as a very important area for conservation of freshwater habitat in the Puget Sound Watershed Characterization habitat assessment, particularly its value for salmonids. The marine shoreline areas of the basin, where McLane Creek flows into Eld Inlet, also were ranked among the highest value marine shoreline segments due to the estuary's value to a variety of shellfish, forage fish, and other marine and nearshore species. Residents value their proximity and access to abundant fish and wildlife populations, and the opportunities that living in the basin afford them to view wildlife in their natural habitat. The County should work to ensure that current regulations continue to protect critical habitat, and look for innovative ways to encourage preservation of open space areas.

Strategies & Actions

- Provide options for protecting and preserving habitat through land use regulations
  - Ensure development occurs in compliance with the Critical Areas Ordinance (TCC 24)
  - Encourage clustered development that preserves more open space and habitat (See Memo, Appendix A)
- Consider long-term protection options for important habitat areas in public and private ownership
  - Work with the Department of Natural Resources (DNR) to determine preservation for priority habitat identified within Capitol Forest
    - Priority areas: Along mainstem McLane Creek, downstream of Beatty Creek junction (sub-basins 65, 71, 79)
  - Consider long-term protection options for priority areas in private ownership, including through purchase of development rights or purchase outright through the county's Conservation Futures program
    - Priority areas: Perkins Creek/Black Hills area (sub-basins 55, 57)
  - Consider expanding the county's Transfer of Development Rights Program to include priority forested lands and riparian areas within McLane Creek basin as applicable sending areas (See Memo, Appendix D)

GOAL M.4 Restore stream and shoreline functions where degraded

Restoration of vegetation along stream corridors, where degraded, can help improve water quality in this basin, and will also provide improved habitat conditions for wildlife, including anadromous fish.

Strategies & Actions

- Encourage restoration of marine shoreline and estuarine functions along Mud Bay
  - Provide priority ranking of funding for projects in this basin, including through Conservation Futures
- Encourage restoration of vegetation within riparian corridors
  - Provide priority ranking for funding of projects in this basin, including through Conservation Futures
    - *Priority areas*: Swift Creek, Beatty Creek, mainstem McLane (sub-basin 65), East Fork McLane
  - Develop outreach tools for streamside landowners to consider restoration opportunities
  - Consider additional funding opportunities for riparian restoration in this basin
  - Work with Bonneville Power Administration to consider options for appropriate vegetation and wetland restoration under power lines

GOAL M.5 Maintain open space and rural character of basin

Public outreach in McLane Creek basin indicates that residents appreciate and wish to perpetuate the rural lifestyle that is available in this basin. Many noted that opportunities to view wildlife and access to open space and passive recreation areas, such as trails, are important to their future vision for the area. Rural character is defined in Washington State's Growth Management Act (RCW 36.70A) as a pattern of land use "in which open space, natural landscape, and vegetation predominate over the built environment" and that supports opportunities for small-scale employment while allowing for use of the land by wildlife. Much of the basin that is not identified as Long-Term Forestry is zoned for a density of one unit per five acres – a greater variety of zoning at lower densities may be more suitable to preserve the current rural character of this basin.

Strategies & Actions

- Ensure land use regulations support rural character
  - Consider lowering zoning densities in some areas of this basin to preserve rural character
  - Develop design guidelines for clustering of development that is appropriate for rural areas (see Memo, Appendix A)
  - Develop a regional approach to track and plan for open space preservation

GOAL M.6 Increase recreational opportunities

Residents in McLane Creek basin value their access to natural recreational areas like Capitol Forest and the McLane Creek Nature Trail. Several additional areas within the basin were identified as places used informally by residents and visitors for hiking and mountain biking. In its planning efforts, the County

and other entities should consider ways to expand existing recreational opportunities to provide additional low-impact recreation in this basin.

Strategies & Actions

- Ensure land use regulations support recreation use in priority areas
  - Adjust zoning around McLane Nature Trail to Public Parks, Trails & Preserves to better reflect use in this area
- Identify opportunities for expanded recreation areas
  - Consider areas for purchase and development of low-impact recreation facilities, including hiking and mountain-biking trails
    - Priority areas: Black Hills, McLane Creek Nature Trail, Capitol Forest

GOAL M.7 Preserve working forest and farm lands in ways that help sustain ecological functions

McLane Creek basin continues to support substantial forest lands, as well as a number of smaller farms. These activities are important to maintaining the rural economy of the area, and help to maintain tree cover and open space in areas that might otherwise convert to residential development. Agricultural lands are exempt from the protections to riparian areas and wetland buffers established under the current Critical Areas Ordinance (TCC 24). In 2014, Thurston County initiated a pilot process for a Voluntary Stewardship Program (VSP) that would develop a method for individual farms to meet the protective intent of the CAO and continue agricultural activities in ways that can be mutually beneficial. As of May 2015, this program was only being initiated in the Chehalis watershed, but could be expanded to additional areas.

Strategies & Actions

- Develop tools and incentives to support agriculture
  - Support the county's pilot Voluntary Stewardship Program (VSP), and encourage expansion to additional areas, including McLane Creek basin
  - Encourage development of stewardship plans for working farms in this basin in cooperation with the Thurston Conservation District
- Ensure land use regulations support areas suitable for forestry
  - Consider zoning changes for forest lands currently in the RR 1/5 zone to better ensure long-term preservation of working forest lands
  - Work with the Department of Natural Resources to understand harvest plans for Capitol Forest and consider how these will impact the McLane Creek basin

5. Implementation and Next Steps

This study identified a number of recommended strategies and actions to protect and improve water quality and aquatic resources in the McLane Creek basin. Accomplishing the goals set out in the previous section will require leadership and continued support from project partners as well as funding for many of the individual actions. Because this study was directed by Thurston County, most of the actions noted are ones that should be led by one or another county department. Additional actions could be taken up by other organizations interested in supporting these strategies.

The actions identified in this study can be grouped into a number of different categories; some may potentially be addressed by work that is currently underway.

Land use. These actions concern changes to zoning, development regulations, or plans that guide land use in the County, such as the Shoreline Master Program (SMP) or Comprehensive Plan (CP). Actions in this category would likely be led by Thurston County's Long-Range Planning Division.

- *Code review:* The County is currently reviewing many of its development codes as required under its NPDES stormwater permit to make low impact development the preferred option for development. This code review is being led by an interdepartmental LID Work Group and is covering topics like tree and vegetation retention, cluster and open space standards, and impervious surface limits.

Programs. These actions would involve the modification of current programs run by the County, or the development of entirely new programs.

- *Outreach and education*: This study identified a need for additional outreach to landowners in a number of categories, and a way to provide centralized information and support for those who may be interested in either preserving large open areas or doing restoration in degraded areas.

The following table includes an implementation plan that identifies the potential lead and timeline for each action.

TABLE 7 IMPLEMENTATION OF BASIN-SPECIFIC ACTIONS

Goals, *Strategies*, Actions			Category	Lead	Partners	Timeline
M.1 Protect basin-wide ecological functions						
	Maintain existing tree cover					
		Establish tree retention standards for the basin	Land use; code review	County	LID Work group	Underway
		Review open space standards	Land use; code review	County	LID Work group	Underway

Goals, *Strategies*, Actions	Category	Lead	Partners	Timeline
Provide incentives to landowners who set aside and retain trees within open space areas	Programs; outreach	County	LID Work group	Medium
Limit the installation of new impervious surfaces				
Encourage clustering of new development	Land use; code review	County	LID Work group	Underway
Review accessory dwelling unit and family member unit standards	Land use; code review	County		Short
Establish impervious surface limits	Land use; code review	County	LID Work group	Medium
Consider developing impervious surface trading program	Programs	County		Long
Ensure protection of riparian corridors and encourage replanting along streams				
Support protective shoreline regulations through update of Thurston County SMP	Land use	County		Underway
Develop outreach and incentive program for landowners interested in restoration	Programs; outreach	County	Stream Team; TCD; CLT; SSSEG	Medium
Support compliance with Critical Areas ordinance (TCC 24)	Land use; ongoing	County		Ongoing
Support preservation of key lands through acquisition				
Provide priority ranking of funding for projects in this basin, including through Conservation Futures program	Programs; ongoing	County		Short
Support acquisitions by land trusts and other NGOs	Ongoing			Long
Monitor key indicators to assess long-term condition of basin				
Continue annual monitoring through benchmark program	Ongoing	TRPC	County	Ongoing
Consider how climate change may affect ecological functions				
Develop a watershed-based climate resilience plan	Land use	TRPC	County	
M.2 Protect and improve water quality				
Identify sources of pollution				
Support the designation of Eld Inlet and its watershed as a Marine Recovery Area	Programs	TCEH		Medium
Implement a PIC program for McLane Basin	Programs	TCEH		Medium

Goals, *Strategies*, Actions	Category	Lead	Partners	Timeline
Minimize and reduce pollution from agricultural activities				
Work with landowners to educate and encourage best management practices for agriculture	Programs; outreach	County	TCD	Medium
Minimize and reduce pollution from septic systems				
Implement a focused Operation and Maintenance program for septic systems in high risk areas of the McLane Creek basin	Programs	TCEH		Medium
Minimize and reduce pollution from stormwater runoff				
Update stormwater regulations to encourage low impact development, where feasible, in accordance with state guidelines	Code review	County		Underway
Investigate and prioritize stormwater retrofit opportunities within this basin in Thurston County's Capital Facilities Plan	Programs	TCWR		Medium
Mitigate for impacts to water quality from new development				
Prioritize wetland areas in this basin for restoration through the county's In-Lieu Fee mitigation program	Programs	TCWR		Short
M.3 Protect critical habitat for wildlife and fish				
Provide options for protecting and preserving habitat through land use regulations				
Ensure development occurs in compliance with the Critical Areas Ordinance (TCC 24)	Land use; ongoing	County		Ongoing
Encourage clustered development that preserves more open space and habitat	Land use; code review	County		Underway
Develop a regional open space plan	Land use	TRPC	County	Medium
Consider long-term protection options for important habitat areas in public and private ownership				
Work with the Department of Natural Resources (DNR) to determine preservation for priority habitat identified within Capitol Forest	Programs			Medium
Consider long-term protection options for priority areas in private ownership, including through purchase of development rights or purchase outright through the county's Conservation Futures program	Programs	County		Long
Consider expanding the county's Transfer of Development Rights Program	Programs	County		Medium

Goals, *Strategies*, Actions	Category	Lead	Partners	Timeline
M.4 Restore stream and shoreline functions where degraded				
Encourage restoration of marine shoreline and estuarine functions along Mud Bay				
Provide priority ranking of funding for projects in this basin, including through Conservation Futures	Ongoing	County		Short
Encourage restoration of vegetation within riparian corridors				
Provide priority ranking for funding of projects in this basin, including through Conservation Futures	Ongoing	County		Short
Develop outreach tools for streamside landowners to consider restoration opportunities	Outreach	County		Medium
Consider additional funding opportunities for riparian restoration in this basin	Programs	County		Long
Work with Bonneville Power Administration to consider options for appropriate vegetation and wetland restoration under power lines	Programs			Medium
M.5 Maintain open space and rural character of basin				
Ensure land use regulations support rural character				
Consider lowering zoning densities in some areas of this basin to preserve rural character	Land use	County		Medium
Develop design guidelines for clustering of development that is appropriate for rural areas	Land use; code review	County	LID Work Group	Underway
M.6 Increase recreational opportunities				
Ensure land use regulations support recreation use in priority areas				
Adjust zoning around McLane Nature Trail to Public Parks, Trails & Preserves to better reflect use in this area	Land use	County		Medium
Identify opportunities for expanded recreation areas				
Consider areas for purchase and development of low-impact recreation facilities, including hiking and mountain-biking trails	Programs	County	RCO	Long
M.7 Preserve working forest and farm lands in ways that help sustain ecological functions				
Develop tools and incentives to support agriculture				
Support the county's pilot Voluntary Stewardship Program (VSP), and encourage expansion to additional areas, including McLane Creek basin	Programs	County		Medium

Goals, *Strategies*, Actions			Category	Lead	Partners	Timeline
		Encourage development of stewardship plans for working farms in this basin in cooperation with the Thurston Conservation District	Programs	TCD	County	Medium
	Ensure land use regulations support areas suitable for forestry					
		Consider zoning changes for forest lands currently in the RR 1/5 zone to better ensure long-term preservation of working forest lands	Land use	County		Medium
		Work with the Department of Natural Resources to understand harvest plans for Capitol Forest and consider how these will impact the McLane Creek basin	Programs	County	DNR	Medium

This study did not include an analysis of the costs associated with the different scenarios, but an initial next step could include a prioritization of actions that includes such an analysis. Collaboration among the different groups and partners with interest in the watershed will be essential to carrying out these recommendations, as will continued monitoring to track the condition of the basin over the long term.

References

AHBL (2012). Integrating LID into Local Codes: A Guidebook for Local Governments. Prepared by AHBL for the Puget Sound Partnership.

Arnold, C. L., Jr., and Gibbons, C.J. (1996). Impervious Surface Coverage - The Emergence of a Key Environmental Indicator. *Journal of the American Planning Association, 62*(2), 243-258.

Northwest Hydraulic Consultants (NHC) (2014). *Thurston County Hydrologic Modeling for Watershed Based Land Use Planning.*

Stanley, S. 2010. *Puget Sound Watershed Characterization. Introduction to the Water Flow Assessment for Puget Sound: A Guide for Local Planners.* Publication No. 10-06-014.

Stanley, S., S. Grigsby, D. Booth, D. Hartley, R. Horner, T. Hruby, J. Thomas, P. Bissonnette, R. Fuerstenberg, J. Lee, P. Olson, and G. Wilhere. 2012. *Puget Sound Characterization – Volume 1: The Water Resource Assessments (Water Flow and Water Quality).* Washington State Department of Ecology. Publication No. 11-06-016. Olympia, WA

Stanley, S., G. Wilhere, C. Hume, S. Grigsby, E. McManus, M. Clancy, and the Watershed Characterization Technical Assistance Team. 2013. *Users Guide for the Puget Sound Watershed Characterization. Version 1. Draft – June 10th, 2013*. Ecology Publication No. 13-06-008.

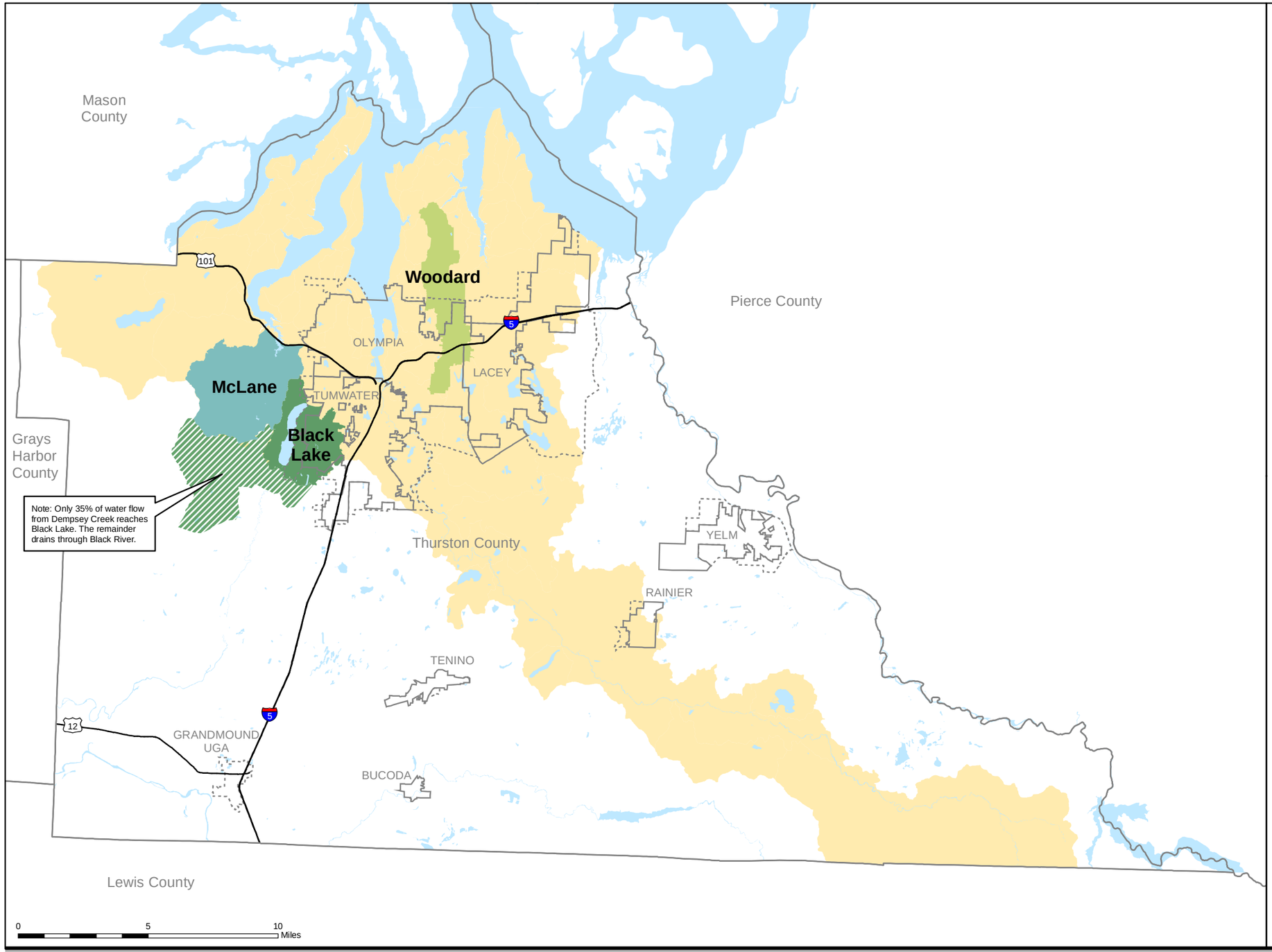
Thurston County Public Health and Social Services Department, Environmental Health Division and Thurston County Resource Stewardship Department, Water Resources Division (TCEH) (2012), Thurston County Water Resources Monitoring Report: 2009-2010 Water Year and 2010-2011 Water Year.

Thurston County Resource Stewardship (2009), *Totten and Eld Inlets Watershed Characterization, Final Report*. http://www.co.thurston.wa.us/waterresources/chara/chara-totten.html

Thurston Regional Planning Council (TRPC) and Thurston County (2013), *Basin Evaluation and Management Strategies for Thurston County WRIAs 13 and 14*.
http://www.co.thurston.wa.us/health/ehrp/annualreport.html

Thurston Regional Planning Council (TRPC) and Thurston County (2013A), *Estimates of Current and Future Impervious Area for Watershed Based Land Use Planning*, Thurston County.

List of Maps



McLane Creek Basin
Map 1: Project Area

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Science to Local Policy Project Area

Modeled Basins
- Black Lake
- McLane Creek
- Woodard Creek

Jurisdiction
- City Limits
- Urban Growth Area (UGA)

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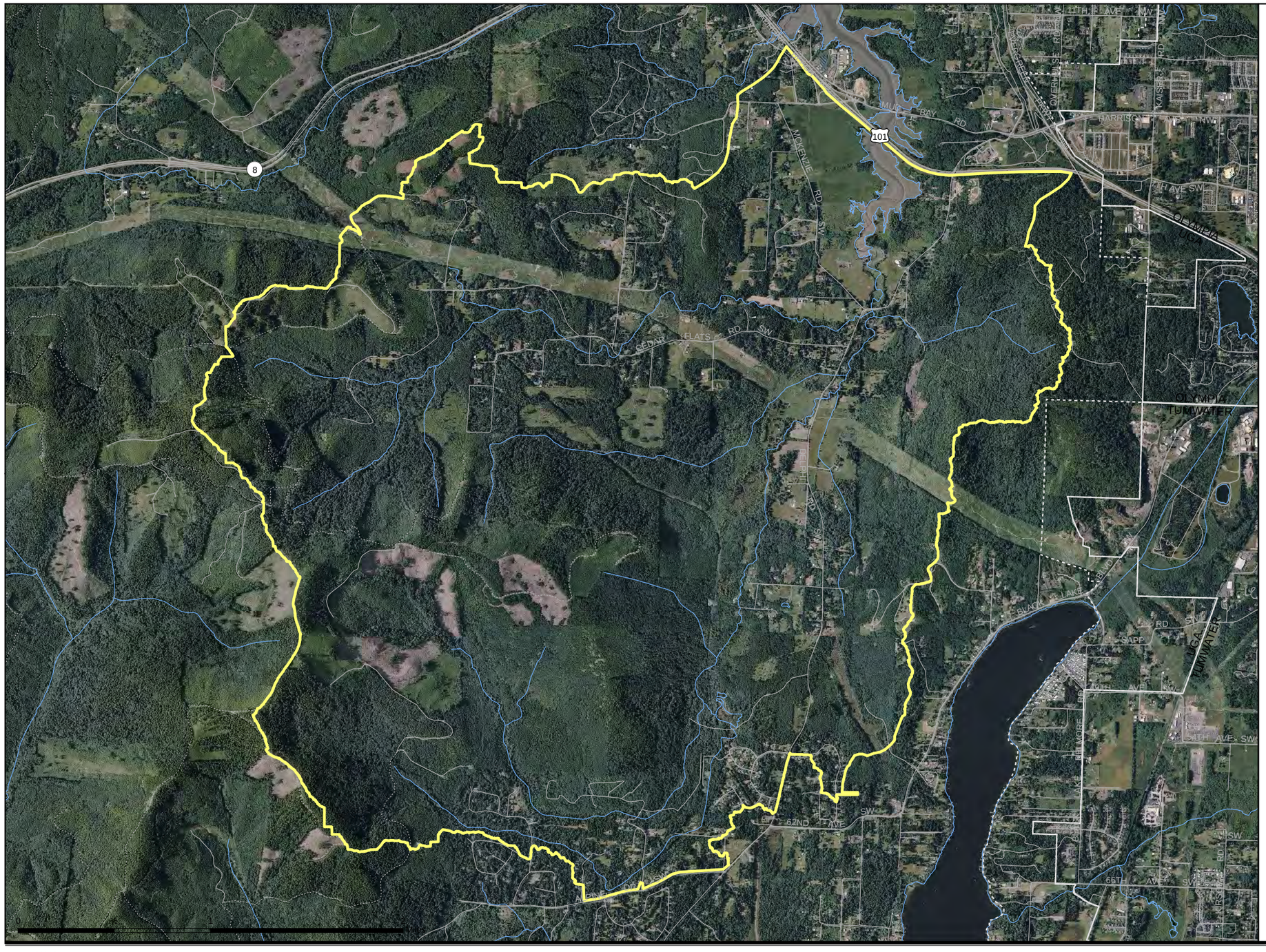

McLane Creek Basin
Map 2: 2012 Aerial Overview

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- Basin Boundary
- City Limits
- Urban Growth Area (UGA)

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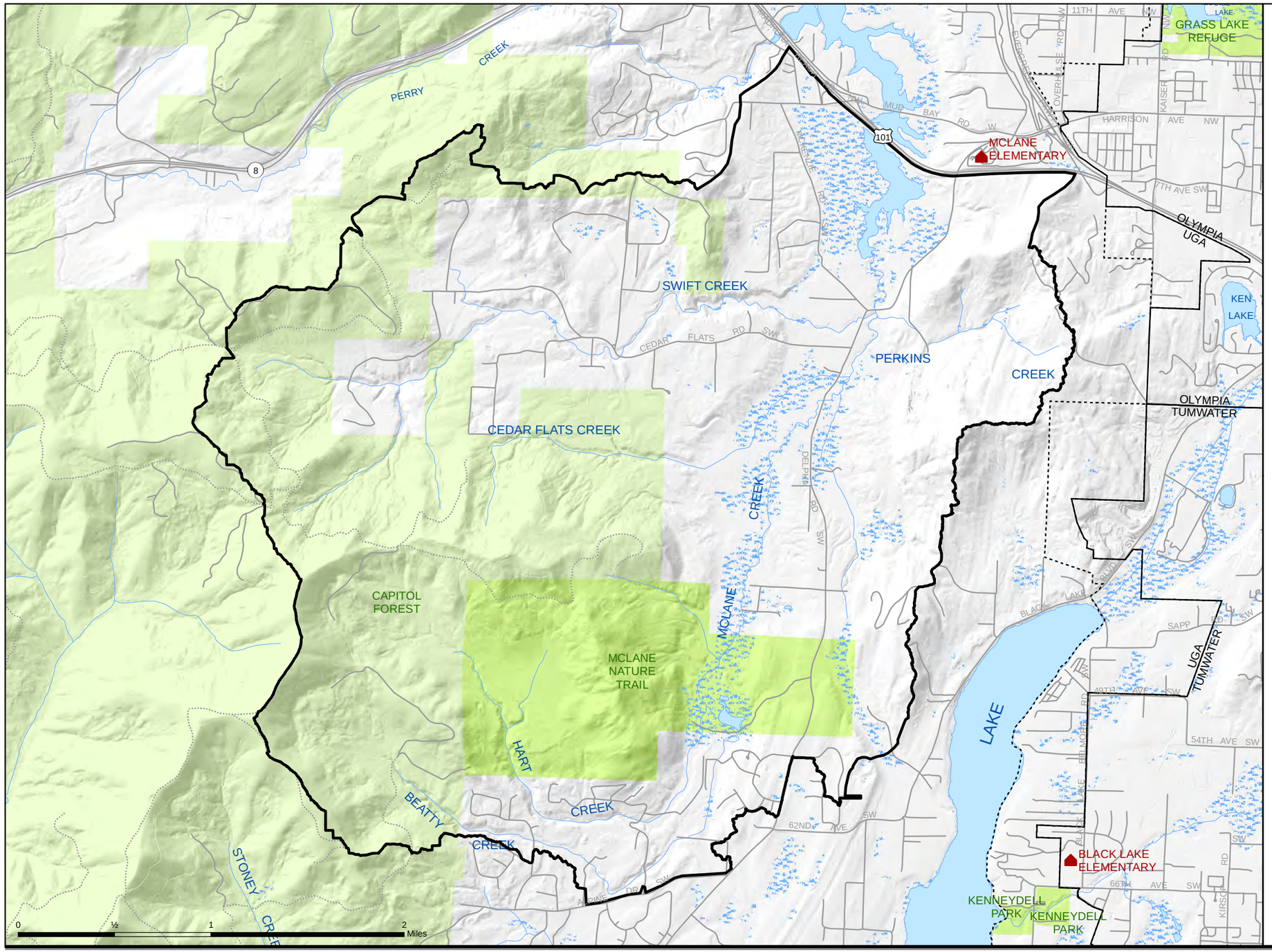

McLane Creek Basin
Map 3: Basin Overview

N W E S

- Basin Boundary
- City Limits
- Urban Growth Area (UGA)
- Wetland Indicators
- Parks & Preserves
- Capitol Forest
- Schools

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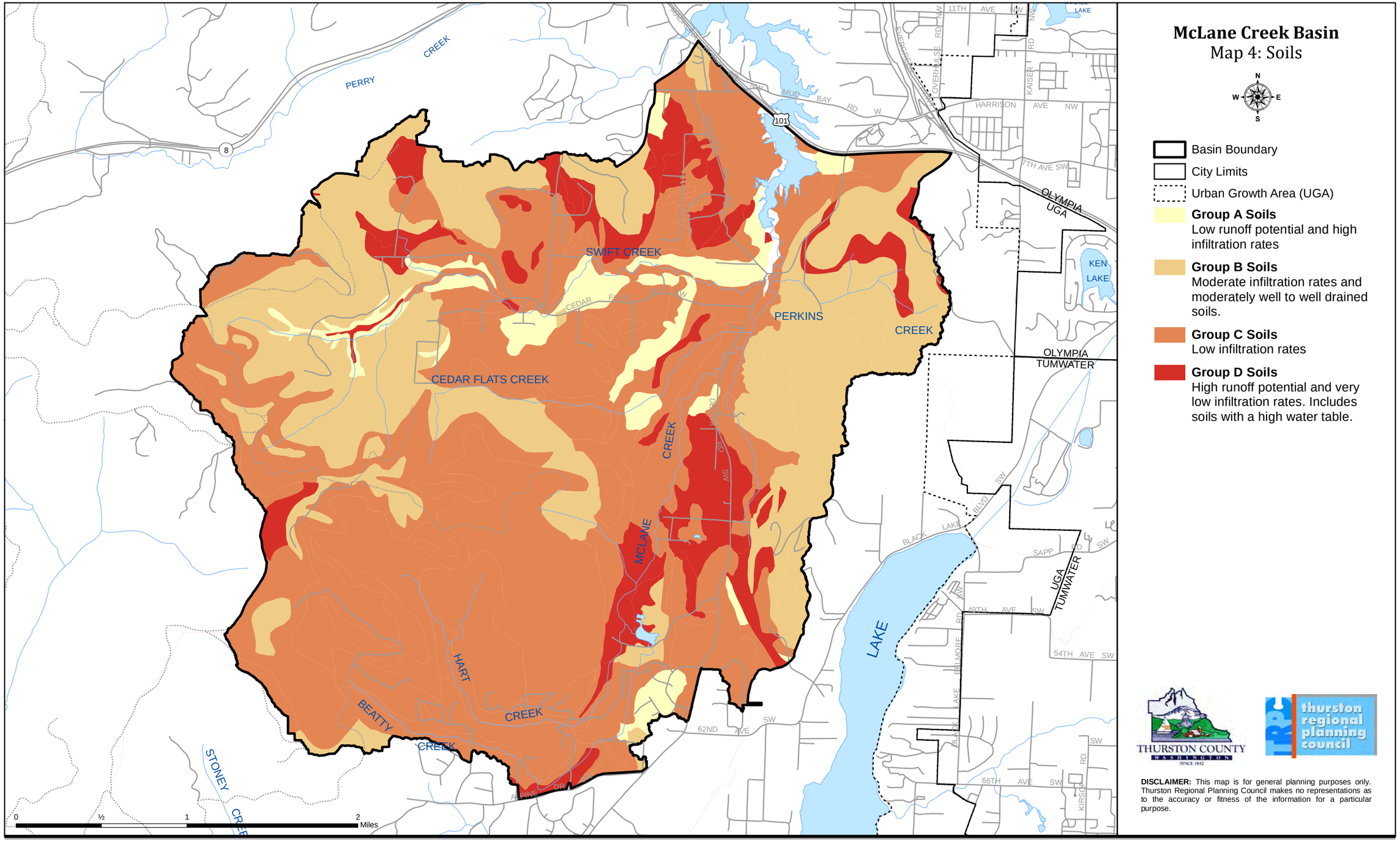

McLane Creek Basin
Map 4: Soils

N W E S

- Basin Boundary
- City Limits
- Urban Growth Area (UGA)

Group A Soils
Low runoff potential and high infiltration rates

Group B Soils
Moderate infiltration rates and moderately well to well drained soils.

Group C Soils
Low infiltration rates

Group D Soils
High runoff potential and very low infiltration rates. Includes soils with a high water table.

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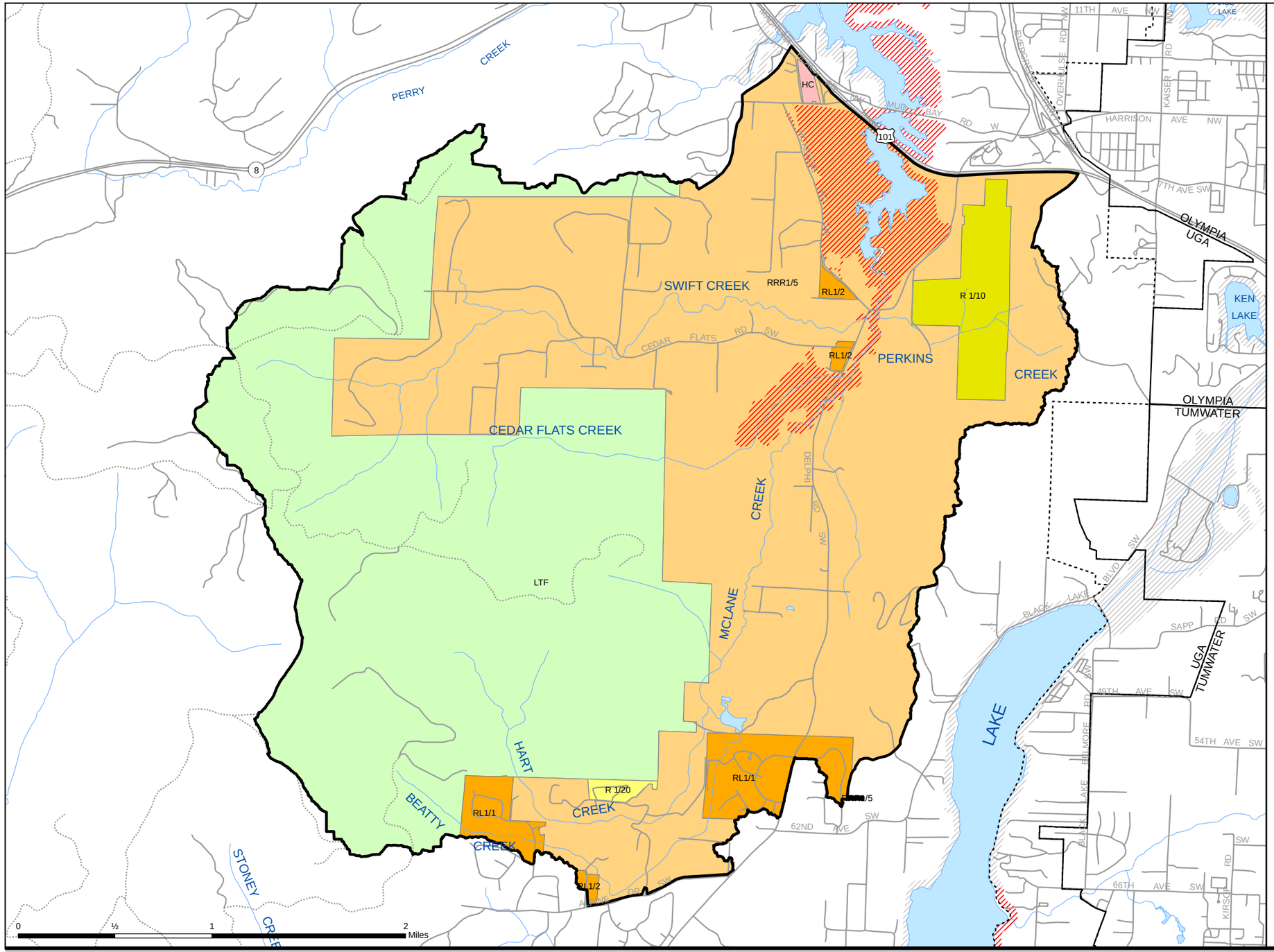

McLane Creek Basin
Map 5: Current Zoning (2014)

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- Basin Boundary
- City Limits
- Urban Growth Area (UGA)

Zoning Category

- RURAL 1/20
- RURAL 1/10
- RURAL RESIDENTIAL RESOURCE 1/5
- RESIDENTIAL LAMIRD (RL 1/1, RL 1/2)
- HIGHWAY COMMERCIAL
- LONG TERM FORESTRY

Shoreline Master Plan Designation

- Conservancy
- Other

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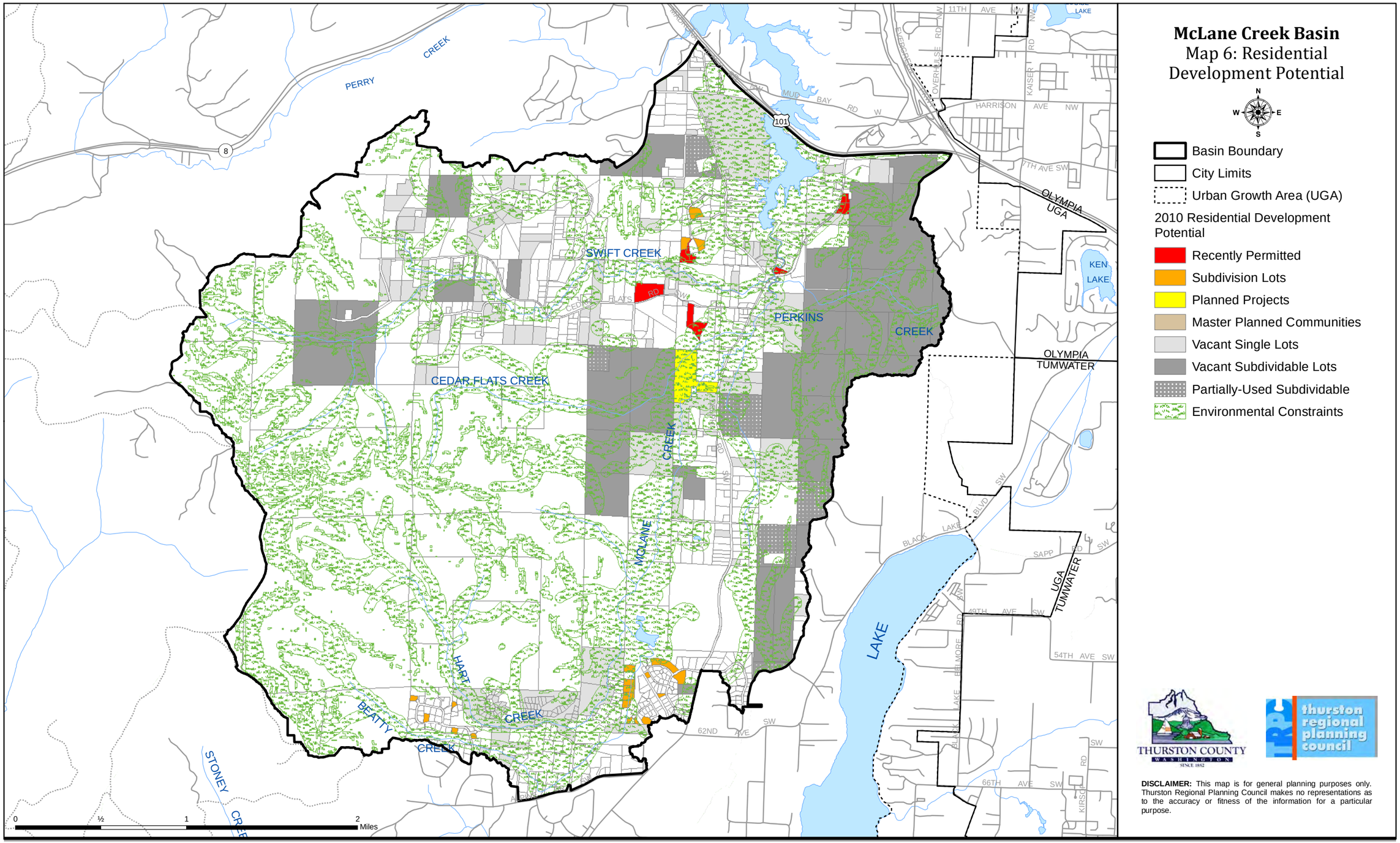

McLane Creek Basin
Map 6: Residential Development Potential

N W E S

- Basin Boundary
- City Limits
- Urban Growth Area (UGA)

2010 Residential Development Potential

- Recently Permitted
- Subdivision Lots
- Planned Projects
- Master Planned Communities
- Vacant Single Lots
- Vacant Subdividable Lots
- Partially-Used Subdividable
- Environmental Constraints

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Recognize chum salmon runs in the mouth of McLane cr. in late Nov & December. Draws large numbers of eagles

Black Hills between Delphi and Black Lake Blvd and south of pwer lines to be preserved & open to trails for Hike-Bike-Horse

old beaver dams, Brown Trout (gone) in utility ROW

Flooding

We have worked for years to improve riparian areas on our farm - but just across Delphi Rd from our farm Bonneville Power crosses pasture land & the McLane Creek is completely barren & unprotected by any trees or shrubs. BPA should mitigate this situ

Stop DNR clear cuts. U.S. Forest Service doesn't clearcut

DNR cut McLane perhaps 6 years ago. We protected near the road to the lake. Speak to DNR about not cutting in the future

Red Tail Part [?]

This creek goes low in August. High gradient

check topos north-foothill to McLane

Off Alpine [...] Please don't develop. It has critical area and not good for septic [...] *contains personal information*

McLane Creek Basin

Map 7: Public Comments from April 2014 Workshop

At the McLane Creek and Black Lake Community Workshop (4/9/2014), participants were asked two questions:

What special areas need protection?

What special concerns do you have?

This map shows the comments that were received.

- Basin Boundary
- City Limits
- Urban Growth Area (UGA)

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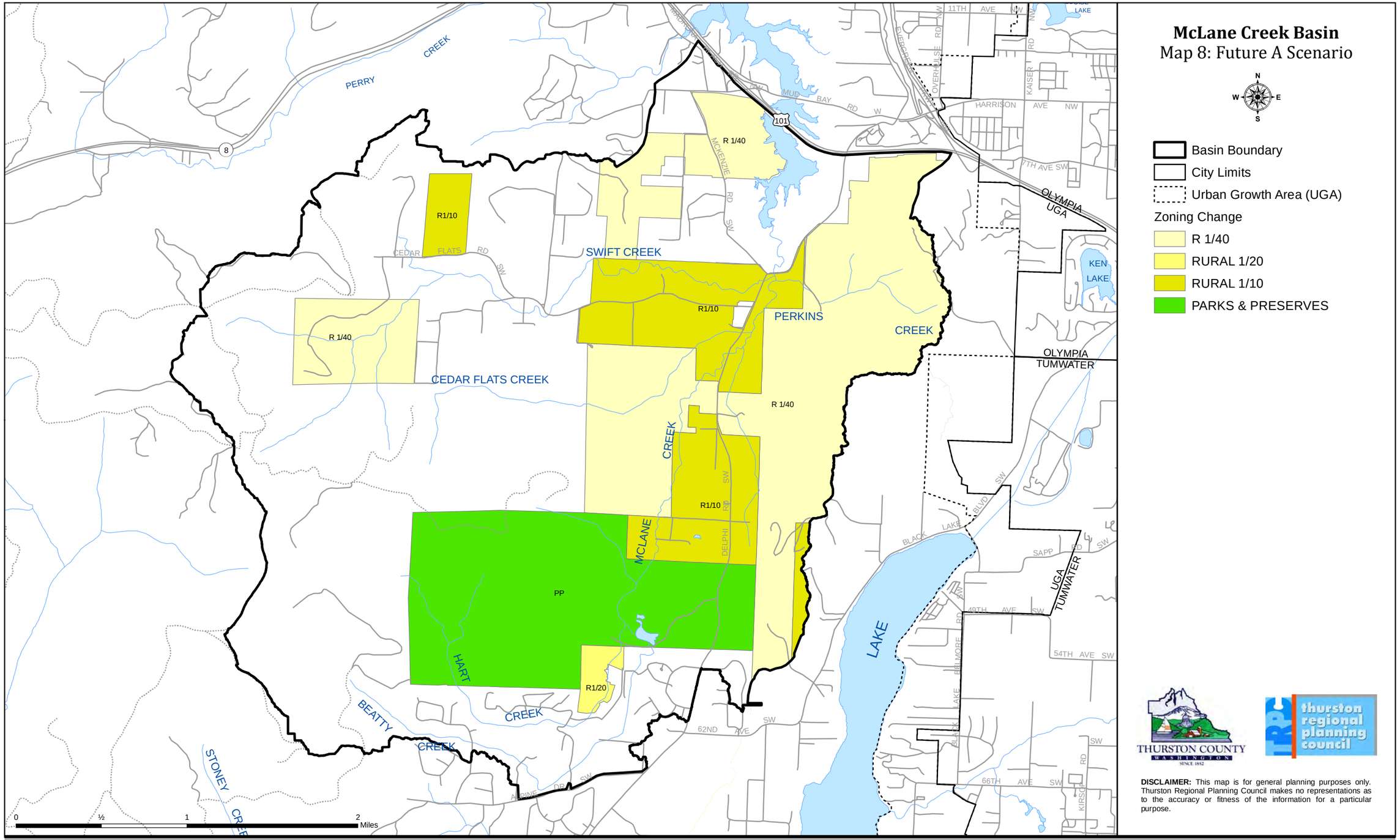

McLane Creek Basin
Map 8: Future A Scenario

N W E S

- Basin Boundary
- City Limits
- Urban Growth Area (UGA)

Zoning Change

- R 1/40
- RURAL 1/20
- RURAL 1/10
- PARKS & PRESERVES

THURSTON COUNTY WASHINGTON SINCE 1852

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McLane Creek Basin
Map 9: Future B Scenario

N
W E
S

- Basin Boundary
- City Limits
- Urban Growth Area (UGA)
- Wetland and/or Riparian Restoration
- Stormwater Retrofit Sites
- Purchase of Development Rights

PERRY CREEK
SWIFT CREEK
PERKINS CREEK
CEDAR FLATS CREEK
MCLANE CREEK
HART CREEK
BEATTY CREEK
STONEY CREEK
LAKE
OLYMPIA UGA
OLYMPIA TUMWATER
TUMWATER UGA
KEN LAKE
MUD BAY RD W
HARRISON AVE NW
7TH AVE SW
11TH AVE NW
MCKENZIE RD SW
CEDAR FLATS RD SW
DELPHI RD SW
62ND AVE SW
49TH AVE SW
54TH AVE SW
66TH AVE SW
BLACK LAKE BLVD SW
SAPP RD SW
KAISER RD NW
OVERHULSE RD NW
EVERGREEN PARK DR SW
KIRSOP RD SW
ALPINE DR SW
8
101

0 ½ 1 2 Miles

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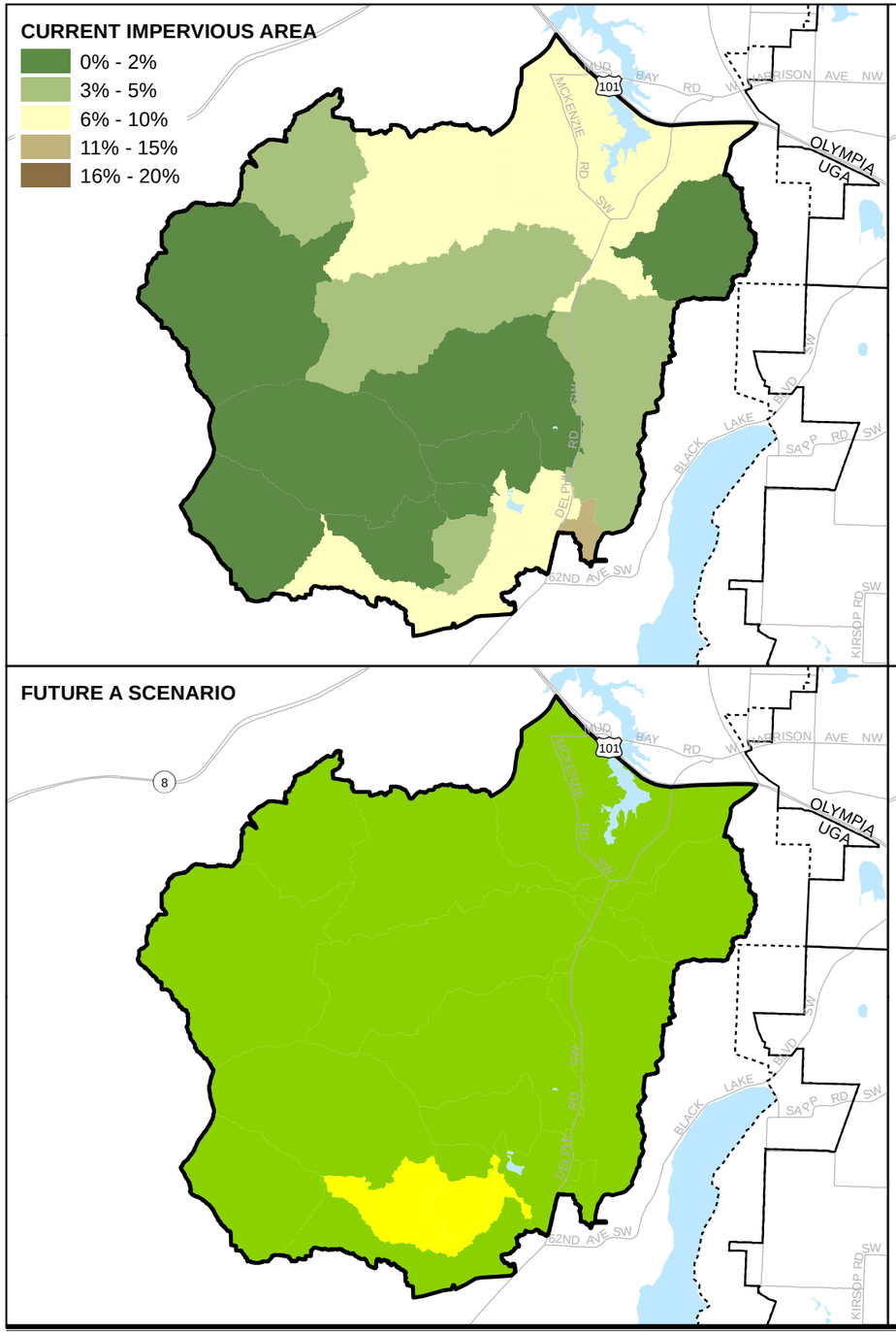

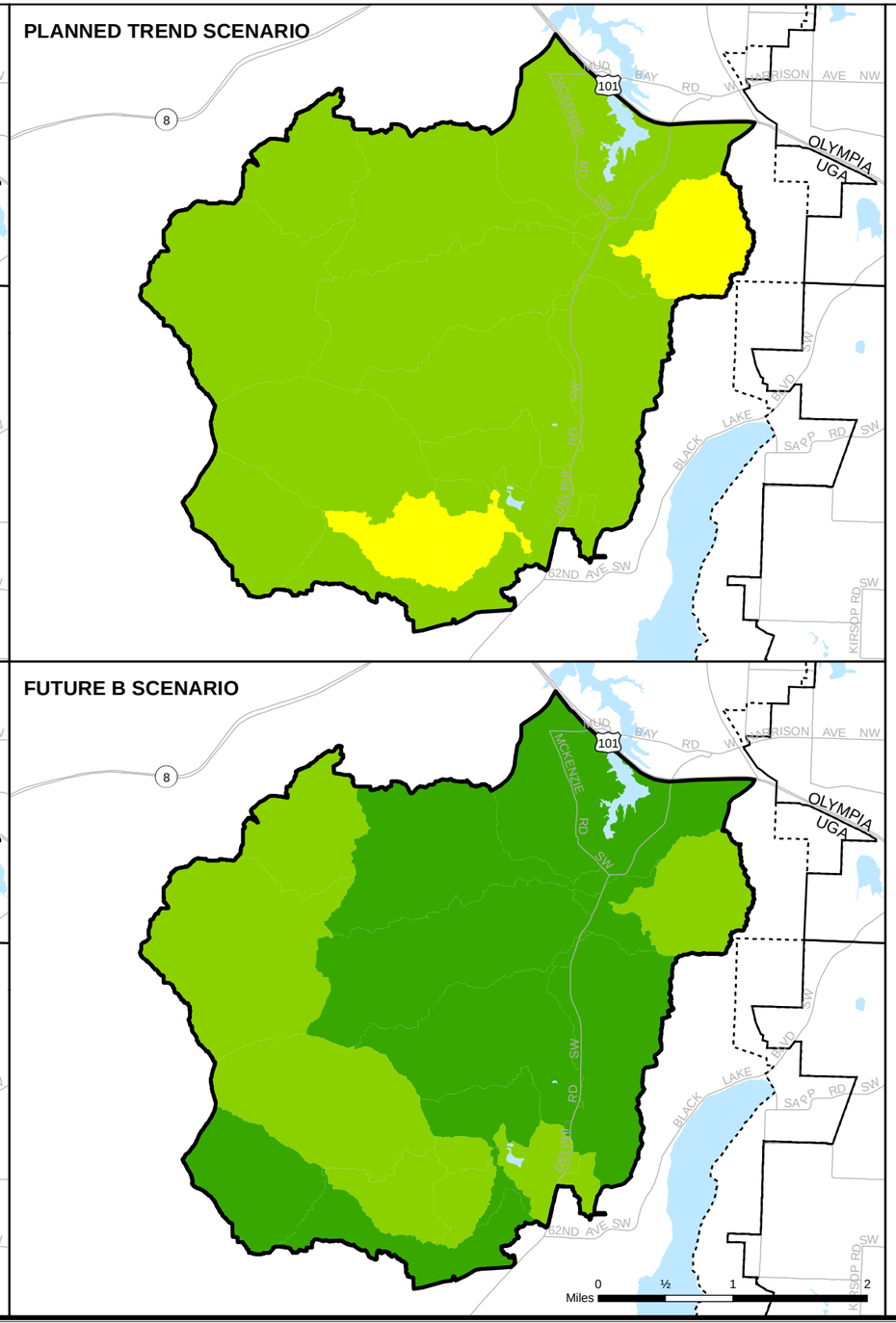

McLane Creek Basin
Map 10: Impervious Area

N
W
E
S

Basin Boundary
City Limits
Urban Growth Area (UGA)

Change in Impervious Area
- Decrease in Impervious Area
- Less than 2.0% Increase
- 2.1% - 5.0%
- 5.1% - 10.0%
- 10% Increase or Greater

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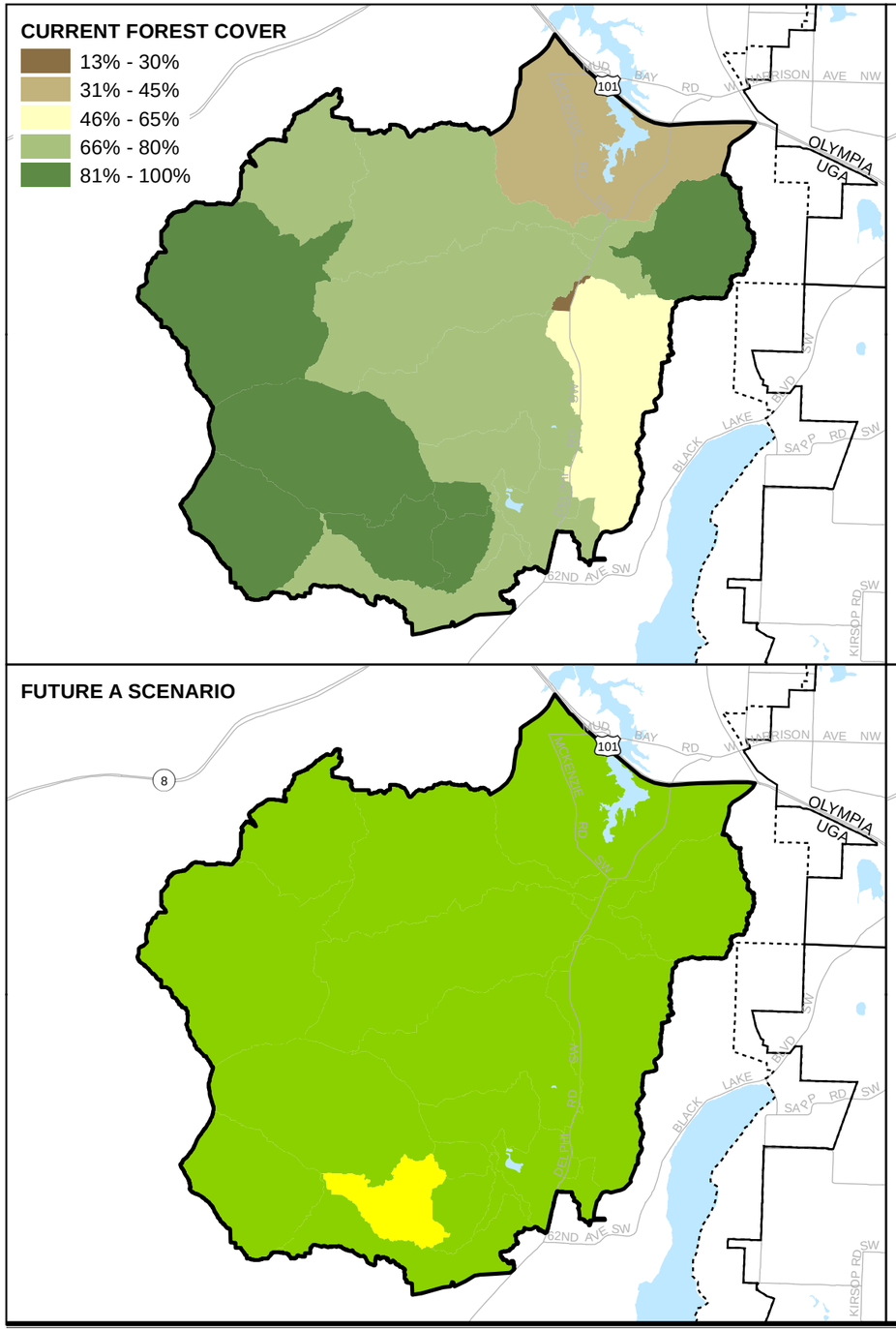
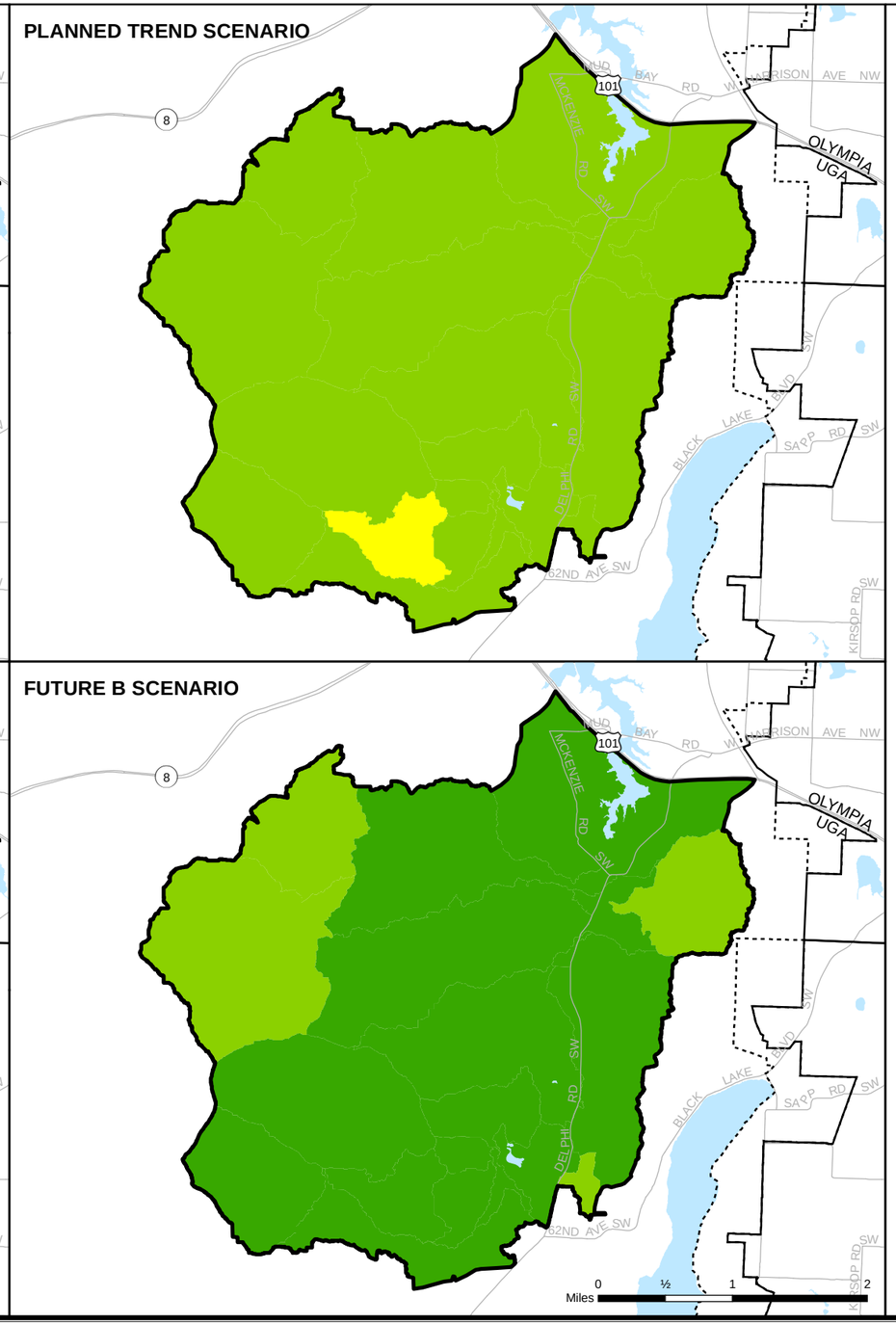
CURRENT FOREST COVER

13% - 30%
31% - 45%
46% - 65%
66% - 80%
81% - 100%



PLANNED TREND SCENARIO



FUTURE A SCENARIO

FUTURE B SCENARIO

McLane Creek Basin
Map 11: Forest Cover

N
W
E
S

Basin Boundary
City Limits
Urban Growth Area (UGA)

Change in Forest Cover

Increase in Forest Cover
Less than 2% Loss
2.0 - 4.9%
5.0 - 9.9%
Greater than 10% Loss

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Appendixes

Appendix A. Thurston County Cluster Developments

Appendix B. Family Member Units in Rural Thurston County

Appendix C. Impervious Surface Limits

Appendix D. Transfer of Development Rights and Purchase of Development Rights