City of Lakewood

Stormwater Management Action Plan: Receiving Water Conditions Assessment

prepared by

City of Lakewood
Public Works and Engineering

in accordance with

NPDES Western Washington Phase II Municipal Stormwater Permit

March 2022

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Introduction

The City of Lakewood owns and operates a stormwater conveyance system that discharges collected stormwater into bodies of surface water under the terms of the NPDES Western Washington Phase II Municipal Stormwater Permit. The current iteration of the NPDES permit, issued August 19, 2019, stipulates in special condition S5.C.1.d that each permittee must complete a Stormwater Management Action Plan (SMAP). The SMAP is a planning process that will result in the identification of specific actions to address water quality concerns in a high-priority watershed within the permittee's jurisdiction. The SMAP is a three-part requirement. The submittal schedule for the three parts is as follows:

i.	*Receiving Water Conditions Assessment*	*March 31, 2022*
ii.	*Receiving Water Prioritization*	*June 30, 2022*
iii.	*Stormwater Management Action Plan*	*March 31, 2023*

This report comprises a complete Receiving Water Conditions Assessment (RWCA), which will be submitted to Ecology by the March 31 deadline. The RWCA will adhere to the following steps, as per the Ecology (2019a) guidance document:

1. *Delineate Basins and Identify Receiving Waters*
2. *Assess Receiving Water Conditions*
3. *Assess Stormwater Management Influence*
4. *Assess Relative Conditions and Contributions*

The guidance document lists the components that must be included in each step and gives suggestions regarding methods and data sources to be used in the process. All requirements will be fulfilled and all questions answered to the best of the City's ability, using the data and knowledge that we have at this time; if components are not able to be included or methodology differs from that suggested in the guidance document, these discrepancies will be noted. Other documents that will be used for reference include the Ecology (2019b) stormwater manual, which defines stormwater issues and guides selection and application of BMPs; and the Washington State Department of Commerce (2016) document *Building Cities in the Rain*, which lists possible data sources and contains guidance for watershed prioritization.

I. Watershed Description and Delineation

Description of Chambers-Clover Watershed

The City of Lakewood is located in the Chambers-Clover watershed, a small lowland watershed situated between two major rivers: the Puyallup to the northeast and the Nisqually to the southwest. The streams, lakes, and wetlands in and around Lakewood are described below based on an examination of published hydrographic data from Pierce County (2017, 2019a and 2019b) as well as numerous maps and written descriptions.

The primary stream network in the watershed is the Chambers-Clover system. The main stem of the network, Clover Creek, originates east of Lakewood, with headwaters and tributaries located in the unincorporated communities of Parkland and Spanaway and on Joint Base Lewis-McChord (JBLM). The creek flows under McChord Field and Interstate 5 and through southeast Lakewood before emptying into the south end of Lake Steilacoom. The stream channel leading to this inlet was created for flood control in the first half of the nineteenth century; the original course of the creek was located to the northeast and now holds a much smaller inlet stream known as Ponce de Leon Creek (Pierce Conservation District 2003). The lake itself is also manmade, impounded behind a dam located at the north end of the lake. The dam was installed in the 1850s to power a grist mill (URS 2004). On the other side of the dam is Chambers Creek, which is joined by tributaries including Flett Creek and Leach Creek before discharging into Puget Sound at Chambers Bay. Most of Lakewood is located within the Chambers-Clover network.

The watershed also contains the American Lake system. American Lake is fed by Murray Creek, which originates on JBLM to the southeast. At the southwest end of the lake, also on military land, water flows into Sequalitchew Lake through a box culvert installed in 1956 (Ecology 1990a). This lake has two outlet branches: one natural channel, known as Sequalitchew Creek, which flows west through a series of small wetlands before entering Puget Sound at the town of DuPont, and one manmade overflow canal that enters the Sound further north (Pierce Conservation District 2003). Although the inlet and outlet streams of the American Lake system are located outside Lakewood, roughly half of the lake itself is inside city limits.

Lakewood also contains a number of small, isolated wetlands and pothole lakes (lakes that do not have a surface outlet). These include Gravelly Lake, Lake Louise, Waughop Lake, Carp Lake, and Charleton Lake (which is located outside city limits but has some watershed area in the city). Seeley Lake and Wards Lake, located on the east side of the city, might be natural potholes, but they are used for stormwater detention and have manmade outlets to Flett Creek.

Although the two stream networks and the individual pothole lakes are in a sense separate features, they are all linked by an extensive groundwater system that exists within the watershed due to the "highly permeable gravelly soils derived from glacial outwash" (Pierce County 1997). A hydrogeologic analysis of the Chambers-Clover watershed confirms that "major lakes in the study area [including] Steilacoom, Gravelly, American, and Spanaway… likely are of glacial (kettle) origin and generally reflect water levels in the shallow groundwater-flow system" and that "numerous springs are present throughout the study area, and contribute to late-summer baseflow to streams" (USGS 2010).

Watershed Delineation

Figure 1 shows the delineated watersheds for Lakewood's receiving waters. Table 1 lists the total land area of the watershed for each receiving water as well as the percentage of this area that is located in Lakewood. Nested indentations are used to indicate receiving waters that are upstream of other waters. Watershed areas are cumulative: the listed value includes the area that drains directly to a given water as well as the areas for any upstream waters.

Watershed delineations were created using GIS tools. Initial delineations based on 2020 LiDAR elevation data were provided by Pierce County, and watershed boundaries were manually adjusted to account for stormwater infrastructure using data from City of Lakewood and WSDOT. Watershed boundaries outside the vicinity of Lakewood were not adjusted for stormwater and are entirely based on the topographical delineations.

Watersheds for specific receiving waters may include areas that actually infiltrate to groundwater, either naturally or through a collection system ending in a storm detention pond or perforated pipe. However, a small number of storm detention ponds located near I-5 were identified and placed in a watershed of their own. These detention ponds have no outlet to any other surface water.

Receiving Waters Excluded From Assessment

Several of the identified receiving waters will not be included in the assessments of the following sections. These excluded waters are as follows:

- **Detention ponds.** These are not natural water bodies and improving water quality in them will not be a priority for SMAP.
- **Receiving waters with 5% or less of their watershed located in Lakewood.** This includes Leach Creek, Wards Lake, Clover Creek, Sequalitchew Creek, Murray Creek, and Charleton Lake. It is unlikely that Lakewood can significantly impact waters over which it has so little jurisdiction. Note: Lake Steilacoom also meets the 5% or less threshold, but it will be included because it is one of the city's major lakes and because the basin draining directly into the lake (not through any tributary stream) is located entirely in Lakewood. Furthermore, Clover Creek tends to dry up during the summer months (Tobiason 2003); at those times, the majority of the actual contributing watershed for Lake Steilacoom is located in Lakewood.
- **Puget Sound.** A small area in the west part of the city drains to Puget Sound via the town of Steilacoom. Because Lakewood's contribution is minimal and because the relevant section of Puget Sound shoreline is an active transport zone for sediment (Ecology 2022a), it will not be a focus for SMAP and will not be included. Chambers Bay, in contrast, is defined as an "area of net deposition of sediment/solids" (Ecology 2019a) and will be included.

The receiving waters that will be included in the assessment are shown in bold in Table 1. These waters include one urban bay, three creeks, and six lakes.

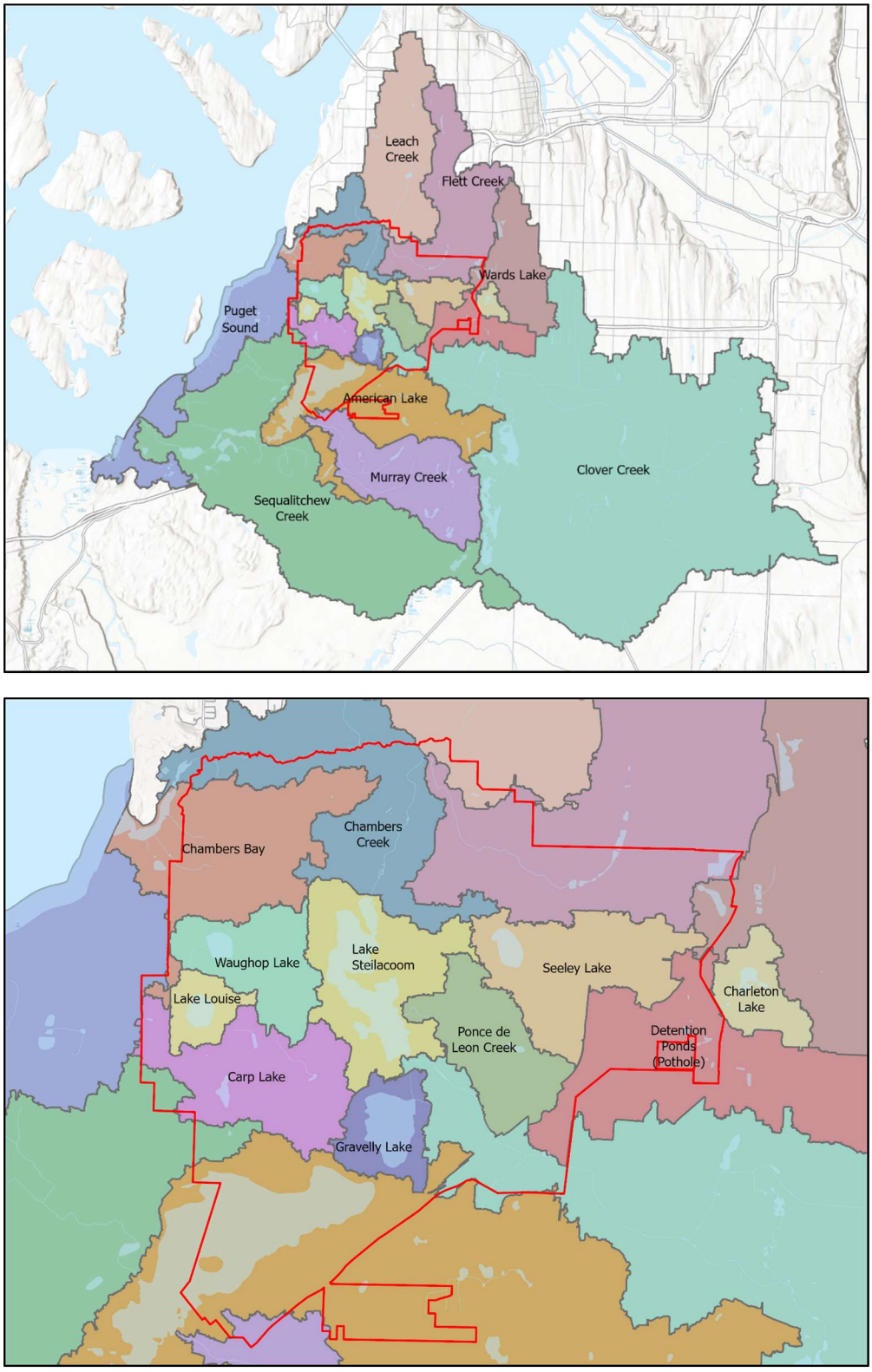

Figure 1 Watershed Delineation

Table 1 List of Receiving Waters with Watershed Areas

Receiving Water	Total Watershed Land Area (square miles)	Portion of Watershed Land in Lakewood
Chambers-Clover System		
Chambers Bay	**91**	**11%**
└ Chambers Creek	**89**	**10%**
└ Leach Creek	8.3	2%
└ Flett Creek	**15**	**24%**
└ Seeley Lake	**1.5**	**100%**
└ Wards Lake	5.1	3%
└ Lake Steilacoom	**62**	**5%**
└ Ponce de Leon Creek	**1.1**	**100%**
└ Clover Creek	60	1%
American Lake-Sequalitchew Creek System		
Sequalitchew Creek	46	5%
└ American Lake	**18**	**11%**
└ Murray Creek	8.8	1%
Pothole Lakes		
Carp Lake	**1.6**	**98%**
Charlton Lake	0.5	<1%
Detention Ponds near I-5	3.0	37%
Gravelly Lake	**0.4**	**100%**
Lake Louise	**0.3**	**100%**
Waughop Lake	**0.9**	**100%**
Puget Sound		
Puget Sound	n/a	n/a

Note: receiving waters shown in bold will be included in the assessment.

II. Receiving Water Conditions

In this section, the condition of Lakewood's identified receiving waters is assessed and explored through the following steps:

1. Assessment of the water quality condition of each receiving water body; identification of water quality impairments
2. Presentation of landscape-scale data that may explain receiving water conditions
3. Discussion of identified impairments in terms of their relationship to stormwater.
4. Discussion of the impacts of future development
5. Discussion of overburdened communities

The data and assessments included in this section will be used as the basis for the analyses that follow in the final two sections of the report.

Water Quality

In this sub-section, the water quality condition of Lakewood's receiving waters is assessed. Background information is provided regarding state water quality standards, designated uses, and the various methods and programs that exist for assessing water quality. The known condition of each individual receiving water is then described, including any historical and contextual information that may be relevant to the condition. Table 2 summarizes the findings of this assessment. Waters that are not fully meeting their desired uses or that have other notable issues affecting downstream waters are marked as impaired.

Background

WAC Designated Uses

Surface waters in Washington State are assigned designated uses by the state water quality standards, WAC 173-201A. Aquatic designated uses are related mainly to the water bodies' use as habitat during the life cycles of local salmon populations and correspond to specific numeric limits for temperature, dissolved oxygen, turbidity, dissolved gas, and pH. All of Lakewood's identified receiving waters are designated "core summer salmonid habitat," although in reality salmon runs are not possible in the city's pothole lakes.

In addition to aquatic uses, all of Lakewood's water bodies have other designated uses including primary contact recreation, which corresponds to limits on bacteria levels. All surface waters in Washington are also subject to narrative criteria regarding human-caused aesthetic impairments "which offend the senses of sight, smell, touch, or taste." These aesthetic criteria are mainly relevant for lakes and are accompanied by nutrient limits based on the trophic state of the lake in question (see "Lake Health and Monitoring" below for discussion of eutrophication).

The state water quality standards paint with a broad brush, and not all designated uses are actually practical for Lakewood's waters. For instance, some of the city's smaller lakes and ponds are not a suitable size for recreational swimming. The "desired" uses given in Table 2 are expressions of the most important functions (or desired functions) for each body of water.

Table 2 Water Quality Summary

Receiving Water	Desired Uses	Desired Uses Being Met?	Other Issues Affecting Downstream Waters	Impaired?
Chambers Bay	Estuarine habitat Salmon habitat	Yes – Estuary is in generally good condition	-	No
Chambers Creek	Salmon habitat	Somewhat – Exceedance of water quality standards for copper	-	Yes
	Recreation	Unknown		
Flett Creek	Salmon habitat	Somewhat – Some issues with dissolved oxygen and pH	Issues with fecal coliform may affect recreation in Chambers Creek	Yes
	Wetland habitat	Unknown		
Seeley Lake	Wetland habitat	No – Wetland receives industrial stormwater, which presumably degrades water quality	-	Yes
Lake Steilacoom	Salmon habitat	Unknown	Sediments are source of copper in Chambers Creek	Yes
	Recreation	Somewhat – High phosphorus levels cause regular algae blooms		
Ponce de Leon Creek	Salmon habitat	No – Dissolved oxygen and pH standards are consistently not met	Primary surface input of phosphorus to Lake Steilacoom	Yes
American Lake	Salmon habitat	Unknown	-	Yes
	Recreation	Somewhat – Occasional bacteria and algae impairments		
Carp Lake	Wetland habitat	Unknown	-	No
Gravelly Lake	Recreation	Yes – Lake is generally clear and free of algae in summer	-	No
Lake Louise	Recreation	Yes – Lake is generally clear and free of algae in summer	-	No
Waughop Lake	Recreation	No – High phosphorus levels cause algae blooms which make swimming and fishing inadvisable	-	Yes

Ecology Water Quality Assessment

Ecology routinely reviews available water sampling data and assigns graded categories to water bodies based on their compliance with water quality standards. An online mapping tool (Ecology 2022b) shows the assigned categories for each water, including "candidate" assignments that were identified in the 2018 assessment and submitted to the EPA for review. As of this assessment, several of Lakewood's receiving waters have been assigned 303(d) status, indicating that the water is consistently not meeting one or more standards. Several others have been flagged as waters of concern, indicating a less consistent or less well-documented trend of non-compliance with water quality standards. These assignments, including 2018 candidates, are identified for each water body in the individual discussions that follow.

Stream Health and Monitoring

Stream health in the Chambers-Clover watershed is best assessed in terms of suitability for salmon. As explained above, the designated aquatic uses are mainly framed to protect salmon functions. An analysis

of salmon habitats in the Chambers-Clover and Puyallup River watersheds found that the lower reaches of Chambers Creek historically supported Chinook salmon and that for Coho salmon, the Chambers/Clover network "was, and still is, the most productive watershed" within the study area (Mobrand Biomentrics 2003). Particularly important parameters for salmon health are instream flow, temperature, and dissolved oxygen.

Since the middle of the twentieth century, Ecology has intermittently conducted stream monitoring for parameters including flow, temperature, dissolved oxygen, turbidity, pH, hardness, bacteria, and nutrients. The three streams that have been identified as significant receiving waters for Lakewood (Flett Creek, Chambers Creek, and Ponce de Leon Creek) have all been included in this monitoring at various times. Recent monitoring of these three streams has also been carried out by Pierce Conservation District. Parameters tracked by the District include dissolved oxygen, temperature, pH, turbidity, and nitrates.

Lake Health and Monitoring

There are a number of monitoring programs that underpin our current understanding of the condition of Lakewood's lakes. From the 1970s to the 1990s, Ecology conducted a series of lake studies that, in various years, assessed American, Steilacoom, Gravelly, Louise, and Waughop lakes. The reports from these studies include descriptions of the lakes' physical geometry, narrative comments regarding lake use, shore development, and known issues, and monitoring results for parameters such as temperature, pH, dissolved oxygen, and nutrients. A similar monitoring program exists today, administered by Pierce Conservation District.

One of the main concerns in Lakewood's lakes is toxic blue-green algae (cyanobacteria), which can affect human health and water quality (Ecology 2010) as well as constituting an aesthetic nuisance. Algae blooms are caused by excess nutrients. The buildup of nutrients, known as eutrophication, is a process that naturally occurs in lakes over a very long period of time but can be accelerated by nutrient-rich runoff.

Ecology has performed some monitoring for toxic algae over the last fifteen years, and the other monitoring programs usually estimate the trophic state of the lake based on indicators including levels of nutrients (phosphorus and nitrogen), concentration of chlorophyll-a, a green pigment found in algae, and water transparency, which can be measured by deploying a black and white secchi disk into the water and measuring the depth to which it can be seen from the surface. (Pierce Conservation District 2017a).

Another factor that plays into algae behavior is stratification, a phenomenon where deep lakes separate into a warm surface layer and a cold, dense lower layer during the summer months (Pierce Conservation District 2020a). When stratification is present, nutrients in the sediment might be less likely to mix into the upper layers of the lake, reducing the likelihood of algae blooms. Temperature stratification has been monitored by both Ecology and Pierce Conservation District.

Assessment of Individual Receiving Waters

American Lake

American lake is the largest lake in Pierce County. Several factors indicate good lake health and oligotrophic (low nutrient) condition: it is highly stratified during the summer months, with deep Secchi visibility (Pierce Conservation District 2017a, 2018a, 2019a, and 2020a), and its "gravel littoral bottom [supports] few aquatic [plants]" (Ecology 1976). However, Ecology (1993) cautions that water quality sampling sites must not be limited to the center of the lake: "because of the large surface area of the lake,

winds can localize algae growth in nearshore areas… Secchi data collected from [open water areas] will underestimate the trophic state of the lake."

In the winter of 1988-1989, the lake experienced the earliest reported instance of a toxic algae bloom west of the cascades. This bloom suggested that the lake "[had] had high nutrient concentrations for many years" (Ecology 1993). Recent monitoring has confirmed that concentrations of phosphorus and ammonia-nitrogen are high in the deep layer of the lake and sometimes mix into the shallow layers near the end of the year as the density stratification breaks down (Pierce Conservation District 2017a, 2018a, and 2020a), apparently contributing to occasional winter algae blooms as in 1989.

American Lake has been issued 303(d) status by Ecology for having fecal coliform counts exceeding the WAC criterion a number of times in the mid-2000s, as well as for several carcinogenic chemicals (PCBs, dieldrin, and dioxins) found in fish tissue in 2002. It has also been flagged for containing Eurasian water-milfoil, an invasive plant species. A Lake Management District was formed in 2019 to address the milfoil issue and coordinate lake treatments (City of Lakewood 2022c). After treatments in 2019, improvements were reported in the 2020 season (AquaTechnex 2022).

Carp Lake

Carp Lake is a small lake that has rarely been subject to monitoring. Water levels drop below ground during the summer months, reflecting the water table. It was initially part of the Pierce Conservation District monitoring program but was often difficult to sample due to its low level and abundance of aquatic plants (Ragland 2021). The report from the last year that Carp Lake was sampled (Pierce Conservation District 2016) states that it was too shallow to allow for deep-water samples and did not stratify at all. It also had relatively low secchi depth measurements, although whether this was due to low water clarity or simply to limited available depth in the lake is not clear. It contained high phosphorus levels comparable to Steilacoom and Waughop lakes and chlorophyll concentrations comparable to Steilacoom, suggesting that it experienced an algae bloom.

The delineated basin for Carp Lake also includes two other small ponds: Boyles Lake and Lost Lake, neither of which have been studied. Because they are near Carp Lake and similarly small and shallow, these lakes are assumed to have similar water quality.

Chambers Bay

Like many Puget Sound estuaries, Chambers Bay has been modified by humans over the last century. A railroad dike crosses the mouth of the bay, with a bridge providing a "very narrow and restricted" outlet (Pierce Conservation District 2003). In 1933, a dam was built across the bay to impound water for now-defunct industrial sites. The dam "blocks approximately 40% of the historical estuary habitat" of Chambers Bay. The feasibility of removing this dam, which would likely aid salmon recovery, is being explored by some parties (Pacific Groundwater Group 2018).

Chambers Creek

Chambers Creek has been extensively monitored in the past; however, with so many different reaches and tributaries, it is difficult to assess the health of the creek as a whole. Various reaches of the creek have been assigned either 303(d) or "water of concern" status by Ecology due to exceedances of water quality standards for temperature, dissolved oxygen, pH, fecal coliform, and copper (likely related to copper sulfate treatments historically applied to Lake Steilacoom). Only one recent monitoring report is available for the creek, and it indicates generally good water quality (Pierce Conservation District 2017b).

The primary impediments to Chambers Creek meeting its designated uses are flow and fish passage. The Chambers-Clover Watershed Management Committee reported in 1997 that the creek contains "excellent" instream habitat that is "limited by stream flow problems" (Pierce County 1997). The dam that impounds Lake Steilacoom was retrofitted with a fish ladder in the 1980s; however, the ladder operation is "subject to available water flows out of the lake and flow manipulation by the Steilacoom Lake Homeowners Association" (Pierce Conservation District 2003). The dam at the mouth of the creek also contains a fish ladder; however, a trap is typically operated between August and February every year, with fishery personnel visiting the dam approximately three times per week to release spawning salmon upstream of the dam; chinook salmon are removed and transported to other hatcheries (Pierce Conservation District 2003).

Flett Creek

The upper reach of Flett Creek consists of a series of connected holding basins constructed in 1981, which receive stormwater from parts of Tacoma and Lakewood (City of Tacoma 2016). Flow into the creek is regulated based on water level in the basins. The lower reach of the creek contains significant wetlands, which were the site of a major dairy farm for most of the last century (Lakewood Historical Society 2017).

Since the shuttering of the dairy in 1994, the lower reach of Flett Creek has been the object of numerous restoration and conservation efforts. In 1994, parts of the dairy property were turned into a research and learning laboratory for nearby Clover Park Technical College (Lakewood Historical Society). A dam removal project to improve fish passage was completed in 2002 (Washington State Recreation and Conservation Office 2021). In 2007, a grant funded invasive species removal and native tree planting projects in the riparian zone (Hanson 2014). In 2021, the City of Tacoma proposed to conduct a feasibility study for a project that would improve salmon habitat in Flett Creek by treating and restoring stormwater that is currently being routed out of the watershed (Ecology 2021).

The success of these restoration efforts is difficult to gauge. In the most recent Water Quality Assessment by Ecology, the creek was identified as a candidate for 303(d) status due to exceedances of dissolved oxygen and fecal coliform criteria detected in 2011 and 2012. Recent monitoring reports by Pierce Conservation District (2017b, 2018b, 2019b, 2020b) show that temperature criteria are consistently met by a wide margin in the creek but that there is a patchier record of compliance with dissolved oxygen and pH standards.

Gravelly Lake

Compared to other nearby lakes that have been extensively studied, Gravelly Lake seems to be in relatively good condition. It has not been issued 303(d) status by Ecology for any water quality parameter. Phosphorus is known to be present in the sediment (Tepper 2013), and high concentrations of phosphorus in the lower layers of the lake (Ecology 1993, Pierce Conservation District 2018a) suggest that deep algae blooms may occur on an annual basis. In general, however, the lake has unusually clear water and is not known to have problems with toxic algae.

The general lack of algae issues might be attributed to the use of controlling chemicals: as of 1993, the lake had been treated with an unspecified algaecide for over 20 years. It is possible that this application actually contributed to deep-water algae blooms by clearing the upper layers of the water and allowing sunlight to penetrate to the deep layers (Ecology 1996). On the other hand, Tepper suggests that the lake's relative clarity is due to its access to a deep silicon-rich aquifer that other lakes in the region are not connected to: the silicon present in the water column promotes annual springtime blooms of diatoms,

which turn the water a bright turquoise color and consume available phosphorus that might otherwise contribute to cyanobacteria blooms in the summer. Another factor that may contribute to Gravelly's health is its stratified condition between May and December every year (Pierce Conservation District 2016, 2017a, 2018a).

Lake Louise

Lake Louise is in relatively good condition. It usually has high density stratification from about May to October and good water clarity comparable to Gravelly and American lakes (Pierce Conservation District 2017a, 2018a, 2019a, 2020a). It has not been issued 303(d) status by Ecology, and it has no known pattern of toxic algae blooms. Ecology (1993) documented that during the 1980s, the lake had been treated with chemicals including copper sulfate to "control weeds, algae, and fish species." However, the Ecology author noted that "compared with other lakes… which are chemically treated to control plants and algae, the water clarity of Lake Louise was very good." The citizen volunteer monitor at the time reported that the worst problem in the lake was "occasional swimmer's itch."

Seeley Lake

Seeley Lake is situated within a park owned by Pierce County. The County describes it as "a wetland with fluctuating water levels throughout the year" (Pierce County 2021a). The wetland is surrounded by a forested loop trail but does not support water recreation such as fishing or swimming. A recent report on proposed park improvements cited community concerns about safety and trash within the park. The proposals included removal of trees and shrubs, including native species, to make the trail safer and improve views of the wetland as well as the installation of signs discouraging illegal dumping (SCJ Alliance 2021). The health of the wetland itself has not been assessed through monitoring. It receives stormwater from surrounding urbanized areas including the Lakewood Industrial Park; the water quality is thus assumed to be somewhat degraded.

Lake Steilacoom

Lake Steilacoom has a well-documented history of issues with algae and aquatic plants caused by excess nutrients. Ecology (1991) recommended "controlling internal cycling of phosphorus from sediment," and the lake is currently assigned 303(d) status for high phosphorus levels in the water column. Since 1955 the lake has been treated to suppress algae and aquatic plants, including application of copper sulfate beginning around 1975 (Ecology 1991). This treatment continued "until the early 1990s… two to three times per year," during which time "no toxic blooms were reported" (Lake Steilacoom Improvement Club 2021a). Copper sulfate was banned in the mid-1990s, and the Improvement Club reports that the lake is now "plagued with toxic cyanobacteria blooms on a seasonal basis" and that after aggressive efforts to find a replacement treatment, the homeowner's association in 2007 "approved future use of [the algaecide] Hydrothol when warranted to avoid blue-green bloom conditions" (2021a). Contact herbicides are also applied annually and have "provided excellent seasonal control" of submersed weeds in the lake (2021b).

Likely due to the historical use of copper sulfate to suppress algae growth, Lake Steilacoom contains high copper levels. Sediment studies (Ecology 1990b, 1992) have found high copper concentrations near the outlet of the lake and determined that lake sediments caused reduced survival rates for benthic macroinvertebrates. Ecology (1991) suggested that the high copper concentration in the lake contributed to a snail kill observed by the citizen volunteer monitor and may have caused shifts "from green algae species to the more undesirable [copper resistant] blue-green species." Downstream waters have been

given 303(d) status for high copper concentrations, and a Total Maximum Daily Load (TMDL) issued in 2000 by the EPA established limits on phosphorus and copper discharges to the lake (EPA 2000).

Ponce de Leon Creek

Ponce de Leon Creek has not been the subject of extensive monitoring. It has only occasionally been included in Ecology's routing stream monitoring program. However, it is classified as a "water of concern" by Ecology on the grounds that water samples taken in 1997 exceeded water quality standards for temperature and dissolved oxygen. Pierce Conservation District (2017b, 2018b, 2019b, 2020b) has found in recent years that temperature standards are typically met by a small margin and that dissolved oxygen and pH standards have typically not been met. Pierce Conservation District's sampling station is located at the upstream end of the creek, shortly after it emerges from the ground, so low D.O. levels are to be expected.

Ponce de Leon Creek has also been included in several studies assessing sources of phosphorus in Lake Steilacoom. KCM (1996) and URS (2004) both found that Ponce de Leon Creek contained higher total phosphorus concentrations than Clover Creek and was the primary source of surface water phosphorus loading in Lake Steilacoom. URS found that most of this phosphorus is from groundwater, which accounts for most of the creek's flow and is the sole source of base flow during the dry season.

Waughop Lake

Waughop Lake has a long-established problem with nutrient levels, which regularly cause toxic algae blooms. Tepper (2013) summarizes that "water clarity is poor, particularly during the summer… the surface is often covered with an algal scum, and the lake, located in Fort Steilacoom Park, is commonly closed to all recreational uses during the summer." In all algae sampling events performed since 2007, the toxin microcystin has been detected at levels above state recreation guidelines (King County 2021). Such algal blooms have been documented since at least 1978 and are linked to high phosphorus content. Brown and Caldwell (2017) found that that phosphorus is "the limiting nutrient for cyanobacteria blooms" in the lake. The lake is currently a candidate for 303(d) status by Ecology due to phosphorus concentrations more than 3 times the WAC criterion for eutrophic lakes, and historical information attached to Ecology's assessment indicates that high phosphorus levels were documented as early as 1985.

Sediment studies (Tepper, Brown and Caldwell) have indicated that the main source of phosphorus loading to the lake water is phosphorus-rich sediment, probably from historical agricultural activity. During the early- and mid-1900s, the nearby Western State Hospital operated a farm and dairy (Skott 2001). Tepper reports that "manure and other agricultural wastes were dumped directly into the lake until 1965." A lake management plan commissioned by the City (Brown and Caldwell) found that the phosphorus issues could be addressed by either extensive dredging or semi-regular alum treatments. In 2020, the City applied a series of two alum treatments to the lake. No toxic algae blooms were reported that year, and lake monitoring found that visibility had improved (Pierce Conservation District 2020a).

Landscape-Scale Data

The following sub-section provides landscape-scale data that may be used to explain and predict receiving water conditions.

Land Use

Land use within Lakewood's portion of each watershed is summarized in Table 3 and shown in Figure 2. Land Use is from the Washington State Department of Commerce (2018) and is described as a "generalized depiction of intended future land use… based primarily upon 2012 zoning and 2010 assessor's records."

Table 3 Land Use

Receiving Water	Open Space and Recreation	Urban Character Residential	Intensive Urban	Public	Right of Way	Industrial	Other*
Chambers Bay	14%	34%	20%	8%	14%	9%	0%
Chambers Creek	11%	35%	23%	6%	14%	11%	0%
Flett Creek	15%	14%	25%	8%	13%	24%	0%
Seeley Lake	1%	7%	30%	12%	15%	36%	0%
Lake Steilacoom	1%	53%	24%	4%	17%	0%	0%
Ponce de Leon Creek	2%	38%	34%	12%	15%	0%	0%
American Lake	12%	44%	12%	1%	18%	12%	3%
Carp Lake	1%	74%	0%	9%	16%	0%	0%
Gravelly Lake	3%	89%	1%	0%	7%	0%	0%
Lake Louise	8%	74%	0%	1%	17%	0%	0%
Waughop Lake	39%	42%	0%	9%	10%	0%	0%

* Includes military land, undesignated land, and water

Land Cover and Impervious Surface

Table 4 summarizes the land cover and total impervious surface for Lakewood's portion of each watershed. These datasets are shown in Figures 3 and 4 respectively. Land cover data is from Washington State Department of Commerce and NOAA (2012) and impervious surface data is from NOAA (2009).

Table 4 Land Cover and Impervious Surface

Receiving Water	Open*	Forested	Low Intensity Developed	Medium Intensity Developed	High Intensity Developed	Total Impervious Surface
Chambers Bay	14%	11%	37%	23%	15%	42%
Chambers Creek	11%	11%	36%	25%	18%	45%
Flett Creek	13%	4%	27%	30%	26%	53%
Seeley Lake	2%	1%	21%	35%	40%	67%
Lake Steilacoom	7%	11%	44%	23%	14%	43%
Ponce de Leon Creek	7%	2%	33%	31%	27%	57%
American Lake	21%	17%	39%	18%	4%	30%
Carp Lake	10%	18%	54%	17%	2%	32%
Gravelly Lake	13%	50%	33%	4%	0%	13%
Lake Louise	14%	12%	60%	13%	0%	30%
Waughop Lake	31%	16%	40%	12%	1%	26%

* Includes wetlands, pasture, shrub/scrub, and other non-forested area with less than 20% impervious surface

Traffic Counts

Figure 5 shows traffic counts for Lakewood roads. Thicker lines indicate the roadway segments that were monitored at least once between 2003 and 2021 (City of Lakewood 2022a) and show the maximum observed Average Daily Traffic count (ADT) for all monitoring events in that time period. Thinner lines show estimated traffic counts for road segments that were not monitored; estimations were made manually based on a combination of factors including road classification as well as traffic loading of nearby monitored segments.

Land Use and Traffic Loading for Direct Stormwater Discharges

Figure 6 shows land use and traffic loading for areas with direct stormwater discharges into bodies of water. The City GIS contains delineations of areas from which stormwater is conveyed into storm drainage and enters a receiving water body through a point source discharge (i.e. not including areas that discharge to detention ponds, areas that may contribute non-point source runoff to a receiving water, or areas that infiltrate either naturally or through perforated pipes). These areas were overlaid with the land use data from Figure 2 and the traffic count data (measured or assumed) from Figure 5 to show what sort of pollution sources may be contributing to receiving waters. Table 5 summarizes the acreage of these direct drainage areas. This summary is not cumulative: the acreage for an area that discharges directly into an upstream water is not included in any downstream waters.

Table 5 Land Use and Traffic Loading for Areas with Direct Stormwater Discharges

Receiving Water	Drainage Area (Acres)						
	Open Space & Recreation	Public	Intensive Urban	Industrial	ADT <7,500	ADT 7,500-15,000	ADT >15,000
Chambers Bay	3	27	1	-	74	10	8
Chambers Creek	1	-	16	1	43	3	20
Flett Creek	2	1	13	1	15	2	33
Seeley Lake	-	2	24	97	8	6	22
Lake Steilacoom	-	-	-	-	38	10	-
Ponce de Leon Creek	-	1	49	-	3	9	5
American Lake	2	-	-	-	-	-	-
Carp Lake	-	1	-	-	14	1	10
Gravelly Lake	-	-	-	-	1	2	2
Lake Louise	-	-	-	-	20	-	-
Waughop Lake	-	22	-	-	-	-	-

Structural Stormwater BMPs

Figure 7 shows structural BMPs currently in use by the City. Pipes that are part of the City's infrastructure (including pipes owned by the City or by private citizens, but not including pipes owned by other public jurisdictions) are categorized according to whether they discharge directly to receiving waters or utilize some type of infiltration BMP such as detention ponds or underground perforated pipes. For each category, the figure also shows the types and locations of vaults, which provide stormwater

treatments such as oil-water separation and filtering of solid materials. Pipe and vault locations are from the City's GIS database.

Septic Systems

Figure 8 shows the locations of active septic systems in Lakewood. This data was provided by Tacoma-Pierce County Health Department (2022). Recent sewer extensions into the neighborhoods of Tillicum and Woodbrook, located in the American Lake watershed, will ideally reduce the number of septic systems in this area in the future.

Stormwater Violations

Figure 9 shows the locations of stormwater violations in Lakewood from 2019 and 2020. These violations have been documented by the City as part of their IDDE (Illicit Discharge Detection and Elimination) efforts. Upon discovery by the City, these spills were reported to Ecology and remediated. Roadway oil spills from car accidents are the most common type of violation (Halar 2022). These records are maintained in an internal database (City of Lakewood 2022b).

Buildable Lands

Figure 10 shows the status of parcels in Lakewood according to the Pierce County buildable lands inventory (Pierce County 2021b), which classifies parcels according to the level of possible future development by comparing existing housing and employment densities with projected build-out densities based on zoning (Pierce County Planning and Public Works 2021). "Pipeline" classification indicates an ongoing development project is located in the parcel.

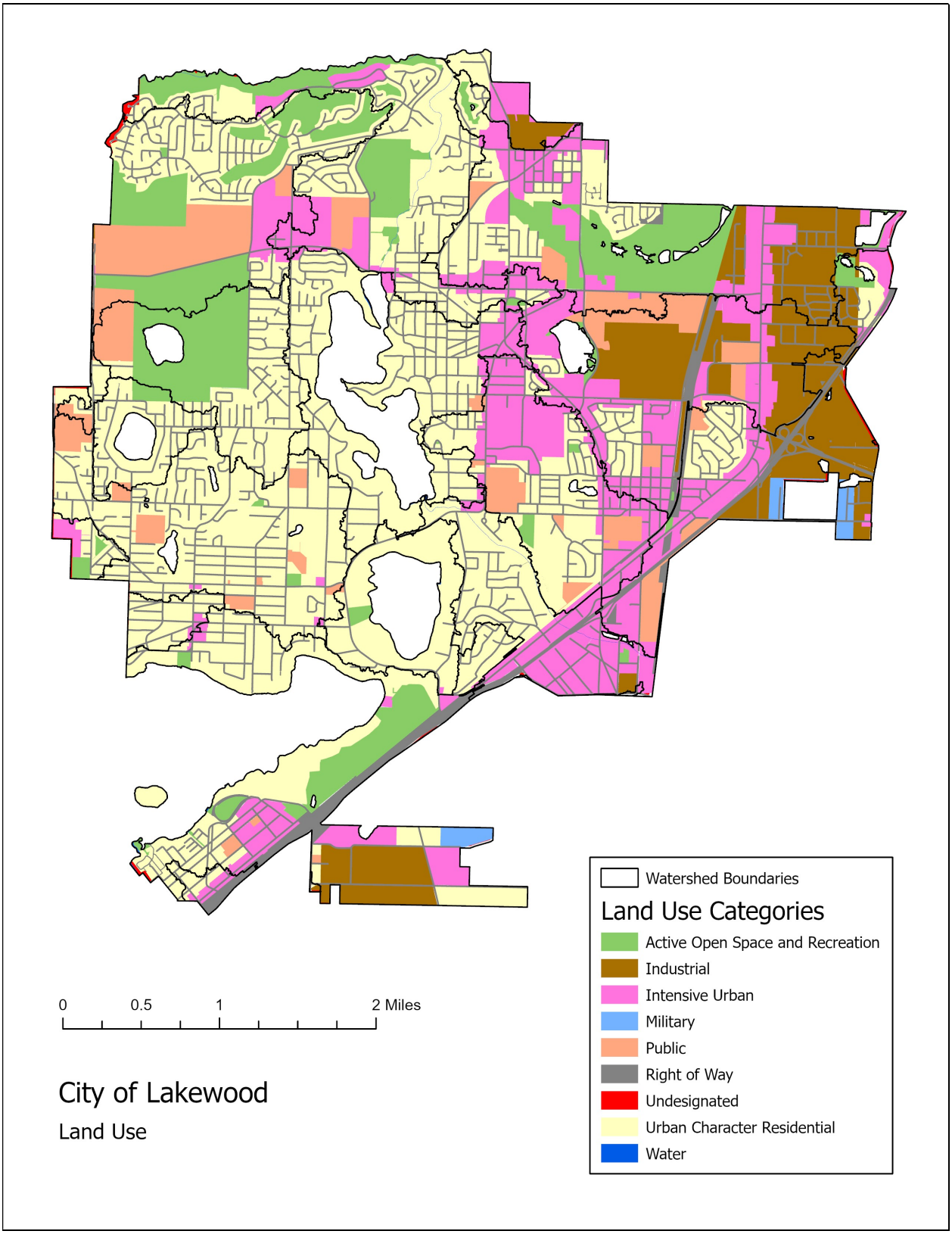

Figure 2 Land Use

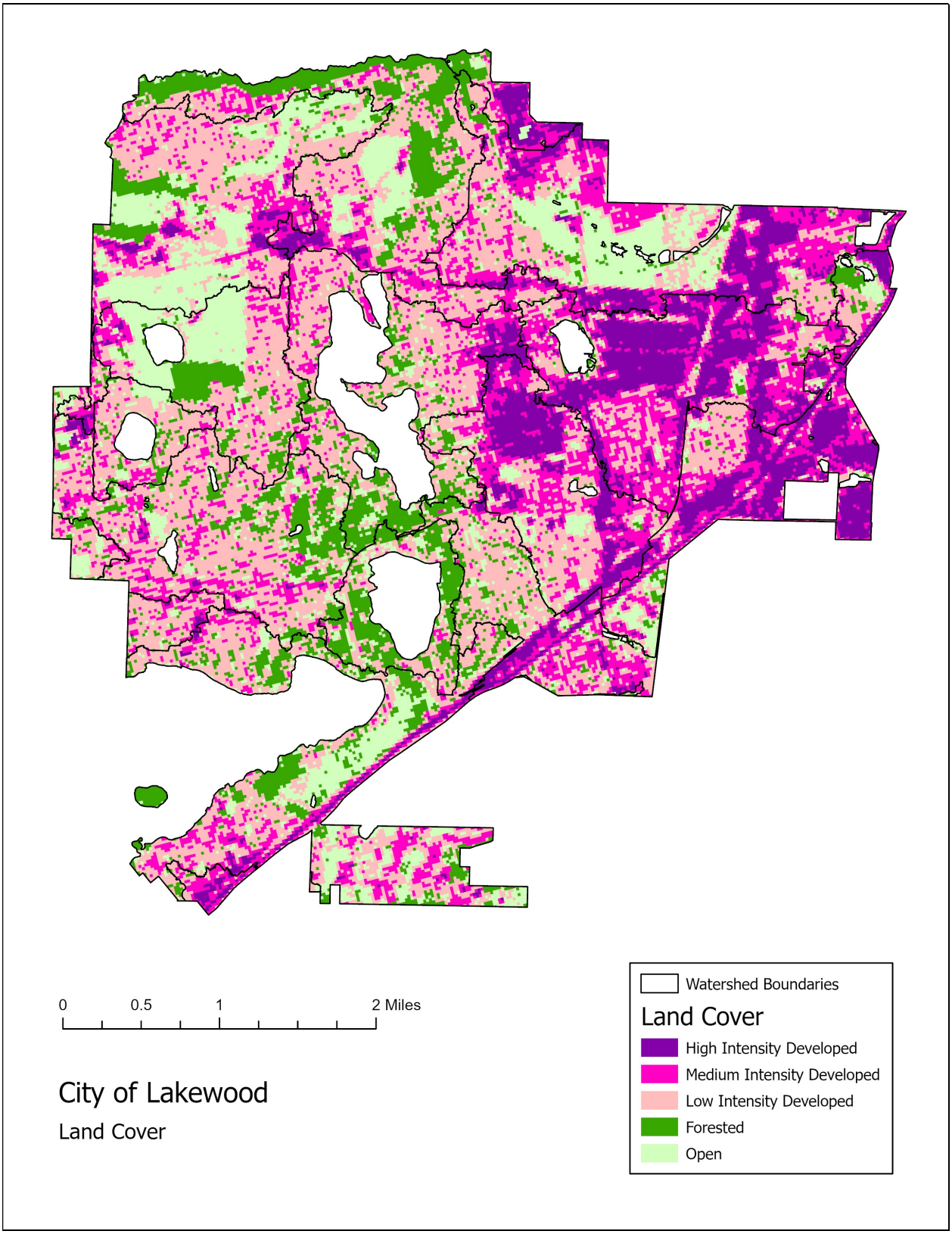

Figure 3 Land Cover

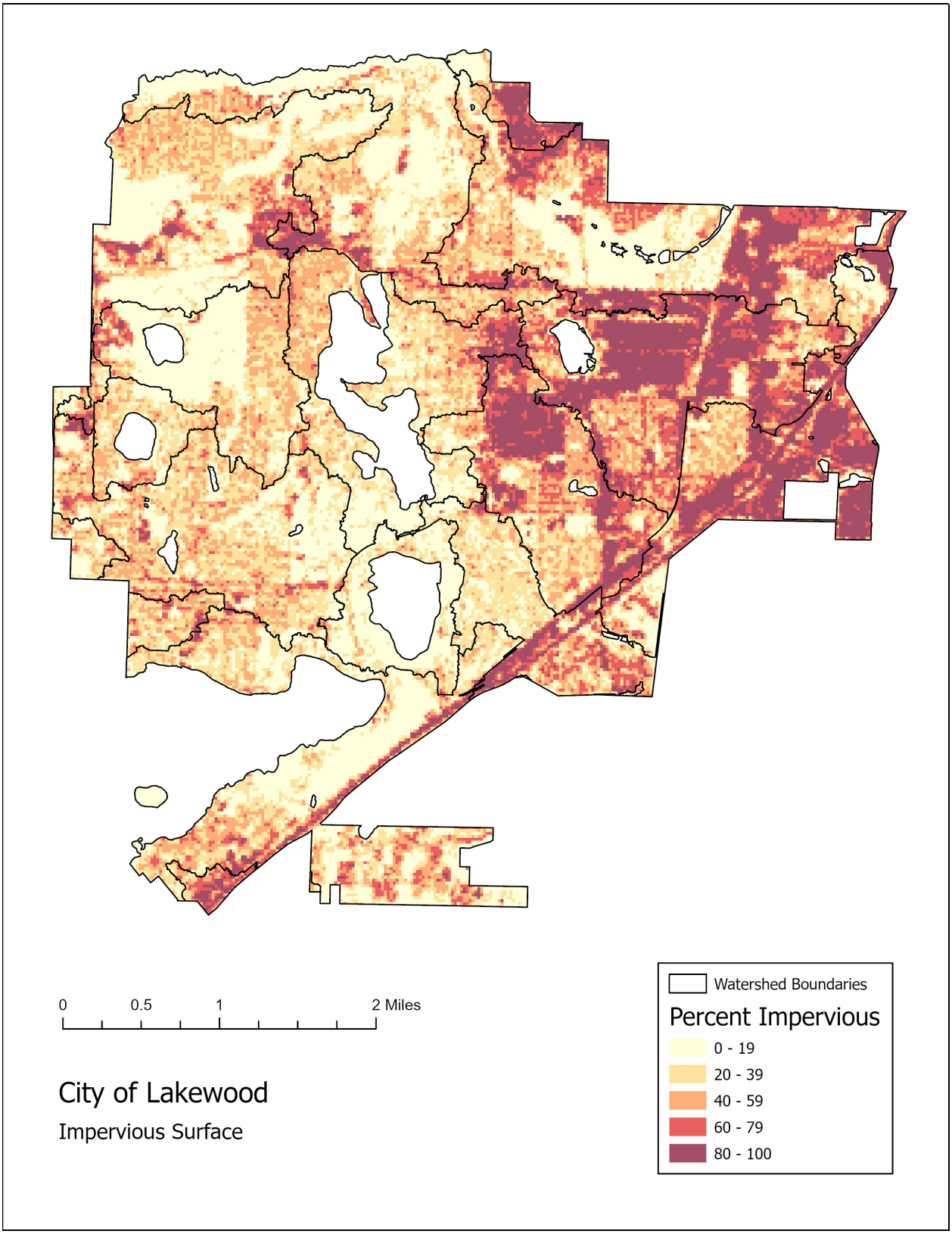

Figure 4 Impervious Surface

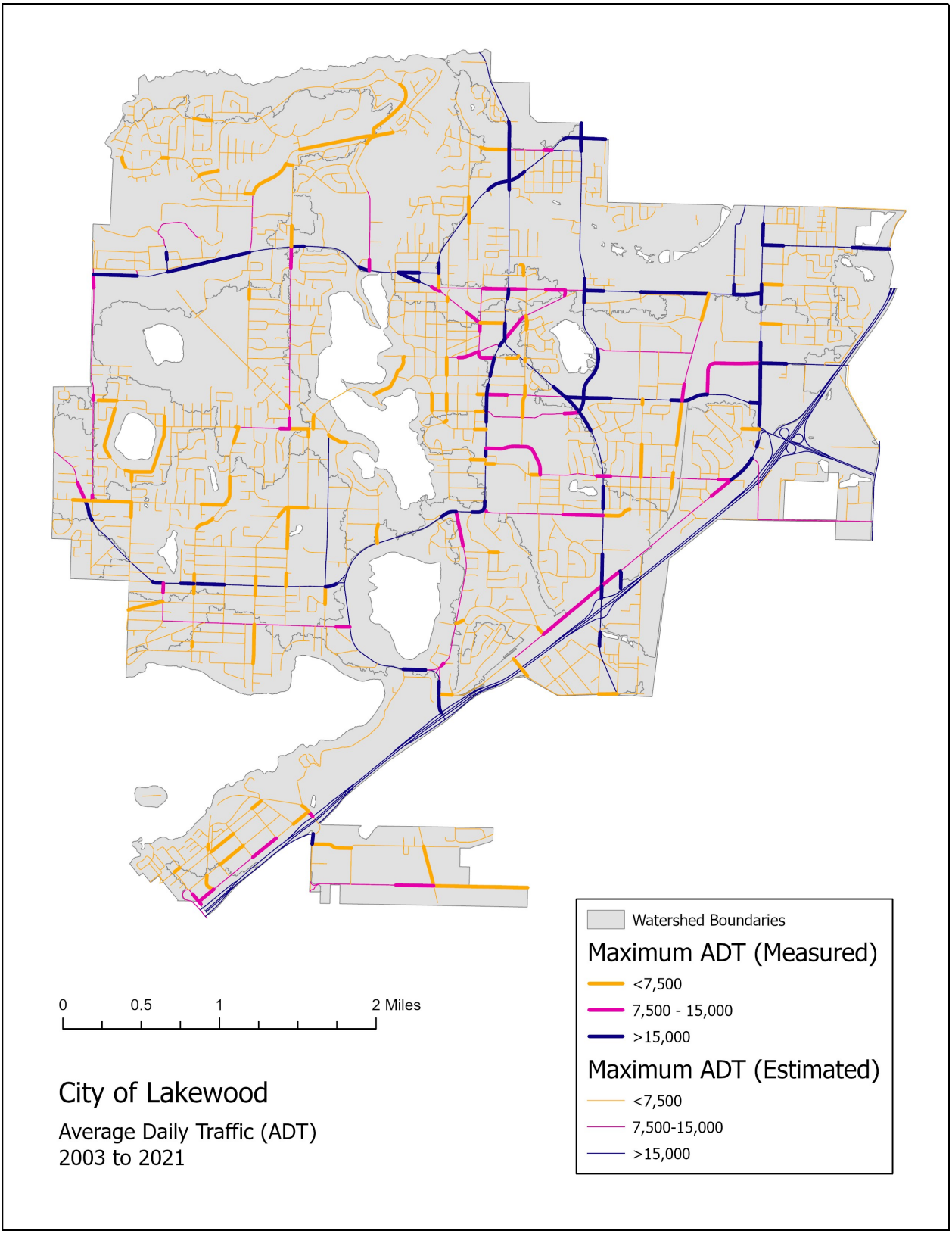

Figure 5 Average Daily Traffic

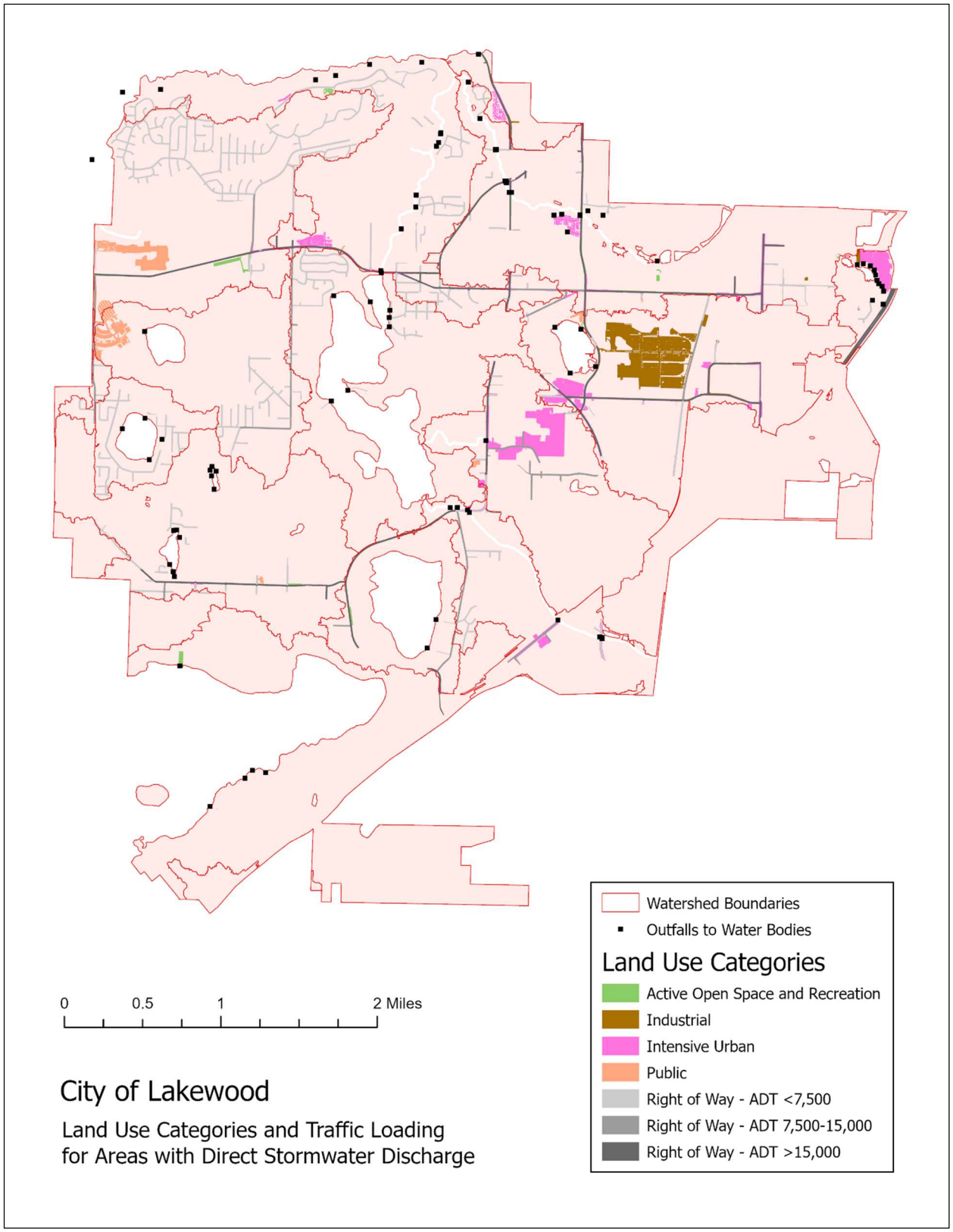

Figure 6 Land Use and Traffic for Direct Discharge

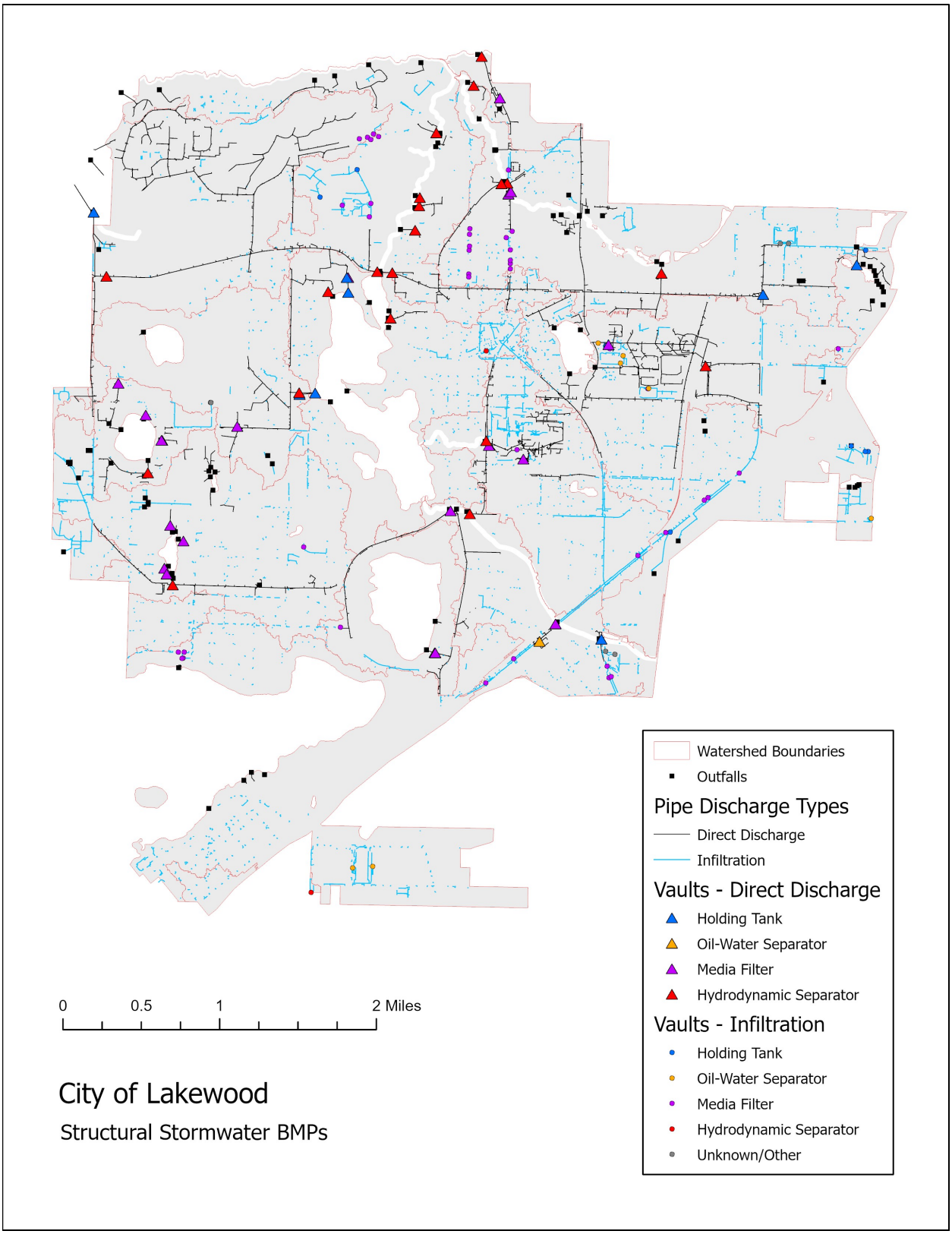

Figure 7 Structural Stormwater BMPs

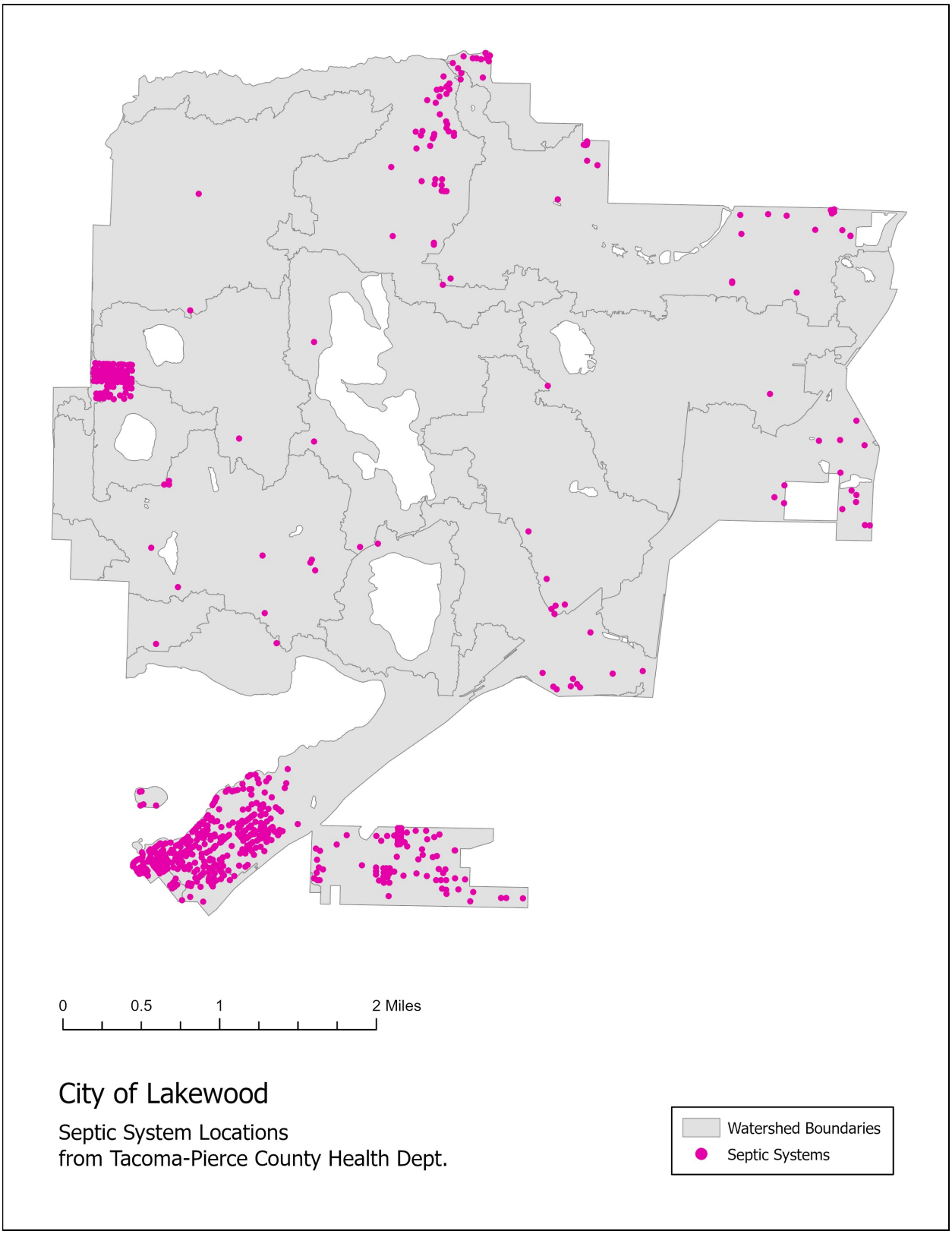

Figure 8 Septic System Locations

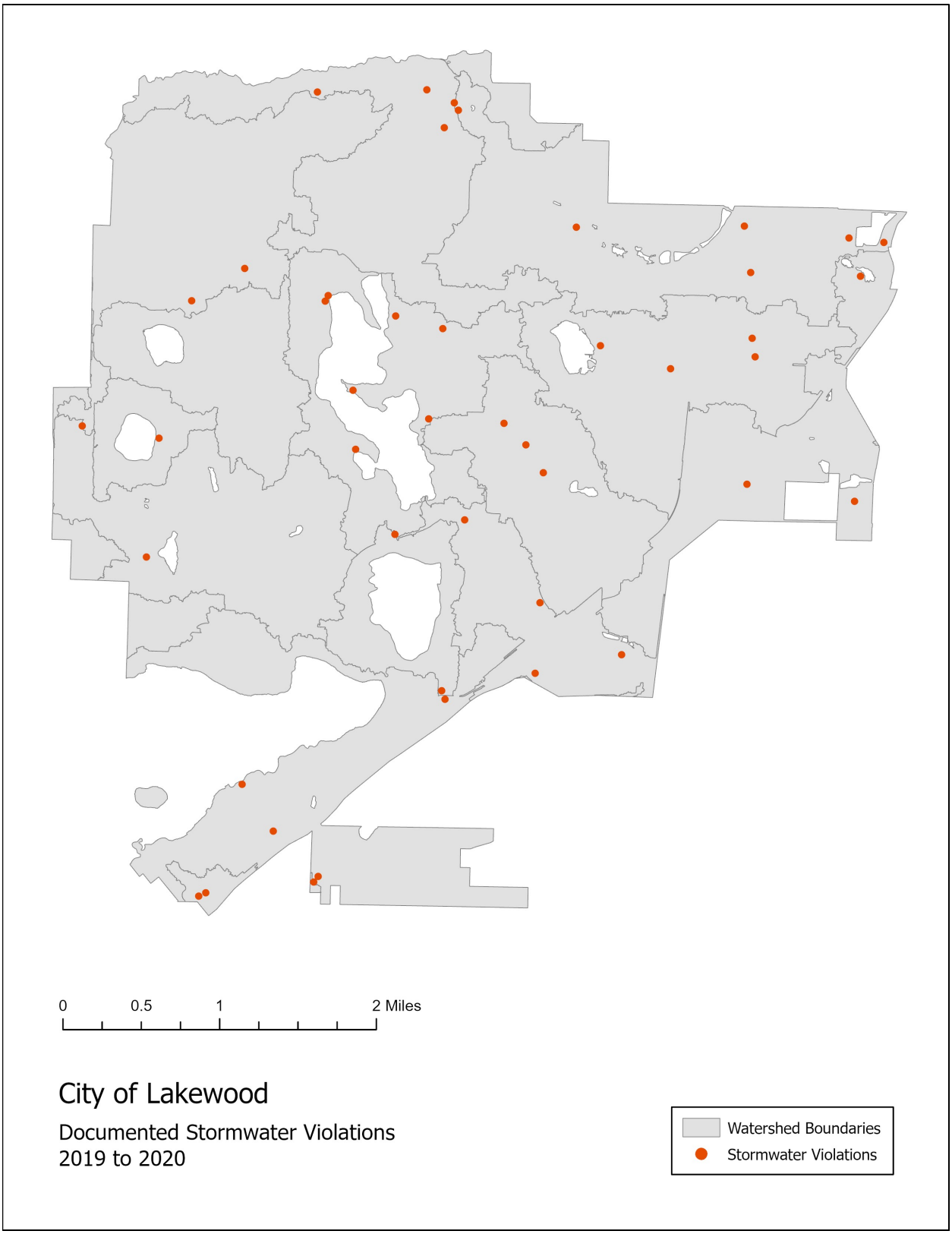

Figure 9 Documented Stormwater Violations 2019-2020

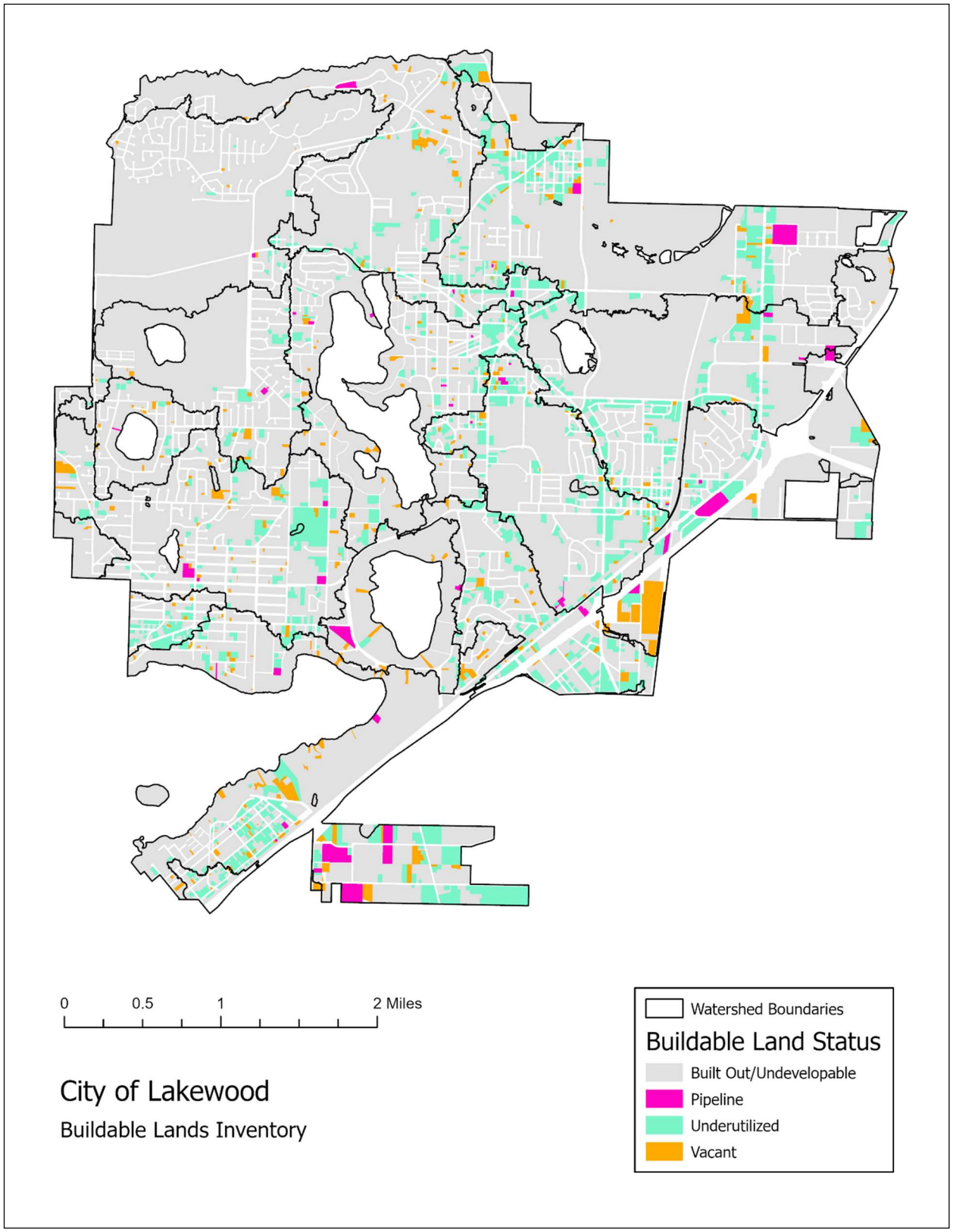

Figure 10 Buildable Lands

Impaired Waters

Previously in this report, Table 2 (page 9) established the known or assumed impairments for each receiving water. Impairments are conditions that cause the receiving water not to meet its desired uses or that may affect downstream waters. Table 6 includes a more detailed discussion of each impairment, including answers to the following questions:

- Is it definitively known that substantial non-stormwater actions are required to address the impairment?
- If the answer to the previous question is no:
    - What contributing sources or activities exist in the portion of the drainage basin that is under Lakewood's jurisdiction? Answers to this question are based on landscape-scale data presented in the previous sub-section.
    - What BMPs are in place to address the impairment? Answers to this question are based on the City's internal records, GIS data which is shown in Figure 7 (page 23), and conversations with city personnel.
    - What other BMPs or enhanced stormwater management actions may help to address the impairment?

Seasonality and flow-dependence are omitted from this detailed discussion. Water quality impairments are generally associated with the summer months, when low stream flows and high temperatures occur.

Discussion of specific loading targets is also omitted. The guidance document recommends considering whether enhanced stormwater management actions may help to meet loading targets for pollutants of concern. However, establishing loading targets requires a degree of technical expertise not available at this time. Loading targets will be established if they are needed for a future step of the SMAP.

Table 6 Receiving Water Impairments

Impairment	Discussion	
Copper standards for salmon habitat are sometimes not met	Known non-stormwater actions required?	Yes: see copper impairment in Lake Steilacoom
Flett Creek		
Dissolved oxygen standards for salmon habitat are sometimes not met	Known non-stormwater actions required?	No
	Contributing sources and activities	• Impervious surfaces[1] • Commercial and industrial land uses[2]
	BMPs currently in use	• Source control BMPs[9] • Structural BMPs[10]
	Possible BMPs or other stormwater actions	• Additional structural BMPs
pH standards for salmon habitat are sometimes not met	Known non-stormwater actions required?	No
	Contributing sources and activities	• Commercial and industrial land uses[3]
	BMPs currently in use	• Source control BMPs[9] • Structural BMPs[10]
	Possible BMPs or other stormwater actions	• Additional structural BMPs

Fecal coliform may affect downstream recreation	Known non-stormwater actions required?	No
	Contributing sources and activities	• Residential and recreational land uses[7,8]
	BMPs currently in use	• Source control BMPs[9] • Structural BMPs[10]
	Possible BMPs or other stormwater actions	• Additional structural BMPs • Additional public education about controlling waste from pets
Seeley Lake		
Industrial stormwater assumed to degrade wetland habitat	Known non-stormwater actions required?	No
	Contributing sources and activities	• Commercial and industrial land uses[2,3,6]
	BMPs currently in use	• Source control BMPs[9] • Structural BMPs[10]
	Possible BMPs or other stormwater actions	• Additional structural BMPs
Lake Steilacoom		
High phosphorus levels affect recreation	Known non-stormwater actions required?	Yes: see phosphorus in Ponce de Leon Creek
Copper in sediment affects downstream salmon habitat	Known non-stormwater actions required?	Yes: removal of sediment would be required to address impairment
Ponce de Leon Creek		
Dissolved oxygen standards for salmon habitat are often not met	Known non-stormwater actions required?	No
	Contributing sources and activities	• Impervious surfaces[1] • Commercial land uses[2]
	BMPs currently in use	• Source control BMPs[9] • Structural BMPs[10]
	Possible BMPs or other stormwater actions	• Additional structural BMPs
pH standards for salmon habitat are often not met	Known non-stormwater actions required?	No
	Contributing sources and activities	• Commercial land uses[3]
	BMPs currently in use	• Source control BMPs[9] • Structural BMPs[10]
	Possible BMPs or other stormwater actions	• Additional structural BMPs
Phosphorus concentration affects downstream recreation	Known non-stormwater actions required?	Yes: naturally high phosphorus concentrations are present in groundwater; removal of phosphorus from groundwater would be required to address impairment
American Lake		
Fecal coliform standards for recreation are sometimes not met	Known non-stormwater actions required?	Yes: side sewer connections to new main line
Occasional algae blooms affect recreation	Known non-stormwater actions required?	No

	Contributing sources and activities	• Residential and recreational land uses[4,5] • Commercial and industrial land uses[6]
	BMPs currently in use	• Source control BMPs[9] • Structural BMPs
	Possible BMPs or other stormwater actions	• Additional structural BMPs • Additional public education about green landscaping techniques • Additional use of infiltration rather than discharge into lake
Waughop Lake		
High phosphorus levels affect recreation	Known non-stormwater actions required?	Yes: the impairment is currently addressed through alum treatment.

The following footnotes contain pollution source information from *Stormwater Management Manual for Western Washington* (Ecology 2019b):

[1] Travel over impervious surfaces can cause elevated temperatures, which reduce available dissolved oxygen.
[2] Biochemical oxygen demand (BOD), which depletes oxygen from waters, can be found in runoff from land used for commercial and industrial purposes such as manufacturing, construction, and transportation-related work.
[3] Acidic pH can be found in runoff from land used for commercial and industrial purposes such as manufacturing, construction, and transportation-related work.
[4] Nutrient sources associated with residential land uses include landscaping fertilizer.
[5] Nutrient sources associated with open recreational land uses such as parks and golf courses include landscaping fertilizer.
[6] Nutrient sources associated with commercial and industrial land uses include some manufacturing work as well
[7] Bacteria sources associated with residential land uses include failing septic systems and pet waste.
[8] Bacteria sources associated with open recreational land uses such as parks and golf courses include pet waste and excess wildlife such as ducks and geese.
[9] Source control strategies used throughout the city include prompt investigation of any reported violations, public outreach and education efforts, and targeted business inspections (Halar 2022).
[10] Figure 7 (page 23) shows structural BMPs used throughout the city. Many areas use infiltration. Hydrodynamic separators are typically installed on outfalls discharging stormwater water from major roads, and media filters are typical for outfalls draining larger residential areas and arterial roads. Some outfalls that drain residential areas or discharge into wetlands such as Seeley Lake contain no structural BMPs.

Future Development

The following sub-section of the report discusses locations and possible effects of future development throughout Lakewood. Table 7 summarizes the findings of this discussion.

Table 7 Future Development Summary

Receiving Water	Expected Development			Expected Impacts	Protections for Receiving Water
	Industrial	Commercial	Residential		
Chambers Bay	None	None	None	n/a	n/a
Chambers Creek	None	Low	None	None[1]	n/a
Flett Creek	None	Medium-low	None	None[1]	n/a
Seeley Lake	None	Medium	None	None[1]	n/a
Lake Steilacoom	None	Low	None	None[1]	n/a
Ponce de Leon Creek	None	Medium	Medium	None[1,2]	n/a

American Lake	High	Medium	Medium	Low[3]	• On-site infiltration required • Compensatory storage required
Carp Lake	None	None	Medium-Low	Low[4]	• On-site infiltration required • Compensatory storage required
Gravelly Lake	None	None	None	n/a	n/a
Lake Louise	None	None	None	n/a	n/a
Waughop Lake	None	None	None	n/a	n/a

[1] Targeted/likely locations for commercial development or redevelopment are in areas that are already commercial with high degrees of impervious surface. Pollutant loading is not expected to increase greatly.
[2] Targeted/likely locations for residential development are already classified as intensive urban, so impervious surface and pollutant loadings are not expected to increase greatly.
[3] The transition of Woodbrook from residential to industrial land use is increasing impervious surface, which disrupts natural drainage. Pollutants associated with residential land use will be replaced by pollutants associated with industrial land use and higher traffic counts. However, impacts on receiving water will be low due to stormwater infiltration and lack of heavy industrial activities.
[4] Areas that are currently used for single-family residential may be transitioned to more dense housing types with more impervious surface. Higher housing density will likely mean higher concentrations of some pollutants, such as bacteria from pet waste.

Locations of Future Development

There are a number of sources for predicting where future development will occur in Lakewood. One source is the Lakewood Comprehensive Plan (City of Lakewood 2019), a planning document required under the Growth Management Act. The plan identifies a number of development goals concerning specific neighborhoods. These goals are described in Table 8, and the locations mentioned are shown in Figure 11. The City's strategies for achieving these goals include promotion and advertising, pursuit of public-private partnerships, tax incentives for development, and improvements to targeted neighborhoods such as sewer and water expansions, bicycle and pedestrian-friendly infrastructure, and expansion of recreational opportunities and library services.

Table 8 Development Goals from Comprehensive Plan

Neighborhood	Type of Development	Goal
Central Business District	Commercial	Turn downtown/Lakewood Towne Center area into a destination for shopping, recreation, and cultural activities
South Tacoma Way/Pacific Highway corridors	Commercial	Reimagine blighted commercial strips along S Tacoma Way and Pacific Highway
Springbrook	Residential	Develop high-density pedestrian-oriented residential neighborhood, especially in areas close to Sounder station
Tillicum	Residential	Develop high-density pedestrian-oriented residential neighborhood
Woodbrook	Industrial	Convert substandard residential properties into industrial center[1]

Lakeview	Residential/Commercial	Develop high-density urban neighborhood near Sounder station; area also includes WSDOT facility to be moved and replaced with commercial properties

[1] Industrial developments planned for Woodbrook will include warehouses but no manufacturing facilities (Ott 2022).

Another tool that might predict the locations of future development is the Pierce County buildable lands inventory, which was shown in Figure 10 (page 26). Most of Lakewood's vacant and underutilized parcels are located on the east and south ends of the city and adjacent to major commercial thoroughfares. Many are located in neighborhoods identified in the Comprehensive Plan.

Ultimately, the locations of development tend to be determined by a combination of economic and regulatory factors, according to a city employee who reviews plans for private development (Sawatzki 2022). One factor is economic disparity: wealthier land owners can afford to hold onto single family homes on large lots, while others who are more impoverished will be more likely to sell to developers. This is likely the reason why industrial development has been able to proceed in the economically depressed Woodbrook neighborhood. A second factor is the fluctuating relationship between land value and cost of construction. The Springbrook neighborhood, for instance, through demographically similar to Woodbrook, has not been developing at the same rate because investors are hesitant about construction costs associated with flood zones, protected trees, and other environmental barriers. On the other hand, there are many empty lots located on the north end of the city near Chambers Creek, where construction would be expensive due to steep slopes or environmentally sensitive locations. Such lots may have been undesirable in the past due to their location, but high land prices might cause them to be targets for development.

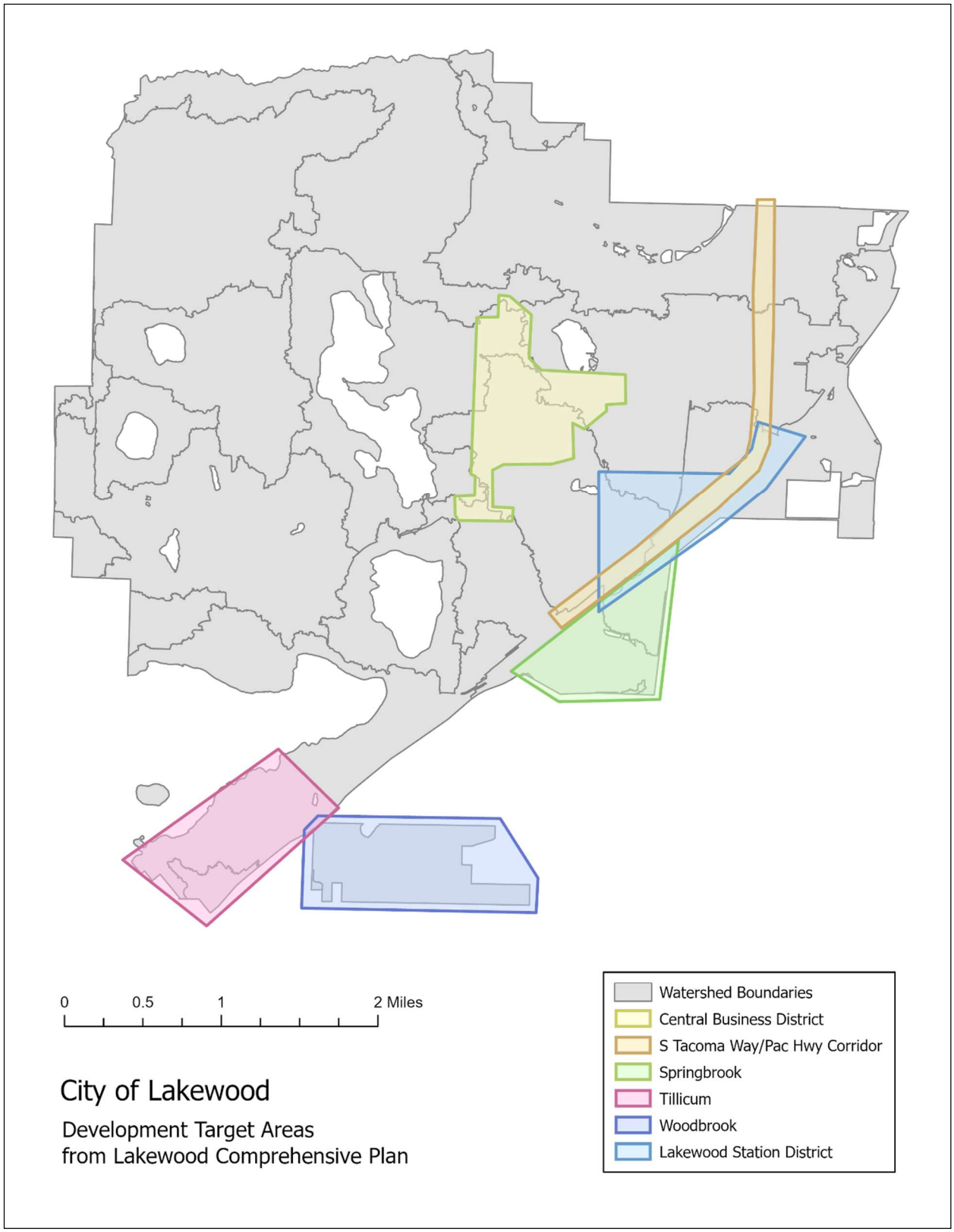

Figure 11 Development Target Areas

Transportation Planning

Currently, the major transportation initiatives in the vicinity of Lakewood include the ongoing WSDOT improvements to I-5 along the JBLM corridor and a planned Sounder train extension into Tillicum (Caulfield 2018). According to public works personnel, there are no plans for major expansions to the city's roadways, which are largely built out at this time; all future transportation improvements planned by the City are minor projects to add pedestrian facilities or improve intersections.

Protection of Riparian Areas

Future development throughout the city will be subject to BMPs; Lakewood Municipal Code states that "BMPs shall be selected, designed, and maintained in accordance with the DOE Stormwater Manual." Projects currently in early planning phases will follow the 2019 manual, and projects that are further along will follow the 2012 or 2014 version. Storm drainage for new development will be required to infiltrate to groundwater, and policies such as compensatory storage and tree planting are in place to mitigate the impacts of development (Sawatzski). Ott (2022) confirmed that the development proceeding in Woodbrook meets infiltration standards.

Additionally, the City's *Shoreline Master Program* (AHBL 2019) designates shoreline zones around certain bodies of water that meet a minimum threshold for open water acreage or flow rate as established in the *Shoreline Analysis Report* (Otak, Inc. 2010). Designated shorelines are shown in Figure 12. The Program states that development proposals falling within these zones should not be allowed if they will result in damage to ecological functions.

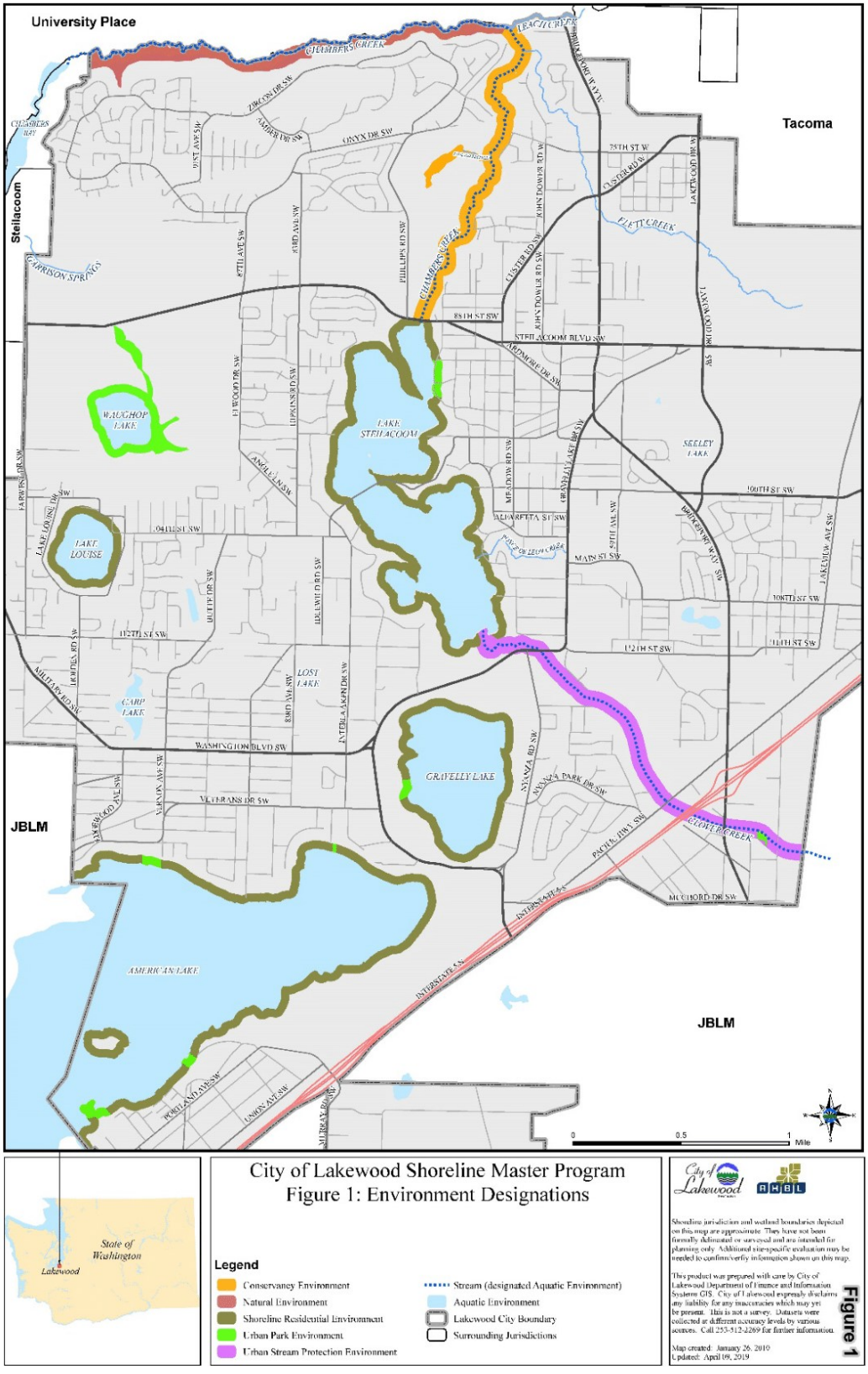

Figure 12 Designated Shorelines from Shoreline Master Program

Overburdened Communities

Overburdened communities are defined by the EPA as populations that "potentially experience disproportionate environmental harms and risks" (EPA 2022). The presence of overburdened communities is typically assessed based on two types of indicators:

1. Proximity to environmental risks such as air pollution and cleanup sites, and
2. Socioeconomic factors such as race, income, and education that may correspond with increased vulnerability to environmental harms.

Figure 13 shows each of Lakewood's census tracts ranked on a scale of one to ten in terms of its environmental health disparity (EHD). This is an overall score taking into account both types of indicators. This ranked dataset was obtained from Washington State Department of Health (2021). Under this scheme, the entirety of Lakewood received a ranking of at least five out of ten. The census tracts with the highest rankings are those located in the northeast corner of the city and several others close to I-5 including Tillicum, Springbrook, and Woodbrook. These tracts are located primarily in the watersheds for Ponce de Leon Creek, Clover Creek, Flett Creek, American Lake, Seeley Lake, and Wards Lake.

The specific impacts of stormwater degradation or receiving water impairments on overburdened communities in Lakewood are difficult to assess. The EHD map shows that Seeley and Wards lakes are located in tracts where overburdened communities are most concentrated. These water bodies serve stormwater functions and are not suitable for fishing or swimming. The lakes that are more appropriate for aquatic recreation tend to be situated in tracts with lower EHD rankings. These lakes are mostly surrounded by private residential development, and the general public's access is limited to public parks and boat launches. This dynamic limits the recreational and aesthetic benefits to members of overburdened communities.

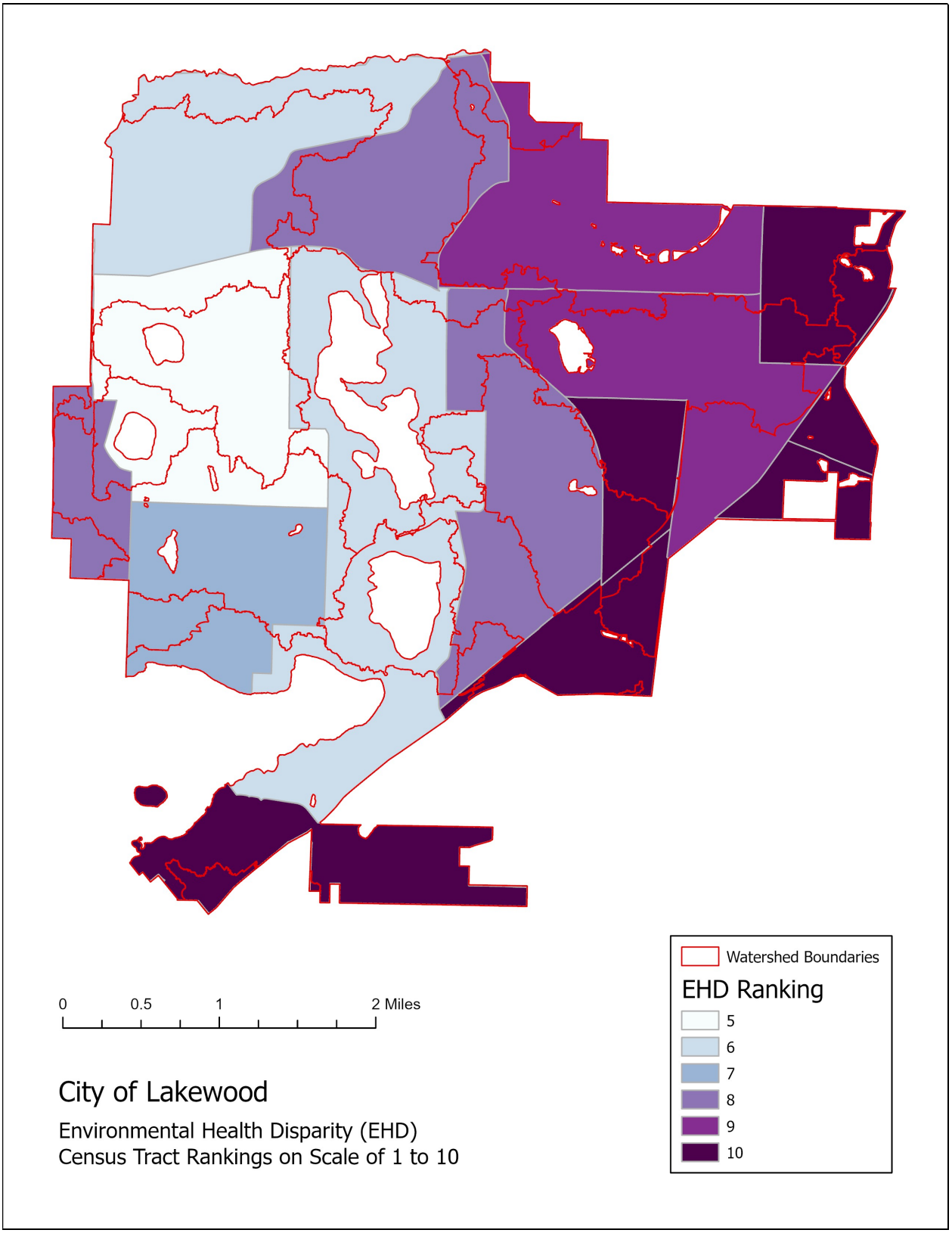

Figure 13 Environmental Health Disparity

III. Stormwater Management Influence

As per the guidance document, receiving waters will be excluded from future steps of the SMAP process if they are not expected to be greatly impacted by stormwater actions. Specifically, to have low stormwater influence, a receiving water must have both "low expected hydrologic impacts" and "low expected pollutant loadings."

The receiving waters of interest to Lakewood and their expected level of stormwater influence are listed in Table 9. Only the receiving waters that do not have low expected stormwater management influence will be carried forward into the final section of this report.

Table 9 Stormwater Management Influence

Receiving Water	Low Hydrologic Impacts?	Low Pollutant Loadings?	Low Stormwater Management Influence?
Chambers Bay	**Yes**[1]	No	No
Chambers Creek	No	No	No
Flett Creek	No	No	No
Seeley Lake	**Yes**[2]	No	No
Lake Steilacoom	No	No	No
Ponce de Leon Creek	No	No	No
American Lake	No	No	No
Carp Lake	**Yes**[2]	No	No
Gravelly Lake	**Yes**[2]	**Yes**[3]	**Yes**
Lake Louise	**Yes**[2]	**Yes**[3]	**Yes**
Waughop Lake	**Yes**[2]	**Yes**[3]	**Yes**

[1] Chambers Bay is flow control-exempt (Ecology 2019b)
[2] These lakes are glacial kettles whose water levels reflect the water table. They have no surface inlets. Thus they are primarily influenced by groundwater flow.
[3] The guidance document offers a number of methodologies for assessing whether a receiving water has low expected pollutant loadings; in this case, the definition used was that 80% or more of the land area has a land use classification of either "open space and recreation" or "urban character residential."

The guidance document suggests that certain topics be discussed for each basin in conjunction with the analysis of stormwater management influence. Topics include major pollutants associated with activities in the watershed, impacts of future development, and possible strategies for addressing pollutant sources. These discussions are located in previous portions of this report.

IV. Relative Conditions and Contributions

The following section presents the narrowed list of receiving waters that will be evaluated in the upcoming Receiving Water Prioritization, which will be submitted to Ecology by the June 30, 2022 deadline. To guide the prioritization process, a number of guiding questions are established below. These questions identify and explain what factors are most important to the prioritization process as it pertains to Lakewood. The questions are then answered for each basin/receiving water using relevant information presented earlier in this report.

Guiding Questions for Basin Prioritization

The guiding questions for the prioritization process are as follows:

- **How important is the receiving water for salmon?** The stormwater manual recommends prioritizing waters with a high potential for either protection or restoration (i.e. ecologically important basins with either a low or a high degree of human-caused degradation) over waters with less ecological importance, as per the Management Matrix from *Building Cities in the Rain*. There are many ways that importance could be characterized, but for the purposes of this question, it is assumed to refer to the potential usefulness of the receiving water for salmon. Salmon are highly important in Puget Sound, and the Chambers-Clover watershed is known to be a particularly productive habitat (Mobrand Biometrics). Furthermore, efforts to improve salmon functions may present opportunities to partner with other organizations or qualify for grants. Thus, waters that are important for salmon will have a higher priority. Salmon importance ratings are assigned as follows: estuaries and creeks that connect to Puget Sound have high importance; lakes that exist within such creek networks and may be inhabited by salmonids have medium or low importance; and lakes and wetlands that do not constitute salmon habitat have no importance. Stream network connectivity is described in detail in Section I.
- **What percent of the basin is located in Lakewood?** Lakewood is at the downstream end of the watershed. Although several significant creeks pass through the city, they are fed mostly from sources outside the City's jurisdiction. Improving these receiving waters may require that pollutant sources in these upstream waters be addressed. A higher percentage of the basin located in city limits means greater influence over the receiving water and a higher priority for the basin. These percentages are taken from Section I of this report.
- **Is it possible that impairments might be addressed through stormwater actions?** Lakewood is highly urbanized and has a long history of human disruptions to its receiving waters. Many of the known water quality impairments for these waters are rooted in this history and would require significant non-stormwater actions to address (e.g. dam removal, native planting, and restoration of natural stream channels). Furthermore, some water quality impairments are primarily caused by groundwater and thus cannot be addressed by improving the quality of stormwater runoff. If there is a chance that at least one of a receiving water's identified impairments can be addressed through stormwater, that receiving water will have a higher priority. The answers to this question are taken from Section II of this report, which discusses water quality impairments in detail.
- **What pollution sources contribute to direct stormwater discharges to receiving waters?** Due to its gravelly soils, much of Lakewood's precipitation infiltrates to groundwater. The City's ability to improve specific receiving waters via stormwater actions is limited by where the system discharges directly to those waters. Furthermore, the City will have greater opportunities to

reduce pollutant loadings in areas with more pollutant sources. Therefore, greater priority will be given to waters that receive direct discharges from areas with pollutant sources of concern. For the purposes of this question, pollutant source of concern are intensive land use types ("industrial" or "intensive urban") and high-traffic roads (ADT of 7,500 or greater). Acreage for these pollutant sources of concern is taken from Table 5 (page 16).

Answers to Guiding Questions for Basin Prioritization

Table 10 answers the guiding questions established above for each receiving water/basin of interest. Receiving waters that were identified in the previous step as having low stormwater management influence are excluded from this list.

Table 10 Answers to Guiding Questions for Basin Prioritization

Receiving Water	Importance for Salmon	Percent of Basin in Lakewood	Impairments Might Be Addressed Through Stormwater?	Pollutant Sources of Concern Contributing to Direct Stormwater Discharge
Chambers Bay	High	11%	No[1]	• Intensive land use: 1 acre • High traffic roads: 18 acres
Chambers Creek	High	10%	No	• Intensive land use: 16 acres • High traffic roads: 23 acres
Flett Creek	High	24%	Yes	• Intensive land use: 14 acres • High traffic roads: 35 acres
Seeley Lake	None	100%	Yes	• Intensive land use: 121 acres • High traffic roads: 28 acres
Lake Steilacoom	Medium	5%	No	• Intensive land use: none • High traffic roads: 10 acres
Ponce de Leon Creek	High	100%	Yes	• Intensive land use: 49 acres • High traffic roads: 14 acres
American Lake	Low	11%	Yes	• Intensive land use: none • High traffic roads: none
Carp Lake	None	98%	No[1]	• Intensive land use: none • High traffic roads: 11 acres

[1] No impairments identified

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