

# **APPENDIX A: Prioritization: Water Quality and Quantity Strategies**

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## 1.0 INTRODUCTION

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The Permit-defined objective of watershed-scale stormwater planning is to identify a stormwater management strategy or strategies that would result in hydrologic and water quality conditions that fully support “existing uses,” and “designated uses,” as those terms are defined in WAC 173-201A-020, throughout the stream system. Poor water quality (temperature, dissolved oxygen, fecal coliform bacteria, turbidity, and toxicants) and altered hydrology in the Bear Creek study area are significant factors in causing the stream and its tributaries to not meet their designated uses (King County, 2017). With the exception of temperature and dissolved oxygen, overall water quality in the Bear Creek watershed appears to be improving since the 1970s. Current fecal coliform concentrations indicate a potential risk to human health, but the concentrations have decreased over the past three decades. Temperature and dissolved oxygen levels are not conducive for salmonids (as represented by violations of the state water quality standards), and long-term trends have indicated that conditions have worsened over the past four decades. The average qualitative Benthic Index of Biotic Integrity (B-IBI) score in the study area is considered “fair.” The “flashiness” of a stream has been linked to poor macroinvertebrate health as measured by B-IBI. Both water quality and quantity concerns may be improved through stormwater management and treatment.

Stormwater best management practices (BMPs) include both low impact development (LID) type facilities, such as pervious pavement or bioretention systems, and more traditional facilities, such as stormwater detention and treatment. LID BMPs generally address stormwater impacts near the source, and traditional facilities are more regional in nature, serving larger areas further away from the source. The impacts of stormwater BMPs are most readily modeled and comprised the primary component of the SUSTAIN optimization model scenarios.

A prioritization method was developed based on stakeholder input with the goal of focusing mitigation in identified, smaller catchments to achieve improvements early in the Bear Creek Watershed-scale Stormwater Management Study (the Study) implementation. To determine these priority catchments, criteria were developed that allowed for evaluating the number/severity of problems and potential opportunities for impactful/cost effective projects in the catchments. Priority catchments are those where the need is greatest and opportunities for cost effective improvement are more available. Individual catchments (as delineated for the Hydrological Simulation Program (HSPF) and System for Urban Stormwater Treatment and Analysis Integration (SUSTAIN) models) were assessed (Figure 1). In some cases, several model catchments were grouped due to similar problems, opportunities, and identified strategies. The selected catchments are at a spatial scale that measurable outcomes would be expected if targeted projects were implemented.

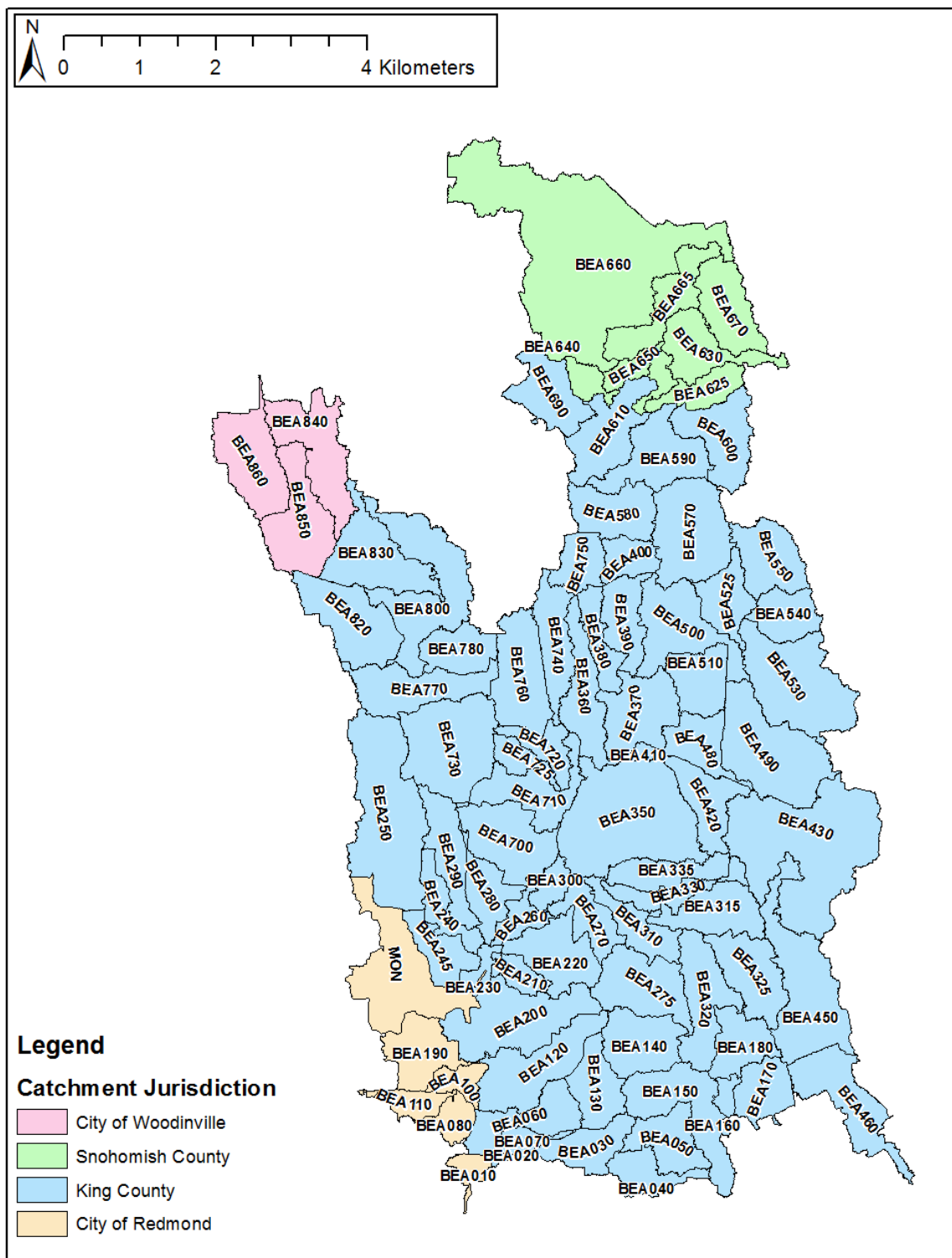


Figure 1. Catchments used for modeling current and future water quality conditions and prioritizing projects.

## **2.0 CATCHMENT PRIORITIZATION**

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Several criteria were assessed to prioritize catchments for stormwater projects within each partner jurisdiction. Catchments with poor water quality and B-IBI score (i.e., with problems) were given more weight (i.e., a greater prioritization) than catchments with good water quality and B-IBI scores. Catchment opportunity is defined as the expected simplicity (or complexity) to which water quality projects could be implemented in the catchment. Catchments with greater opportunity were given more weight. The criteria used in the prioritization are detailed in Table 1.

The prioritization score is the summation of the criteria scores, with higher values representing higher priority.

**Table 1. Criteria for evaluating catchments for water quality and hydrology projects.**

Criteria	Definition	Explanation	Data Source	Scoring	Important Limitations/ Caveats
<b>Water Quality Conditions</b> (Modeled Existing)	Number of modeled exceedances of water quality standards (temperature, turbidity, fecal coliform, copper, zinc)	Data on modeled water quality were used to highlight areas of the watershed where conditions are not expected to support designated uses	HSPF Model	Number of parameters with exceedances <ul style="list-style-type: none"> <li>○ 5 parameters - 30 points</li> <li>○ 4 parameters- 25 points</li> <li>○ 2 to 3 parameters – 15 points</li> <li>○ 1 parameter - 10 points</li> <li>○ 0 parameters – 0 points</li> </ul>	<ul style="list-style-type: none"> <li>• Water quality conditions were modeled using HSPF from recent water quality data at a select number of sites. Conditions were extrapolated to un-monitored catchments based on land use</li> </ul>
<b>B-IBI</b> (Modeled Existing)	B-IBI associated with the modeled flow metrics in the catchment	B-IBI is a multi-metric index that calculates a single, numerical score designed to represent information about the ecological health of a stream.	HSPF Model and WRIA 8 B-IBI Regression	B-IBI Score <ul style="list-style-type: none"> <li>○ Less than 40 - 20 points</li> <li>○ 40 to 60 - 10 points</li> <li>○ More than 60 - 5 points</li> </ul>	<ul style="list-style-type: none"> <li>• The modeled B-IBI scores are based on best-fit regressions with flow metrics.</li> <li>• The flow metrics used to estimate B-IBI were modeled through HSPF based on land use, stormwater facilities, and monitored flows in the basin.</li> </ul>



Criteria	Definition	Explanation	Data Source	Scoring	Important Limitations/ Caveats
<b>Untreated Impervious Area</b>	The amount of impervious area in the catchment without existing stormwater treatment	Untreated impervious areas are a priority because stormwater may cause flashiness in streams in addition to delivering pollutants.	<ul style="list-style-type: none"> <li>• 2011 National Land Cover Database Impervious Surface (30 m resolution)</li> <li>• Mapped King County and Redmond stormwater catchments</li> </ul>	Percent impervious surface without treatment in catchment <ul style="list-style-type: none"> <li>○ More than 80% - 30 points</li> <li>○ 50 to 80% - 20 points</li> <li>○ 30 to 50% - 10 points</li> <li>○ Less than 30% - 5 points</li> </ul>	<ul style="list-style-type: none"> <li>• Additional development has occurred between 2011 and 2017.</li> <li>• Many stormwater facilities drainage areas' are not mapped and therefore designated as untreated.</li> <li>• Not all stormwater facilities may be providing an adequate amount of treatment.</li> </ul>
<b>Existing Stormwater Facilities</b>	The number of existing stormwater facilities in the catchment	Existing facilities are an opportunity for retrofitting to meet current stormwater design standards, improving both stream flashiness and water quality.	<ul style="list-style-type: none"> <li>• King County Stormwater Facilities Shapefile (storm_fac_point – accessed 2016).</li> <li>• City of Redmond</li> <li>• Snohomish County</li> </ul>	Number of existing stormwater facilities in catchment <ul style="list-style-type: none"> <li>○ More than 5 facilities – 10 points</li> <li>○ 2 to 5 facilities – 5 points</li> <li>○ 0 to 1 facilities – 0 points</li> </ul>	Existing facilities may not be present in the inventory.

Criteria	Definition	Explanation	Data Source	Scoring	Important Limitations/ Caveats
<b>Horse and Livestock (Forage) Land</b>	The amount of land in the catchment with land use designated as horse or livestock	Horses and livestock can have negative impacts on stream water quality due to bank erosion, runoff from manure, and low riparian and instream habitat complexity. They represent an opportunity to install agricultural BMPs through partnerships with landowners and the King Conservation District.	King County Agricultural Land Use 2013 (ag_landuse2013)	Acres of 200ft stream buffer in horse or livestock land <ul style="list-style-type: none"> <li>More than 10 acres – 15 points</li> <li>5 to 10 acres – 10 points</li> <li>Less than 5 acres – 5 points</li> </ul>	<ul style="list-style-type: none"> <li>Existing agricultural BMPs are not available and were not assessed.</li> <li>Land use may have changed between 2013 and 2017, including conversion to or from horse/livestock land.</li> </ul>
<b>Property Value</b>	The average assessed value of property from King and Snohomish counties normalized by area within the catchment	Catchments with low property values represent an opportunity to purchase property for the purpose of construction regional stormwater facilities in addition to instream and out-of-stream habitat improvement projects.	<ul style="list-style-type: none"> <li>King County Parcel database using 2016 assessed values</li> <li>Snohomish County Parcel database using 2016 assessed values</li> </ul>	Average cost per acre in catchment <ul style="list-style-type: none"> <li>Less than \$500,000/acre – 20 points</li> <li>\$500,000 to \$1,000,000/acre – 10 points</li> <li>\$1,000,000 to \$5,000,000/acre – 10 points</li> <li>More than \$5,000,000/acres – 2 points</li> </ul>	<ul style="list-style-type: none"> <li>Assessed value does not always equal the market value.</li> <li>Willingness to sell was not assessed.</li> </ul>

Criteria	Definition	Explanation	Data Source	Scoring	Important Limitations/ Caveats
<b>Public Lands and Easements</b>	The amount of publicly owned land within the catchment	Public lands are a priority for stormwater and tree planting projects due to lower costs associated with construction and obtaining access.	<ul style="list-style-type: none"> <li>King County Parcel database</li> <li>Snohomish County Parcel database</li> </ul>	Fraction of catchment that is public land <ul style="list-style-type: none"> <li>More than 30% – 20 points</li> <li>10 to 30% – 10 points</li> <li>Less than 10% – 5 points</li> </ul>	Not all public land may be suitable for stormwater facility construction or tree planting.
<b>Right-of-Ways</b>	The amount of city and county road right-of-ways in the catchment	Right-of-ways represent an opportunity to construct BMPs (or habitat projects) near roadways that can treat stormwater without purchasing private land.	<ul style="list-style-type: none"> <li>King County Right of Way</li> <li>Snohomish County Right of Way (2015-07)</li> </ul>	Fraction of catchment that is ROW <ul style="list-style-type: none"> <li>More than 20% – 15 points</li> <li>10 to 20% – 8 points</li> <li>Less than 10% – 5 points</li> </ul>	Not all right-of-ways are suitable for stormwater facility construction or tree planting
<b>Roof Area</b>	Building roof area within catchment	Building rooftops are opportunities for on-site stormwater management (e.g., rain gardens, cisterns, dry wells)	LiDAR data (does not include Snohomish County)	Fraction of catchment that is rooftop <ul style="list-style-type: none"> <li>More than 10% - 15 points</li> <li>5 to 10% - 10 points</li> <li>Less than 5% - 5 points</li> </ul>	Older LiDAR data may not represent the current building roof footprint

Criteria	Definition	Explanation	Data Source	Scoring	Important Limitations/ Caveats
<b>Areas Susceptible to Groundwater Contamination (ASGWC) and Wellhead Protection Zones (WPZ)</b>	ASGWC and WPZs have specific regulations for maintaining groundwater quality	CARAs and WPZs represent a potential limitation to constructing stormwater BMPs that utilize infiltration.	<ul style="list-style-type: none"> <li>• King County Areas Susceptible to Groundwater Contamination</li> <li>• Redmond Wellhead Protection Zones (WPZ)</li> <li>• WA Department of Health Wellhead Protection Areas (WHPA)</li> </ul>	Not scored but evaluated along other attributes	New WPZs are anticipated from the City of Redmond in the near future.

## **3.0 PRIORITY KING COUNTY CATCHMENTS**

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For catchments located primarily within unincorporated King County, The data input to the prioritization metric and the resulting final score are displayed in Table 2 with the catchments ranked. The following sections detail the five top-ranked catchments and discuss potential projects and actions to improve water quality and hydrology.

**Table 2. Ranked catchments located primarily in King County and prioritization metric input data. Grouped catchments highlighted with the same color, except catchment outside study area shaded in grey.**

Catchment	Scoring Metrics									Total Score
	Water Quality Score	B-IBI Score	Untreated Impervious Score	Stormwater Facility Score	Forage Livestock Score	Property Cost Score	Public Land Score	Right-of-Way Score	Roof Score	
BEA120	15	10	10	5	15	10	20	0	5	90
BEA230	15	10	30	0	0	15	0	8	5	83
BEA200	15	10	10	5	15	5	10	0	10	80
BEA740	15	20	10	0	0	10	0	8	10	73
BEA250	15	20	0	10	0	5	0	8	15	73
BEA300	15	10	5	0	0	15	20	0	5	70
BEA800	10	10	5	5	0	10	20	0	5	70
BEA160	15	20	5	0	0	5	10	8	5	68
BEA280	15	10	10	5	0	10	0	8	10	68
BEA170	15	20	0	5	0	5	0	8	15	68
BEA750	15	20	10	0	0	5	0	8	10	68
BEA770	15	20	10	0	0	5	0	8	10	68
BEA245	15	10	10	5	10	5	0	0	10	65
BEA030	15	10	5	0	15	15	0	0	5	65
BEA040	15	20	10	0	0	10	0	0	10	65
BEA060	25	10	10	0	0	5	10	0	5	65
BEA130	15	10	10	10	0	15	0	0	5	65
BEA430	15	10	5	10	0	5	10	0	10	65
BEA990	15	10	10	0	10	10	0	0	10	65
BEA450	15	10	0	10	0	5	20	0	5	65
BEA510	15	10	10	5	0	15	0	0	10	65
BEA690	15	10	0	5	0	10	20	0	5	65
BEA070	5	0	10	0	0	15	20	8	5	63

Catchment	Scoring Metrics									Total Score
	Water Quality Score	B-IBI Score	Untreated Impervious Score	Stormwater Facility Score	Forage Livestock Score	Property Cost Score	Public Land Score	Right-of-Way Score	Roof Score	
BEA020	15	10	5	0	0	10	10	8	5	63
<b>BEA240</b>	<b>15</b>	<b>10</b>	<b>10</b>	<b>5</b>	<b>0</b>	<b>5</b>	<b>0</b>	<b>8</b>	<b>10</b>	<b>63</b>
BEA710	15	10	0	10	0	10	0	8	10	63
BEA940	15	10	10	0	0	10	0	8	10	63
BEA335	15	10	10	5	0	10	0	0	10	60
BEA350	15	10	10	0	0	5	10	0	10	60
BEA590	15	10	0	0	0	10	20	0	5	60
BEA600	15	10	0	10	0	10	10	0	5	60
BEA720	15	10	10	5	0	10	0	0	10	60
BEA830	15	10	5	5	0	10	10	0	5	60
BEA460	15	10	5	0	0	5	20	0	5	60
BEA540	15	10	0	0	0	10	20	0	5	60
BEA760	15	10	10	0	0	5	0	8	10	58
BEA400	15	10	5	0	0	10	0	8	10	58
BEA210	15	10	10	0	0	15	0	0	5	55
BEA050	15	10	10	0	0	10	0	0	10	55
BEA275	15	10	5	0	0	10	10	0	5	55
BEA490	15	10	5	10	0	10	0	0	5	55
BEA570	15	10	0	0	0	15	10	0	5	55
BEA910	15	10	10	0	0	10	0	0	10	55
BEA950	15	10	10	0	0	10	0	0	10	55
BEA325	5	10	0	0	0	15	20	0	5	55
BEA380	15	10	10	0	0	10	0	0	10	55
BEA390	15	10	5	0	0	15	0	0	10	55
BEA525	15	10	5	5	0	15	0	0	5	55

Catchment	Scoring Metrics									Total Score
	Water Quality Score	B-IBI Score	Untreated Impervious Score	Stormwater Facility Score	Forage Livestock Score	Property Cost Score	Public Land Score	Right-of-Way Score	Roof Score	
BEA530	15	10	5	5	0	10	0	0	10	55
BEA270	15	10	5	0	0	5	0	8	10	53
BEA610	15	10	5	0	0	15	0	0	5	50
BEA150	15	10	10	0	0	10	0	0	5	50
BEA220	15	10	5	5	0	5	0	0	10	50
BEA370	15	10	5	0	0	15	0	0	5	50
BEA500	15	10	5	0	0	15	0	0	5	50
BEA580	15	10	5	5	0	10	0	0	5	50
BEA780	15	10	10	0	0	10	0	0	5	50
BEA140	15	10	5	0	0	15	0	0	5	50
BEA315	5	10	0	5	0	5	20	0	5	50
BEA360	15	10	10	0	0	5	0	0	10	50
BEA410	15	10	5	0	0	15	0	0	5	50
BEA420	15	10	10	0	0	5	0	0	10	50
BEA480	15	10	10	0	0	10	0	0	5	50
BEA550	15	10	5	0	0	15	0	0	5	50
BEA725	15	10	10	0	0	10	0	0	5	50
BEA820	15	10	0	5	0	10	0	0	10	50
BEA900	15	0	10	0	0	5	10	0	5	45
BEA730	15	10	10	0	0	10	0	0	10	45
BEA180	5	0	0	0	0	15	20	0	5	45
BEA260	15	10	10	0	0	5	0	0	5	45
BEA290	15	10	0	5	0	5	0	0	10	45
BEA700	15	10	5	0	0	10	0	0	5	45
BEA330	15	10	0	0	0	10	0	0	5	40



Catchment	Scoring Metrics									Total Score
	Water Quality Score	B-IBI Score	Untreated Impervious Score	Stormwater Facility Score	Forage Livestock Score	Property Cost Score	Public Land Score	Right-of-Way Score	Roof Score	
BEA320	5	0	0	0	0	2	20	0	5	32
BEA310	5	10	5	0	0	5	0	0	5	30

### 3.1 BEA120 – Lower Mackey Creek (Score: 95)

The Lower Mackey Creek (BEA120) catchment includes lower Mackey Creek to its mouth at the confluence with Bear Creek (Table 3). The catchment is 256 acres in area. Much of the catchment is horse pasture, which may or may not have agricultural BMPs in place. A program to identify missing agricultural BMPs and incentive their installation is identified, with a specific focus on the parcels in this catchment (Table 4). The catchment is one-quarter public land, with Mackey Creek running through public land (Figure 2). With a focus on public lands, a program to identify and improve poor riparian habitat is identified. This can be done in concert with instream habitat restoration projects.

The retention/detention (RD) facilities were both constructed prior to 1990 and likely do not meet current design standards (Figure 3). It is identified that these facilities be inspected and, if needed, updated to provide better storage and water quality treatment (Table 4). Because the area is highly susceptible to groundwater contamination, road runoff would need to be treated prior to infiltration (Figure 4 and Figure 5).

**Table 3. Available data for Lower Mackey Creek (BEA120) catchment.**

Criteria	Data
<b>Existing water quality problems</b>	<ul style="list-style-type: none"> <li>• Temperature (40% of summer 7-DADMax temperatures exceed water quality standards)</li> <li>• Dissolved Oxygen (3 of 3 summer samples did not meet water quality standards)</li> <li>• Fecal Coliform (the stream did not meet the geometric mean and 90th percentile water quality criteria)</li> <li>• Total Suspended Solids (wet-weather samples are twice that of baseflow samples)</li> <li>• Copper (one wet-weather sample exceeded the chronic toxicity criterion)</li> </ul>
<b>Existing instream habitat problems</b>	Loss of vegetation and instream large organic debris (Entranco, 1994)
<b>B-IBI (WRIA8 Regression)</b>	Fair (46.9)
<b>Riparian land cover</b>	Pasture: 28% Trees: 42% Shrub: 19% Impervious: 4% Other: 8%
<b>Public Lands</b>	25% public land
City of Redmond	Farrell McWhirter Farm Park (3126069017, 3126069004)
King County Parks	3126069052
<b>Horse and Livestock Lands</b>	35 acres 3126069099, 3126069064, 3126069147, 3126069011, 3126069017 (City of Redmond), 1243100060, 1243100063, 1243100025, 1243100033, 1243100045, 1243100049, 1243100016, 1243100030, 1243100040, 1243100111, 1243100112

Criteria	Data
<b>Right-of-Ways</b>	13 acres (including road surface) 196th Ave NE NE 103rd St NE 106th St (near confluence) NE Redmond Way ROW W to E from 196th AVE NE (just south of NE 113th St) to NE Redmond Rd (intersects Mackey) ROW NNW to SSE from NE 116th St (near 200th Ave NE) to NE Redmond Rd (intersects Mackey)
<b>Property Value</b>	\$313,825 Lower costs along Lower Mackey (below McWhirter Park)
<b>Untreated Impervious Area</b>	8% of catchment is untreated impervious land <ul style="list-style-type: none"> <li>• Horse barns/house in lower Mackey Creek</li> <li>• Generally pasture/open land/forest</li> </ul>
<b>Existing Stormwater Facilities</b>	<ul style="list-style-type: none"> <li>• RD Pond for Little Bit Therapeutic (D99099) – date built unknown</li> <li>• RD Pond for Tall Firs Equestrian (D97150) – date built unknown</li> <li>• RD Pond/trench for residential at west end of NE 103rd St – built 1990</li> </ul>
<b>Easements</b>	None
<b>Groundwater</b>	<ul style="list-style-type: none"> <li>• Lower Mackey Creek – High Susceptible to Groundwater Contamination and in Redmond Wellhead Protection Zone 2 (outside Redmond jurisdiction)</li> <li>• Upper catchment – medium/low susceptibility</li> <li>• WPZ Avon Villa Trailer Park – north end of lower Mackey</li> </ul>
<b>Stream Shade</b>	53% of the stream has less than 50% shading Hot spots of low shade: <ul style="list-style-type: none"> <li>• Confluence with Bear Creek (owned by King County Parks)</li> <li>• PSE Easement over Mackey Creek from 196th Ave NE to NE Redmond Rd (W to E)</li> </ul>

**Table 4. Summary of Identified Strategies for Lower Mackey Creek (BEA120) catchment.**

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Incentivize agricultural BMPs for horse pastureland			X	X	
Plant trees on public land with poor stream shading - McWhirter Park		X		X	
Inspect and optimize the existing D97150 and D90930 stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X

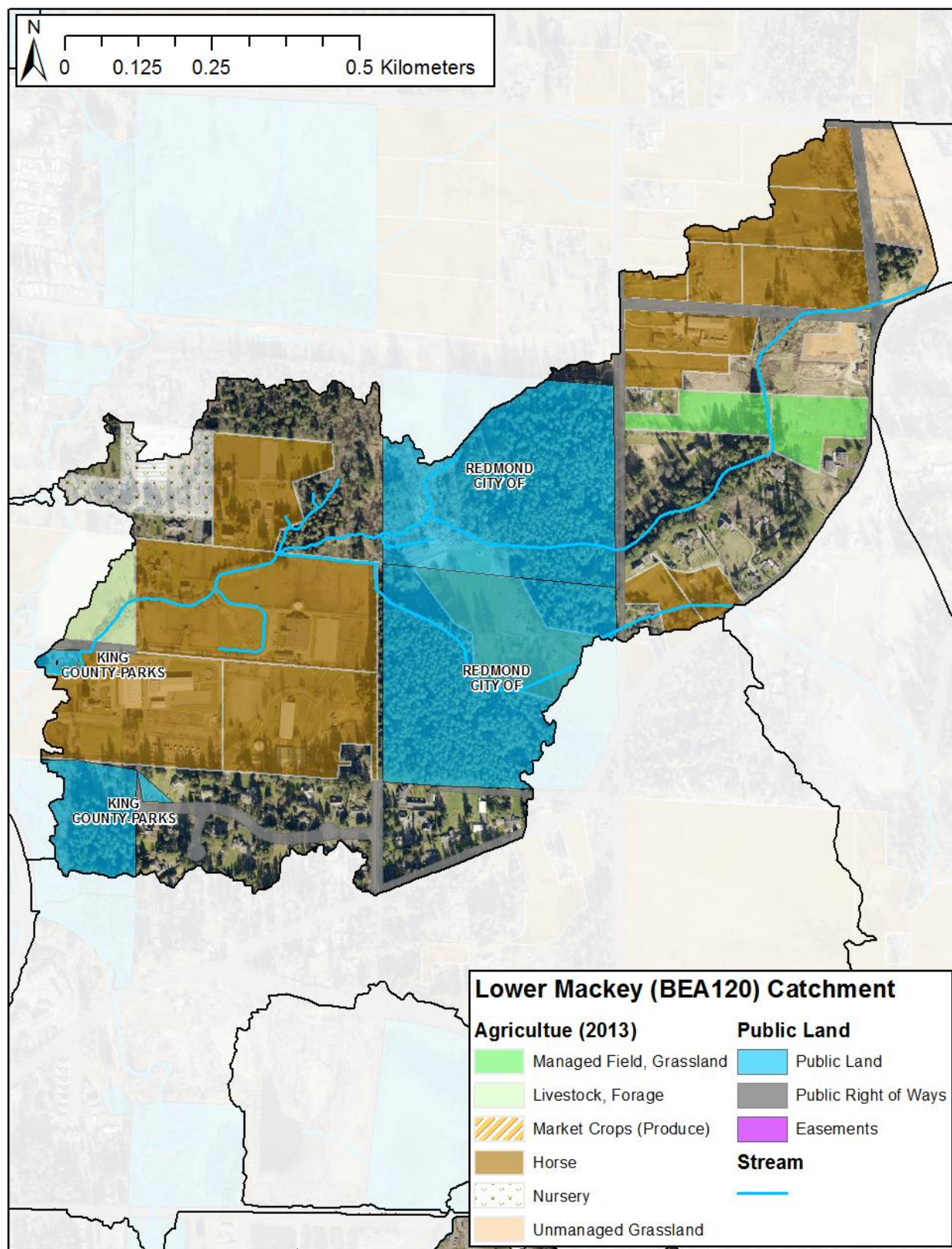
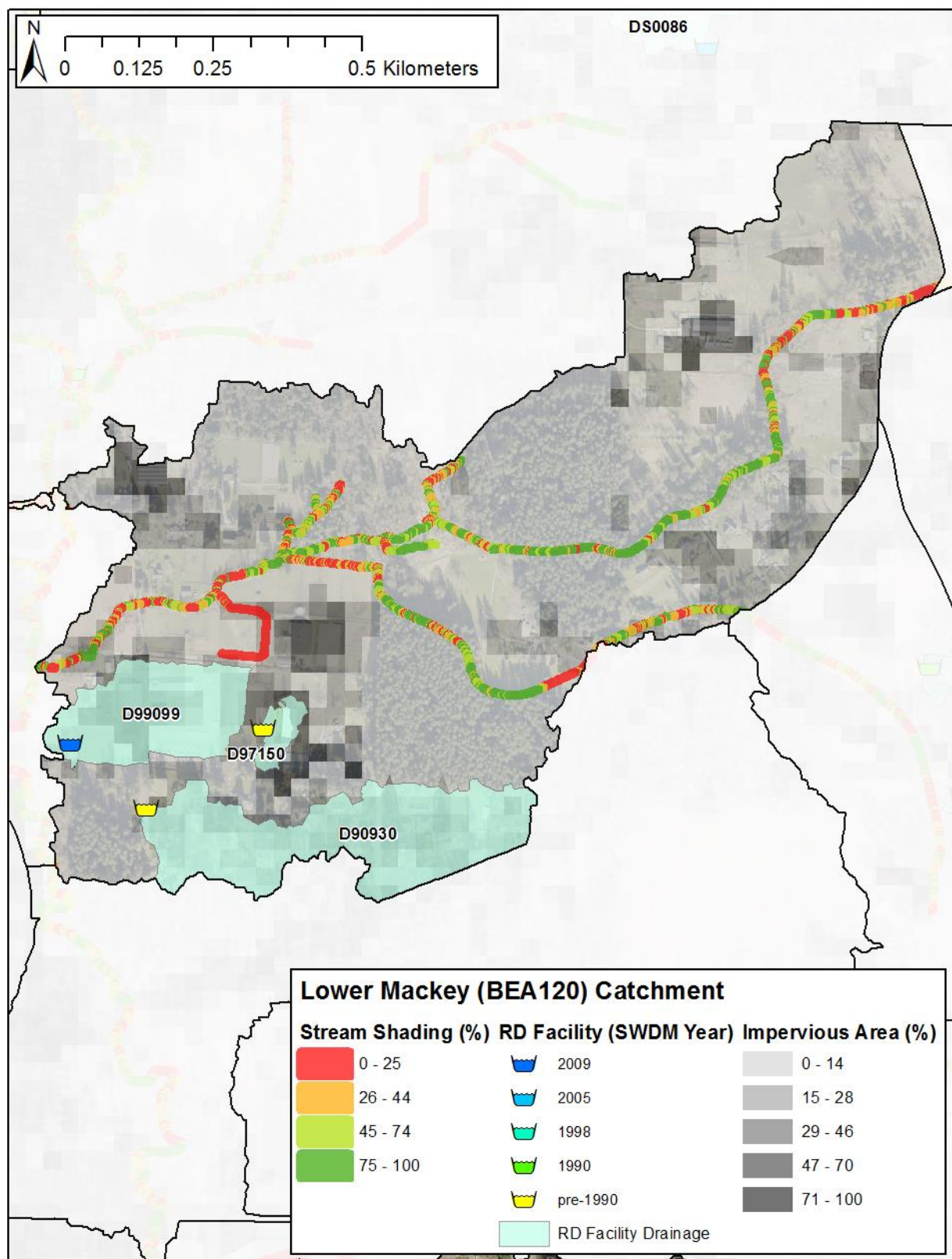


Figure 2. Lower Mackey Creek (BEA120) catchment agricultural and public land.





**Figure 3. Lower Mackey Creek (BEA120) catchment stream shading, impervious area, and RD facilities and their drainage area.**

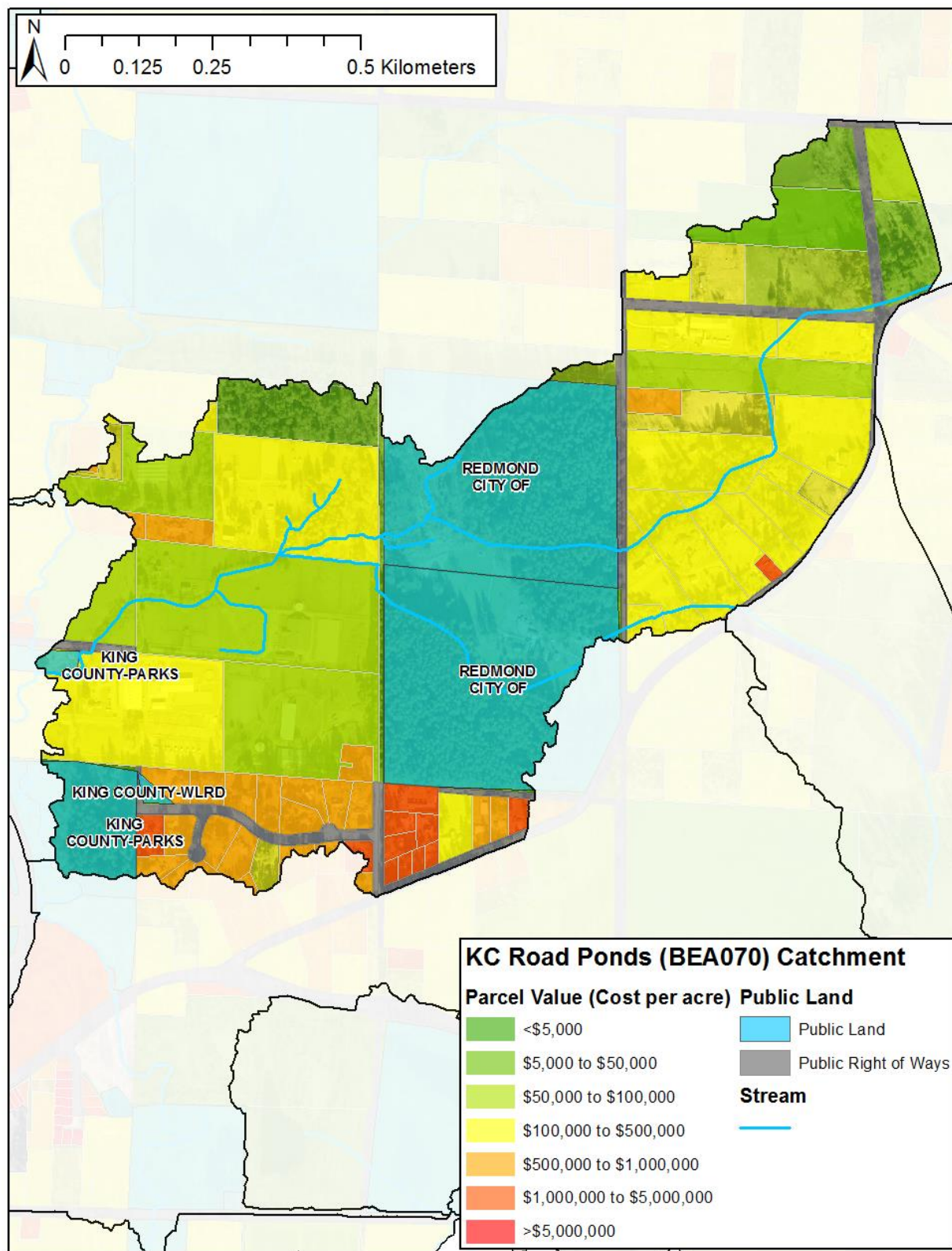
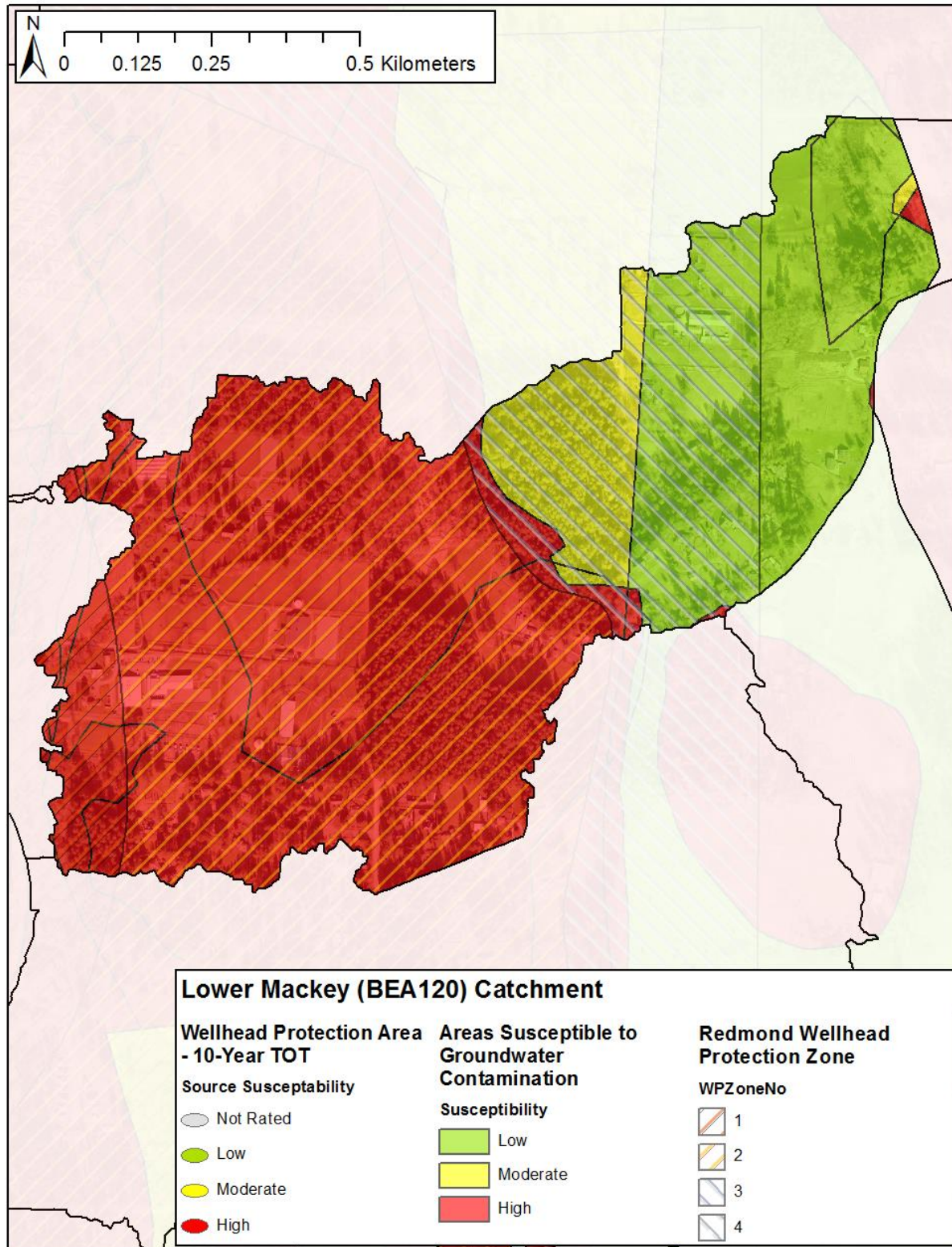


Figure 4. Lower Mackey Creek (BEA120) catchment parcel values and public lands.





**Figure 5.** Lower Mackey Creek (BEA120) catchment groundwater protection areas. Bottom-left to top-right hatching for Redmond indicates infiltration restriction for pollution-generating hard surfaces runoff, excluding single-family residential runoff. No wellhead protection 10-year TOT in catchment.



## 3.2 BEA230/240/245/250 – English Hill (Score: 88)

The English Hill catchments (BEA230/240/245/250) all drain to Bear Creek downstream of the confluence with Cottage Lake Creek. These catchments were grouped because of their similar land use and the likely need to address the four in order to have measurable water quality improvement downstream. The catchments are a total of 754 acres in area. The catchments drain to a wetland near Bear Creek prior to flowing into the creek. The tributaries are not named. The catchments are low density development and farmland near Bear Creek (BEA230) (Figure 6) and medium-density residential developments further upstream in the catchment (BEA240/245/250) (Table 5). Very little is public land (3%) (Figure 8).

Much of the upper catchments are served by regional stormwater facilities built prior to 1990 (Figure 7). These facilities likely do not meet current flow control requirements and do not provide significant water quality treatment. It identified that these facilities be inspected and, if needed, updated to provide better storage and water quality treatment. Because the area is highly susceptible to groundwater contamination in the lower catchment, road runoff would need to be treated prior to infiltration (Figures 9).

A program to identify missing agricultural BMPs and incentive their installation is identified, with a specific focus on the parcels in this catchment (Table 6).

**Table 5. Available data for English Hill catchments (BEA230/240/245/250).**

Criteria	Data
Existing water quality problems	Water quality in the unnamed Bear Creek tributary was not monitored
Existing instream habitat problems	No data
B-IBI (WRIA8 Regression)	Fair (49.4) (BEA230)
Riparian land cover	Pasture: 23% Trees: 26% Shrub: 18% Impervious: 12% Other: 21% (water, bare area, grass, etc.)
Public Lands	3% public land
King County Roads	7273100123 7273100183 7273100185 7273100201 3026069046
King County WLRD	0200800560 2802200310 4188000760 4188000810 8121201040 5701700600 5701700644 6641200130

Criteria	Data
	3293200220 9578050400 9578050410 5649300590 5649300600 9288950090
City of Redmond	2526059110
Seattle Public Utilities	1326059051 (Tolt Pipeline)
<b>Horse and Livestock Lands</b>	6.1 acres 7273100115; 7273100116 (livestock) 2355000010 (horse) 2426059005 (horse) 1326059146 (horse) 1326059150 (horse) 1326059151 (horse)
<b>Right-of-Ways</b>	97 acres (including road surface) Avondale Rd
<b>Property Value</b>	\$1,823,378 Several low cost (<\$50,000/acre) parcels along Avondale Rd Relatively lower cost in upper catchment near Tolt Pipeline.
<b>Untreated Impervious Area</b>	7% of catchment is untreated impervious land <ul style="list-style-type: none"> <li>• Avondale Rd</li> <li>• Large parking/equipment storage lots</li> <li>• Residential area north of NE 128<sup>th</sup> St and along 175<sup>th</sup> Ave NE</li> <li>• 175<sup>th</sup> Ave NE to 178<sup>th</sup> Ave NE and NE 133<sup>rd</sup> St to NE 136<sup>th</sup> St</li> </ul>
<b>Existing Stormwater Facilities</b>	<ul style="list-style-type: none"> <li>• RD Pond for Coconour Residence (DS0044) built in 2003</li> <li>• RD Pond for Sunrise Division Tract D (D90766) built in 1980</li> <li>• RD Pond for Sunrise Division Tract F (D90810) built in 1980</li> <li>• RD Pond for Langtree Estates (D91119) built in 1983</li> <li>• RD Pond for Amerley on English Hill (D90942) built in 1981</li> <li>• RD Pond for Mount Clare Estates (D90327) built in 1978</li> <li>• RD Pond for Park Ave Ridge (D92054) built in 1990</li> <li>• RD Pond for Wyndham Knoll (D91747) built in 1988</li> <li>• RD Pond for Hollymor III (D90963) built in 1982</li> <li>• RD Pond for Highgrove (D91277) built in 1987</li> <li>• RD Pond (D92054) built in 1988</li> <li>• RD Pond for English Hill Estates (D92094) built in 1992</li> <li>• RD Vault for Kempin Meadows (D99142) built in 2009</li> <li>• RD Pond for Morning Meadows (D91783) built in 1977</li> <li>• RD Pond for Westbrook Estates (D92812) built in 1993</li> </ul>
<b>Easements</b>	None
<b>Groundwater</b>	<ul style="list-style-type: none"> <li>• Western portion of catchment in Redmond Wellhead Protection Zone 3</li> <li>• Catchment is highly susceptible to groundwater contamination.</li> </ul>
<b>Stream Shade</b>	66% of the stream has less than 50% shading Hot spots of low shade: <ul style="list-style-type: none"> <li>• Western tributary</li> <li>• Bear Creek above western tributary</li> </ul>

**Table 6. Summary of Identified Strategies for English Hill catchments (BEA230/240/245/250).**

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Incentivize agricultural BMPs for pastureland			X	X	
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X

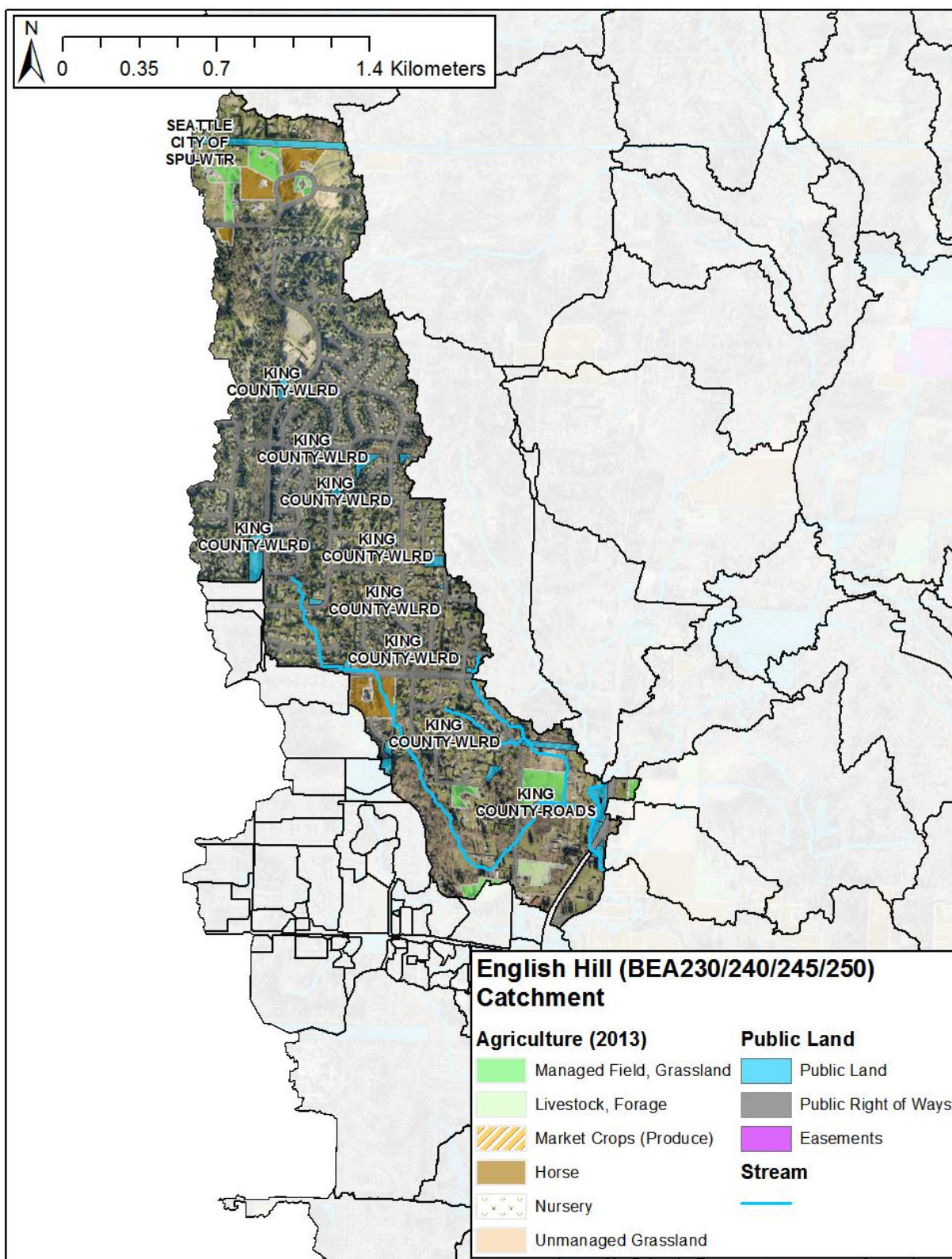


Figure 6. English Hill (BEA230/240/245/250) catchment agricultural and public land.



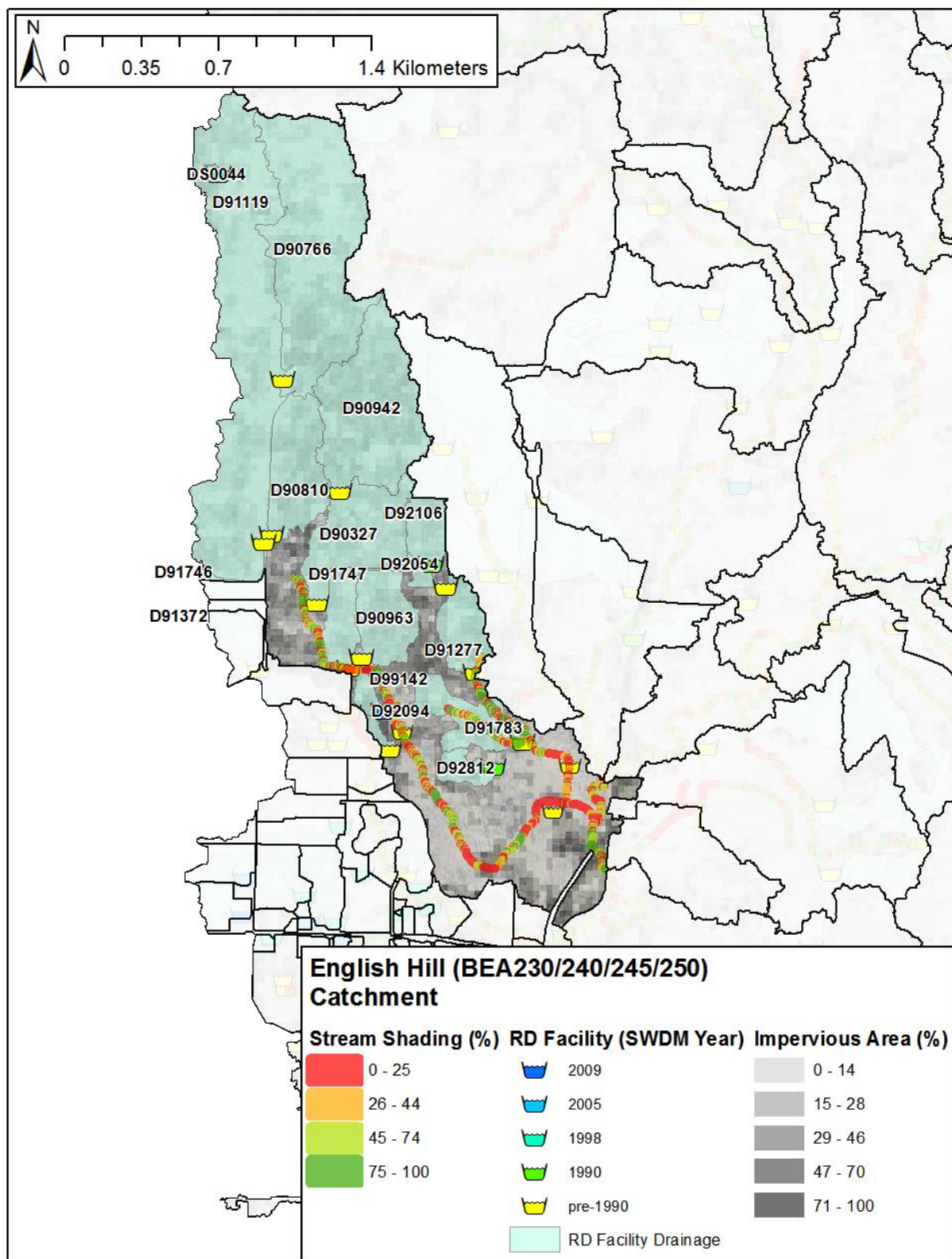


Figure 7. English Hill (BEA230/240/245/250) catchment stream shading, impervious area, and RD facilities and their drainage area.

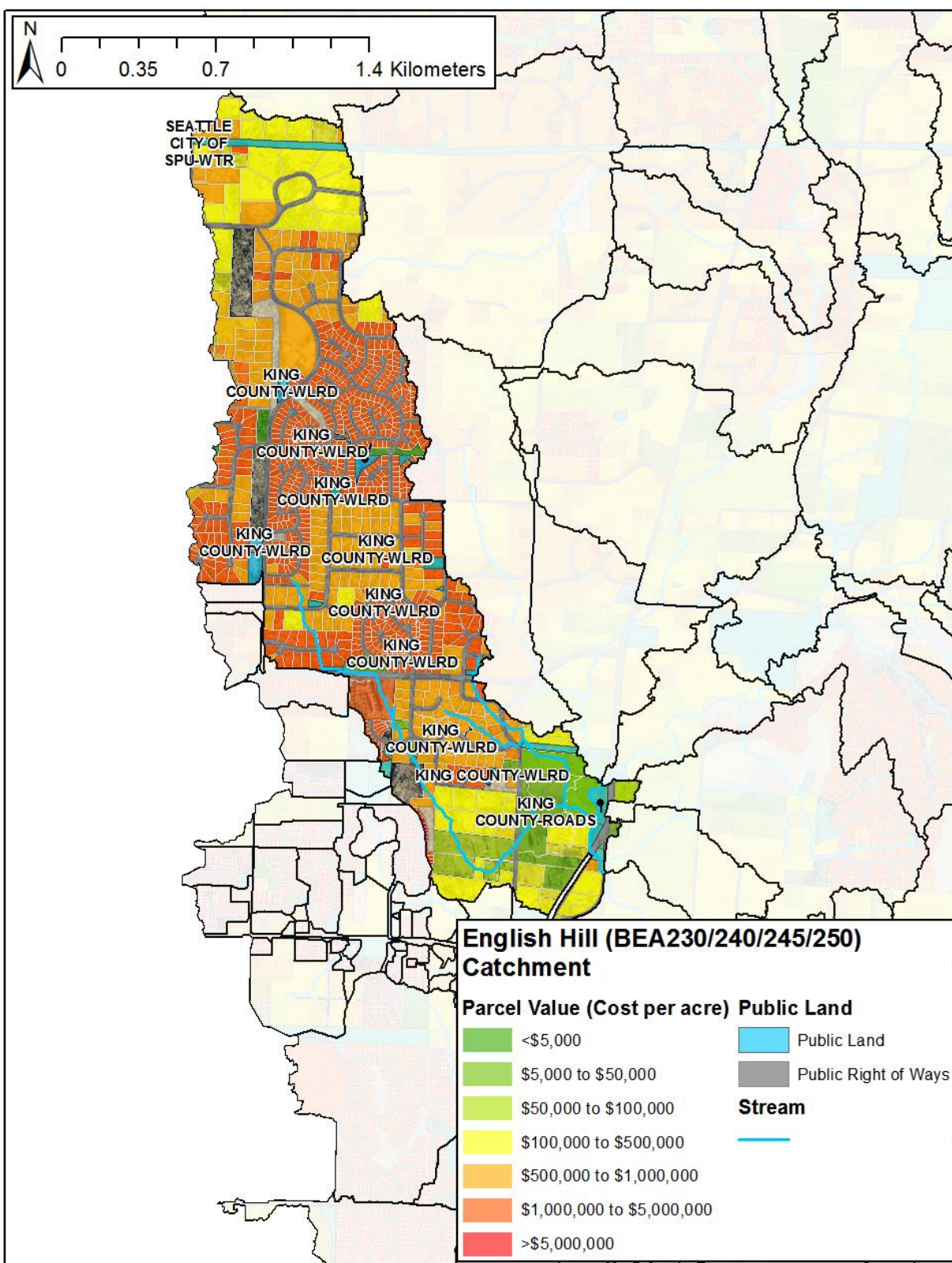
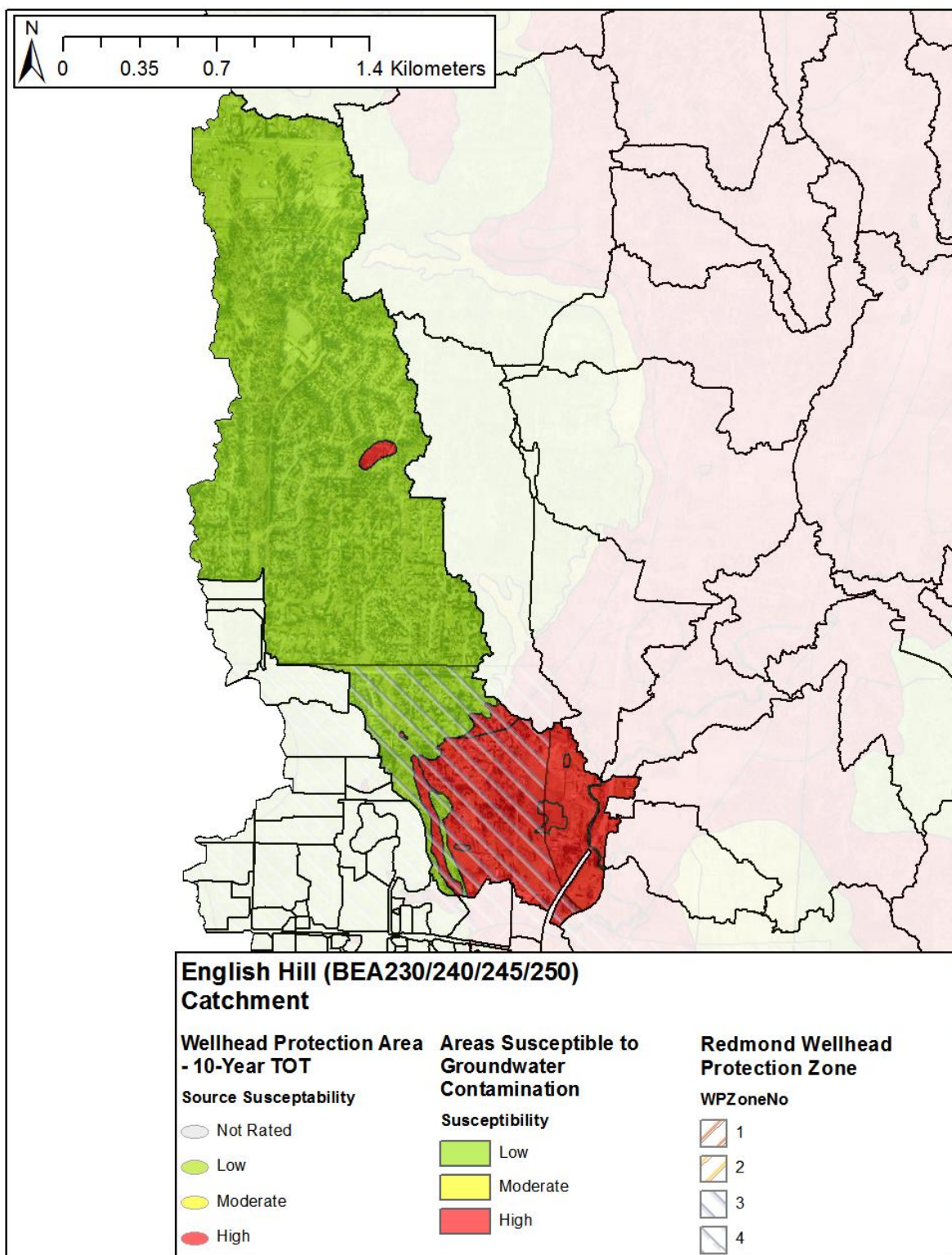


Figure 8. English Hill (BEA230/240/245/250) catchment parcel values and public lands.





**Figure 9.** English Hill (BEA230/240/245/250) catchment groundwater protection areas. Bottom-left to top-right hatching for Redmond indicates infiltration restriction for pollution-generating hard surfaces runoff, excluding single-family residential runoff. No wellhead protection 10-year TOT in catchment.

### 3.3 BEA200 – Avondale and 116th (Score: 83)

The Avondale and 116<sup>th</sup> St (BEA200) catchment is along Lower Bear Creek. The catchment is 320 acres in area. The catchment contains mainstem Lower Bear Creek, as well as several unnamed tributaries (Table 7). The land use in the catchment varies from medium-density commercial and residential development along Avondale Road to the west to horse pasture land throughout the eastern catchment (Figure 10). The existing horse pasture may or may not have agricultural BMPs in place. A program to identify missing agricultural BMPs and incentive their installation is identified, with a specific focus on the parcels in this catchment (Table 8). Less than 20% is public lands (Figure 12).

Several of the RD facilities were both constructed prior to 1990 and likely do not meet current design standards (Figure 11). It identified that these facilities be inspected and, if needed, updated to provide better storage and water quality treatment. It is also identified that the Avon Villa Mobile Home Park be targeted for stormwater BMP facilities. Because some of the catchment is highly susceptible to groundwater contamination, road runoff may need to be treated prior to infiltration (Figure 13).

**Table 7. Available data for BEA200 (Avondale and 116<sup>th</sup> St) catchment.**

Criteria	Data
<b>Existing water quality problems (Lower Bear Creek)</b>	<ul style="list-style-type: none"> <li>• Temperature (91% of summer 7-DADMax temperatures exceed water quality standards)</li> <li>• Dissolved Oxygen (2 of 3 summer samples did not meet water quality standards)</li> <li>• Fecal Coliform (the stream did not meet the geometric mean and 90th percentile water quality criteria)</li> <li>• Total Suspended Solids (wet-weather samples are five-times that of baseflow samples)</li> </ul>
<b>Existing instream habitat problems (Lower Bear Creek)</b>	<ul style="list-style-type: none"> <li>• Lower habitat quality (King County et al., 1989)</li> <li>• Bank Erosion/Instability and Lack of Instream Habitat Diversity (Entranco, 1994)</li> <li>• Loss of vegetation and instream large organic debris (King County et al., 1994)</li> </ul>
<b>B-IBI (WRIA8 Regression)</b>	Fair (54.5)
<b>Riparian land cover</b>	Pasture: 12% Trees: 26% Shrub: 25% Impervious: 15% Non-forested wetland: 0% Other: 16%
<b>Public Lands</b>	16% public land
King County Roads	7273100085
King County Property Services	3126069157



Criteria	Data
City of Redmond	3126069002 (Juel Community Park) 3126069004 (Farrel-McWhirter Park) 3126069156 3126069160
Horse and Livestock Lands	30 acres 7273100008; 7273100040; 7273100055; 7273100056; 7273100065; 7273100067; 7273100238; 7273100239; 7273100226; 7273100229; 7273100231; 3126069001; 3126069011; 3126069114; 3126069119; 3126069120; 1243100005; 1243100010; 1243100016; 1243100025; 1243100033; 1243100040; 2926069011; 2926069061; 2926069075; 2926069081
Right-of-Ways	15 acres (including road surface) Avondale NE 116 <sup>th</sup> St Several residential streets
Property Value	\$1,077,084 per acre Lower costs along outside of Redmond city limits along NE 116 <sup>th</sup> St
Untreated Impervious Area	20% of catchment is untreated impervious land (drainages are not mapped for Redmond stormwater facilities) <ul style="list-style-type: none"> <li>Residences near 196<sup>th</sup> AVE NE and NE 113<sup>th</sup> St</li> <li>Avon Villa Mobile Home Park</li> </ul>
Existing Stormwater Facilities	<ul style="list-style-type: none"> <li>RD Pond for Glosten (DS0086) – built 2008</li> <li>RD Pond for DOT (DT0050) – built 1993</li> <li>Redmond Vault (03-3125) – built 2003 (Texaco)</li> <li>Redmond Pond (95-0980) – build date unknown</li> <li>Redmond Vault (96-2370) – built 1996 (Bear Creek Overlook)</li> <li>Redmond Pond/Vault (91-1140) – built 1991 (Essex Park Townhouses)</li> <li>Redmond Vault (04-0700) – built 2005 (Avondale Retail=</li> </ul>
Easements	<ul style="list-style-type: none"> <li>None</li> </ul>
Groundwater	Much of the catchment is in Redmond Wellhead Protection Zone 3. The SE region near Avondale and 116 <sup>th</sup> St is Zone 2, which restricts infiltration of pollution-generating hard surfaces runoff, excluding single-family residential runoff. The catchment has low to high susceptibility to groundwater contamination.
Stream Shade	49% of the stream has less than 50% shading Hot spots of low shade: <ul style="list-style-type: none"> <li>Low canopy cover through Bear Creek Natural Area; invasive grass present</li> </ul>

**Table 8. Summary of Identified Strategies for BEA200 (Avondale and 116<sup>th</sup> St) catchment.**

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Incentivize agricultural BMPs for pastureland			X	X	
Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X

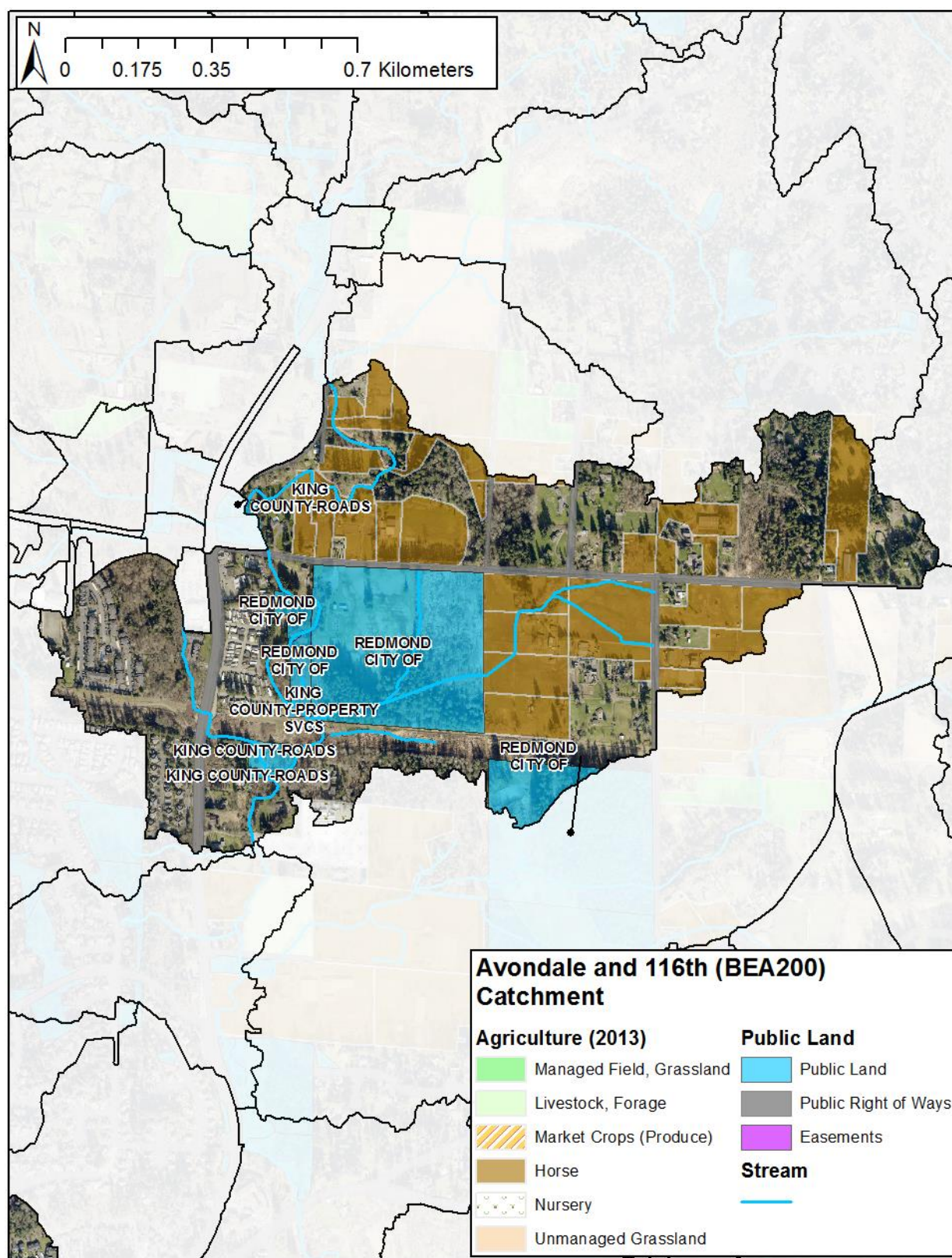


Figure 10. Avondale and 116th (BEA200) catchment agricultural and public land.



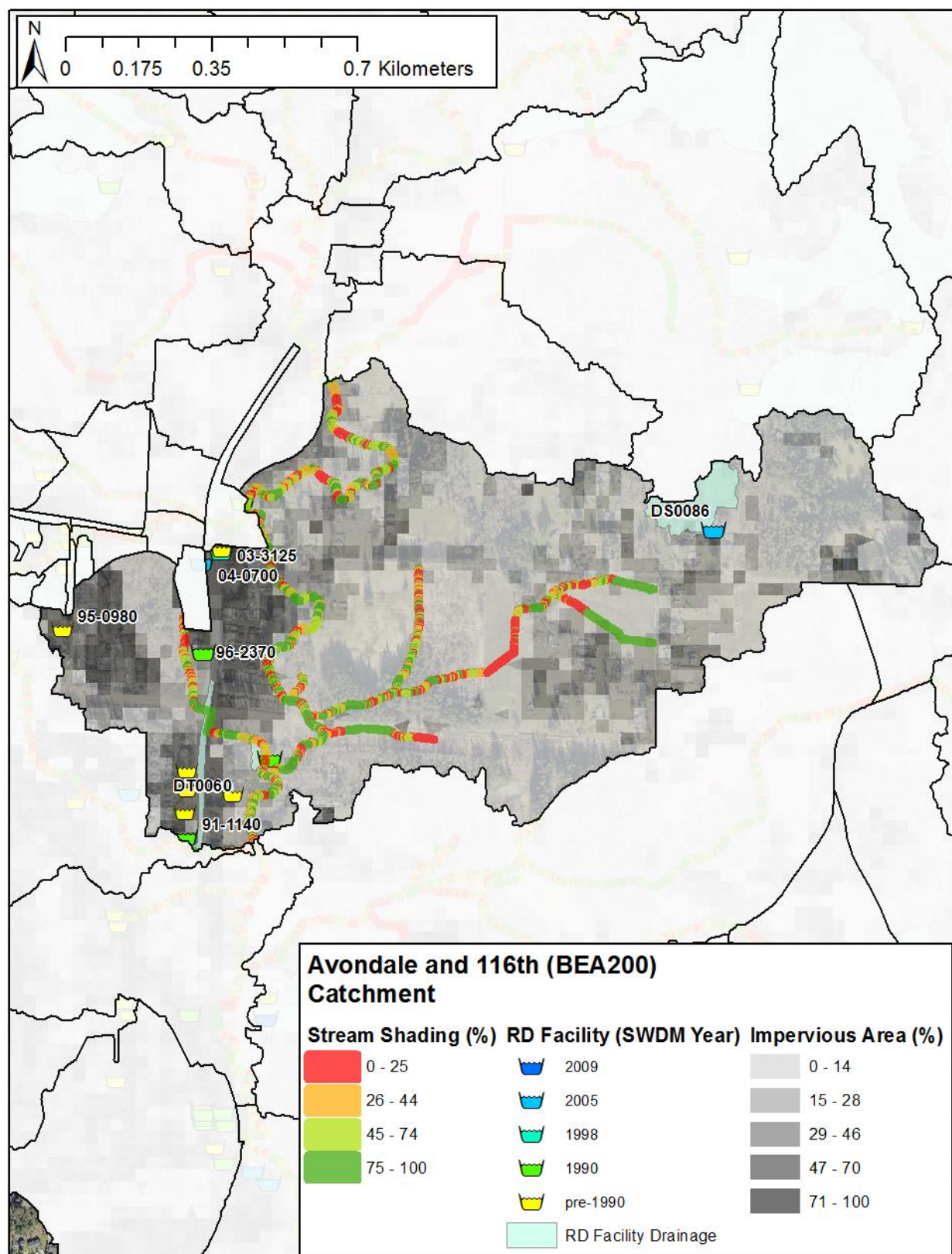


Figure 11. Avondale and 116th (BEA200) catchment stream shading, impervious area, and RD facilities and their drainage area.

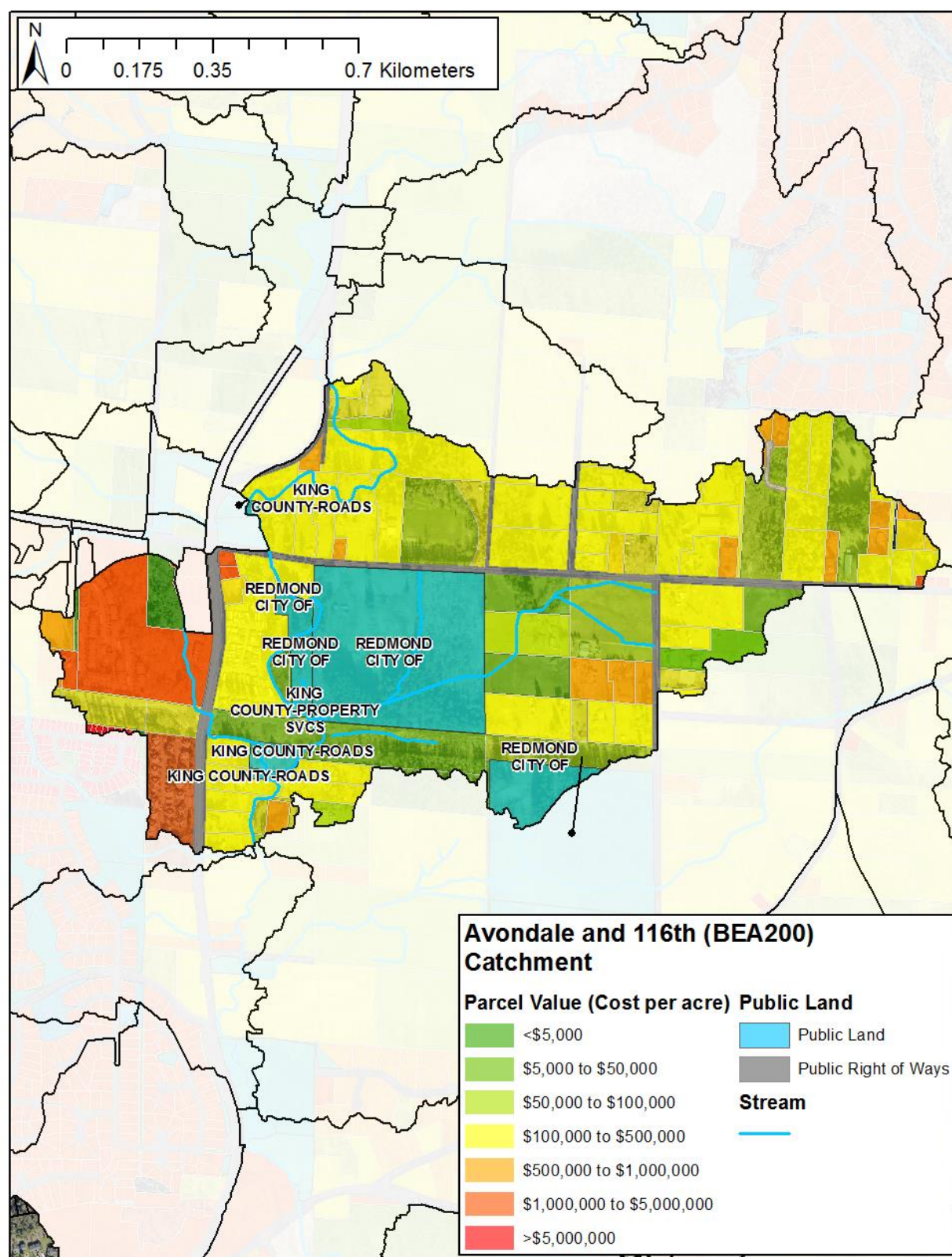
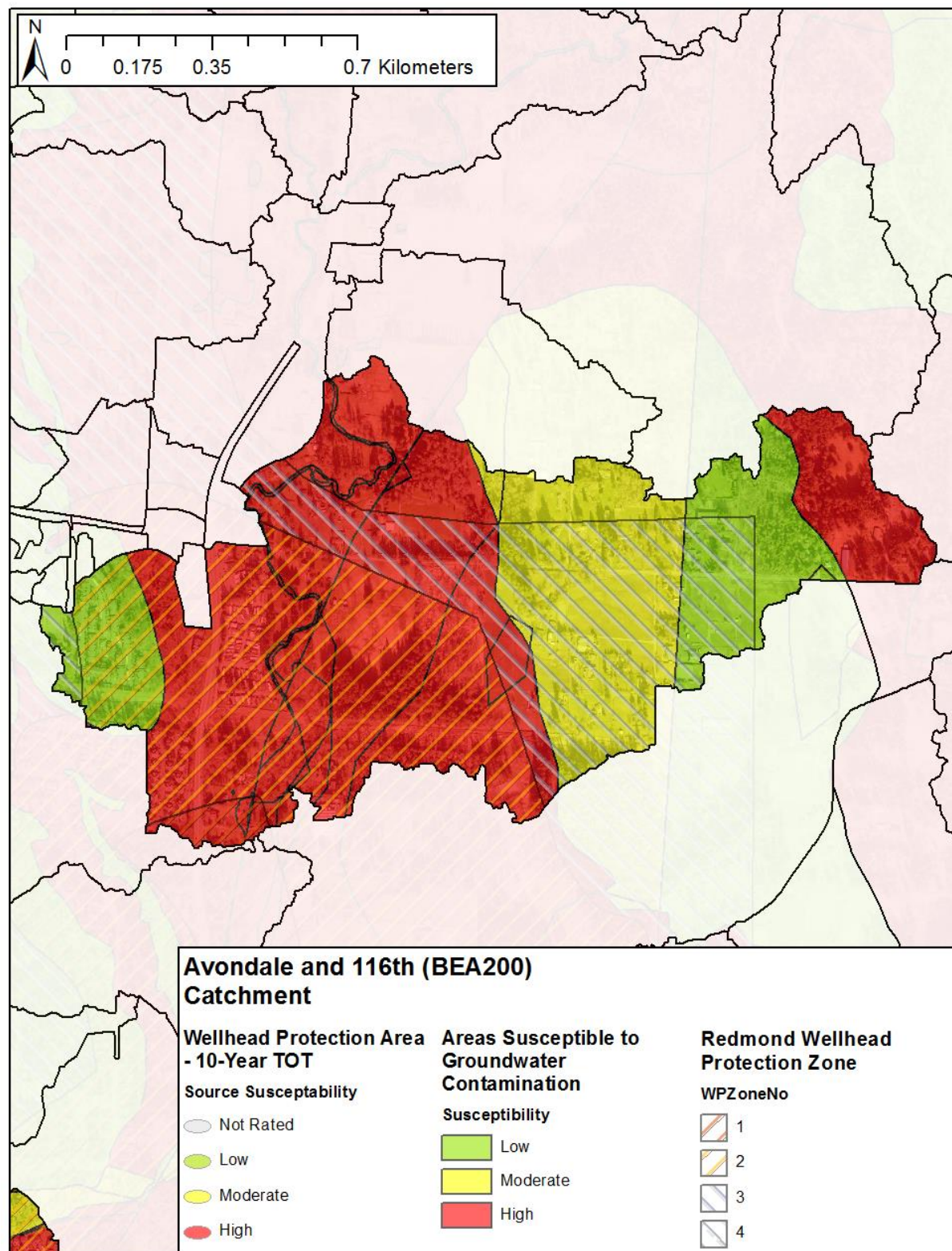


Figure 12. Avondale and 116th (BEA200) catchment parcel values and public lands.





**Figure 14.** Avondale and 116th (BEA200) catchment groundwater protection areas. Bottom-left to top-right hatching for Redmond indicates infiltration restriction for pollution-generating hard surfaces runoff, excluding single-family residential runoff. No wellhead protection 10-year TOT in catchment.

### 3.4 BEA740 – Avondale and 165th St (Score 83)

The Avondale and 165<sup>th</sup> St (BEA740) catchment is a tributary to Cottage Lake Creek. The catchment is 160 acres in area. The catchment is predominately low-density residential development, with some medium-density residential and commercial development towards the northern end. Avondale Road is major arterial. Installation of roadside bioretention facilities is identified in the Avondale right-of-way. Because the area is highly susceptible to groundwater contamination, road runoff would need to be treated prior to infiltration.

**Table 9. Available data for BEA740 (Avondale and 165<sup>th</sup> St) catchment.**

Criteria	Data
<b>Existing water quality problems (Cottage Lake Creek)</b>	<ul style="list-style-type: none"> <li>• Temperature (72% of summer 7-DADMax temperatures exceed water quality standards)</li> <li>• Dissolved Oxygen (2 of 3 summer samples did not meet water quality standards)</li> <li>• Fecal Coliform (the stream did not meet the geometric mean and 90th percentile water quality criteria)</li> <li>• Total Suspended Solids (wet-weather samples are more than twice that of baseflow samples)</li> </ul>
<b>Existing instream habitat problems</b>	No data for tributary
<b>B-IBI</b>	Poor (23.2)
<b>Riparian land cover</b>	Pasture: 0% Trees: 27% Shrub: 0% Impervious: 18 % Non-forested wetland: 0% Other: 55%
<b>Public Lands</b>	1.3 percent public lands
King County Roads	1628700110; 1628700114; 1628700130; 1774500095
King County Property Services	6139800660
<b>Horse and Livestock Lands</b>	None
<b>Right-of-Ways</b>	22 acres (including road surface) Avondale Several residential streets
<b>Property Value</b>	\$927,793
<b>Untreated Impervious Area</b>	20% of catchment is untreated impervious land <ul style="list-style-type: none"> <li>• Commercial/residential area along Avondale Rd</li> <li>• Congregation Kol Ami (16530 Avondale Rd NE)</li> </ul>
<b>Existing Stormwater Facilities</b>	<ul style="list-style-type: none"> <li>• Vault for Cottage Lake Elementary School (D98524) – built 2004</li> <li>• Vault for Cottage Lake Elementary School (D98525) – built 2004</li> </ul>

Criteria	Data
Easements	None
Groundwater	<ul style="list-style-type: none"> <li>Low to high susceptibility to groundwater contamination</li> </ul>
Stream Shade	81% of the stream has less than 50% shading

**Table 10. Summary of Identified Strategies for BEA740 (Avondale and 165<sup>th</sup> St) catchment.**

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X



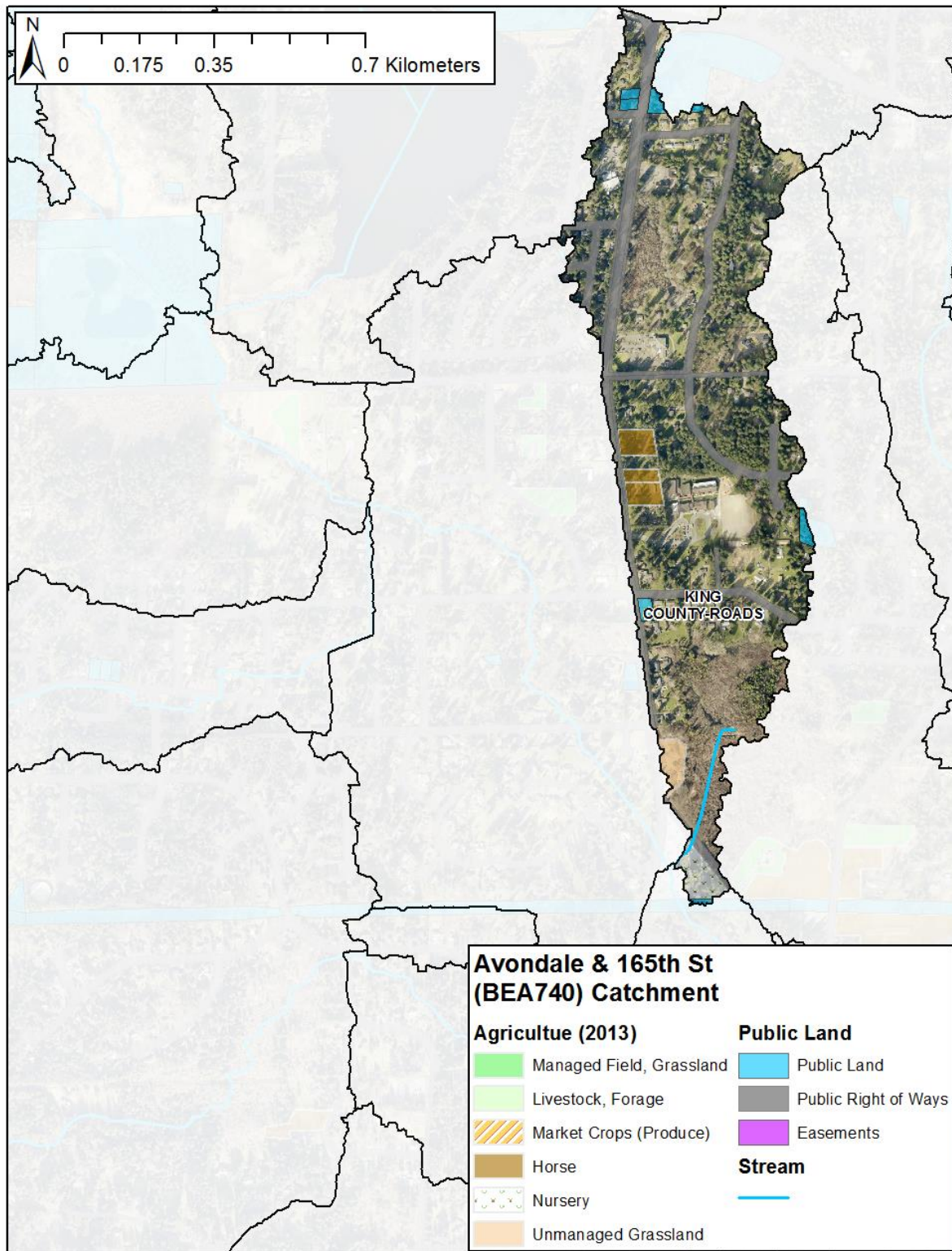
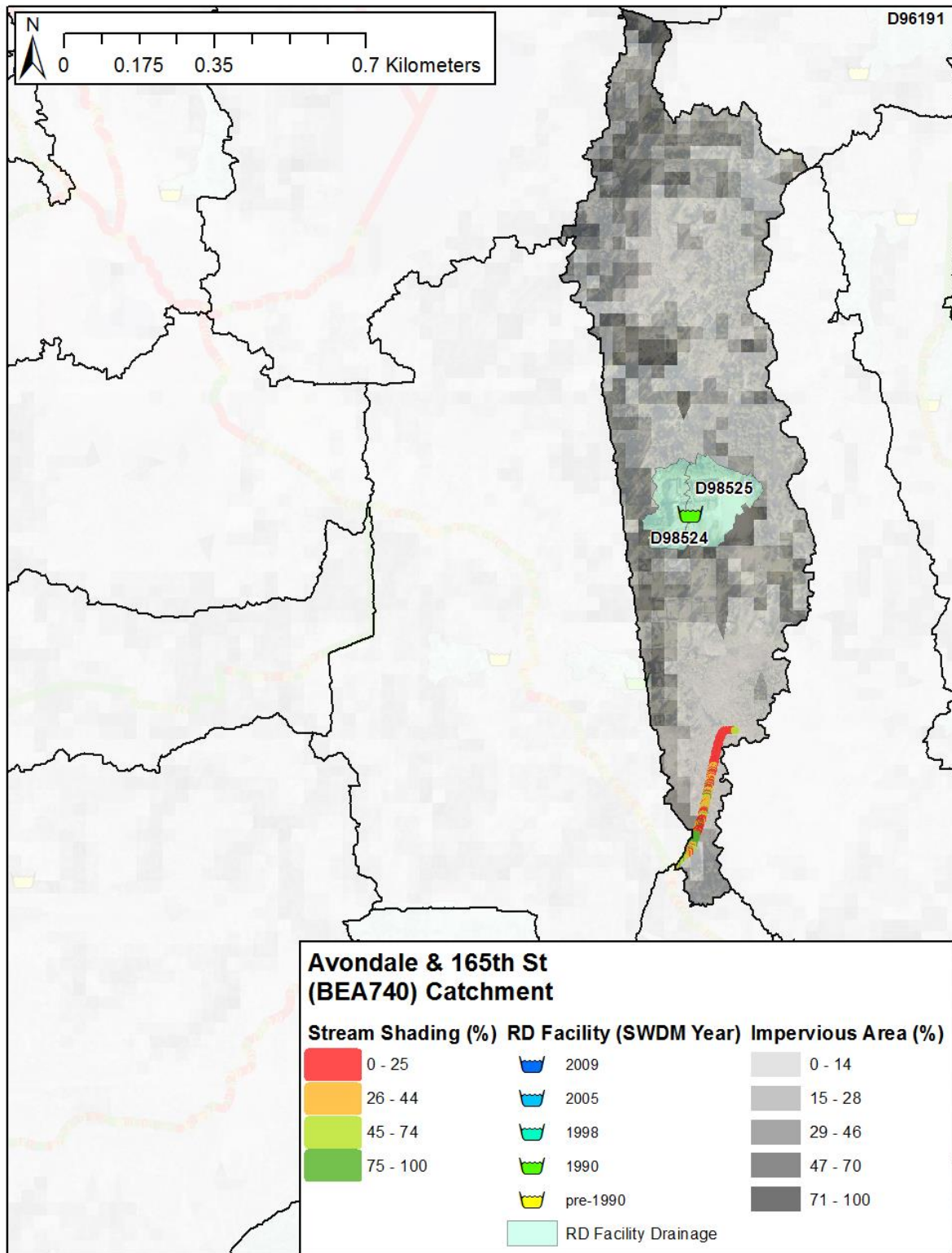


Figure 15. Avondale and 165th St (BEA740) catchment agricultural and public lands.



**Figure 16. Avondale and 165th St (BEA740) catchment stream shading, impervious area, and RD facilities and their drainage area.**



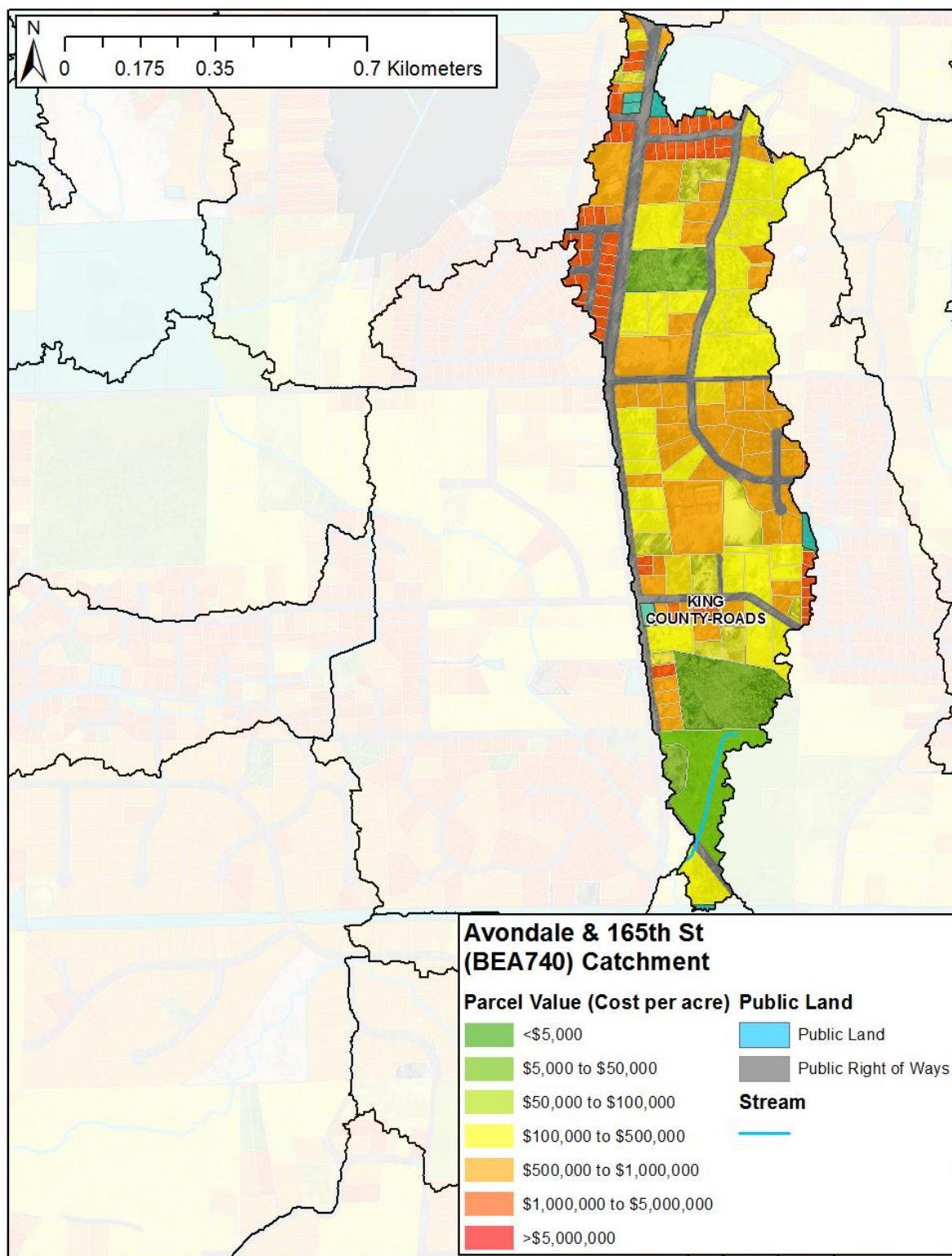


Figure 17. Avondale and 165th St (BEA740) catchment parcel values and public lands.

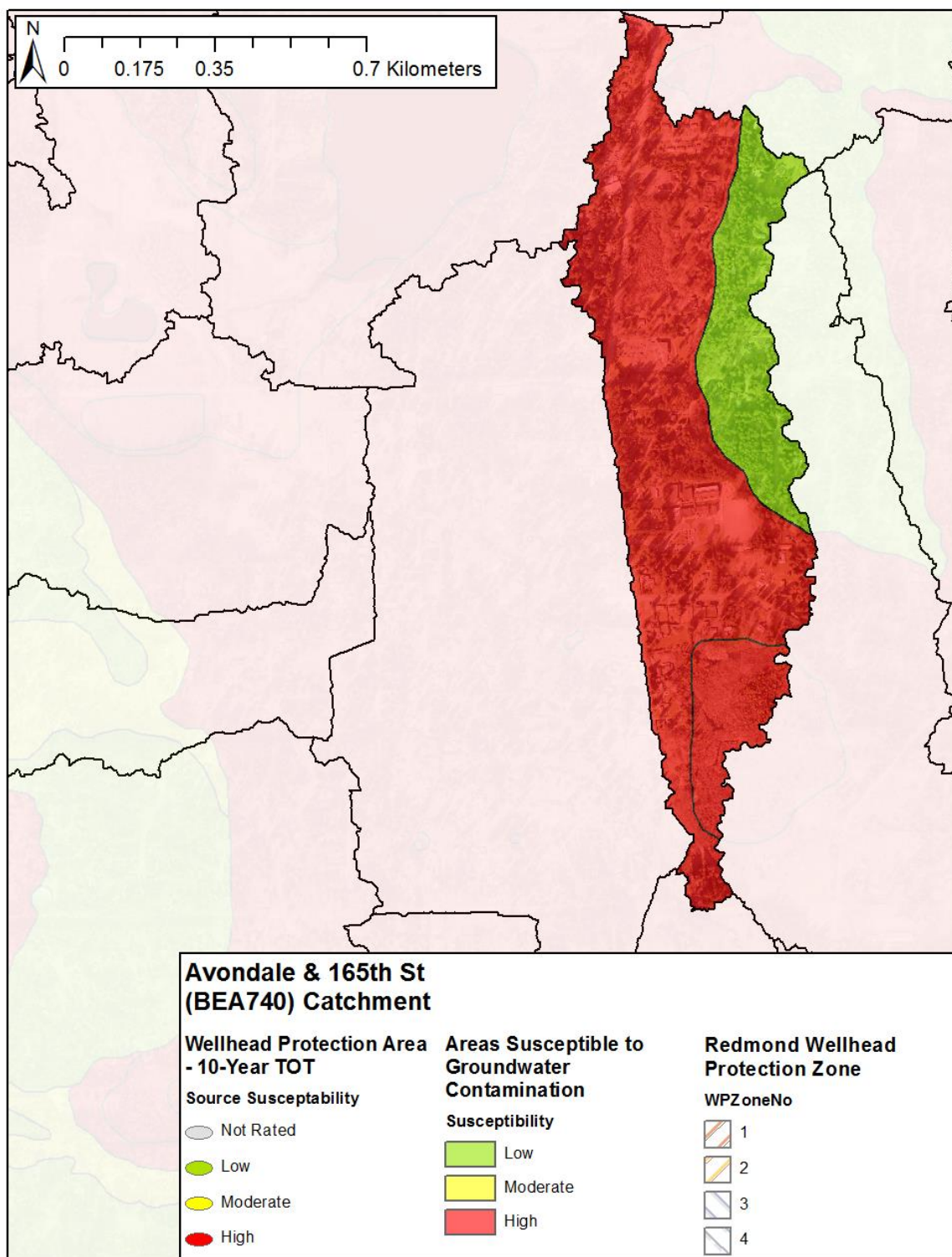


Figure 18. Avondale and 165th St (BEA740) catchment groundwater protection areas. No wellhead protection 10-year TOT in catchment.

### 3.5 BEA300 – Mid Bear Creek Natural Area (Score: 75)

The Mid Bear Creek Natural Area (BEA300) is approximately 1.2 km upstream of the confluence of Bear and Cottage Lake creeks. The catchment is 63 acres in area. While much of the catchment is forested, the immediate stream area is often unshaded with the presence of reed canarygrass, an invasive plant. Riparian restoration and tree planting is identified within the County-owned Bear Creek Natural Area.

The RD facility serving Fire Station #33 was constructed prior to 1990 and likely does not meet current design standards (Figure 19). It identified that the facility be inspected and, if needed, updated to provide better storage and water quality treatment. Because the area is highly susceptible to groundwater contamination, road runoff would need to be treated prior to infiltration.

**Table 11. Available data for Mid Bear Creek Natural Area (BEA300) catchment.**

Criteria	Data
<b>Existing water quality problems (Middle Bear Creek)</b>	<ul style="list-style-type: none"> <li>• Temperature (87% of summer 7-DADMax temperatures exceed water quality standards)</li> <li>• Dissolved Oxygen (3 of 3 summer samples did not meet water quality standards)</li> <li>• Fecal Coliform (the stream did not meet the geometric mean and 90th percentile water quality criteria)</li> <li>• Total Suspended Solids (wet-weather samples are twice that of baseflow samples)</li> </ul>
<b>Existing instream habitat problems (Middle Bear Creek)</b>	Not properly functioning: Pool quantity, large wood debris At risk: pool quality (Parametrix, 2002)
<b>B-IBI (WRIA8 Regression)</b>	Fair (55.7)
<b>Riparian land cover</b>	Pasture: 28% Trees: 45% Shrub: 32% Impervious: 5% Non-forested wetland: 8% Other: 11%
<b>Public Lands</b>	44% public land
King County Roads	0625100020; 0625100021
King County Parks	7701961400; 3026069103; 0625100116 (Middle Bear Creek Natural Area)
<b>Horse and Livestock Lands</b>	None
<b>Right-of-Ways</b>	5 acres (including road surface) Bear Creek Road NE NE 133rd St

Criteria	Data
<b>Property Value</b>	\$441,281 Lower costs along either side of NE 133rd St
<b>Untreated Impervious Area</b>	4% of catchment is untreated impervious land <ul style="list-style-type: none"> <li>NE 133rd St and 198th Dr NE</li> <li>Generally forested</li> </ul>
<b>Existing Stormwater Facilities</b>	<ul style="list-style-type: none"> <li>RD Pond for Fire Station #33 (D96906) – built 1986</li> </ul>
<b>Easements</b>	None
<b>Groundwater</b>	<ul style="list-style-type: none"> <li>High Susceptibility to Groundwater Contamination</li> </ul>
<b>Stream Shade</b>	56% of the stream has less than 50% shading Hot spots of low shade: <ul style="list-style-type: none"> <li>Low canopy cover through Bear Creek Natural Area; invasive grass present</li> </ul>

**Table 12. Summary of Identified Strategies for Mid Bear Creek Natural Area (BEA300) catchment.**

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Remove invasive reed canarygrass and plant riparian trees on County-owned land		X		X	
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X



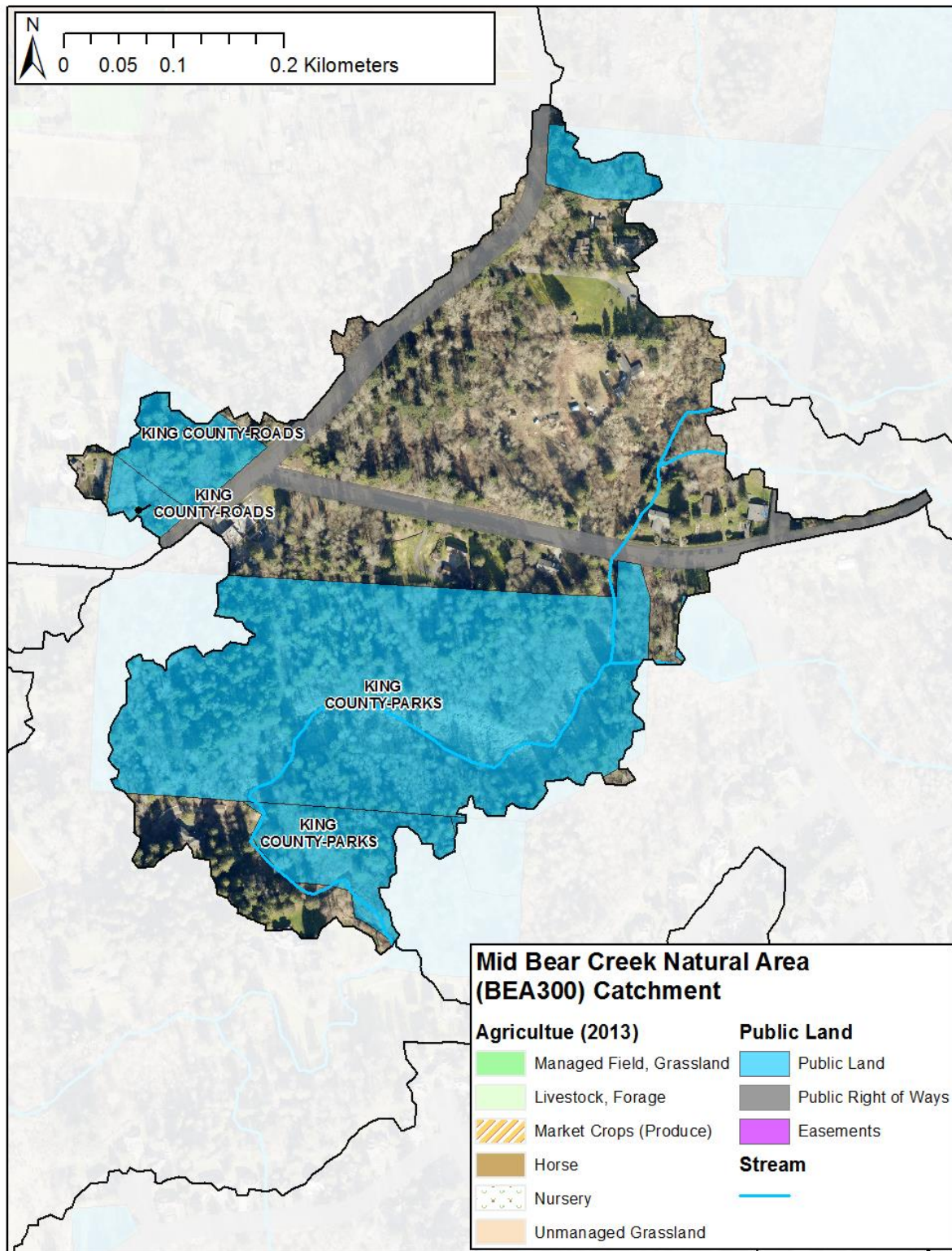
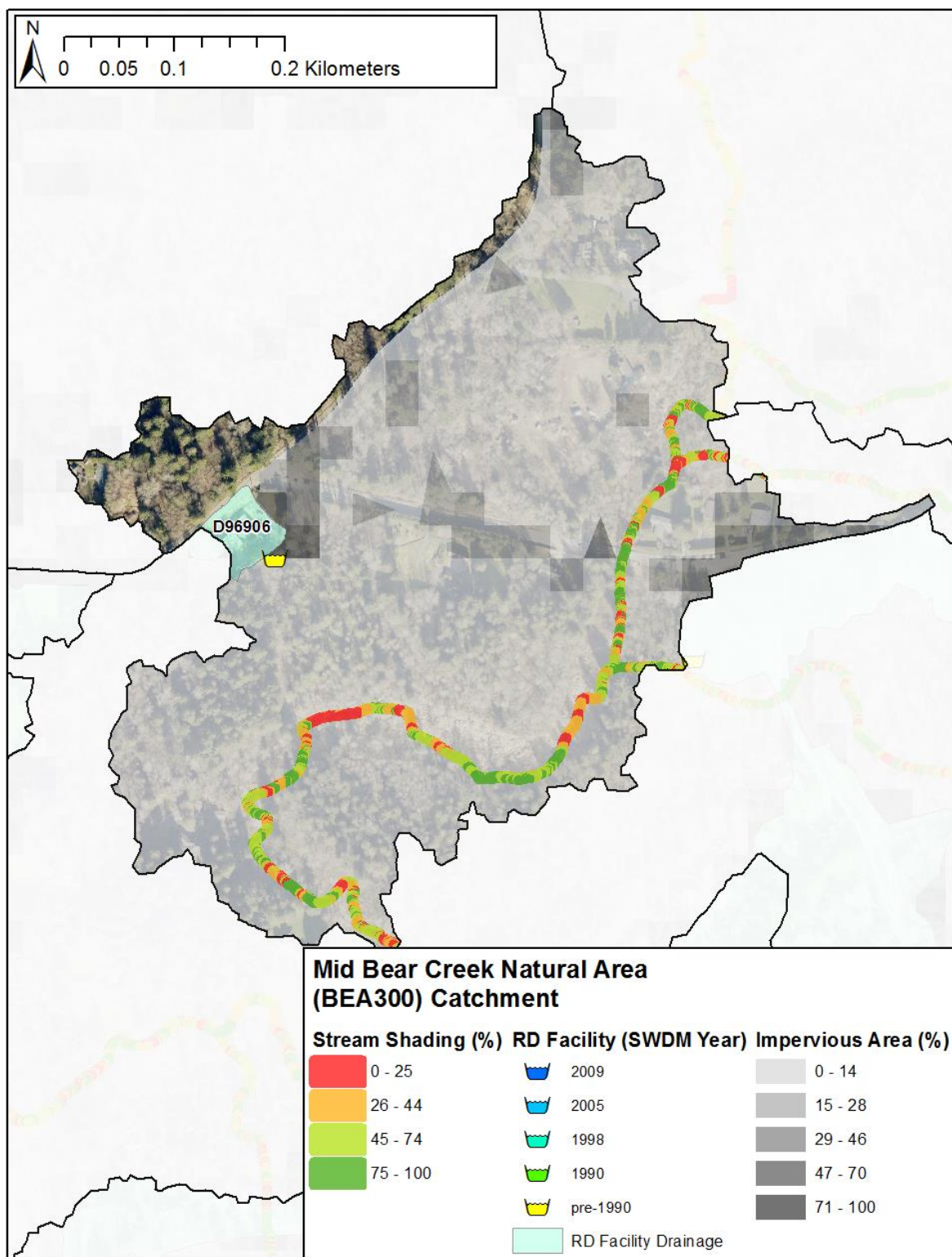


Figure 19. Mid Bear Creek Natural Area (BEA300) catchment agricultural and public land.



**Figure 20. Mid Bear Creek Natural Area (BEA300) catchment stream shading, impervious area, and RD facilities and their drainage area.**



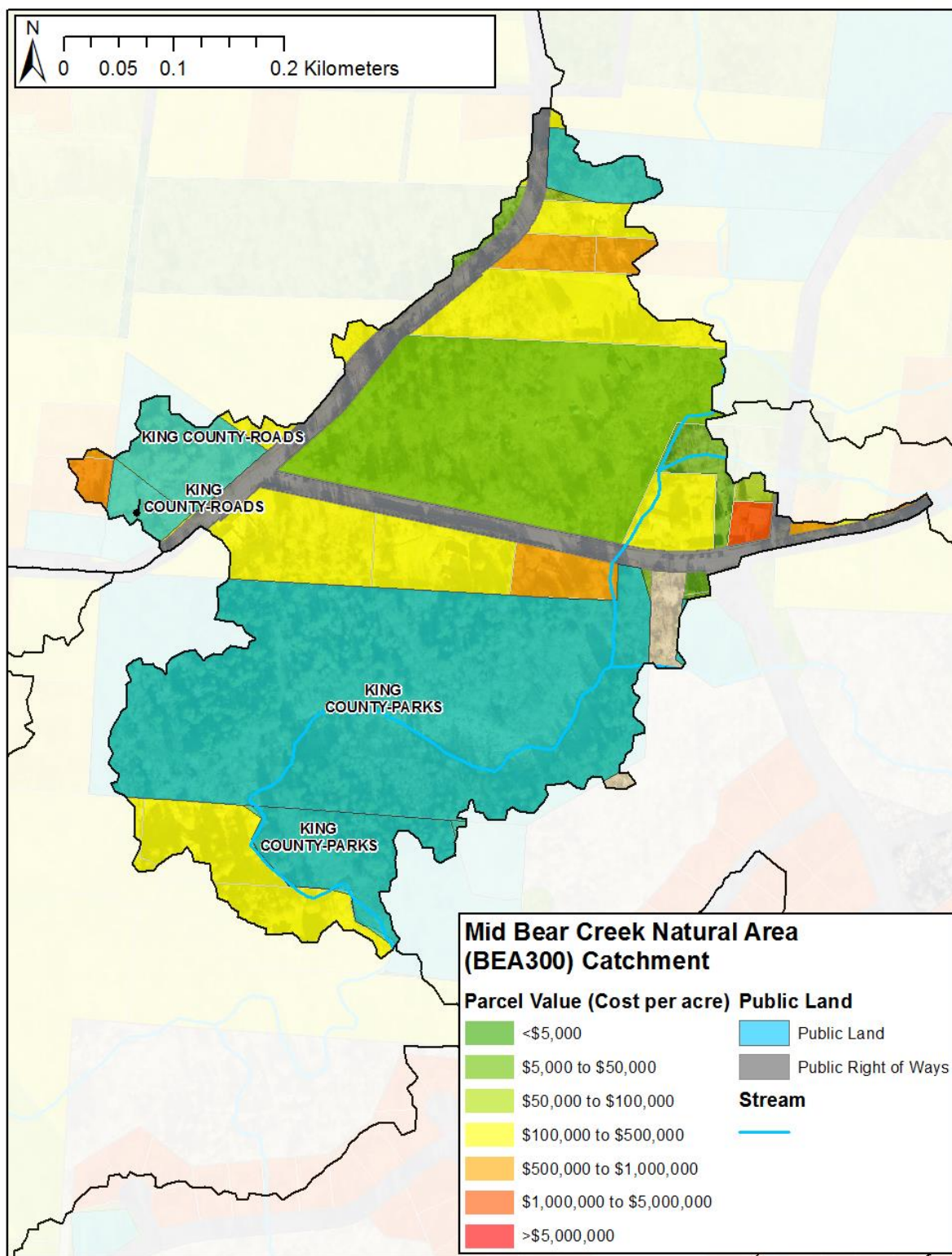
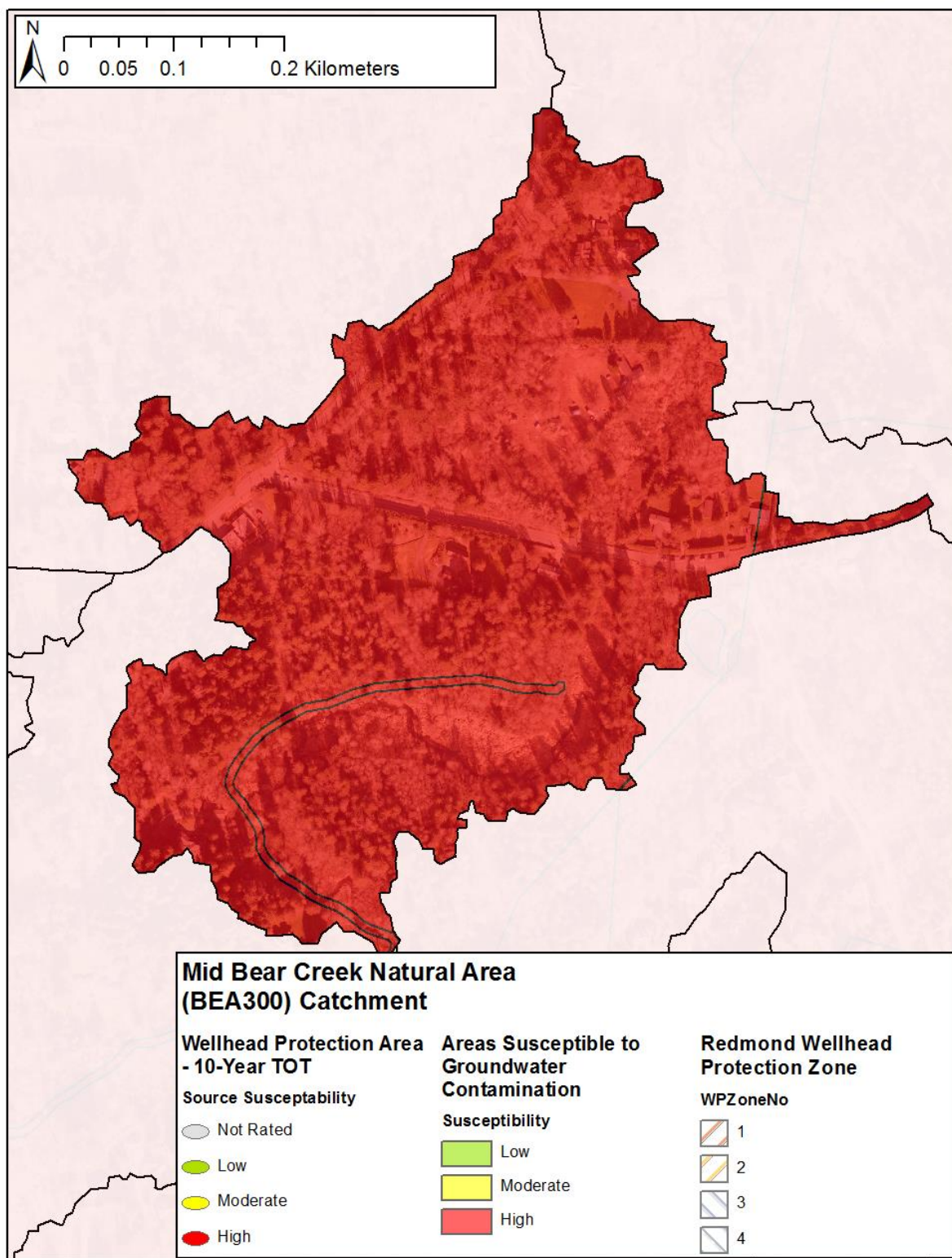


Figure 21. Mid Bear Creek Natural Area (BEA300) catchment parcel values and public lands.



**Figure 22. Mid Bear Creek Natural Area (BEA300) catchment groundwater protection areas. No wellhead protection 10-year TOT in catchment.**

## 4.0 PRIORITY SNOHOMISH COUNTY CATCHMENTS

For catchments located primarily within unincorporated Snohomish County, The data input to the prioritization metric and the resulting final score are displayed in Table 13 with the catchments ranked. The following sections detail the five top-ranked catchments and discuss potential projects and actions to improve water quality and hydrology.

In addition to the three priority catchments identified in the Bear Creek study area, the Maltby catchment (BEA970) and Paradise Lake Conservation Area (BEA920) were identified as priority catchments. The catchments are not within the Bear Creek study area, draining to Cottage Lake. However, the BEA970 catchment and the northern and southern sections of BEA920 are highly impervious, which has negative consequences on the hydrology and water quality in Daniels Creek and eventually Cottage Lake.

**Table 13. Ranked catchments located primarily in Snohomish County and prioritization metric input data. Grouped catchments highlighted with the same color, except catchment outside study area shaded in grey.**

Catchment	Scoring Metrics									Total Score
	Water Quality	B-IBI	Untreated Impervious	Storm-water Facility	Forage Live-stock	Property Cost	Public Land	Right-of-way	Roof	
BEA970	15	30	30	0	0	15	10	8	5	118
BEA920	15	10	5	0	0	10	20	0	5	65
BEA960	15	10	5	0	0	10	20	0	5	65
BEA625	15	10	0	0	0	15	20	0	5	65
BEA660	15	10	0	0	0	15	20	0	5	65
BEA630	15	10	10	0	0	15	0	8	5	63
BEA620	15	10	5	0	0	15	10	0	5	60
BEA640	15	10	0	0	0	15	10	0	5	55
BEA670	15	0	10	0	0	15	0	0	10	50
BEA665	15	10	5	0	0	15	0	0	5	50
BEA650	15	10	0	0	0	15	0	0	5	45

## 4.1 BEA620/625/630 – NE Paradise Lake (Score: 65)

The NE Paradise Lake (BEA620/625/630) catchments drain to Paradise Lake. The catchments are 318 acres in area. The catchments are a mix of low-density, rural residential and forested land use. It is identified that the existing stormwater detention and treatment infrastructure be inspected and their drainage area assessed. If undersized or not meeting current standards, it is identified the detention facilities be upgraded. Gaps in the current stormwater infrastructure should be identified and new facilities constructed or flows rerouted to existing facilities. Tree plantings suitable for the wetland environment along the waterway are also identified.

**Table 14. Available data for NE Paradise Lake (BEA620/625/630) catchments.**

Criteria	Data
<b>Existing water quality problems</b>	<ul style="list-style-type: none"> <li>Bear Creek above Paradise Lake water quality was not assessed</li> <li>Downstream Paradise Lake is highly productive and on the 303(d) of impaired waters for total phosphorus.</li> </ul>
<b>Existing instream habitat problems</b>	Highest quality habitat (King County et al., 1989)
<b>B-IBI (WRIA8 Regression)</b>	Fair (51.7, 48.9, and 42.5)
<b>Riparian land cover</b>	2% impervious 80% forested 8% shrub 7% other 3% pasture
<b>Public Lands</b>	20% public land
King County Parks	0526069001, 0526069028
Snohomish County	00793000099700 (retention pond)
Cross Valley Water District	27063300400800
<b>Horse and Livestock Lands</b>	4 acres 27063300300700
<b>Right-of-Ways</b>	27 acres (including road surface) Several residential streets and connectors Siler Logging Company Railroad
<b>Property Value</b>	\$226,572 Western catchment is generally lower cost per acre
<b>Untreated Impervious Area</b>	6% of catchment is untreated impervious land
<b>Existing Stormwater Facilities</b>	There is one stormwater facility mapped by Snohomish County along 234th St SE
<b>Easements</b>	None
<b>Groundwater</b>	<ul style="list-style-type: none"> <li>Critical Aquifer Recharge Areas are not mapped in Snohomish County</li> <li>King County portion of catchment is low susceptibility to groundwater contamination</li> <li>A 10-year TOT wellhead protection area in the eastern catchment with low susceptibility to contamination</li> </ul>
<b>Stream Shade</b>	43% of the stream has less than 50% shading

**Table 15. Summary of Identified Strategies for NE Paradise Lake (BEA620/625/630) catchments.**

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Incentivize agricultural BMPs for horse pastureland			X	X	
Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X



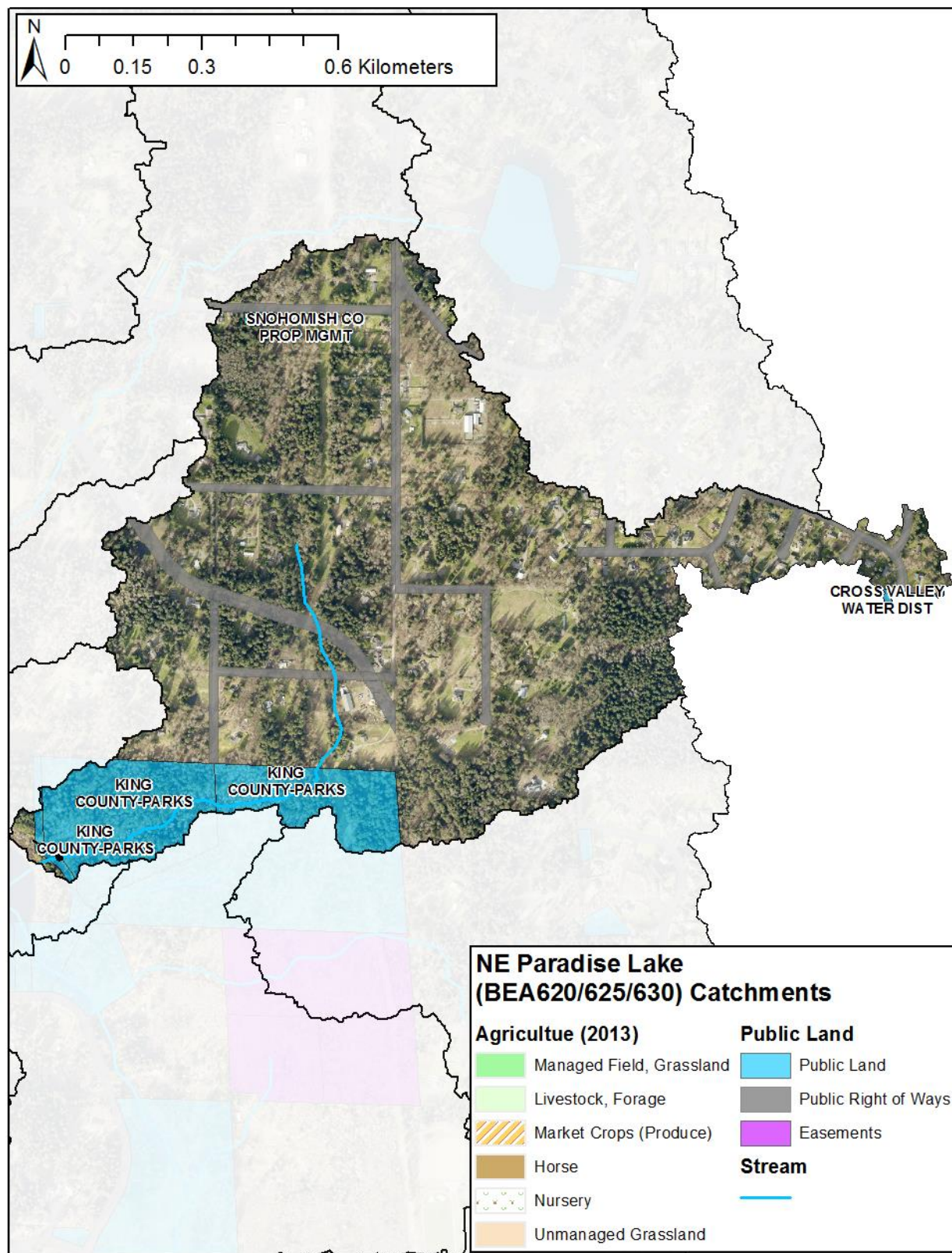


Figure 23. NE Paradise Lake (BEA620/625/630) catchment agricultural and public land.



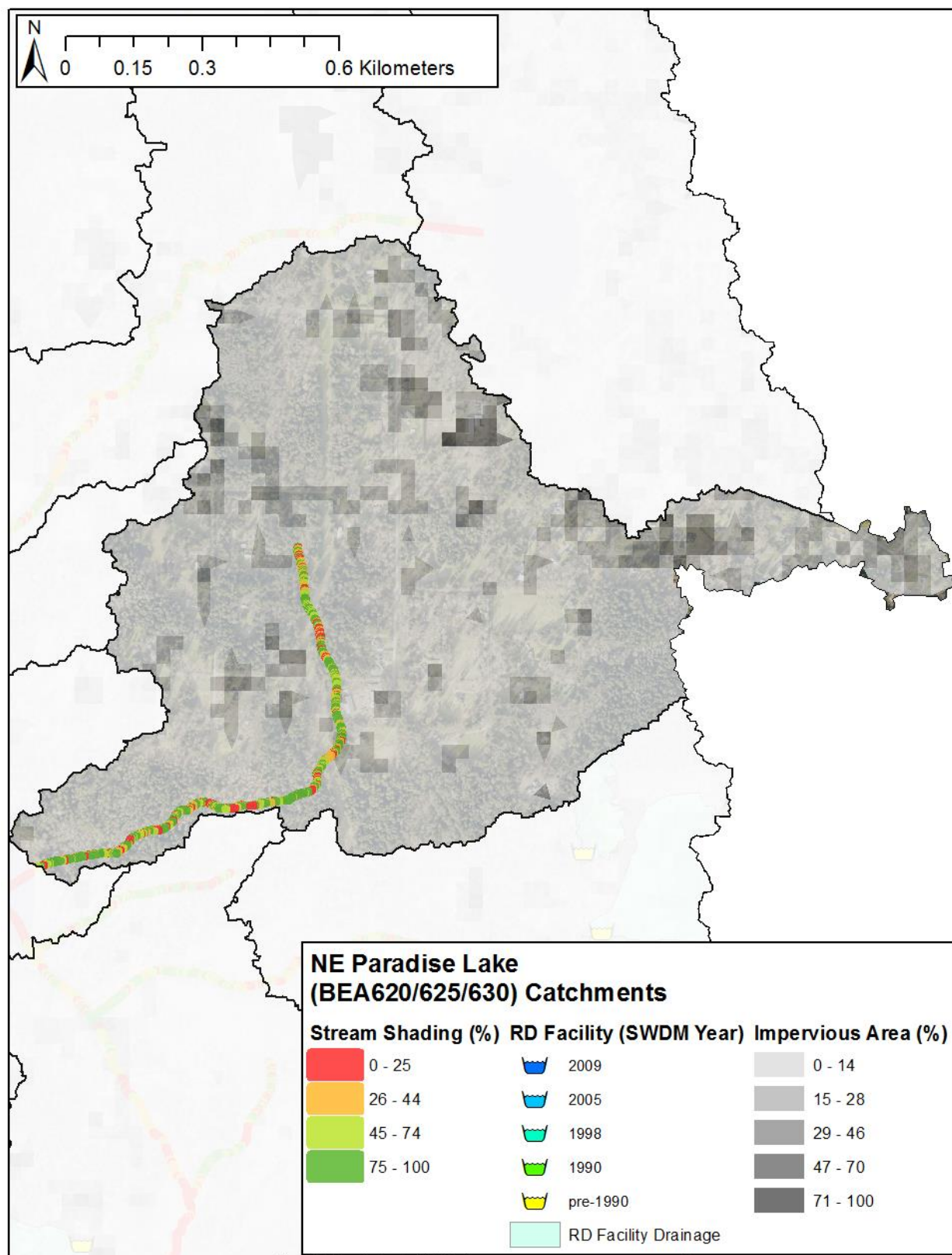


Figure 24. NE Paradise Lake (BEA620/625/630) catchment stream shading, impervious area, and RD facilities and their drainage area.

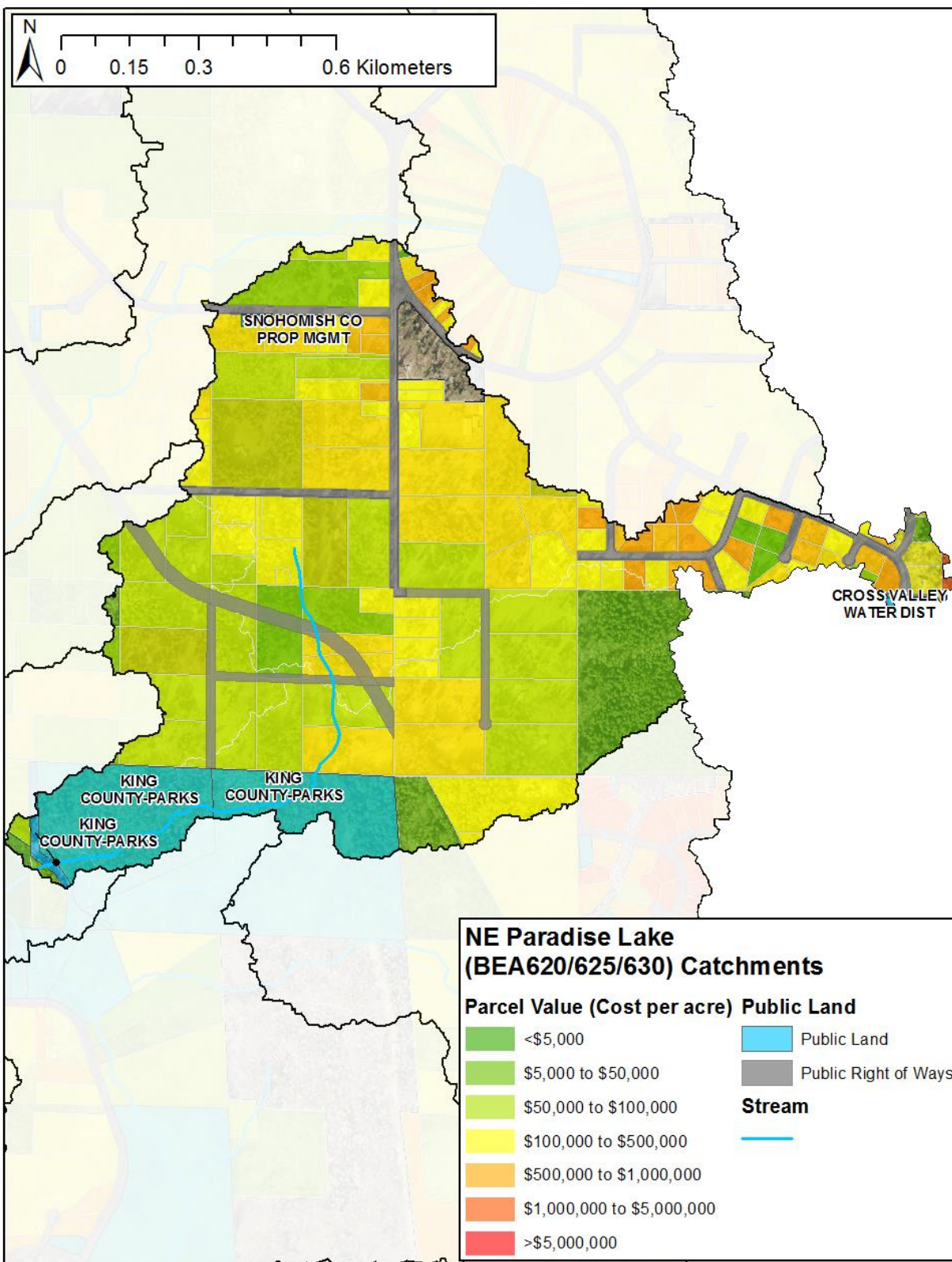


Figure 25. NE Paradise Lake (BEA620/625/630) catchment parcel values and public lands.



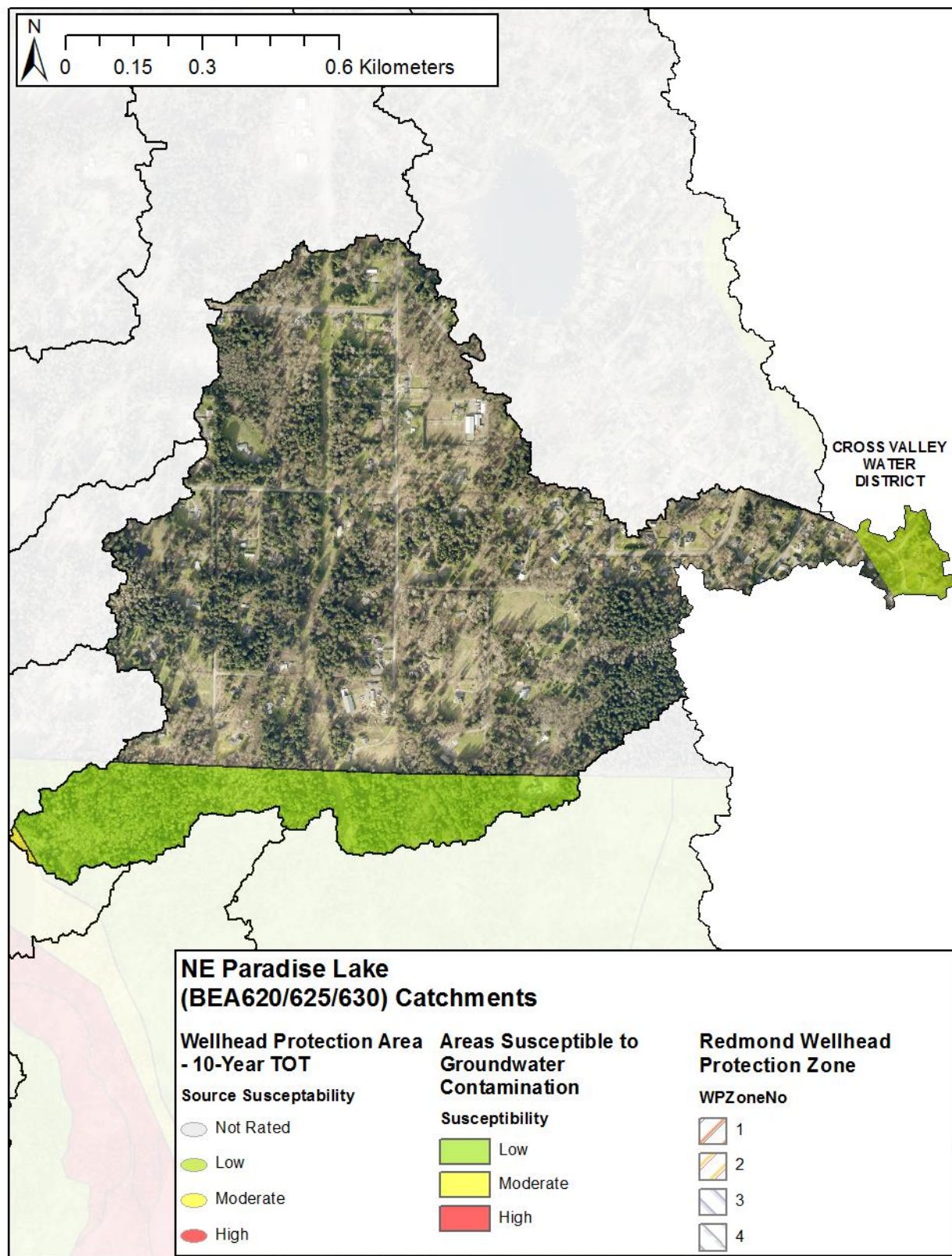


Figure 26. NE Paradise Lake (BEA620/625/630) catchment groundwater protection areas.

## 4.2 BEA640/660 – Bear Above Paradise Lake (Score: 65)

The Bear Above Paradise Lake (BEA640 and 660) catchments drain to Paradise Lake. The catchment is 1220 acres in area. Much of the catchments are owned by Snohomish County as part of the Paradise Valley Conservation Area, which is composed of forest and wetlands.

Low-density residential development is also present in the eastern and northwestern portions of the catchments. The installation of LID features in developed areas and along roadways is identified. An incentive program may be used for LID installation for existing development.

It is identified that the existing stormwater detention and treatment infrastructure be inspected and their drainage area assessed. If undersized or not meeting current standards, it is identified the detention facilities be upgraded. Gaps in the current stormwater infrastructure should be identified and new facilities constructed or flows rerouted to existing facilities. Tree plantings suitable for the wetland environment along the waterway are also identified.

**Table 16. Available data for Bear Above Paradise Lake (BEA640/660) catchments.**

Criteria	Data
<b>Existing water quality problems</b>	<ul style="list-style-type: none"> <li>Bear Creek above Paradise Lake water quality was not assessed</li> <li>Downstream Paradise Lake is highly productive and on the 303(d) of impaired waters for total phosphorus.</li> </ul>
<b>Existing instream habitat problems</b>	No data
<b>B-IBI (WRIA8 Regression)</b>	Fair (58.5 and 58.2)
<b>Riparian land cover</b>	2% impervious 45% trees 8% shrubs 30% non-forested wetland 11% other 4% pasture
<b>Public Lands</b>	34% public land - Paradise Valley Conservation Area
Snohomish County Property Management	27063100100100; 27063000302000; 27063100100200; 27063200200200; 27063100200300
Snohomish County Public Utility District 1	27062900401600
<b>Horse and Livestock Lands</b>	None
<b>Right-of-Ways</b>	60 acres (including road surface) Paradise Lake Rd Echo Lake Rd Siler Logging Company Railroad

Criteria	Data
<b>Property Value</b>	\$202,953/acre Residential parcels are generally lower cost per acre
<b>Untreated Impervious Area</b>	4% of catchment is untreated impervious land There are several stormwater detention and treatment facilities in the catchment, but their drainage areas have not yet been mapped.
<b>Existing Stormwater Facilities</b>	There are several stormwater detention and treatment facilities in the catchment, but their drainage areas have not yet been mapped.
<b>Easements</b>	None
<b>Groundwater</b>	<ul style="list-style-type: none"> <li>• Critical Aquifer Recharge Areas are not mapped in Snohomish County</li> <li>• Several 10-year TOT wellhead protection areas in catchment with low to high susceptibility to contamination operated by the Cross Valley Water District.</li> </ul>
<b>Stream Shade</b>	65% of the stream has less than 50% shading Hot spots of low shade: <ul style="list-style-type: none"> <li>○ Bear Creek flows through a largely unshaded wetland</li> </ul>

**Table 17. Summary of Identified Strategies for Bear Above Paradise Lake (BEA640/660) catchments.**

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X



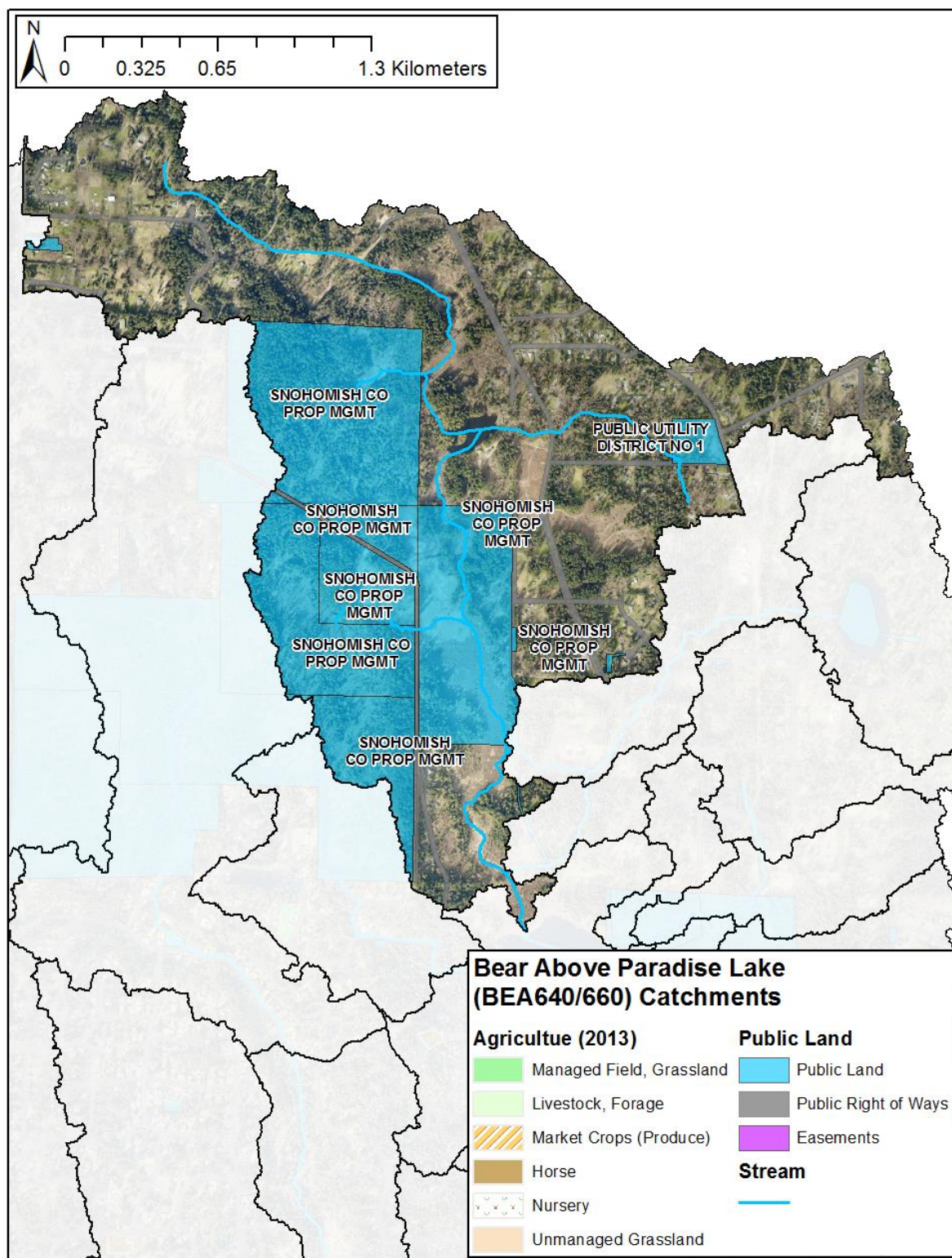
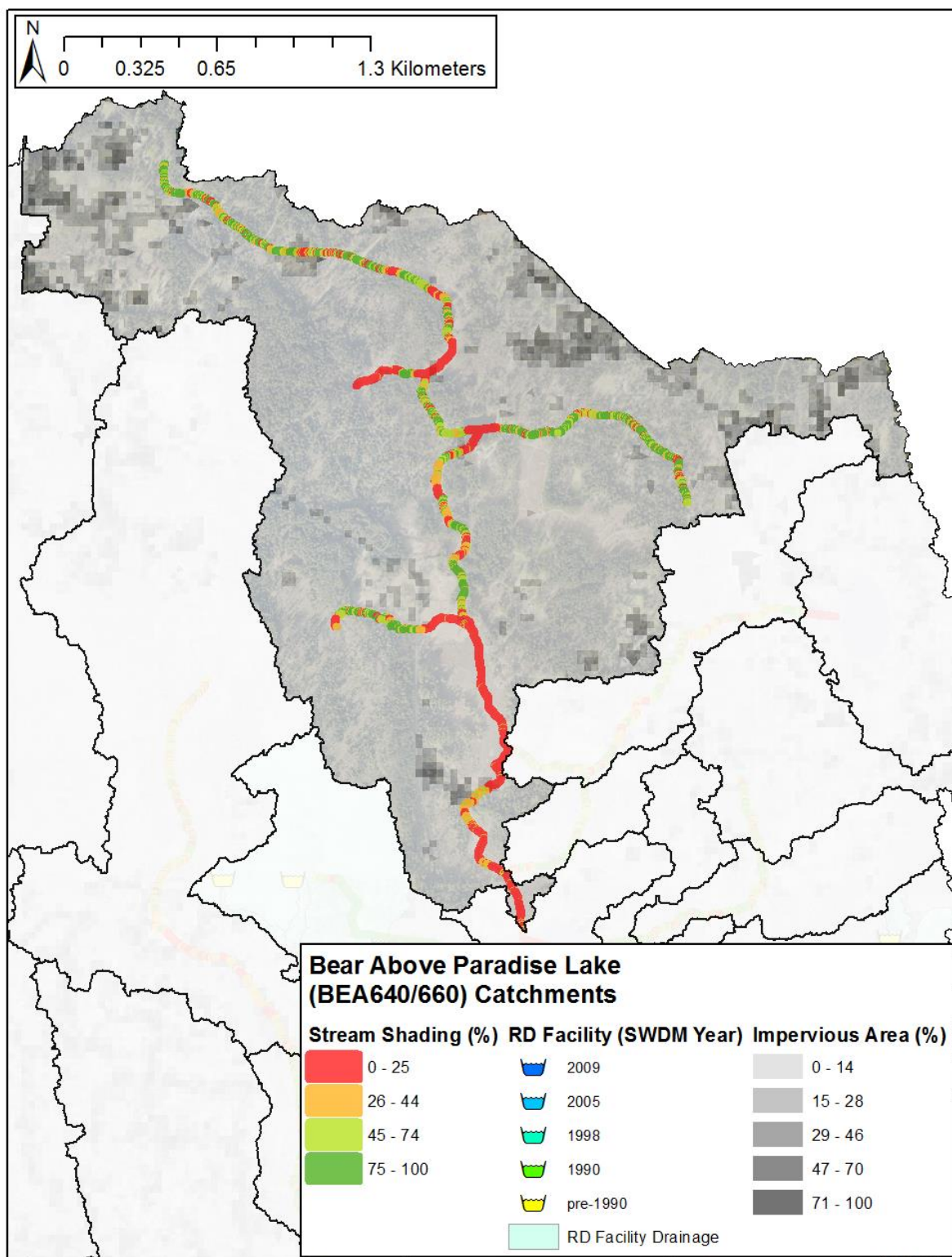


Figure 27. Bear Above Paradise Lake (BEA640/660) catchment agricultural and public land.





**Figure 28. Bear Above Paradise Lake (BEA640/660) catchment stream shading, impervious area, and RD facilities and their drainage area.**

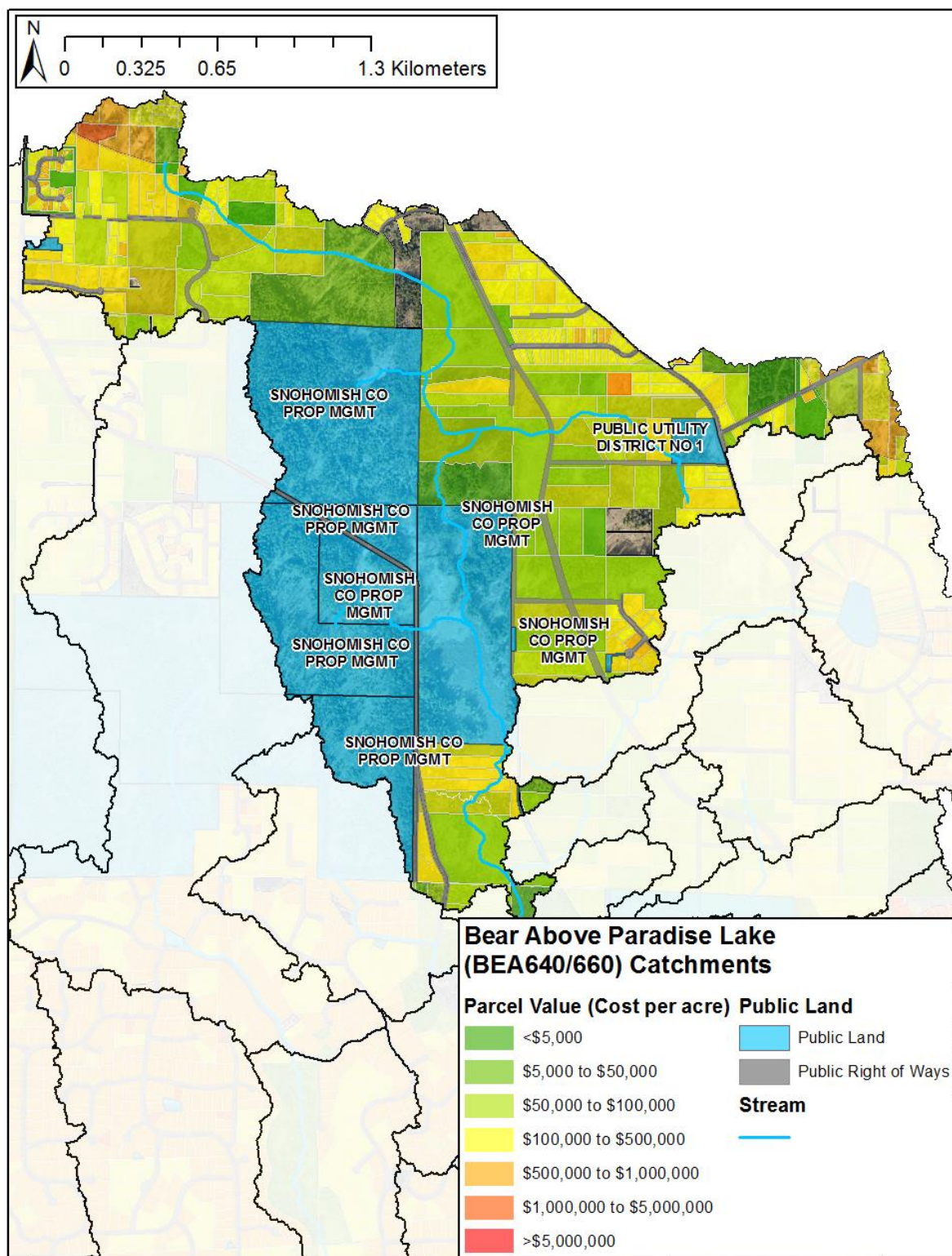


Figure 29. Bear Above Paradise Lake (BEA640/660) catchment parcel values and public lands.



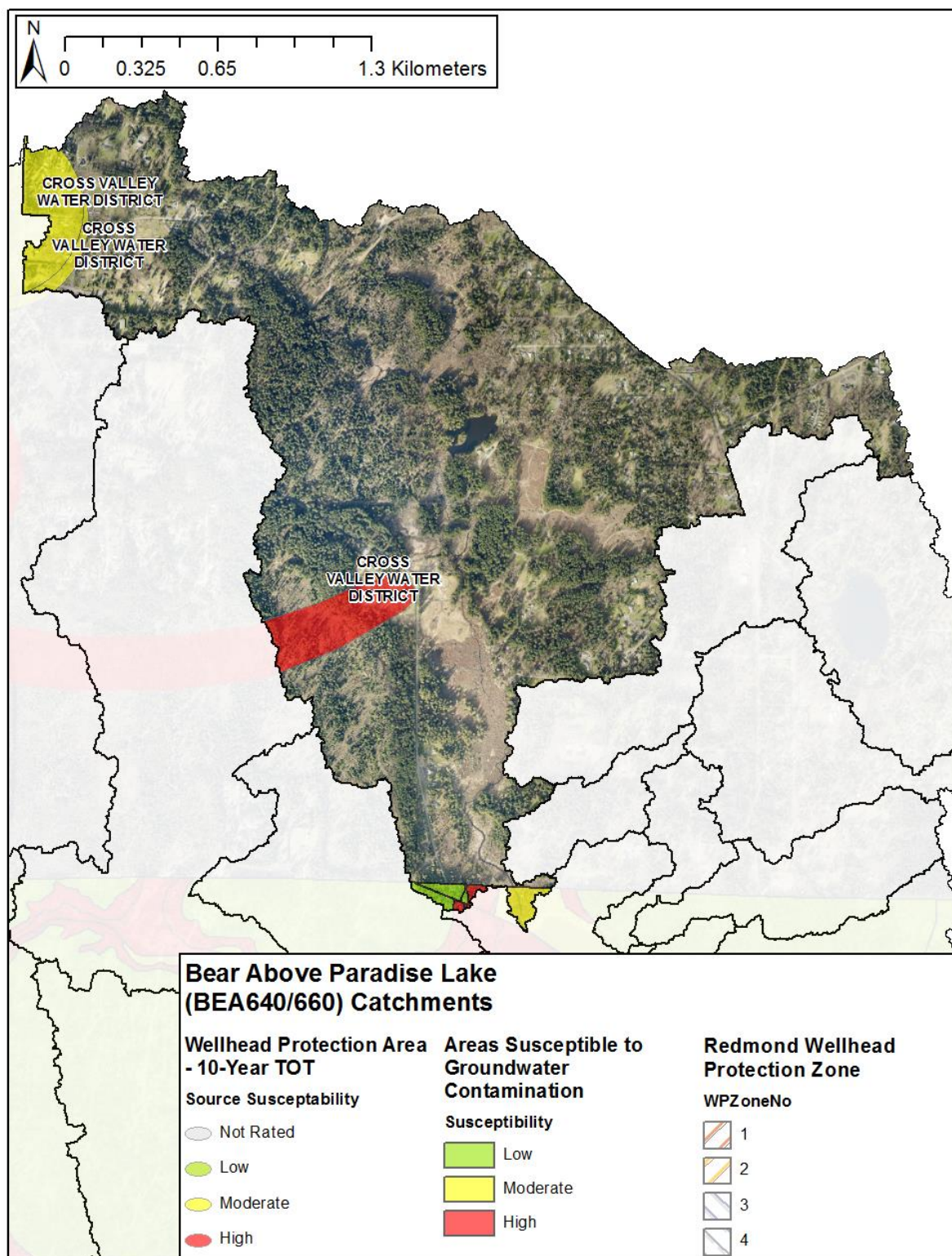


Figure 30. Bear Above Paradise Lake (BEA640/660) catchment groundwater protection areas.

## 4.3 BEA670 – Echo Lake (Score: 55)

The Echo Lake (BEA670) catchment drains to Bear Creek Above Paradise Lake (BEA640/660). The catchment is 185 acres in area. The catchment is mostly low-density residential with Echo Lake receiving its runoff.

It is identified that the existing stormwater detention and treatment infrastructure be inspected and their drainage area assessed. If undersized or not meeting current standards, it is identified the detention facilities be upgraded. Gaps in the current stormwater infrastructure should be identified and new facilities constructed or flows rerouted to existing facilities. Tree plantings along the waterway are also identified.

Snohomish County is identified to continue encouraging shoreline restoration along Echo Lake, to support septic inspection, and to support lawn and garden lakeside best management practices (e.g., P-free fertilizers, dog waste pickup).

**Table 18. Available data for Echo Lake (BEA670) catchment.**

Criteria	Data
<b>Existing water quality problems (Echo Lake)</b>	<ul style="list-style-type: none"> <li>Not assessed as part of water quality assessment.</li> <li>Echo Lake is on the 303(d) of impaired water for total phosphorus.</li> </ul>
<b>Existing instream habitat problems</b>	No data
<b>B-IBI (WRIA8 Regression)</b>	Good (63.2)
<b>Riparian land cover</b>	5% impervious 3% trees 7% non-forested wetland 84% other (water)
<b>Public Lands</b>	5% public land
State Department of Game	00433100006300 (Echo Lake); 00433100003800
<b>Horse and Livestock Lands</b>	None
<b>Right-of-Ways</b>	14 acres (including road surface) Echo Lake Rd Several residential streets
<b>Property Value</b>	\$439,093 Residential parcels are generally lower cost per acre
<b>Untreated Impervious Area</b>	8% of catchment is untreated impervious land
<b>Existing Stormwater Facilities</b>	There are three stormwater facilities mapped by Snohomish County along E Echo Lake Rd.
<b>Easements</b>	None
<b>Groundwater</b>	<ul style="list-style-type: none"> <li>Critical Aquifer Recharge Areas are not mapped in Snohomish County</li> <li>A 10-year TOT wellhead protection area in the eastern catchment with low susceptibility to contamination</li> </ul>
<b>Stream Shade</b>	97% of the stream has less than 50% shading Hot spots of low shade: <ul style="list-style-type: none"> <li>Echo Lake outlet is not well-shaded</li> </ul>

**Table 19. Summary of Identified Strategies for Echo Lake (BEA670) catchment.**

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Shoreline restoration/stewardship along Echo Lake		X	X	X	
Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X



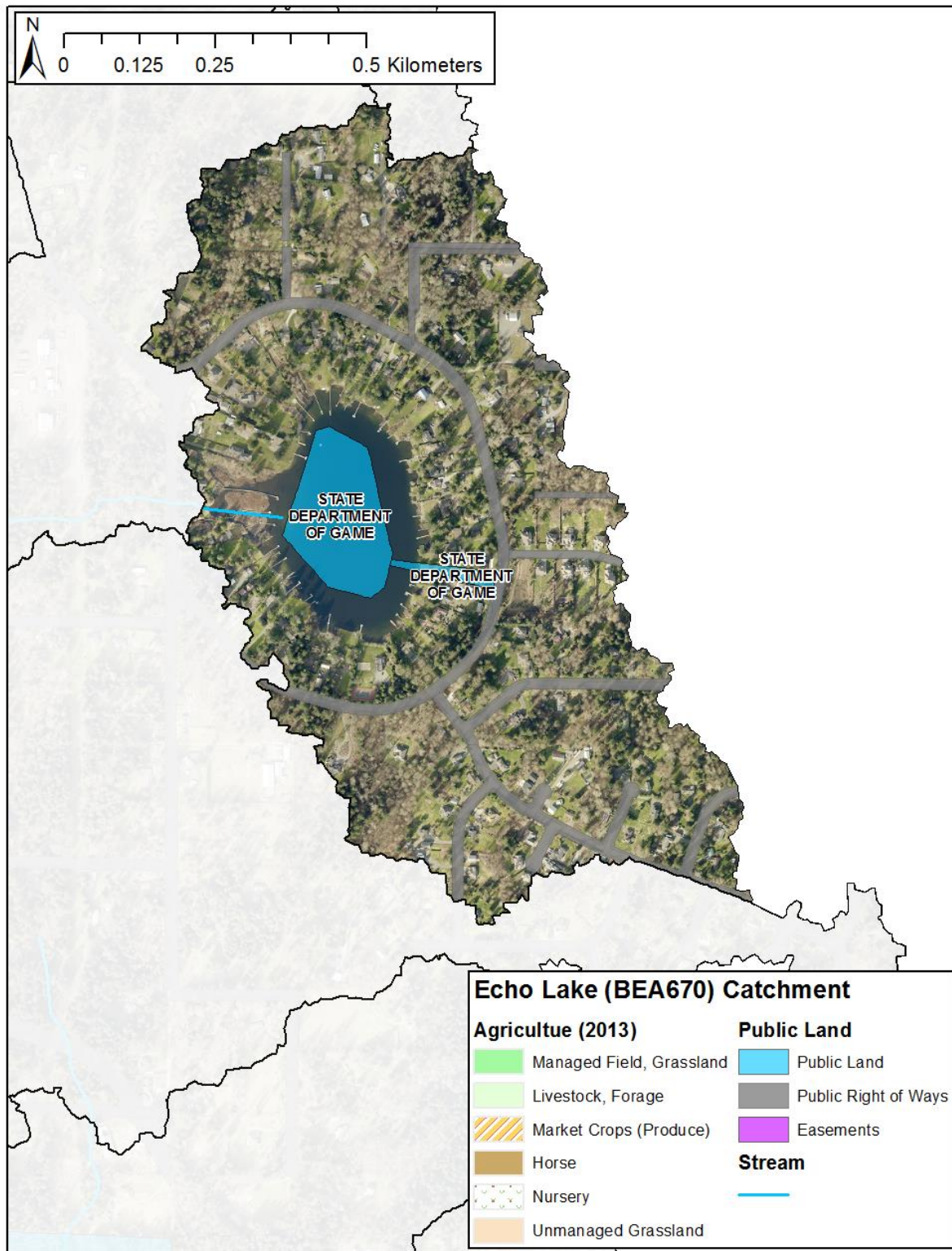
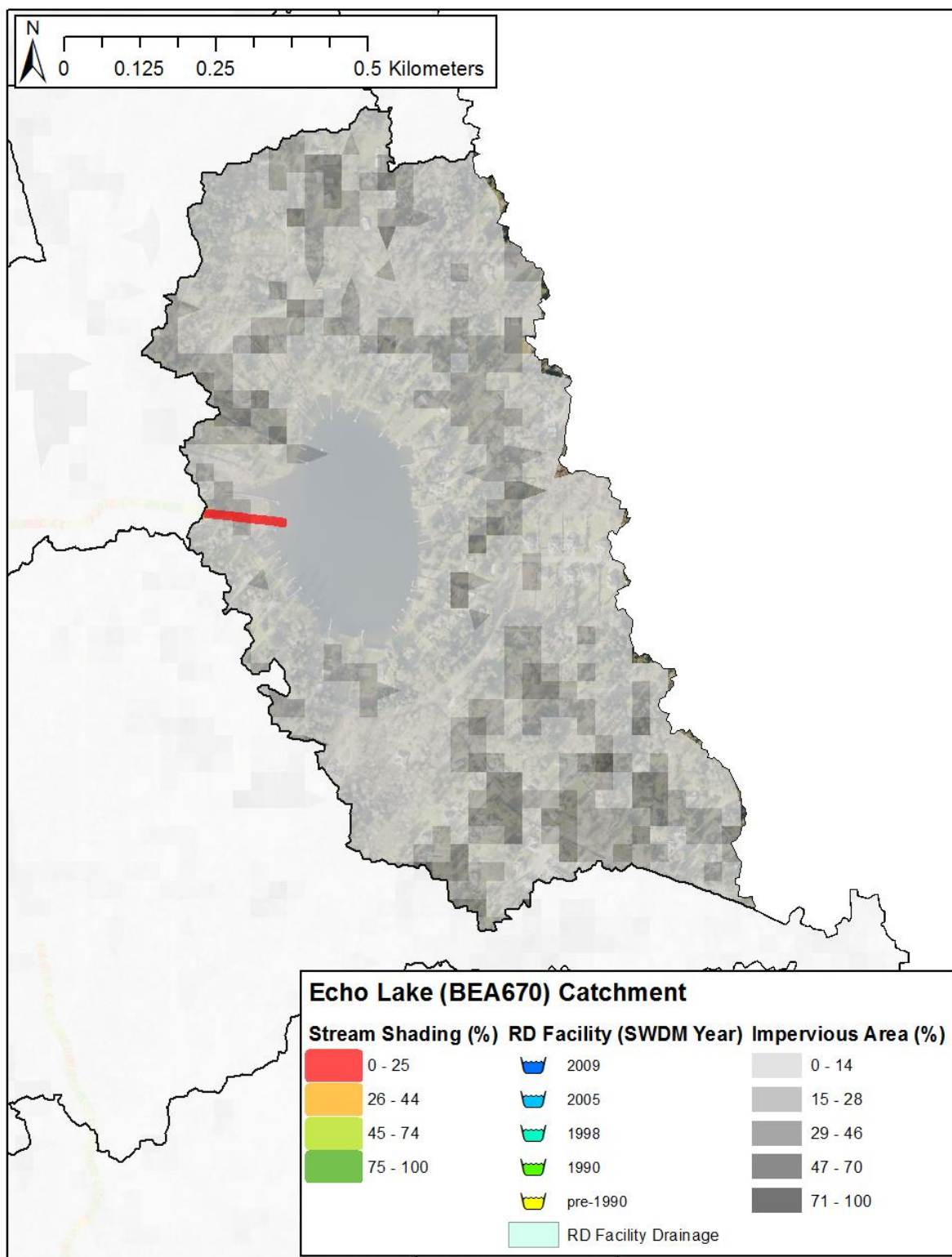


Figure 31. Echo Lake (BEA670) catchment agricultural and public land.



**Figure 32. Echo Lake (BEA670) catchment stream shading, impervious area, and stormwater (RD) facilities and their drainage area.**

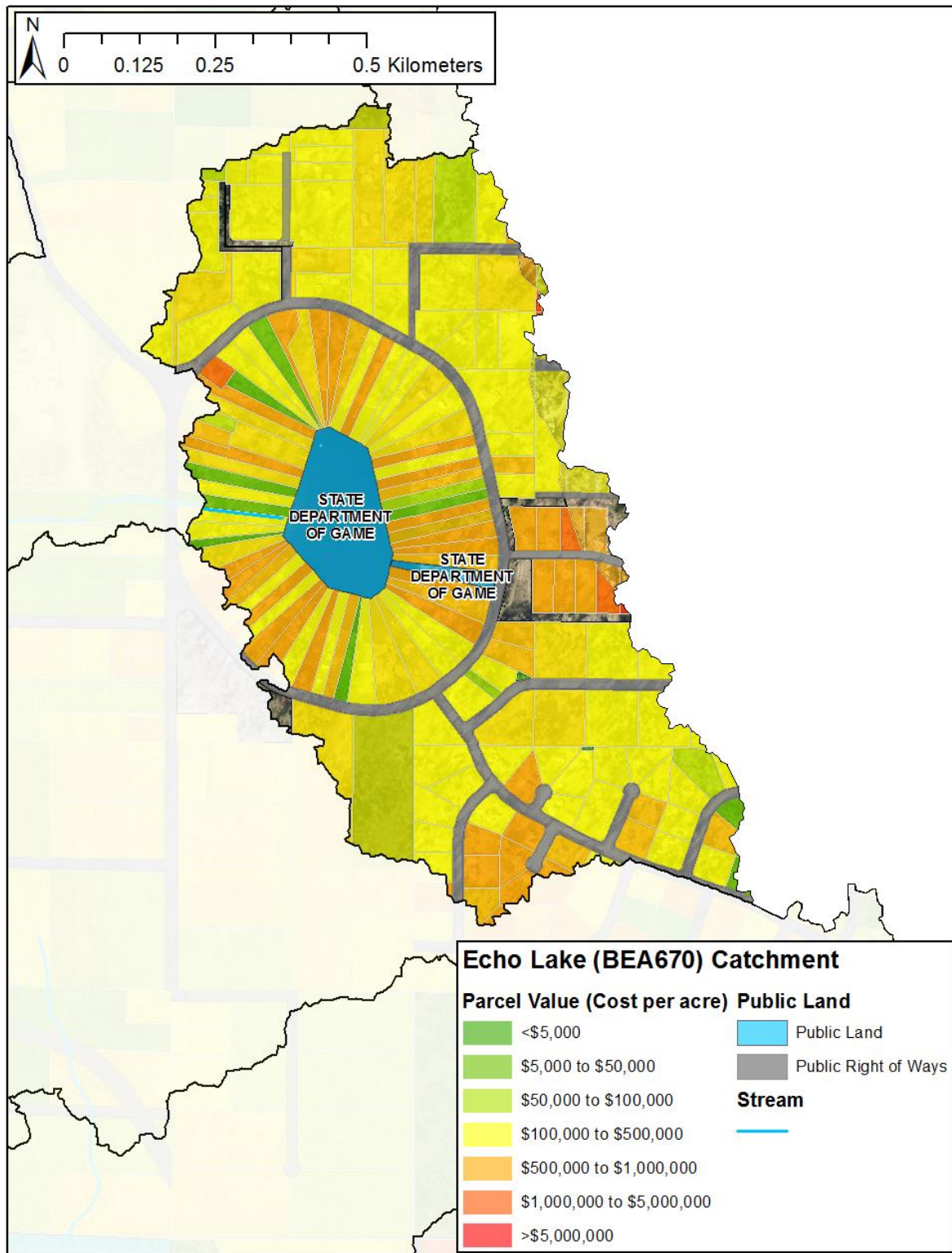


Figure 33. Echo Lake (BEA670) catchment parcel values and public lands.



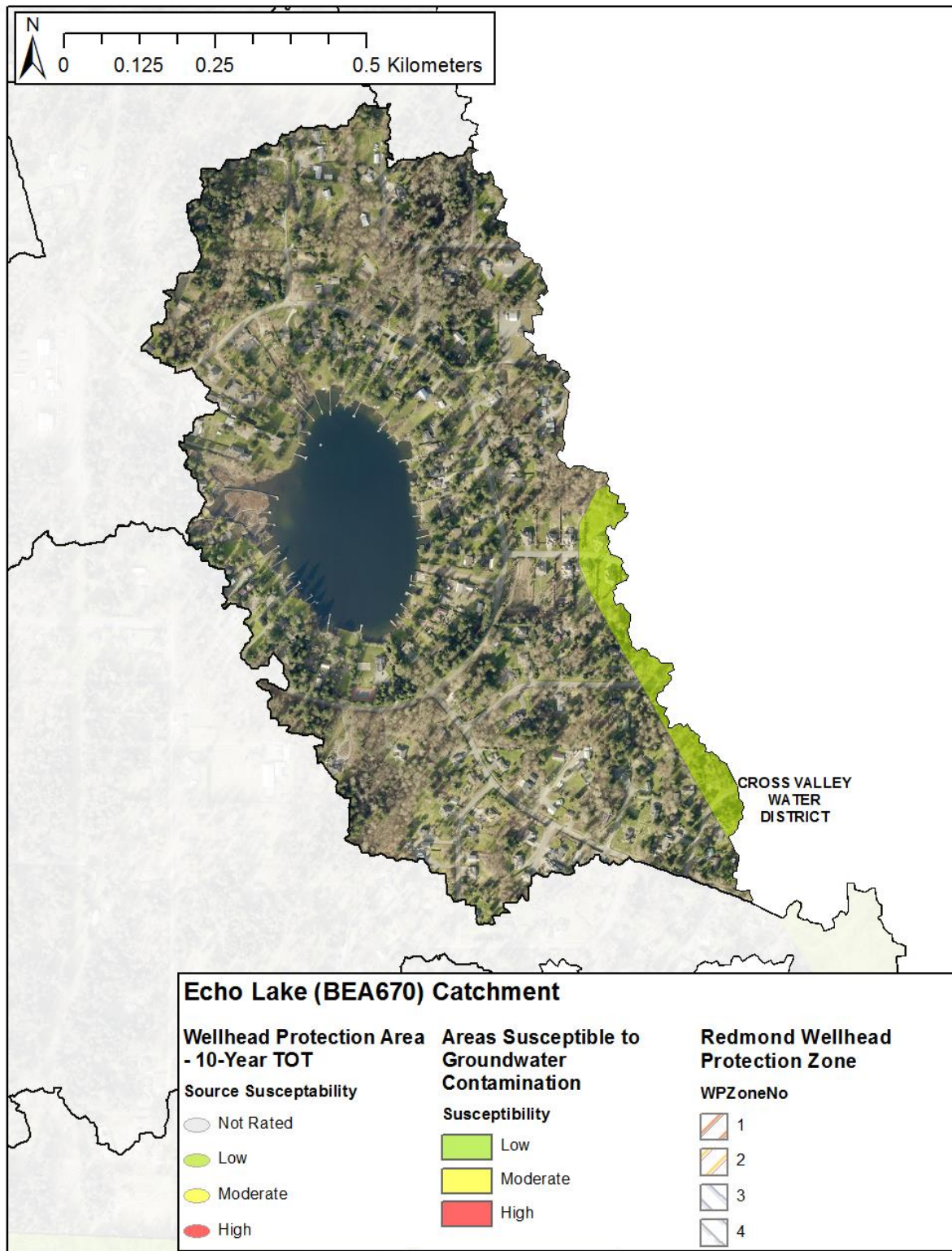


Figure 34. Echo Lake (BEA670) catchment groundwater protection areas



## 4.4 BEA970 – Maltby (Score: 118) (outside study area – drains to Cottage Lake)

The Maltby (BEA970) catchment drains to Crystal Lake, whose outlet is Daniels Creek that drains to Cottage Lake. The catchment is 693 acres in area. The catchment is a mixture of industrial and residential land use. It is identified that the existing stormwater detention and treatment infrastructure be inspected and their drainage area assessed. If undersized or not meeting current standards, it is identified the detention facilities be upgraded. Gaps in the current stormwater infrastructure should be identified and new facilities constructed or flows rerouted to existing facilities. Tree plantings along the waterway are also identified.

Table 20. Available data for Maltby (BEA970) catchment.

Criteria	Data
<b>Existing water quality problems (Crystal Lake -&gt; Daniels Creek -&gt; Cottage Lake)</b>	<ul style="list-style-type: none"> <li>Not assessed as part of water quality assessment.</li> <li>Downstream Crystal Lake is moderately productive and phosphorus limited.</li> <li>Downstream Cottage Lake has a TMDL for phosphorus.</li> </ul>
<b>Existing instream habitat problems</b>	No data
<b>B-IBI (WRIA8 Regression)</b>	Very poor (6.1)
<b>Riparian land cover</b>	No data
<b>Public Lands</b>	13% public land
Monroe School District	27052500100300 27052500102400
University of Washington	27051400400100 27052400200500
East County Park and Recreation	27052400205000 27052400202100
Cross Valley Water District	27052400300900 00427200002100 27052500102500
Snohomish County	27052400308800
Port of Seattle	27052400404800 27052500204400
WSDOT	27052400300500 00619304600003 27052400300300 27052500200100 27052500101500 27052500105100 27052500101900
<b>Horse and Livestock Lands</b>	None
<b>Right-of-Ways</b>	142 acres (including road surface) <ul style="list-style-type: none"> <li>SR 522</li> <li>SR 524</li> <li>Yew Way</li> </ul>

Criteria	Data
	<ul style="list-style-type: none"> <li>Paradise Lake Road</li> <li>Several residential streets</li> </ul>
Property Value	\$419,197
Untreated Impervious Area	33% of catchment is untreated impervious land Much of the southwest and northwest industrial areas are highly impervious
Existing Stormwater Facilities	There are several stormwater detention and treatment facilities in the catchment, but their drainage areas have not yet been mapped.
Easements	None
Groundwater	Several 10-year TOT wellhead protection areas in catchment with moderate susceptibility to contamination
Stream Shade	66% of the stream has less than 50% shading <ul style="list-style-type: none"> <li>Hot spots of low shade: <ul style="list-style-type: none"> <li>Along Yew Way</li> </ul> </li> </ul>

**Table 21. Summary of Identified Strategies for Maltby (BEA970) catchment.**

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X

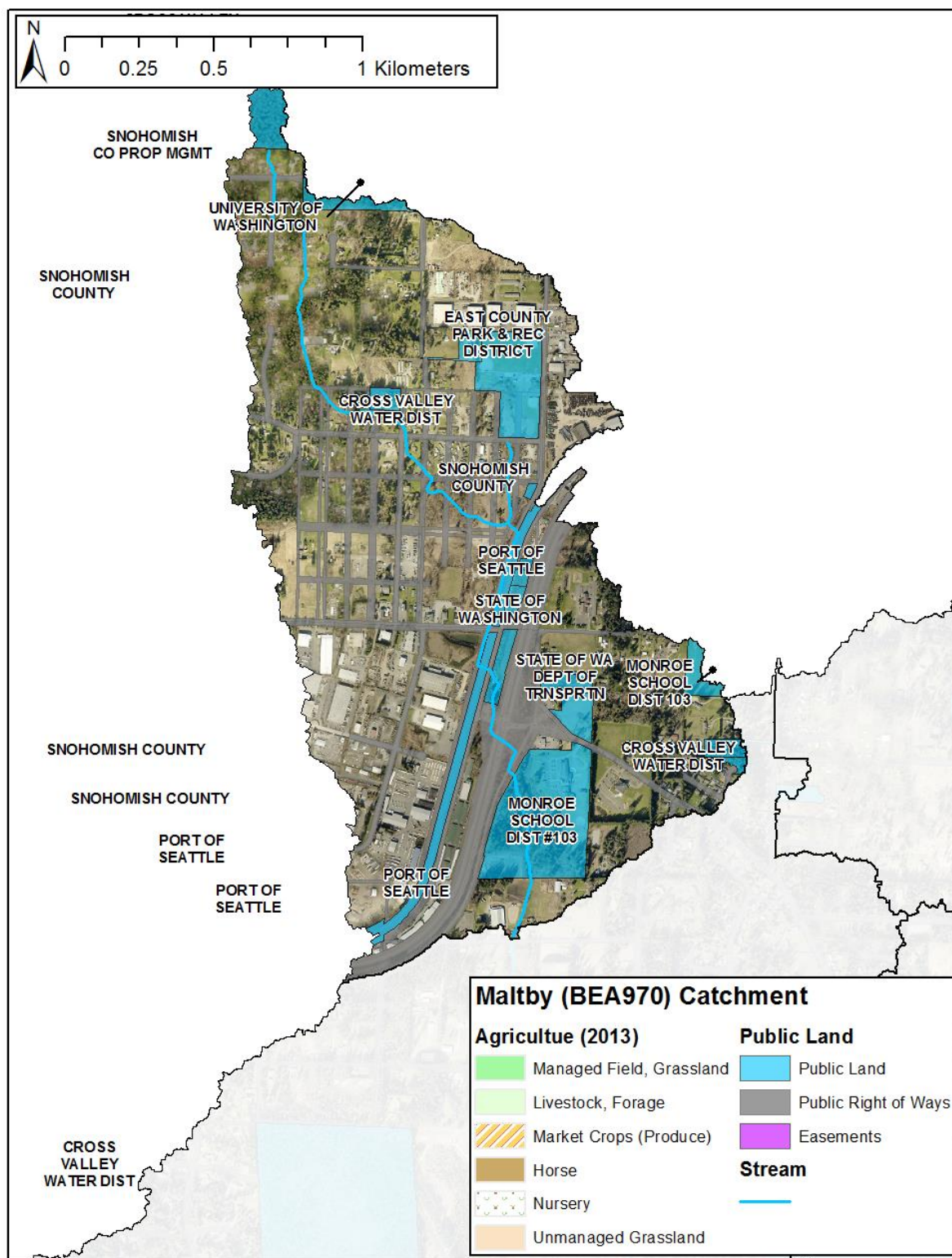
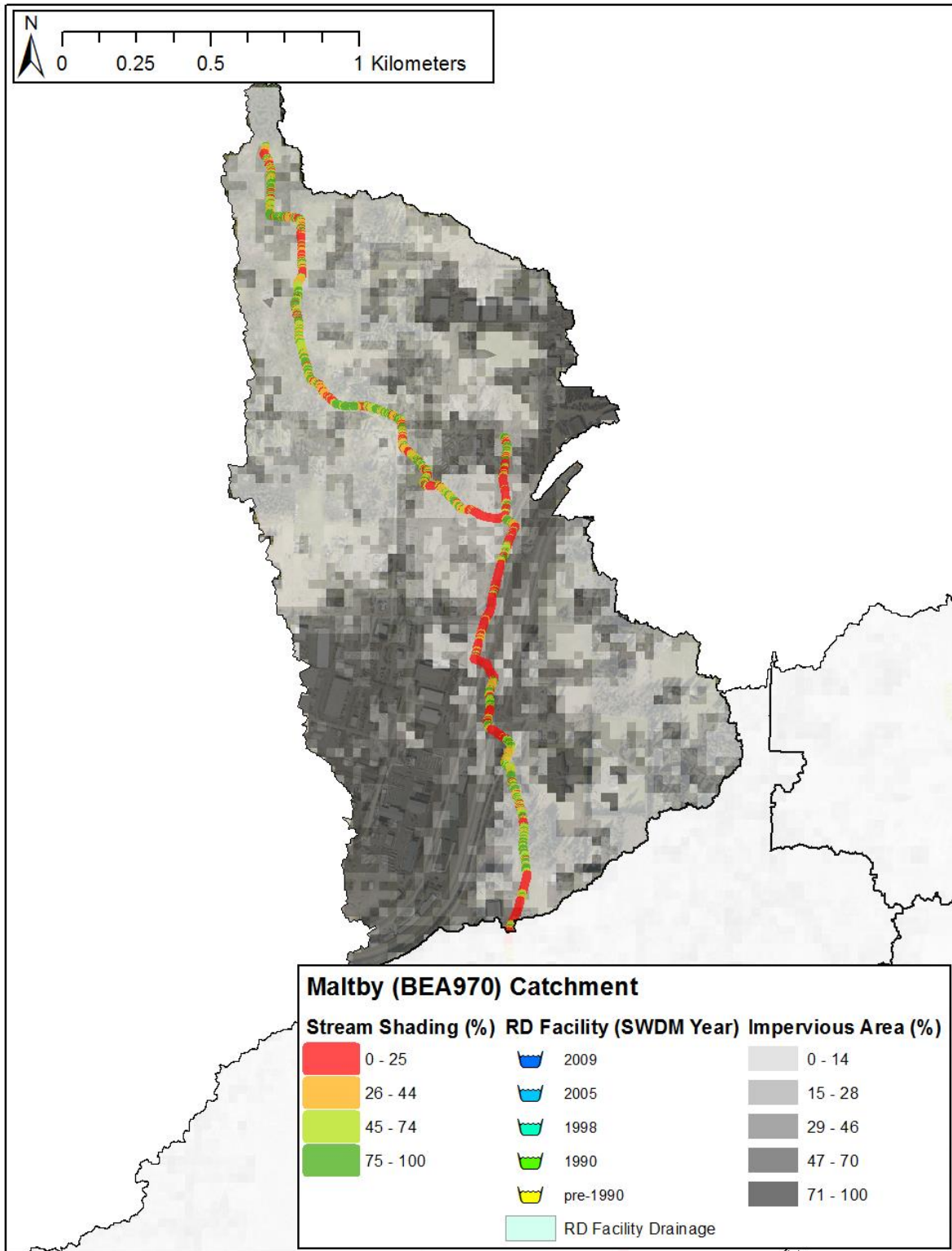


Figure 35. Maltby (BEA970) catchment agricultural and public land.



**Figure 36. Maltby (BEA970) catchment stream shading, impervious area, and RD facilities and their drainage area.**



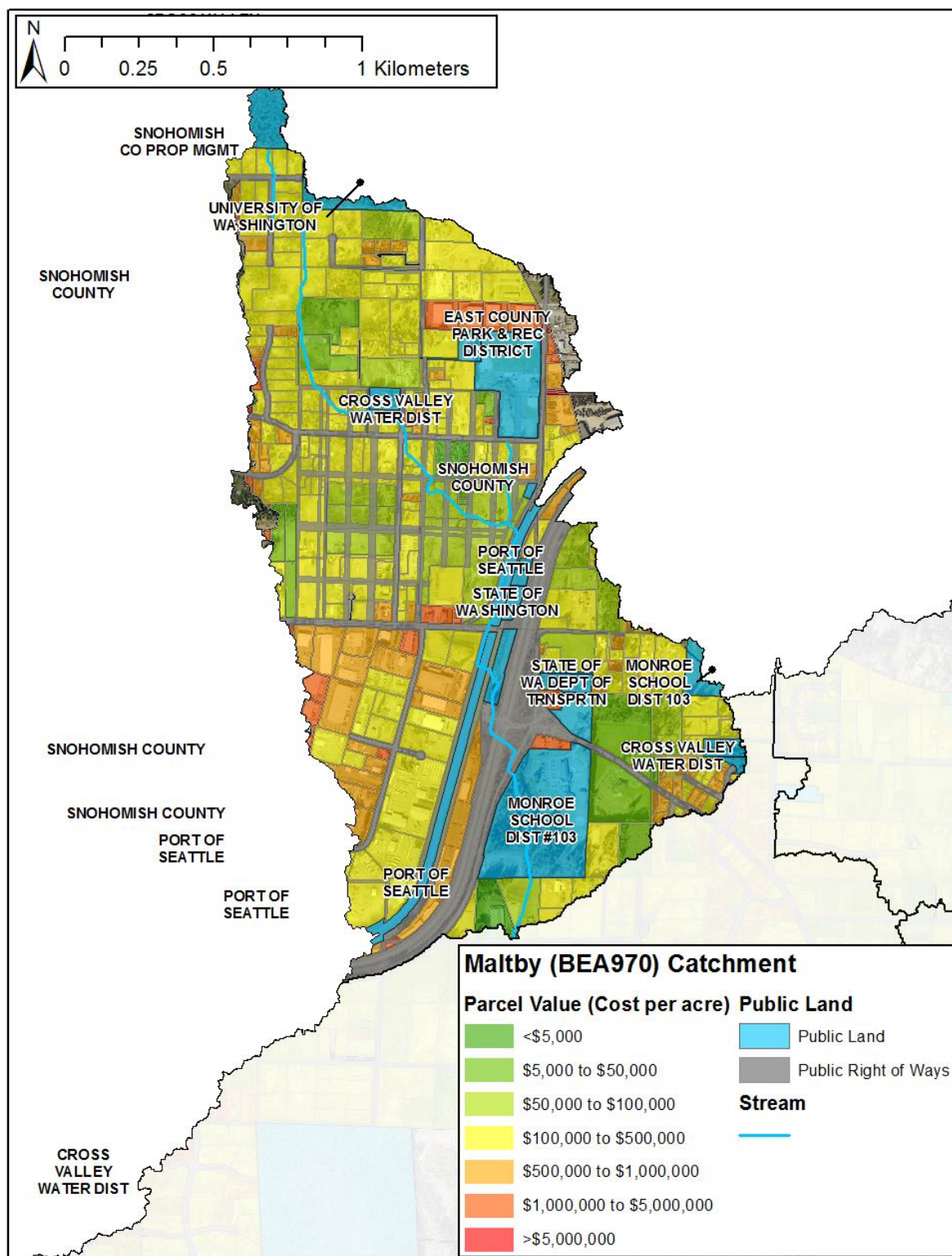


Figure 37. Maltby (BEA970) catchment parcel values and public lands.

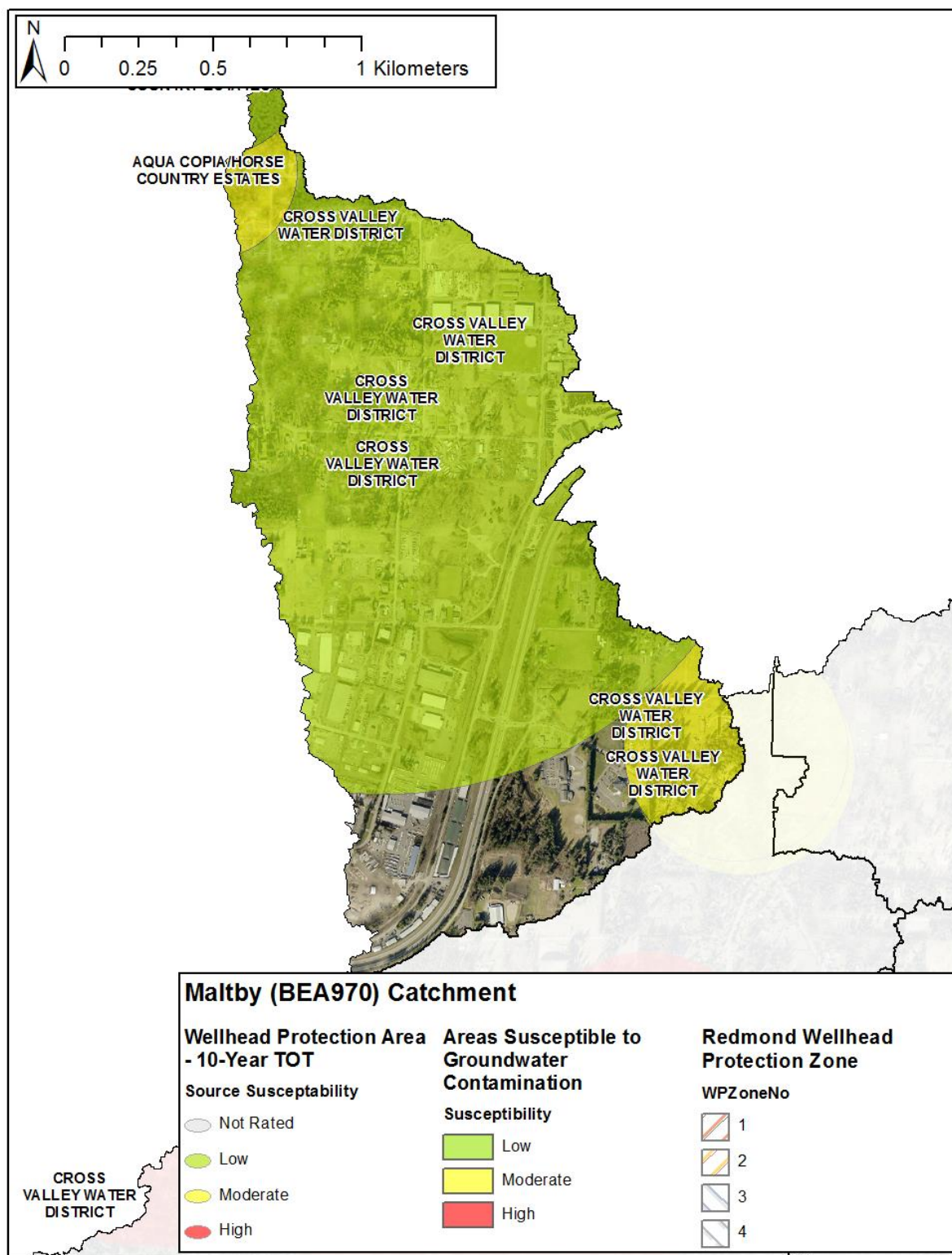


Figure 38. Maltby (BEA970) catchment groundwater protection areas.

## 4.5 BEA920 – Paradise Valley Conservation Area (Score: 65) (outside study area – drains to Cottage Lake)

The Paradise Valley Conservation Area (BEA920) catchment drains to Cottage Lake. The catchment is 593 acres in area. The catchment is a mixture of residential land use and conserved natural areas (Paradise Valley Conservation Area owned by Snohomish County). The catchment includes both King and Snohomish counties, including the residential development along NE 201<sup>st</sup> Dr in King County. It is identified that the existing stormwater detention and treatment infrastructure be inspected and their drainage area assessed. If undersized or not meeting current standards, it is identified the detention facilities be upgraded. Gaps in the current stormwater infrastructure should be identified and new facilities constructed or flows rerouted to existing facilities. Tree plantings along the waterway are also identified.

**Table 22. Available data for Paradise Valley Conservation Area (BEA920) catchment.**

Criteria	Data
<b>Existing water quality problems</b>	<ul style="list-style-type: none"> <li>Not assessed as part of water quality assessment.</li> <li>Downstream Cottage Lake has a TMDL for phosphorus.</li> </ul>
<b>Existing instream habitat problems</b>	No data
<b>B-IBI (WRIA8 Regression)</b>	Fair (52.9)
<b>Riparian land cover</b>	No data
<b>Public Lands</b>	43% public land
King County WLRD	9359300710
Snohomish County	27063100300100 27063100100200 27063100200300 00422800003400 27063000302000
<b>Horse and Livestock Lands</b>	no
<b>Right-of-Ways</b>	36 acres (including road surface) Paradise Lake Road Several residential streets in King and Snohomish counties
<b>Property Value</b>	\$635,043 per acre
<b>Untreated Impervious Area</b>	8% of catchment is untreated impervious land
<b>Existing Stormwater Facilities</b>	Snohomish County detention pond (MA0339RMDP) Snohomish County detention pond (MA0334RMDP)
<b>Easements</b>	None
<b>Groundwater</b>	<ul style="list-style-type: none"> <li>King County portion of catchment is low susceptibility to groundwater contamination</li> <li>A 10-year TOT wellhead protection area in the eastern catchment with low susceptibility to contamination</li> </ul>
<b>Stream Shade</b>	73% of the stream has less than 50% shading

**Table 23. Summary of Identified Strategies for Paradise Valley Conservation Area (BEA920) catchment.**

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X



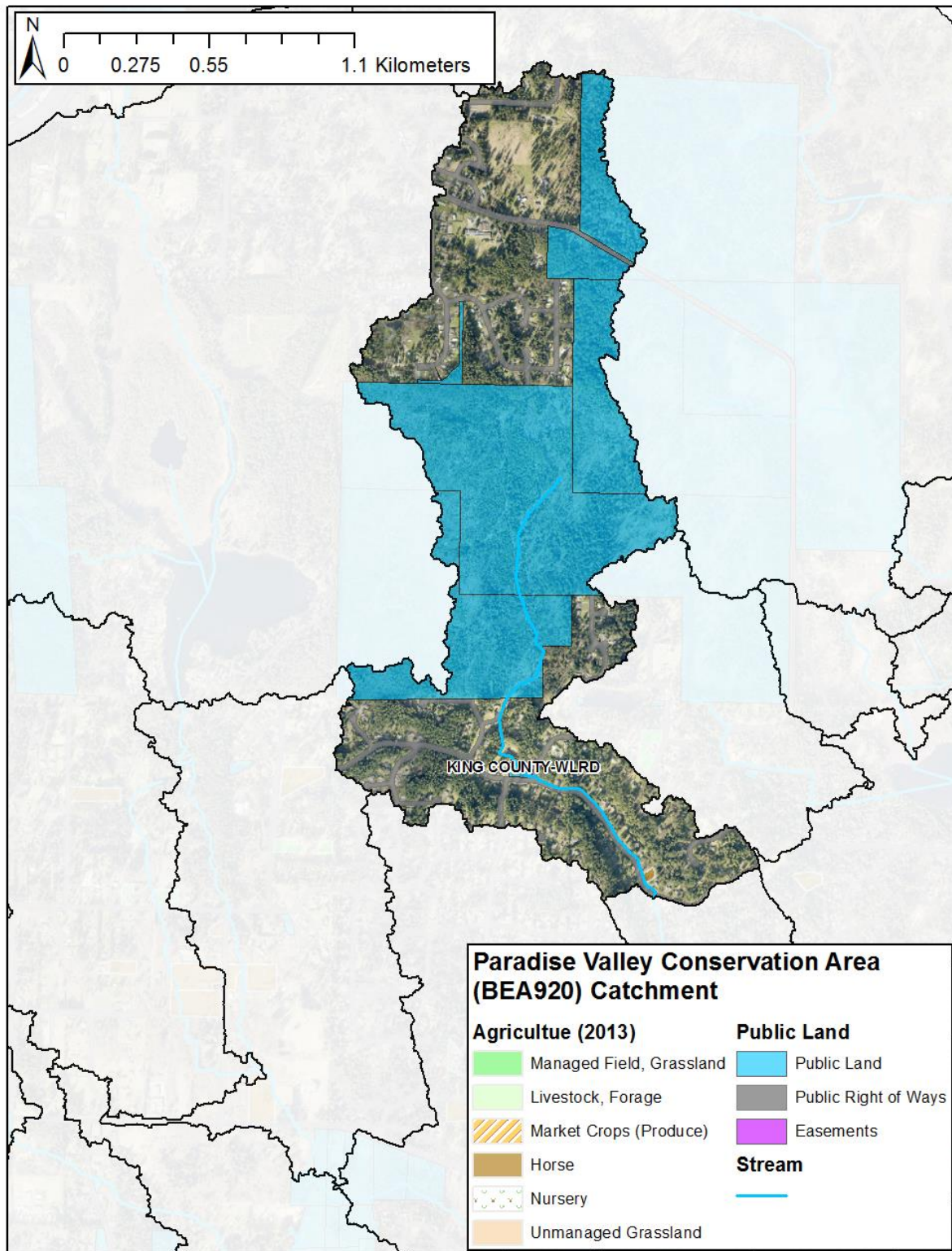
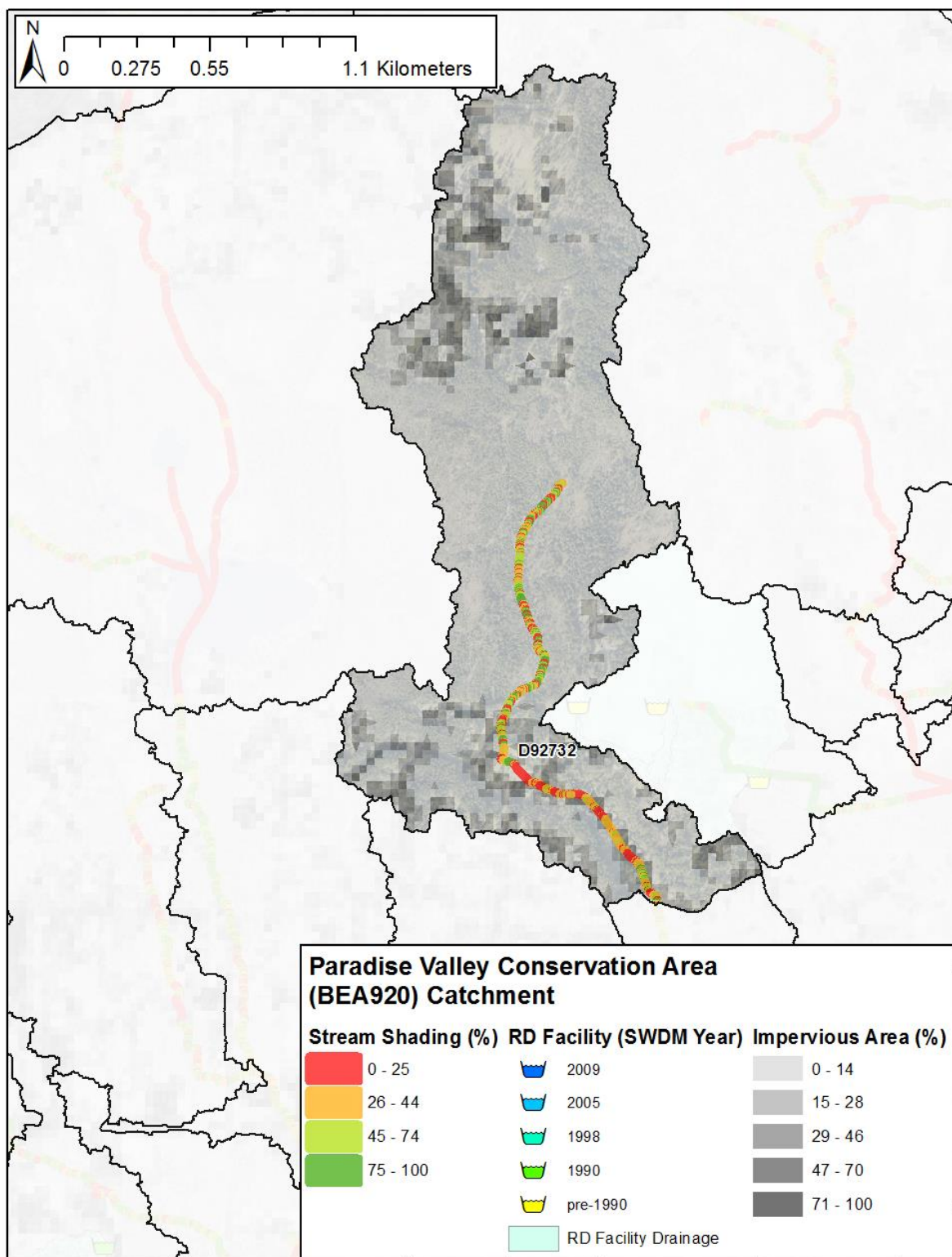


Figure 39. Paradise Valley Conservation Area (BEA920) catchment agricultural and public land.



**Figure 40. Paradise Valley Conservation Area (BEA920) catchment stream shading, impervious area, and stormwater (RD) facilities and their drainage area.**



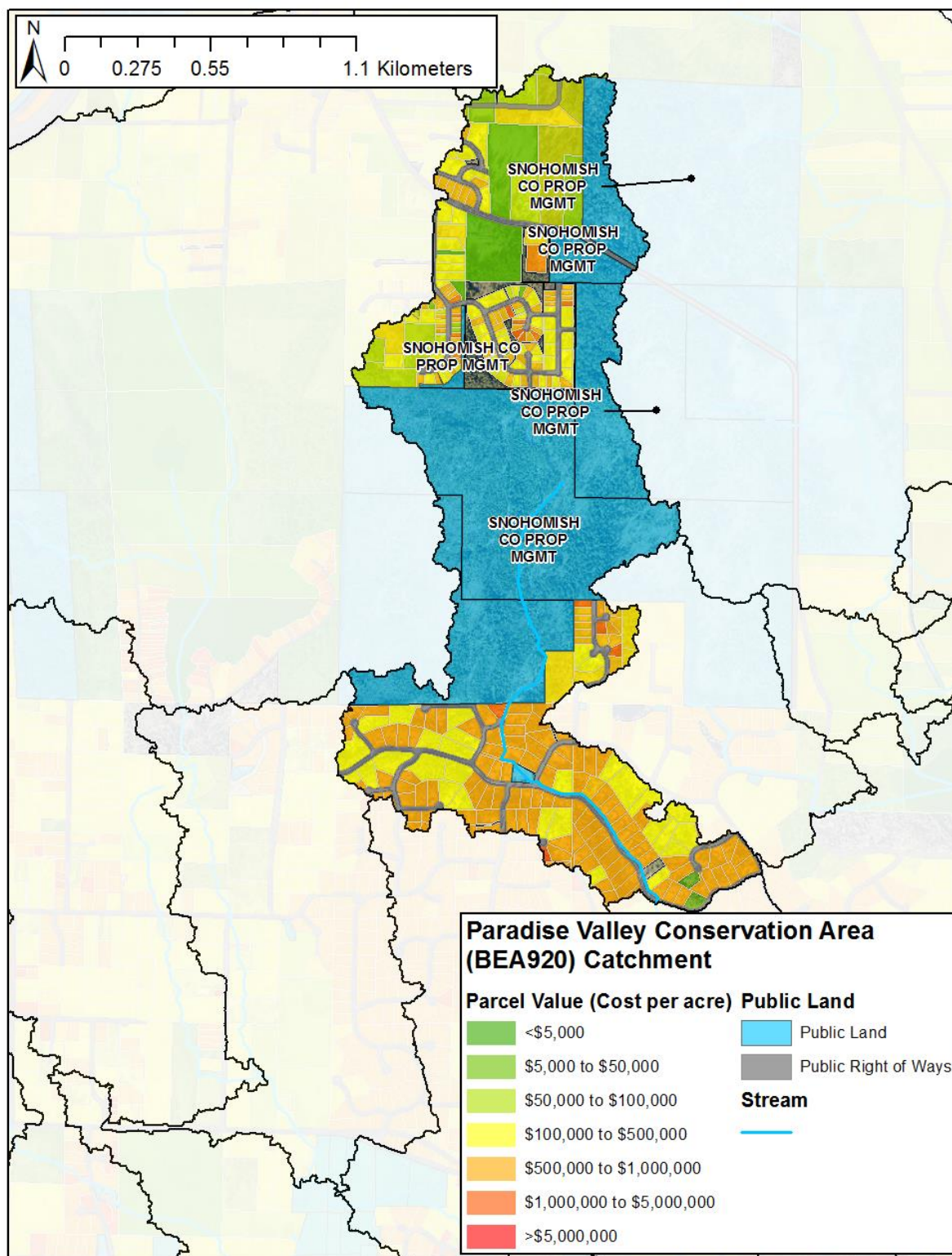


Figure 41. Paradise Valley Conservation Area (BEA920) catchment parcel values and public lands.

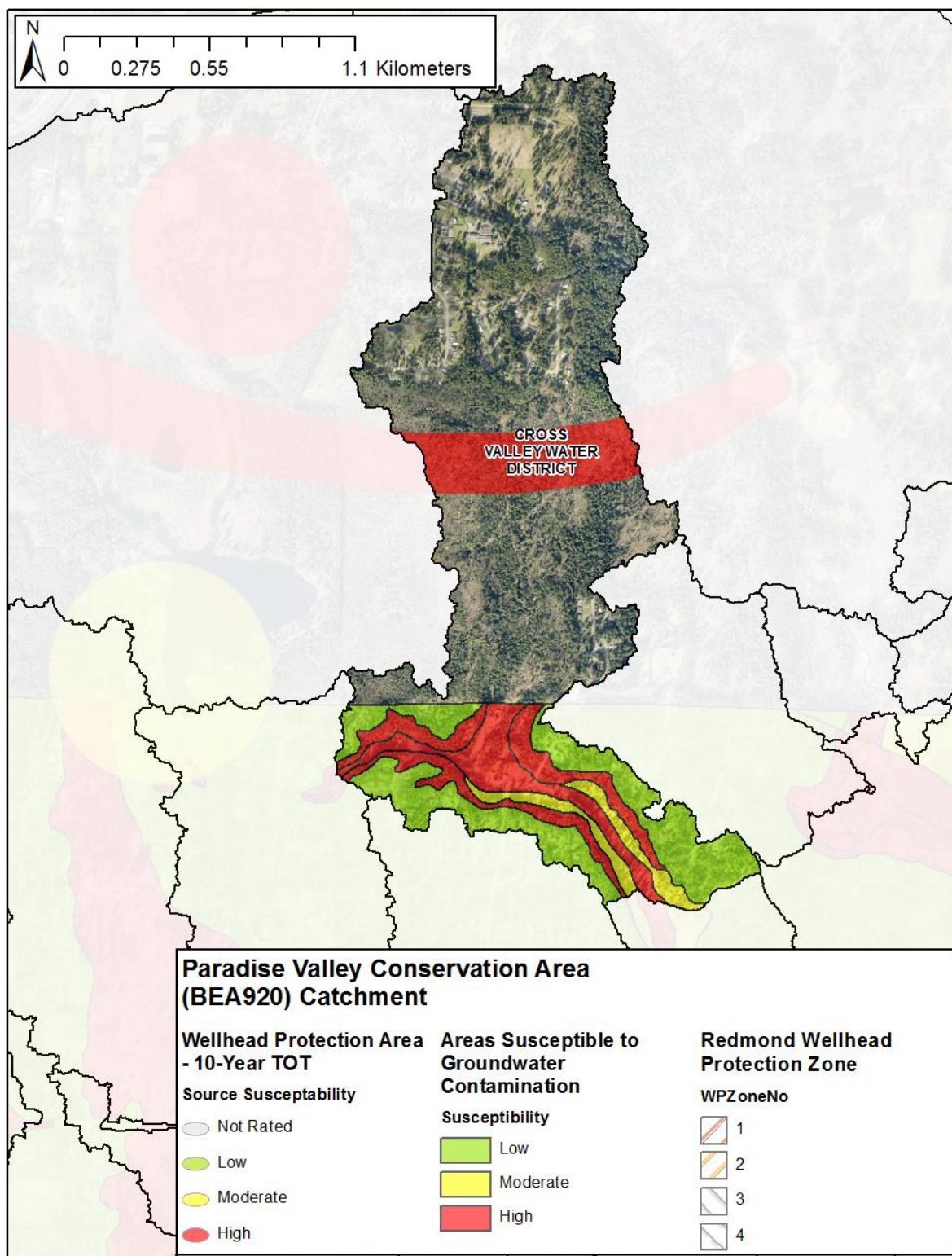


Figure 42. Paradise Valley Conservation Area (BEA920) catchment groundwater protection areas.



## 5.0 PRIORITY CITY OF REDMOND CATCHMENTS

For catchments located primarily within the City of Redmond, The data input to the prioritization metric and the resulting final score are displayed in Table 24 with the catchments ranked. The following sections detail the five top-ranked catchments and discuss potential projects and actions to improve water quality and hydrology.

**Table 24. Ranked catchments located primarily in City of Redmond and prioritization metric input data.**

Catchment	Scoring Metrics									Total Score
	Water Quality	B-IBI	Untreated Impervious	Storm-water Facility	Forage Live-stock	Property Cost	Public Land	Right - of-way	Roof	
BEA190	15	20	30	0	0	5	10	8	15	103
MON	25	30	10	10	0	5	0	8	15	103
BEA110	15	20	30	0	0	5	0	15	15	100
BEA100	15	10	30	0	10	5	10	8	10	98
BEA010	25	10	30	0	0	10	0	0	15	90
BEA080	15	20	30	0	0	5	0	8	10	88

### 5.1 BEA190 – Tyler’s Creek (Score: 103)

The Tyler’s Creek watershed is 168 acres, and 167 acres are located in the City. Land use is predominantly single-family residential. There are large tracts of undeveloped land in the headwaters.

Most of the developed watershed needs stormwater runoff treatment facilities. In addition, replanting buffers with shade producing trees would help lower water temperature, especially during low flow periods. Last, retrofitting the NE 116th Street with stormwater treatment facilities would significantly reduce the untreated stormwater runoff entering Tyler’s Creek.

The installation of LID features throughout the catchment is identified. An incentive program may be used for LID installation for existing development.

**Table 25. Available data for Tyler's Creek (BEA190) catchment.**

Criteria	Data
<b>Existing water quality problems</b>	<ul style="list-style-type: none"> <li>Not assessed as part of water quality assessment.</li> </ul>
<b>Existing instream habitat problems</b>	<ul style="list-style-type: none"> <li>Known fish passage barriers</li> </ul>
<b>B-IBI (WRIA8 Regression)</b>	Very poor (13)
<b>Riparian land cover</b>	18% impervious 32% trees 35% shrub 15% other (water, bare area, grass, etc.)
<b>Public Lands</b>	10% public land
<b>City of Redmond</b>	3626059137(Utility ROW) 2193320520 2193320530 2193310720 2193320540
<b>Horse and Livestock Lands</b>	none
<b>Right-of-Ways</b>	24 acres (including road surface) Several residential streets
<b>Property Value</b>	\$4,583,834 per acre
<b>Untreated Impervious Area</b>	36% of catchment is untreated impervious area based on mapped facility drainage area Emerald Heights Retirement Community Residential streets
<b>Existing Stormwater Facilities</b>	<ul style="list-style-type: none"> <li>Several ponds near Emerald Heights built before 1990</li> <li>Redmond Vault 890104002</li> <li>Redmond Vault 08-0840</li> <li>Redmond Pond 06-0200 built in 2006</li> <li>Several Redmond Ponds (no recording number)</li> </ul>
<b>Easements</b>	None
<b>Groundwater</b>	Much of the catchment is in Redmond Wellhead Protection Zone 3. The eastern region is Zone 2, which restricts infiltration of pollution-generating hard surfaces runoff, excluding single-family residential runoff. The catchment has low to high susceptibility to groundwater contamination.
<b>Stream Shade</b>	60% of the stream has less than 50% shading Hot spots of low shade: <ul style="list-style-type: none"> <li>Near utility ROW</li> </ul>

**Table 26. Summary of Identified Strategies for Tyler's Creek (BEA190) catchment.**

Strategy	Benefits
----------	----------

	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X

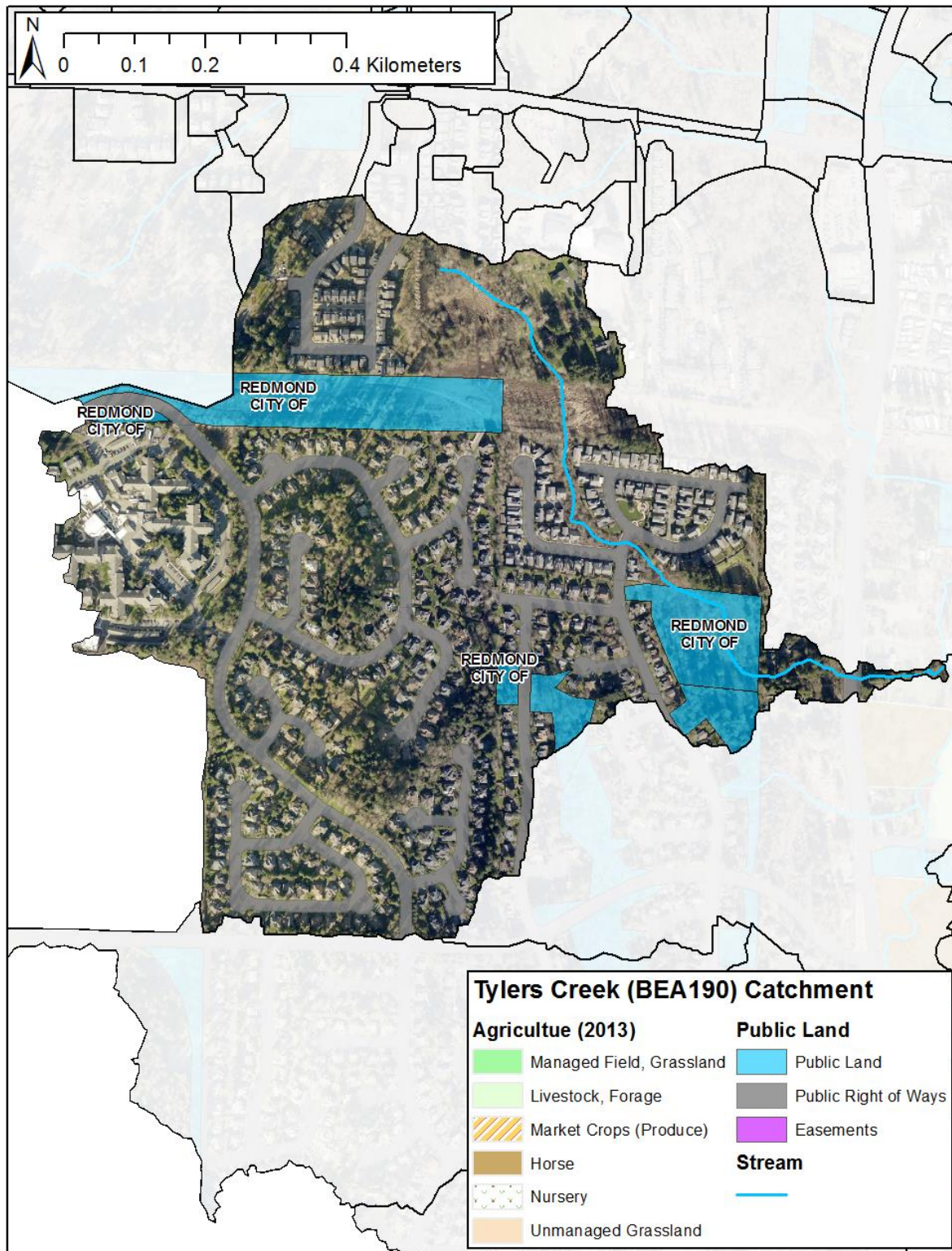
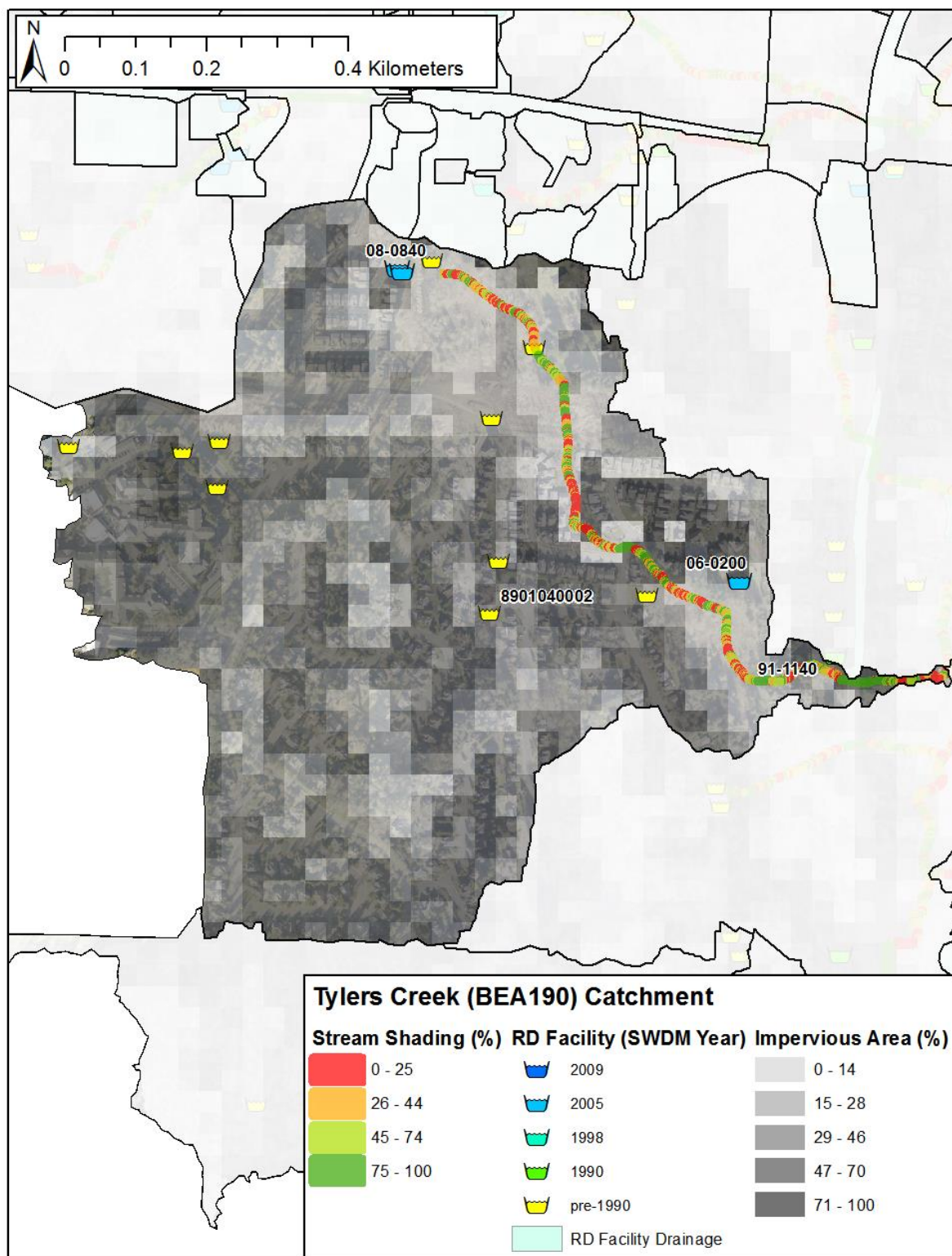


Figure 43. Tyler's Creek (BEA190) catchment agricultural and public land.





**Figure 44.** Tyler's Creek (BEA190) catchment stream shading, impervious area, and RD facilities and their drainage area.

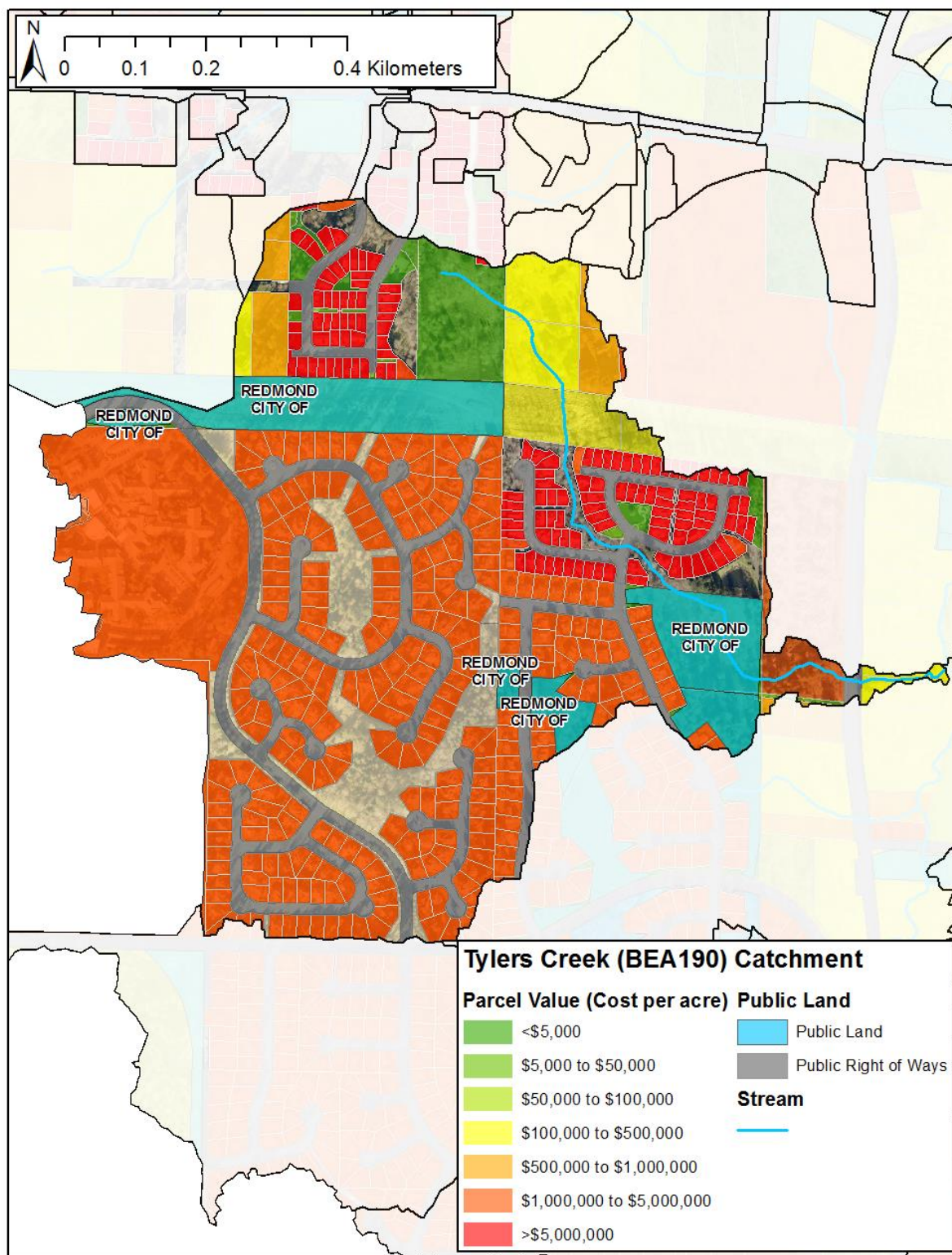
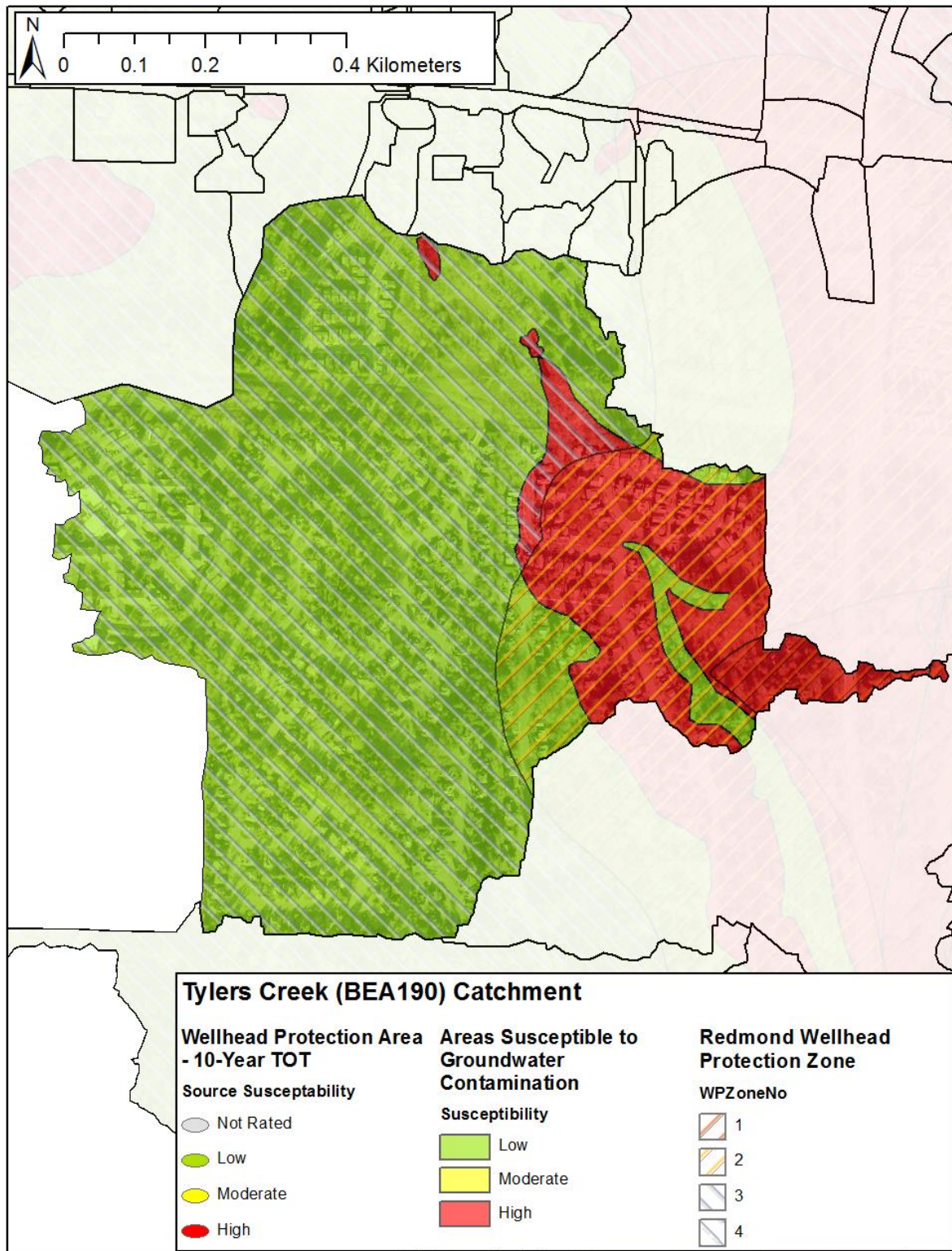


Figure 45. Tyler's Creek (BEA190) catchment parcel values and public lands.





**Figure 46.** Tyler's Creek (BEA190) catchment groundwater protection areas. Bottom-left to top-right hatching for Redmond indicates infiltration restriction for pollution-generating hard surfaces runoff, excluding single-family residential runoff.

## 5.2 MON – Monticello Creek (Score: 103)

The Monticello Creek (MON) catchment drains Monticello Creek, which is predominately located within the City of Redmond. The catchment is 359 acres in area. The catchment is urbanized; near the mouth of Monticello Creek, commercial development is present and the remainder of the watershed is low- to mid-density residential. The installation of a regional facility that treats runoff from the commercial land at Avondale and 116<sup>th</sup> St is identified; the facility could also treat runoff along the length of 116<sup>th</sup> St.

The RD facilities D91746 and D91372 were both constructed prior to 1990 and the DT0059 facility was constructed in 1993. It is likely they do not meet current design standards. It identified that these facilities be inspected and, if needed, updated to provide better storage and water quality treatment. There are several municipal and private stormwater facilities located within the City of Redmond. The inspection of these facilities is also identified.

The installation of LID features throughout the catchment is identified. An incentive program may be used for LID installation for existing development.

**Table 27. Available data for Monticello Creek (MON) catchment.**

Criteria	Data
<b>Existing water quality problems</b>	<ul style="list-style-type: none"> <li>• Temperature (54% of summer 7-DADMax temperatures exceed water quality standards)</li> <li>• Fecal Coliform (the stream did not meet the geometric mean and 90th percentile water quality criteria)</li> <li>• Total Suspended Solids (wet-weather samples are 20-times that of baseflow samples)</li> </ul>
<b>Existing instream habitat problems</b>	Moderate habitat quality (King County et al., 1989)
<b>B-IBI (WRIA8 Regression)</b>	Poor (34.3)
<b>Riparian land cover</b>	13% impervious 31% trees 29% shrub 12% pasture 13% other (water, bare area, grass, etc.)
<b>Public Lands</b>	7% public lands
<b>City of Redmond</b>	3626059137 (utility ROW); 3626059101; 7273100100; 2526059202 (stormwater pond); 1873100710 (Curry Drainage); 2526059224; 2526059233 (stormwater pond); 2568200960 (Fisher Village Drainage); 2568200980 (Fisher Village Drainage); 8560800220 (Taloor Aye Drainage); 9348700640 (stormwater pond); 9526600760 (Woodlands West Storm Drainage); 9578090480 (Wynstone Storm Drainage); 2526059109 (Smith



Criteria	Data
	Woods); 2526059110 (Smith Woods)
King County WLRD	1862000400; 9578050390
King County Property Services	2526059203
King County Parks	7273100080
King County Roads	7273100085 (Stormwater Pond: DT0059)
<b>Horse and Livestock Lands</b>	None
<b>Right-of-Ways</b>	52 acres (including road surface) NE 116 <sup>th</sup> St NE 128 <sup>th</sup> St Several residential streets
<b>Property Value</b>	\$3,470,461 Property values are generally lower outside Redmond city limits and along the south fork (however, these parcels were developed in 2017 and likely are not viable for acquisition).
<b>Untreated Impervious Area</b>	8% of catchment is untreated impervious land <ul style="list-style-type: none"> <li>Avondale Rd and NE 116<sup>th</sup> St</li> </ul>
<b>Existing Stormwater Facilities</b>	<ul style="list-style-type: none"> <li>RD Pond for Avondale Rd north of NE 116th St (DT0059) –built 1993</li> <li>RD Pond for Wyndham Knoll (D91746) – built 1988</li> <li>RD Pond for Crown Heights (D91372) – built 1986</li> <li>Redmond Pond 04-0925 – built 2004</li> <li>Redmond Pond 03-2500 – built 2003</li> <li>Redmond Pond 01-1600 – built 2002</li> <li>Redmond Pond 02-1850 – built 2002</li> <li>Redmond Pond 06-1200 – built 2006</li> <li>Redmond Pond 04-0250 – built 2004</li> <li>Redmond Pond 04-0925 – built 2004</li> <li>Redmond Pond 03-2850 – built 2003</li> <li>Redmond Pond 03-2500 – built 2003</li> <li>Redmond Pond 95-0980 – built before 1990</li> <li>Redmond Pond 02-1010 – built 2003</li> <li>Redmond Vault 00-0100 – built 1999</li> <li>Redmond Vault 95-0980 – built before 1990 (Einstein Elementary)</li> <li>Redmond Vault 04-0700 – built 2005</li> <li>Redmond Vault 07-1300 – built 2007</li> <li>Redmond Vault 04-1150 – built 2004</li> <li>Redmond Vault 06-1850 – built 2006</li> <li>Redmond Vault 96-2370 – built 1996</li> <li>Redmond Vault 12-0180 – built 2012</li> </ul>
<b>Easements</b>	None
<b>Groundwater</b>	Much of the catchment is in Redmond Wellhead Protection Zone 3. The SE region near Avondale and 116 <sup>th</sup> St is Zone 2, which restricts infiltration of pollution-generating hard surfaces runoff, excluding single-family residential runoff.

Criteria	Data
	The catchment has low to high susceptibility to groundwater contamination.
<b>Stream Shade</b>	82% of the stream has less than 50% shading Hot spots of low shade: <ul style="list-style-type: none"> <li>North of the Redmond city limit along the Monticello Creek North Fork</li> <li>The south fork upstream of 116<sup>th</sup> St NE.</li> </ul>

**Table 28. Summary of Identified Strategies for Monticello Creek (MON) catchment.**

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Incentivize agricultural BMPs for horse pastureland			X	X	
Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X

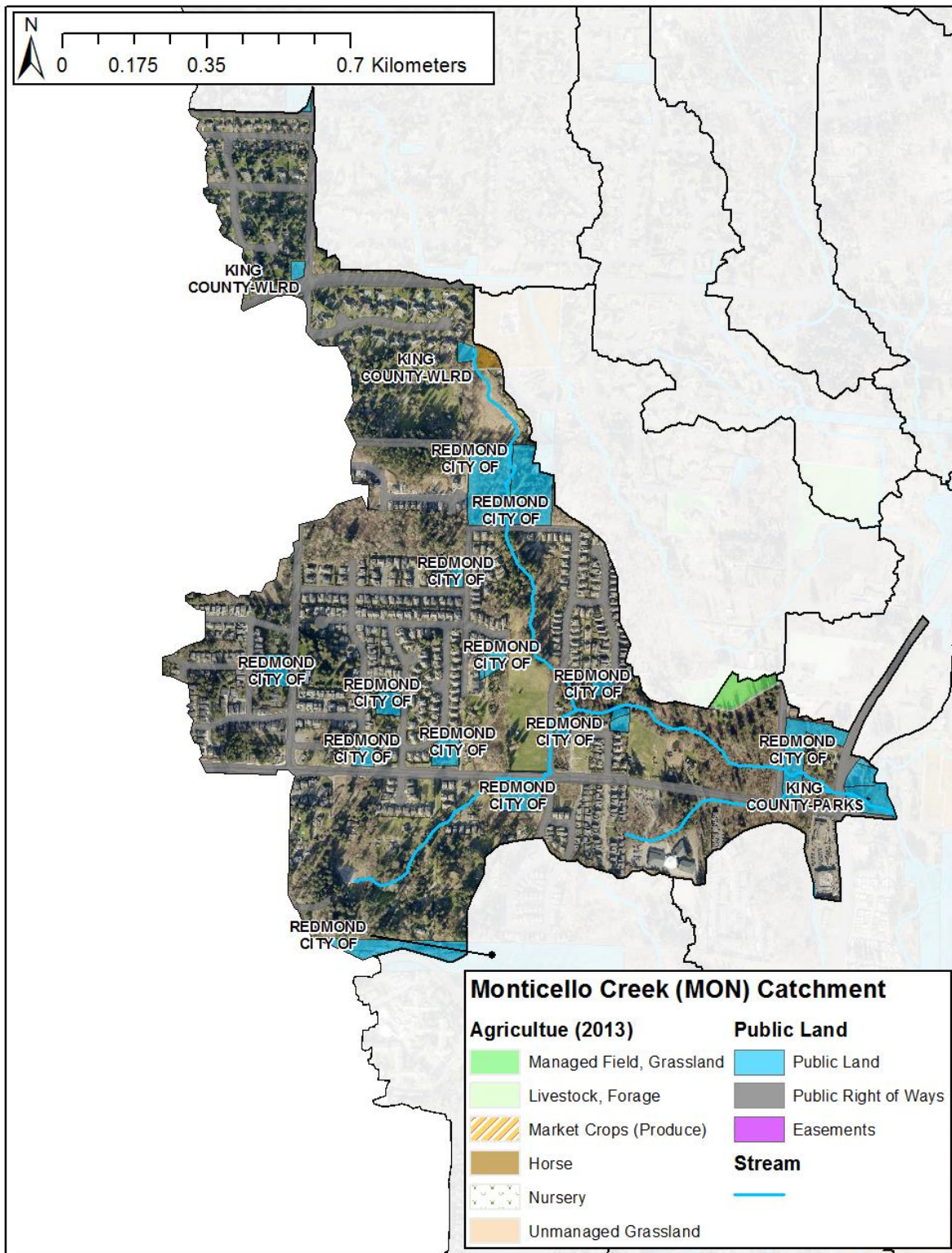


Figure 47. Monticello Creek (MON) catchment agricultural and public land.

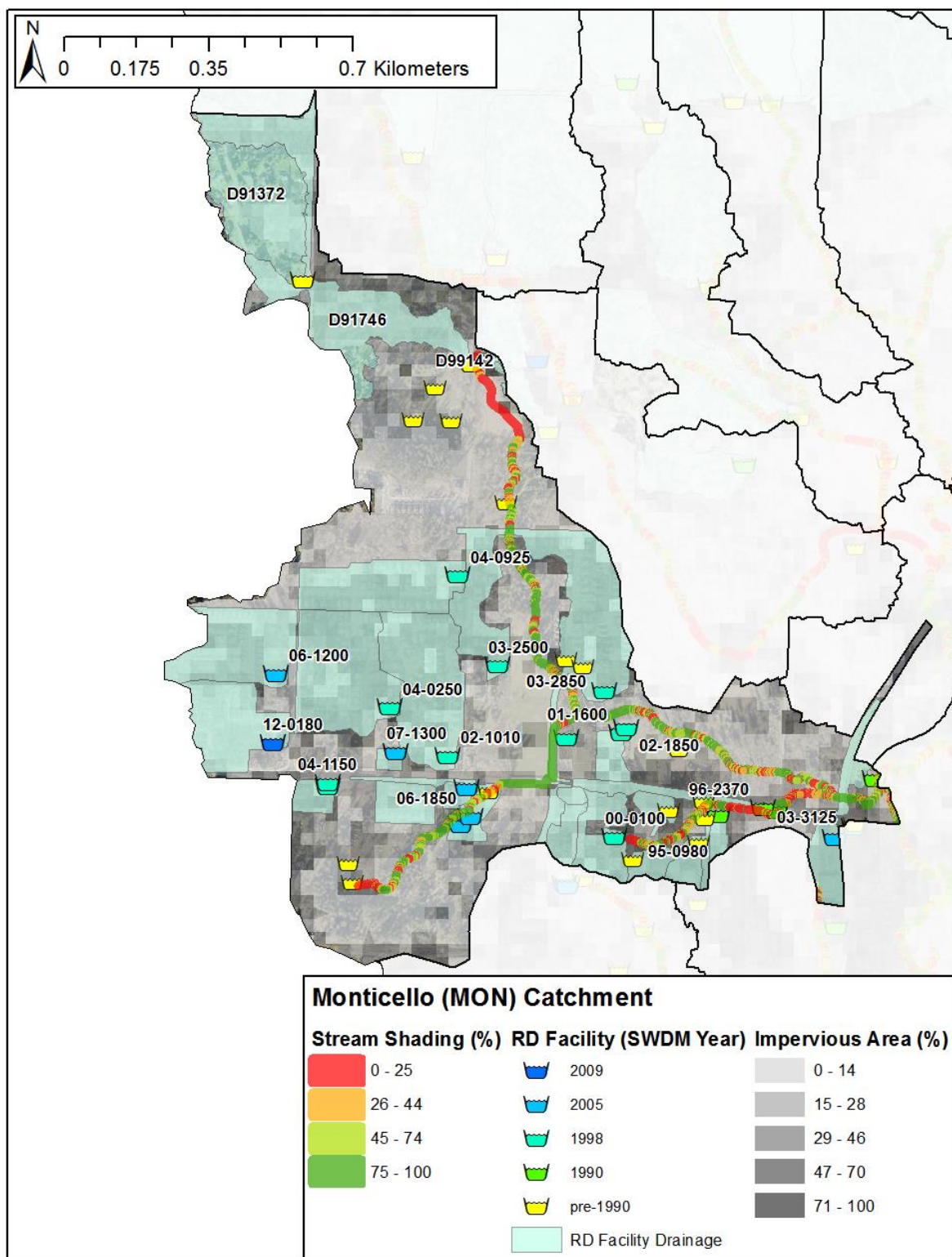


Figure 48. Monticello Creek (MON) catchment stream shading, impervious area, and RD facilities and their drainage area.



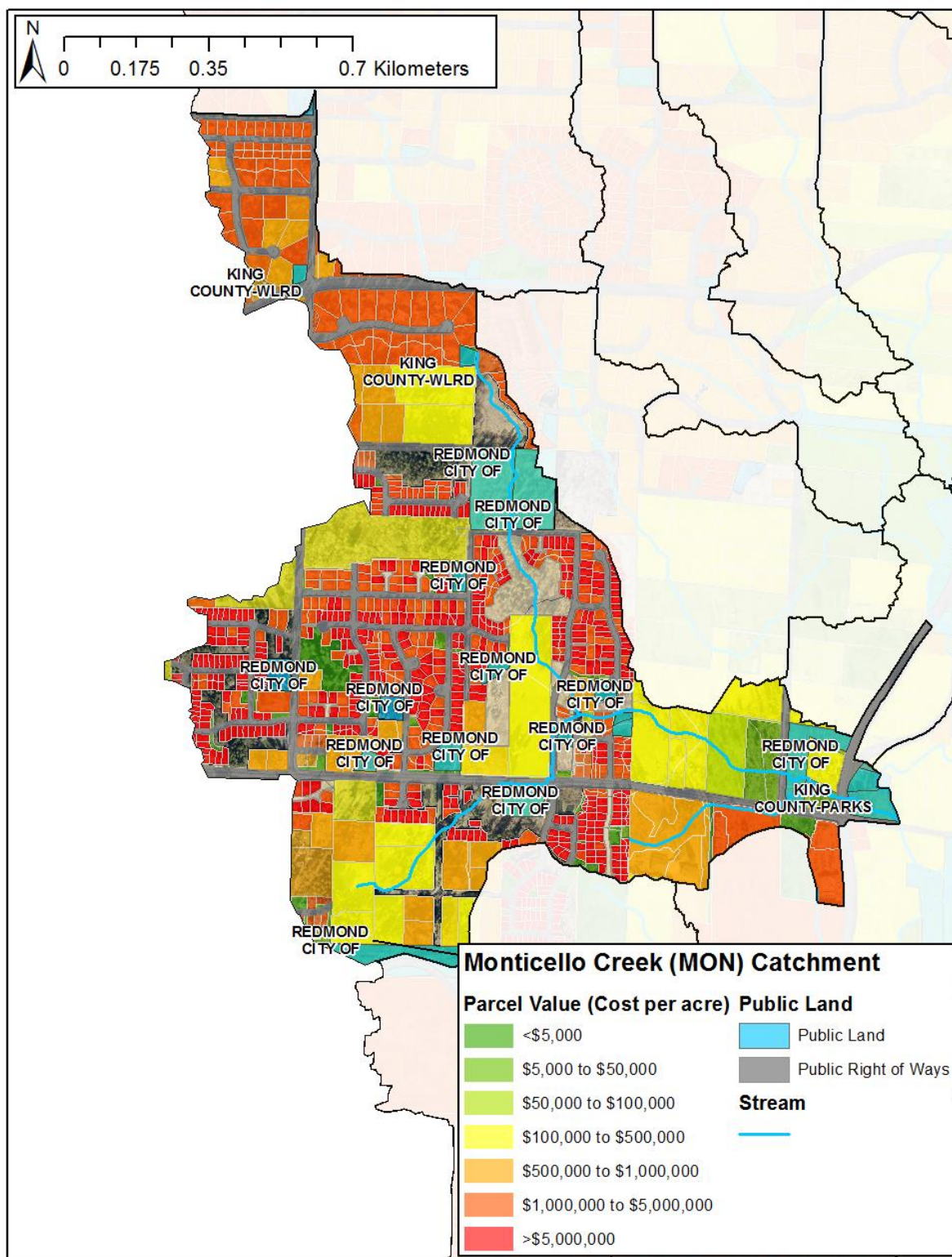
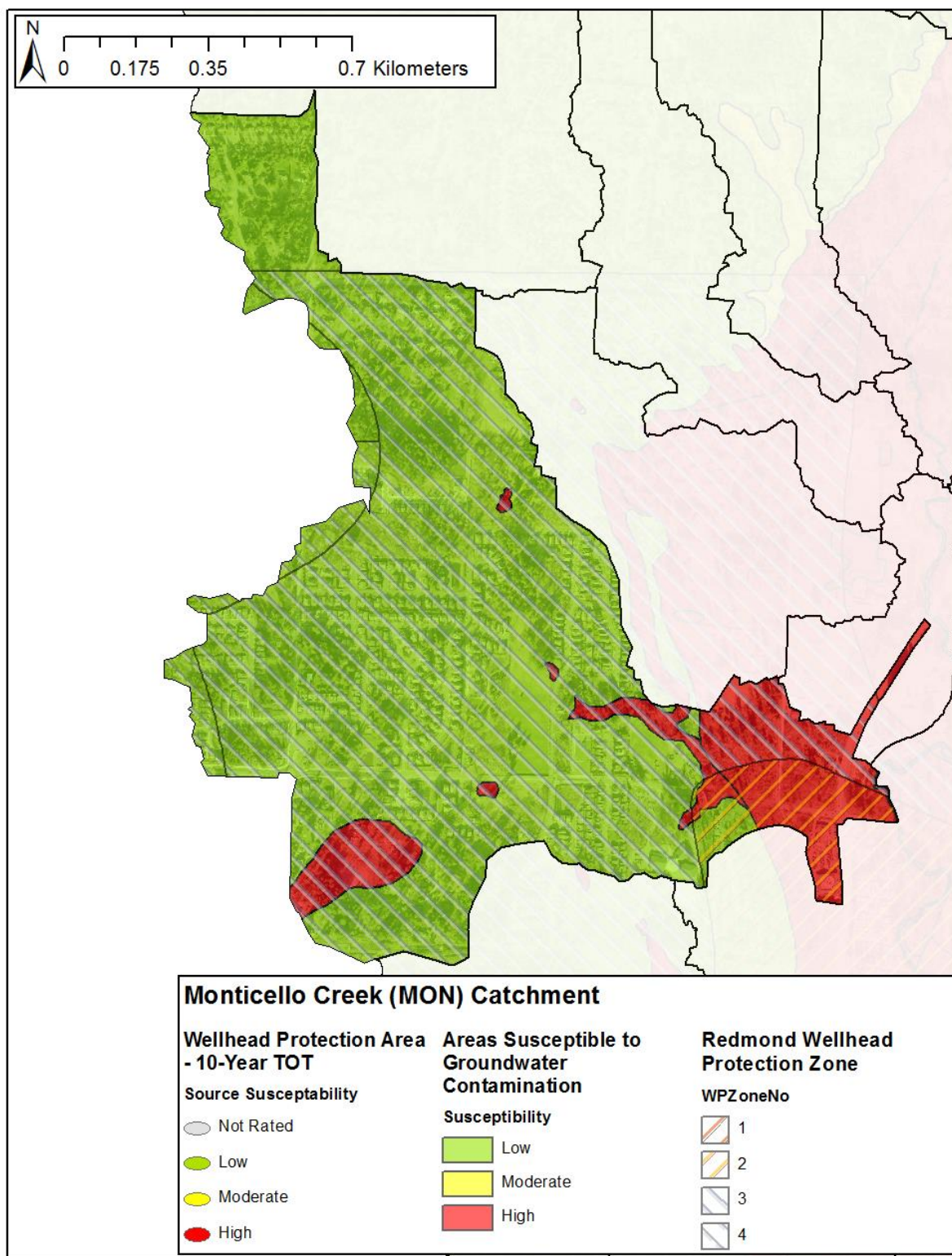


Figure 49. Monticello Creek (MON) catchment parcel values and public lands.



**Figure 50. Monticello Creek (MON) catchment groundwater protection areas. Bottom-left to top-right hatching for Redmond indicates infiltration restriction for pollution-generating hard surfaces runoff, excluding single-family residential runoff.**

## 5.3 BEA110 – 177th Ave and NE 104th St (Score: 100)

The 177<sup>th</sup> Ave and NE 104<sup>th</sup> St catchment (BEA110) is 64 acres in area. The catchment is predominately mid-density residential development with a small amount of greenspace in the western region (Hartman Park). The catchment does not have a stream. Surface water drains to BEA100 and then mainstem Bear Creek.

Three City of Redmond stormwater facilities are mapped in the catchment. Two were built prior to 1990 and the other does not have a build date. It is likely they do not meet current design standards. It identified that these facilities be inspected and, if needed, updated to provide better storage and water quality treatment.

Property within the catchment is expensive (averaging \$2.8 million per acre). Acquisition of private land to build stormwater facilities is not likely to be feasible. The installation of LID features throughout the catchment is identified. An incentive program may be used for LID installation for existing development. Construction of roadside bioswales is also identified along NE 104<sup>th</sup> St.

**Table 29. Available data for 177<sup>th</sup> Ave and NE 104<sup>th</sup> St (BEA110) catchment.**

Criteria	Data
<b>Existing water quality problems</b>	No stream in catchment
<b>Existing instream habitat problems</b>	No stream in catchment
<b>B-IBI (WRIA8 Regression)</b>	Very poor (9.4)
<b>Riparian land cover</b>	No riparian area in catchment
<b>Public Lands</b>	5% public land
City of Redmond	3626059015 (Hartman Park) 2193310700 2193310710
<b>Horse and Livestock Lands</b>	None
<b>Right-of-Ways</b>	14 acres (including road surface) Several residential streets
<b>Property Value</b>	\$2,769,998 per acre
<b>Untreated Impervious Area</b>	36% of catchment is untreated impervious area Residential streets
<b>Existing Stormwater Facilities</b>	<ul style="list-style-type: none"> <li>Redmond Vault 870526004 built in 1987</li> <li>Redmond pond (no recording number)</li> <li>Redmond Vault (E-0154) built in 1987</li> </ul>

Criteria	Data
Easements	None
Groundwater	Nearly all of the catchment is in Redmond Wellhead Protection Zone 3. The far eastern region is Zone 2, which restricts infiltration of pollution-generating hard surfaces runoff, excluding single-family residential runoff. The catchment has low susceptibility to groundwater contamination except in the far east, which is high susceptibility.
Stream Shade	No stream in catchment

**Table 30. Summary of Identified Strategies for 177<sup>th</sup> Ave and NE 104<sup>th</sup> St (BEA110) catchment.**

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X



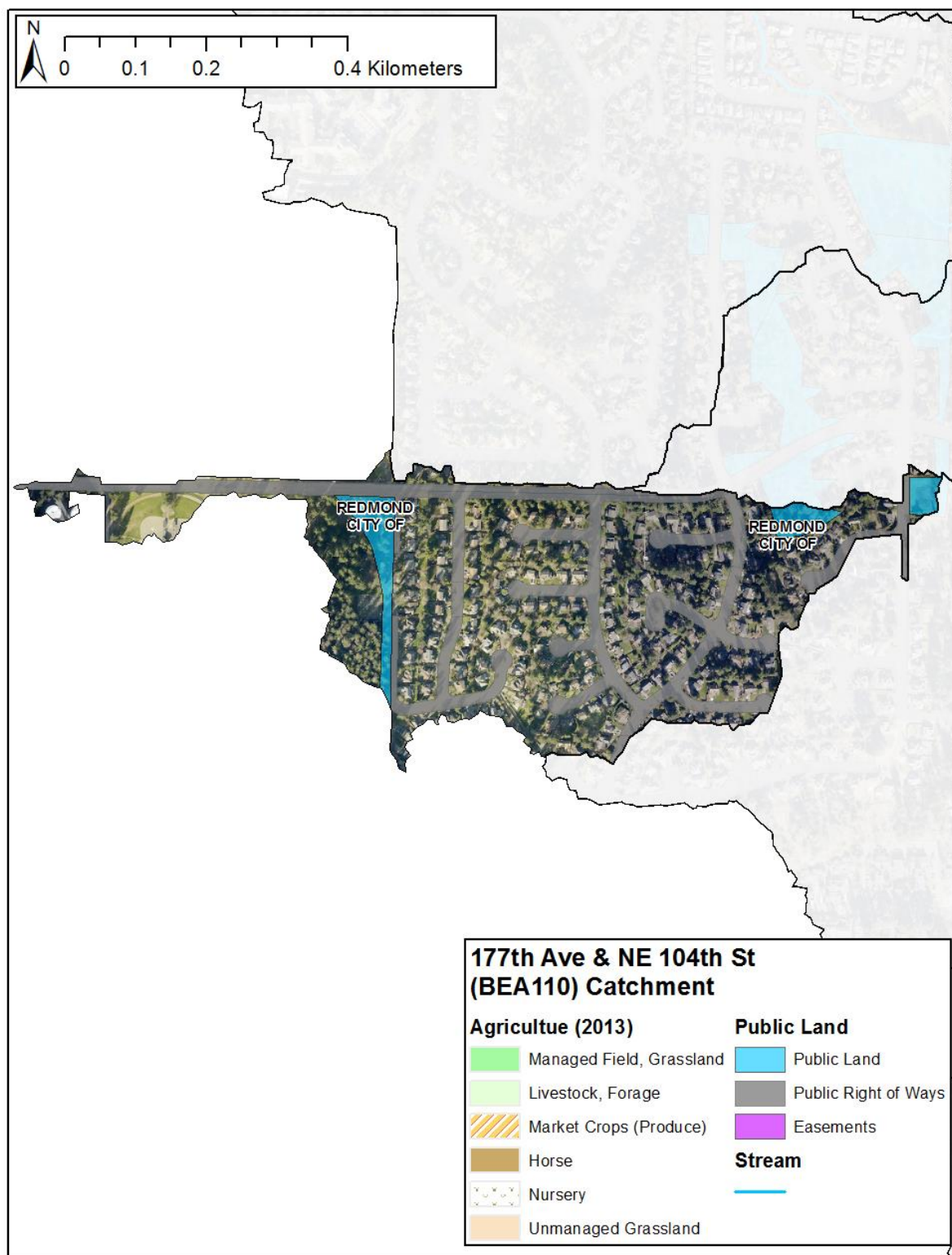
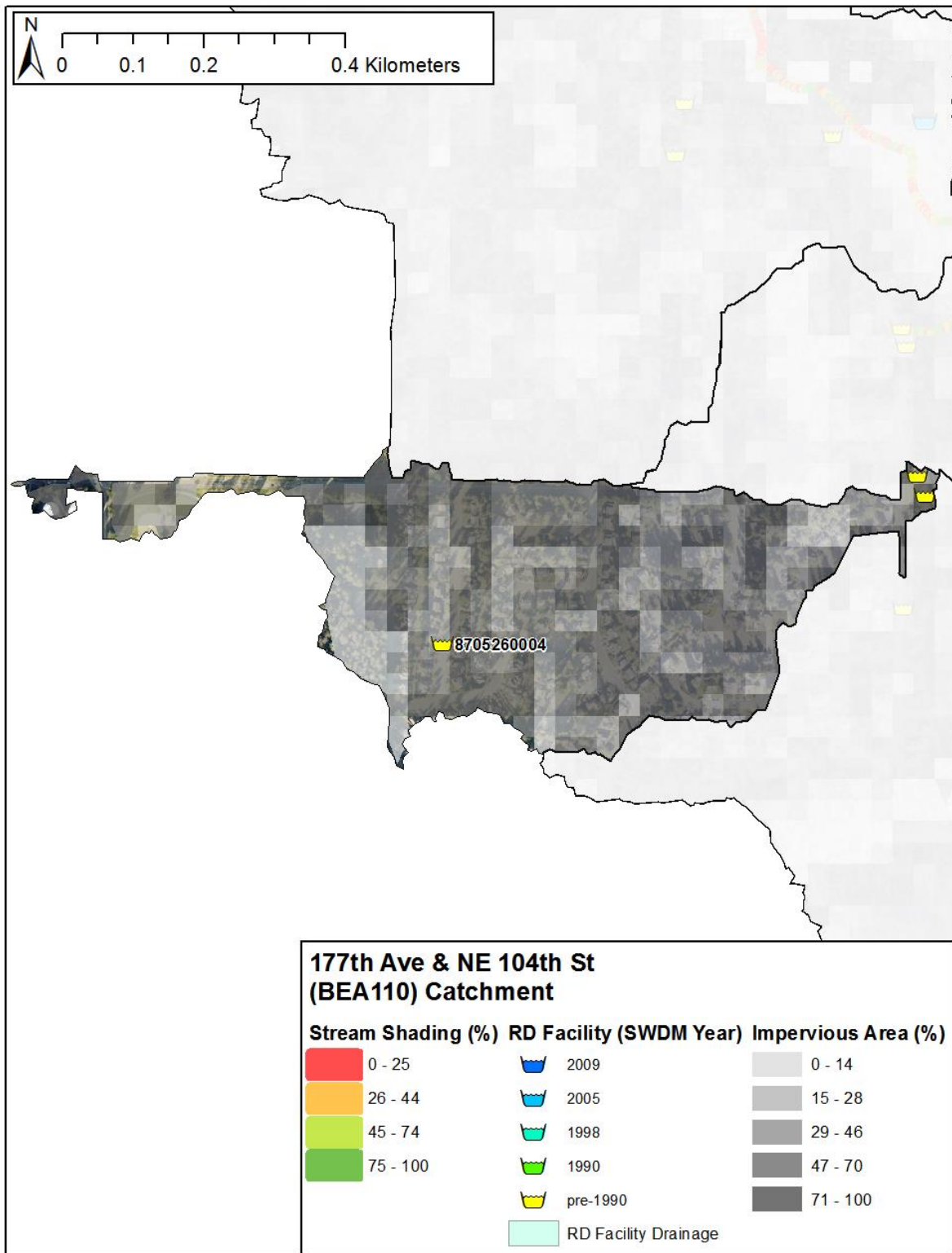


Figure 51. 177th Ave and NE 104th (BEA110) catchment agricultural and public land.



**Figure 52.** 177th Ave and NE 104th (BEA110) catchment stream shading, impervious area, and RD facilities and their drainage area.

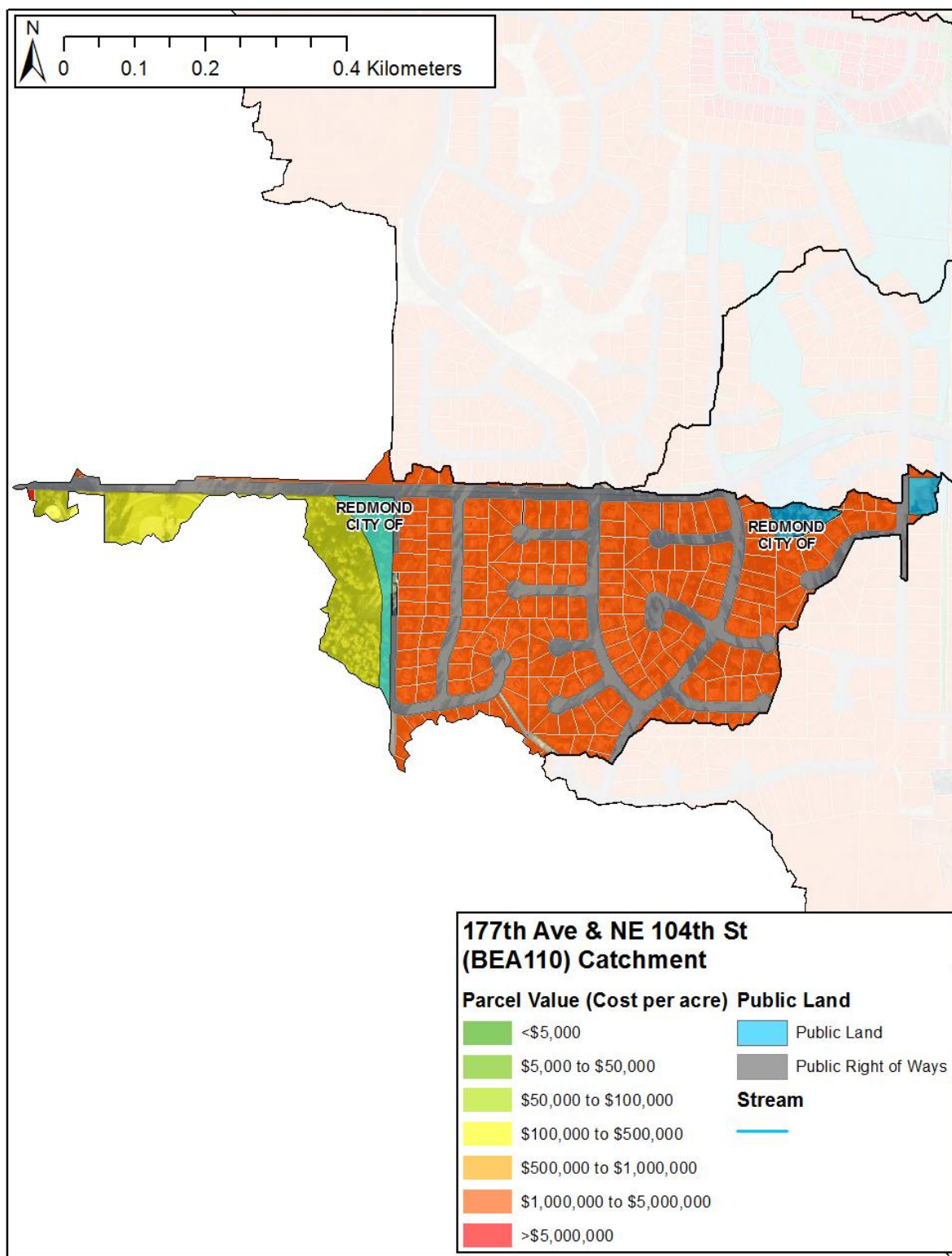
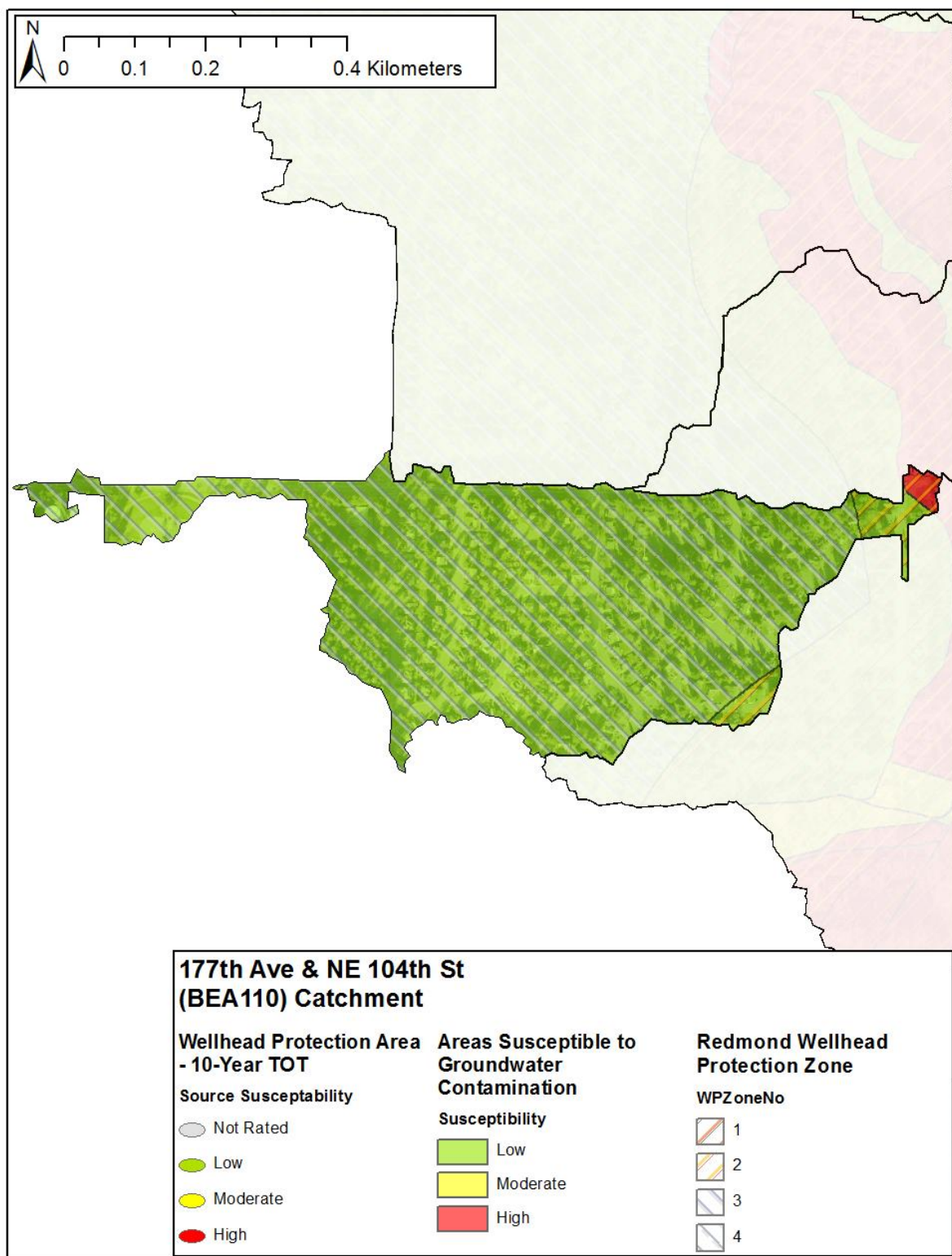


Figure 53. 177th Ave and NE 104th (BEA110) catchment parcel values and public lands.





**Figure 54.** 177th Ave and NE 104th (BEA110) catchment groundwater protection areas. Bottom-left to top-right hatching for Redmond indicates infiltration restriction for pollution-generating hard surfaces runoff, excluding single-family residential runoff.



## 5.4 BEA100 – 184th Ave and NE 104th St (Score: 103)

The 184<sup>th</sup> Ave and NE 104<sup>th</sup> St catchment (BEA100) is 63 acres in area. The catchment is predominately mid-density residential development with a small amount of greenspace in the western region (Hartman Park). The catchment does not have a stream. Surface water drains to BEA100 and then mainstem Bear Creek.

Three City of Redmond stormwater facilities are mapped in the catchment. Two were built prior to 1990 and the other in 1995. It is likely they do not meet current design standards. It identified that these facilities be inspected and, if needed, updated to provide better storage and water quality treatment.

With Redmond city limits, property is expensive (>\$1 million per acre). Acquisition of private land to build stormwater facilities is not likely to be feasible. The installation of LID features throughout the catchment is identified. An incentive program may be used for LID installation for existing development. Construction of roadside bioswales is also identified along NE 104<sup>th</sup> St and Avondale Rd.

**Table 31. Available data for 184<sup>th</sup> Ave and NE 104<sup>th</sup> St (BEA100) catchment.**

Criteria	Data
<b>Existing water quality problems</b>	<ul style="list-style-type: none"> <li>• Temperature (91% of summer 7-DADMax temperatures exceed water quality standards)</li> <li>• Dissolved Oxygen (2 of 3 summer samples did not meet water quality standards)</li> <li>• Fecal Coliform (the stream did not meet the geometric mean and 90th percentile water quality criteria)</li> <li>• Total Suspended Solids (wet-weather samples are five-times that of baseflow samples)</li> </ul>
<b>Existing instream habitat problems</b>	<ul style="list-style-type: none"> <li>• Lower habitat quality (King County et al., 1989)</li> <li>• Bank Erosion/Instability and Lack of Instream Habitat Diversity (Entranco, 1994)</li> <li>• Loss of vegetation and instream large organic debris (King County et al., 1994)</li> </ul>
<b>B-IBI (WRIA8 Regression)</b>	Fair (53.1)
<b>Riparian land cover</b>	11% impervious 17% trees 35% shrub 20% pasture 18% other (water, bare area, grass, etc.)
<b>Public Lands</b>	16% public land
City of Redmond	2193310690 2193310700 2193320520 2193310710

Criteria	Data
	2193310720
King County Parks	3126069053 3126069052 3126069016 3126069038
<b>Horse and Livestock Lands</b>	9 acres 3126069011 (Little Bit Therapeutic Riding) 3126069043 (Sage Meadows) 3126069010 (Livestock)
<b>Right-of-Ways</b>	10 acres (including road surface) Avondale Rd NE 104 <sup>th</sup> Ave Several residential streets
<b>Property Value</b>	\$2,339,919 per acre
<b>Untreated Impervious Area</b>	27% of catchment is untreated impervious area
<b>Existing Stormwater Facilities</b>	<ul style="list-style-type: none"> <li>Redmond vault 99-2030 built in 1995</li> <li>Two Redmond vaults (no recording numbers) built in 1983 on 2193310720</li> </ul>
<b>Easements</b>	none
<b>Groundwater</b>	<ul style="list-style-type: none"> <li>The catchment is in both Redmond Wellhead Protection Zone 1 and 2, which restricts infiltration of pollution-generating hard surfaces runoff, excluding single-family residential runoff.</li> <li>The catchment has low to high susceptibility to groundwater contamination.</li> </ul>
<b>Stream Shade</b>	58% of the stream has less than 50% shading Hot spots of low shade: Near 3126069010 pasture

**Table 32. Summary of Identified Strategies for 184<sup>th</sup> Ave and NE 104<sup>th</sup> St (BEA100) catchment.**

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Incentivize agricultural BMPs for horse pastureland			X	X	
Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X

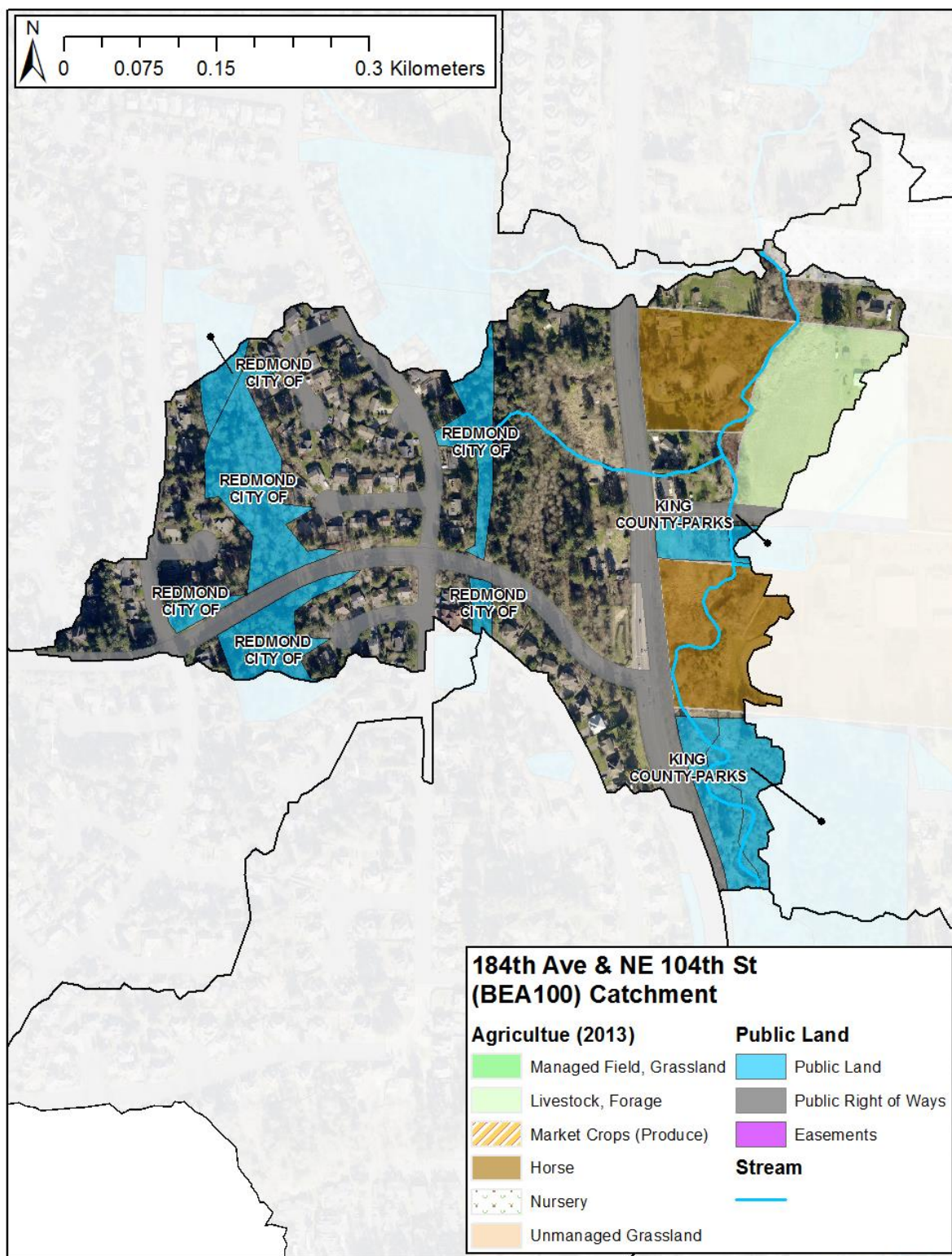
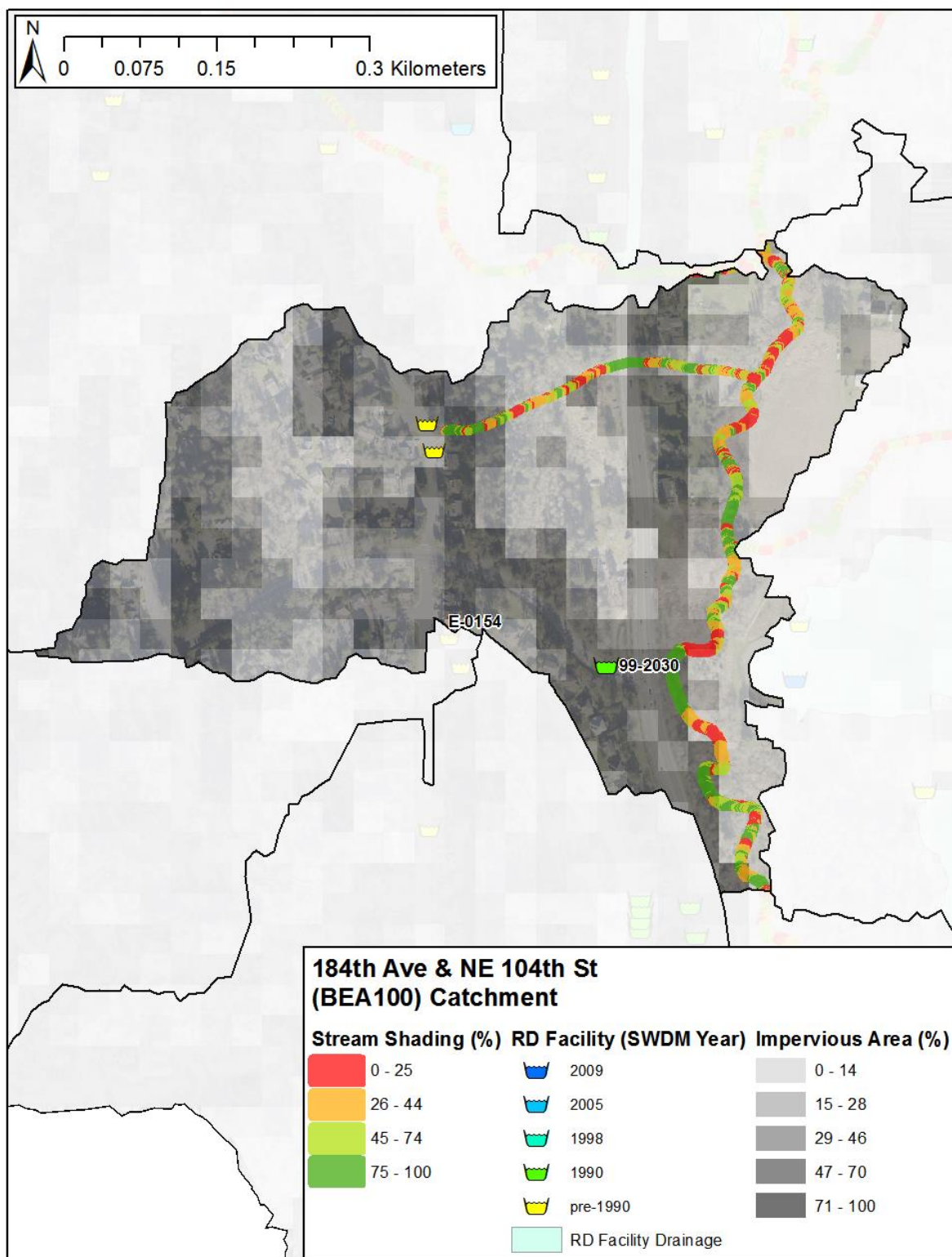


Figure 55. 184th Ave and NE 104th St (BEA100) catchment agricultural and public land.





**Figure 56.** 184th Ave and NE 104th St (BEA100) catchment stream shading, impervious area, and RD facilities and their drainage area.

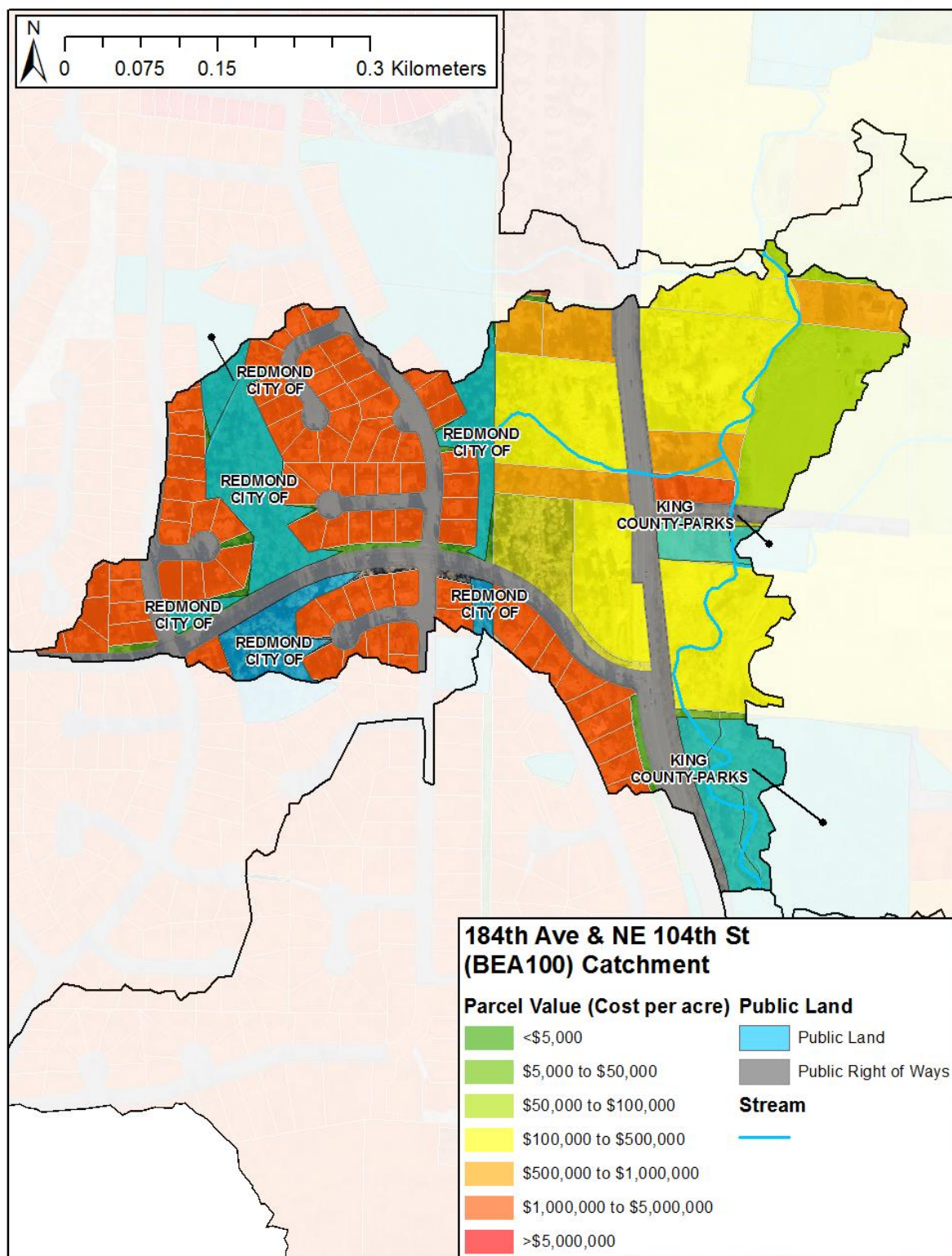
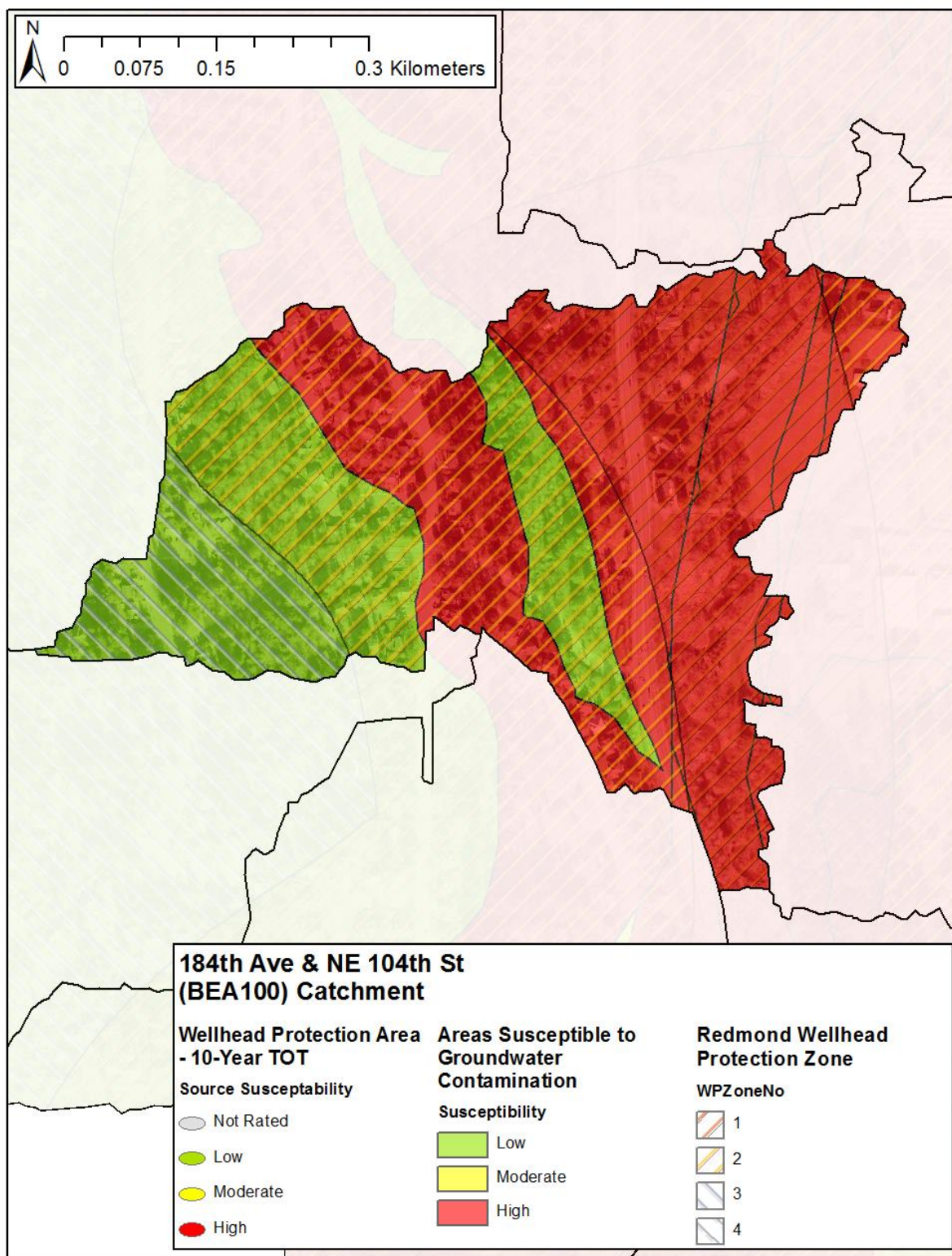


Figure 57. 184th Ave and NE 104th St (BEA100) catchment parcel values and public lands.





**Figure 58.** 184th Ave and NE 104th St (BEA100) catchment groundwater protection areas. Bottom-left to top-right hatching for Redmond indicates infiltration restriction for pollution-generating hard surfaces runoff, excluding single-family residential runoff.

## 5.5 BEA010 – Bear Creek Mouth (Score: 90)

The Bear Creek Mouth (BEA010) catchment is the outlet for the study area. The catchment is 44 acres in area. Most of the catchment drains the Friendly Village mobile home park within the City of Redmond. Installation of a stormwater facility that treats runoff from Friendly Village is identified. Tree planting along the Redmond-owned riparian area is identified, and a program that incentivizes planting within Friendly Village’s riparian area is also identified.

**Table 33. Available data for Bear Creek Mouth (BEA010) catchment.**

Criteria	Data
<b>Existing water quality problems</b>	<ul style="list-style-type: none"> <li>• Temperature (91% of summer 7-DADMax temperatures exceed water quality standards)</li> <li>• Dissolved Oxygen (2 of 3 summer samples did not meet water quality standards)</li> <li>• Fecal Coliform (the stream did not meet the geometric mean and 90th percentile water quality criteria)</li> <li>• Total Suspended Solids (wet-weather samples are five-times that of baseflow samples)</li> </ul>
<b>Existing instream habitat problems</b>	<ul style="list-style-type: none"> <li>• Lower habitat quality (King County et al., 1989)</li> <li>• Bank Erosion/Instability and Lack of Instream Habitat Diversity (Entranco, 1994)</li> <li>• Loss of vegetation and instream large organic debris (King County et al., 1994)</li> </ul>
<b>B-IBI (WRIA8 Regression)</b>	Fair (52.7)
<b>Riparian land cover</b>	25% impervious 11% trees 24% shrub 8% pasture 34% other (water, bare area, grass, etc.)
<b>Public Lands</b>	9% public land
City of Redmond	0625069013; 0625069126; 0625069025; 0625069121
WSDOT	0625069159
<b>Horse and Livestock Lands</b>	None
<b>Right-of-Ways</b>	0.50 acres
<b>Property Value</b>	\$810,184 Residential parcels are generally lower cost per acres
<b>Untreated Impervious Area</b>	48% of catchment is untreated impervious land The Friendly Village Mobile Home Park does not have documented stormwater facilities and has a high level of imperviousness.
<b>Existing Stormwater Facilities</b>	<ul style="list-style-type: none"> <li>• Redmond Pond 92-0200 – built 1992</li> </ul>
<b>Easements</b>	None



Criteria	Data
Groundwater	<ul style="list-style-type: none"> <li>The catchment is in both Redmond Wellhead Protection Zone 1 and 2, which restricts infiltration of pollution-generating hard surfaces runoff, excluding single-family residential runoff.</li> <li>The catchment has moderate to high susceptibility to groundwater contamination.</li> </ul>
Stream Shade	82% of the stream has less than 50% shading <ul style="list-style-type: none"> <li>Hot spots of low shade:                             <ul style="list-style-type: none"> <li>Friendly Village waterfront</li> <li>Lower reach of Bear Creek</li> </ul> </li> </ul>

Table 34. Summary of Identified Strategies for Bear Creek Mouth (BEA010) catchment.

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Incentivize agricultural BMPs for horse pastureland			X	X	
Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X

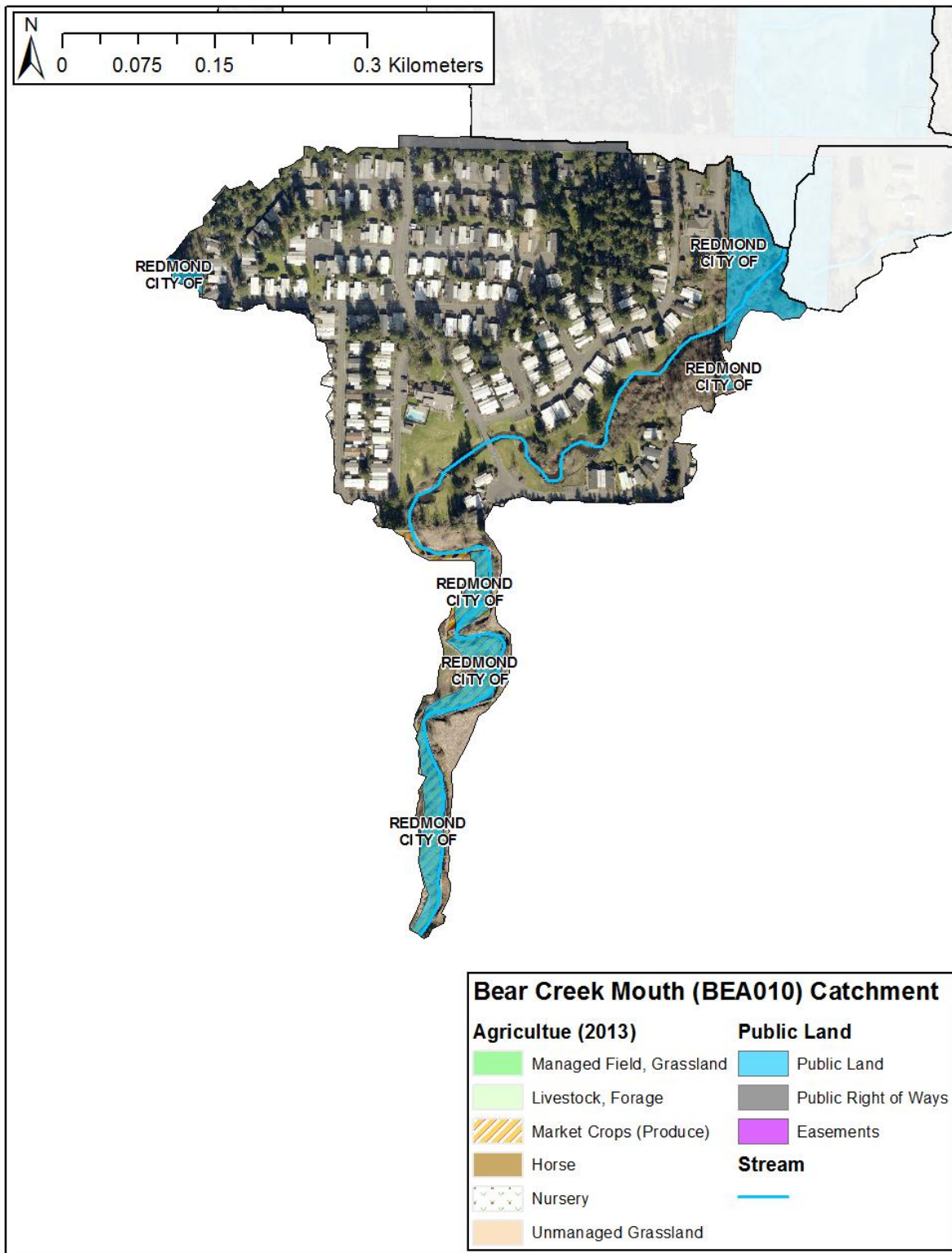
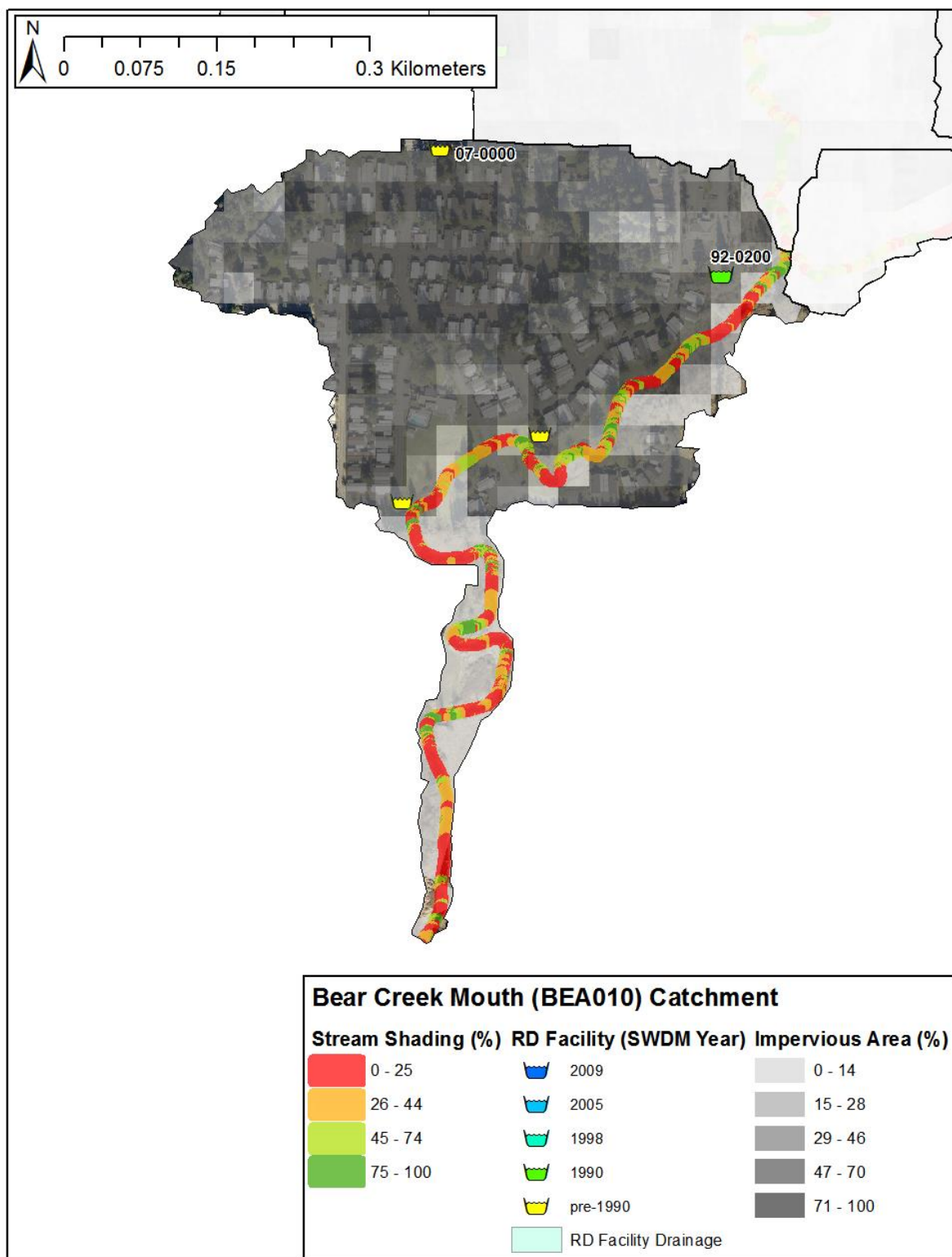


Figure 59. Bear Creek mouth (BEA010) catchment agricultural and public land.



**Figure 60. Bear Creek mouth (BEA010) catchment stream shading, impervious area, and RD facilities and their drainage area.**

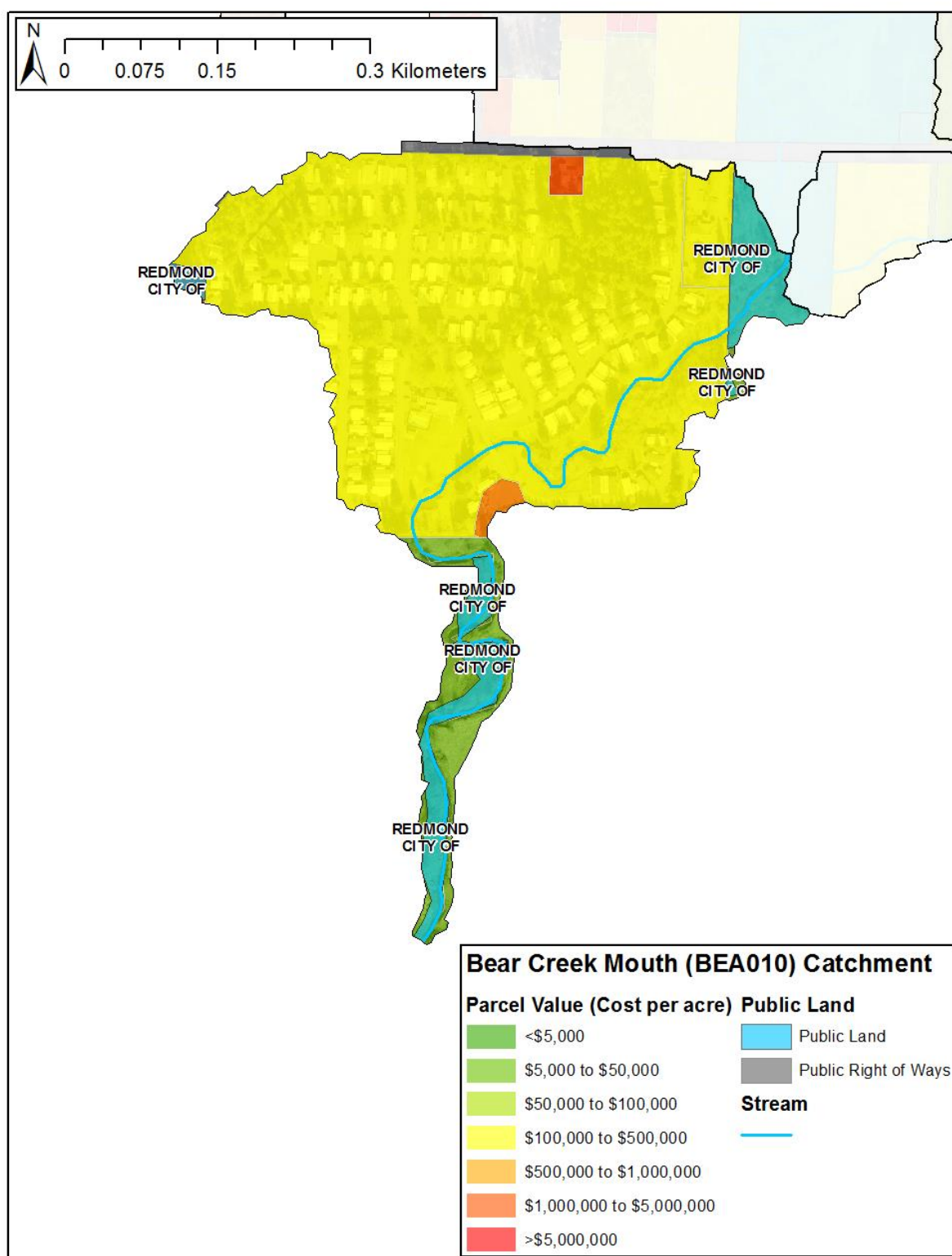
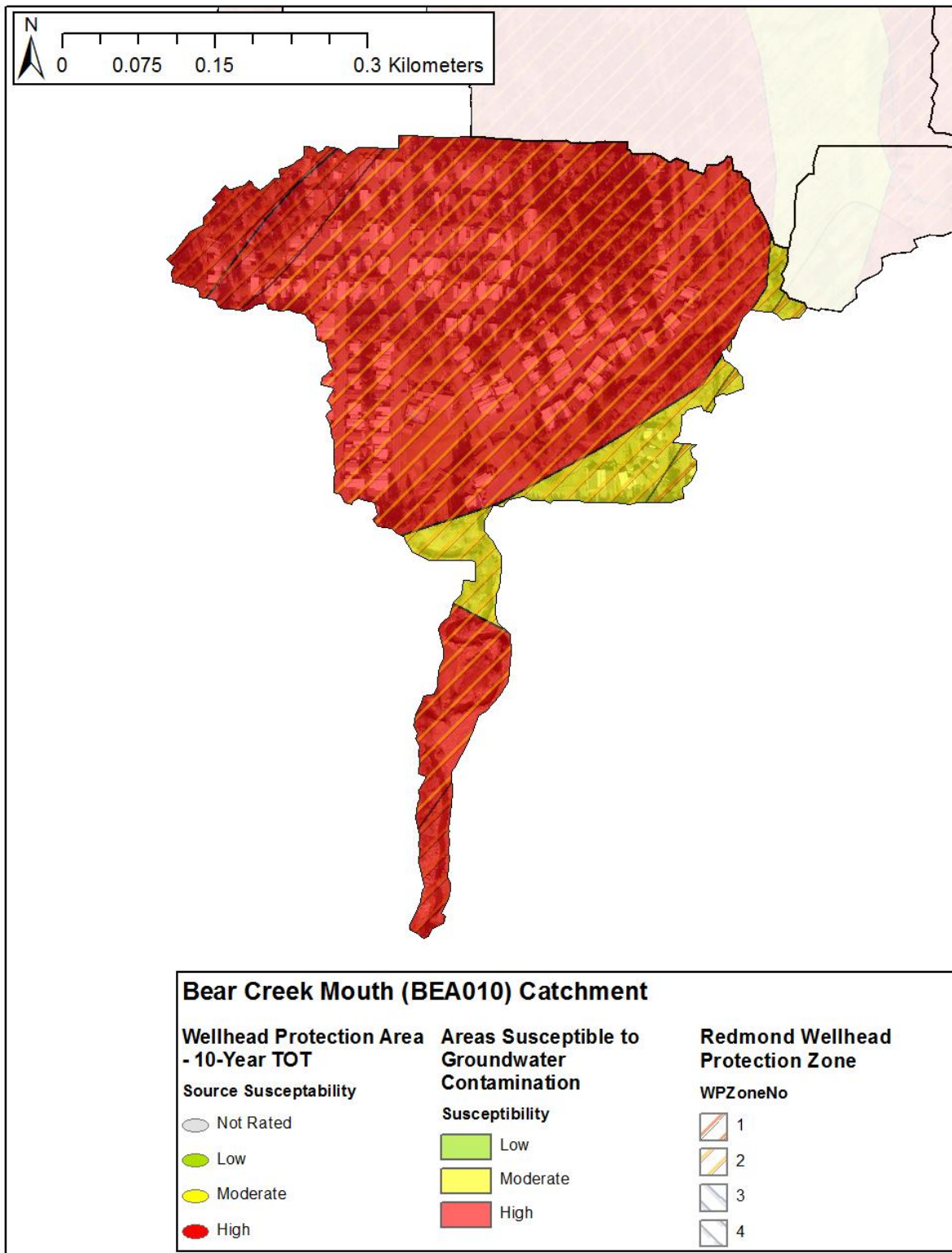


Figure 61. Bear Creek mouth (BEA010) catchment parcel values and public lands.





**Figure 62.** Bear Creek mouth (BEA010) catchment groundwater protection areas. Bottom-left to top-right hatching for Redmond indicates infiltration restriction for pollution-generating hard surfaces runoff, excluding single-family residential runoff.

## 6.0 PRIORITY CITY OF WOODINVILLE CATCHMENTS

For catchments located primarily within the City of Woodinville, The data input to the prioritization metric and the resulting final score are displayed in Table 35 with the catchments ranked. The following sections detail the ranked catchments and discuss potential projects and actions to improve water quality and hydrology.

**Table 35. Ranked catchments located primarily in City of Woodinville and prioritization metric input data.**

Catchment	Scoring Metrics									Total Score
	Water Quality	B-IBI	Untreated Impervious	Storm-water Facility	Forage Live-stock	Property Cost	Public Land	Right-of-way	Roof	
<b>BEA840</b>	15	20	20	0	0	10	0	0	10	75
<b>BEA860</b>	15	20	10	0	0	10	0	8	10	73
<b>BEA850</b>	15	10	10	0	0	10	0	8	10	63

### 6.1 BEA840 – East Woodinville (Score: 75)

The East Woodinville catchment (BEA840) is 255 acres in area. The catchment is predominately low- to mid-density residential development and contains the Wellington Elementary School and Leota Middle School campuses. The catchment drains to Cold Creek downstream of Lake Leota.

No stormwater facilities for the school campuses are mapped (Figure 67). If no stormwater facilities currently receive flow from the campuses, the construction of new facilities are identified.

The installation of LID features throughout the catchment is identified. An incentive program may be used for LID installation for existing development. Construction of roadside bioswales is also identified where other facilities are lacking.

**Table 36. Available data for East Woodinville (BEA840) catchment.**

Criteria	Data
<b>Existing water quality problems (Cold Creek)</b>	<ul style="list-style-type: none"> <li>Inadequate temperature data were available. The creek went dry during some of the summer sampling period.</li> <li>Dissolved Oxygen (1 of 1 summer samples did not meet water quality standards)</li> <li>Fecal Coliform (the stream did not meet the geometric mean and 90th percentile water quality criteria)</li> </ul>

Criteria	Data
Existing instream habitat problems	No data
B-IBI (WRIA8 Regression)	Poor (20.8)
Riparian land cover	27% impervious 44% trees 8% shrub 2% pasture 19% other (water, bare area, grass, etc.)
Public Lands	1% public land
City of Woodinville	8031000080 (Stonegate drainage)
King County Water and Land	9238430710 (Wellington) 0126059277 (stormwater)
Horse and Livestock Lands	None
Right-of-Ways	22 acres (included road surface) Woodinville-Duvall Rd Several residential streets
Property Value	\$739,905 per acre
Untreated Impervious Area	19% of catchment is untreated impervious Drainage areas for stormwater facilities are not mapped.
Existing Stormwater Facilities	<ul style="list-style-type: none"> <li>• RD Pond (PD0136) year built unknown – Wellington Hills</li> <li>• RD Pond (PD0139) year built unknown – Wellington Hills</li> <li>• RD Pond (PD0129) year built unknown – Cedar Heights</li> <li>• RD Pond (PD0130) year built unknown – Cedar Heights</li> <li>• RD Pond (PD0130) built 2009</li> </ul>
Easements	none
Groundwater	The catchment has low to high susceptibility to groundwater contamination
Stream Shade	18% of the stream has less than 50% shading

Table 37. Summary of Identified Strategies for East Woodinville (BEA840) catchment.

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Incentivize agricultural BMPs for horse pastureland			X	X	

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Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X



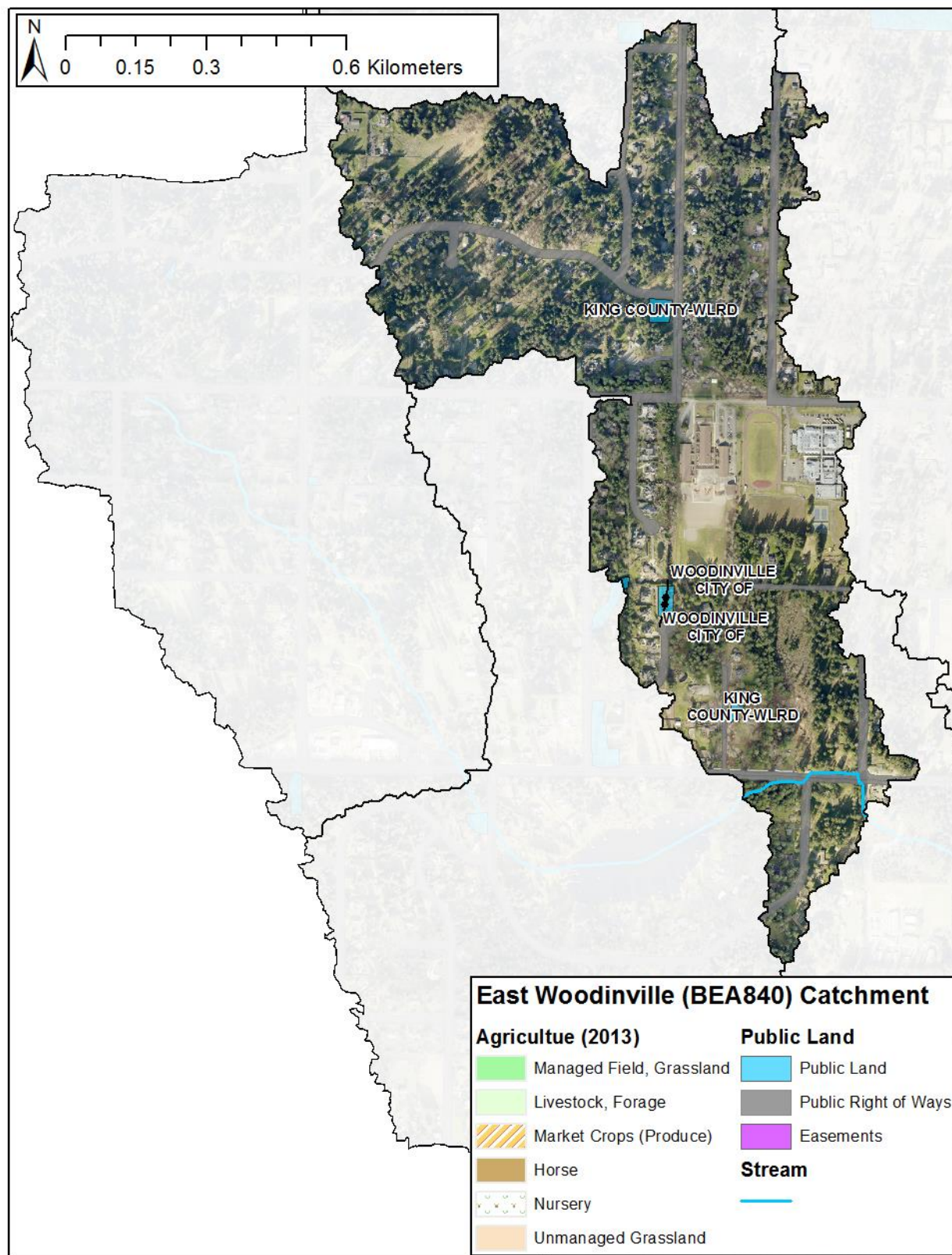


Figure 63. East Woodinville (BEA840) catchment agricultural and public land.

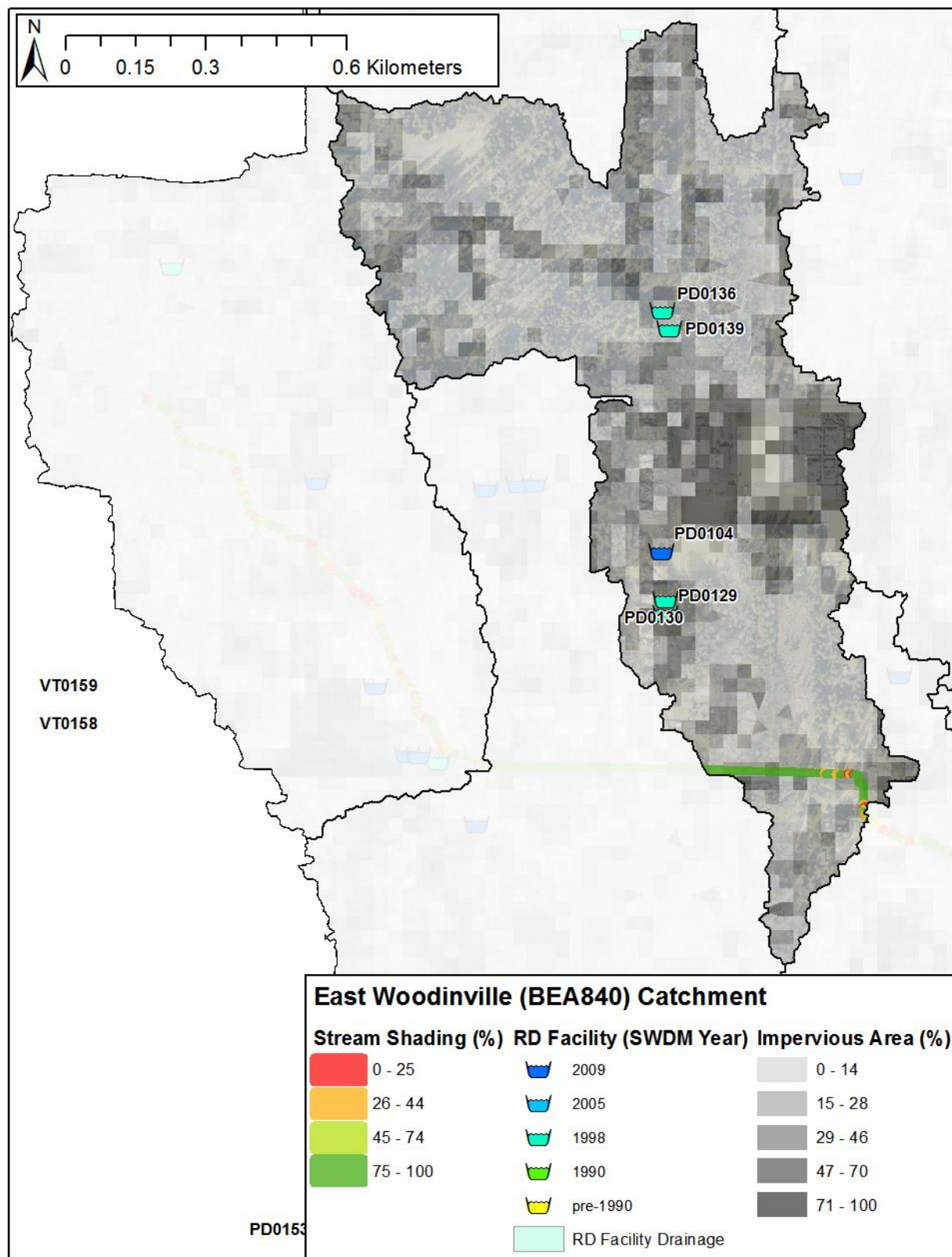


Figure 64. East Woodinville (BEA840) catchment stream shading, impervious area, and RD facilities and their drainage area.



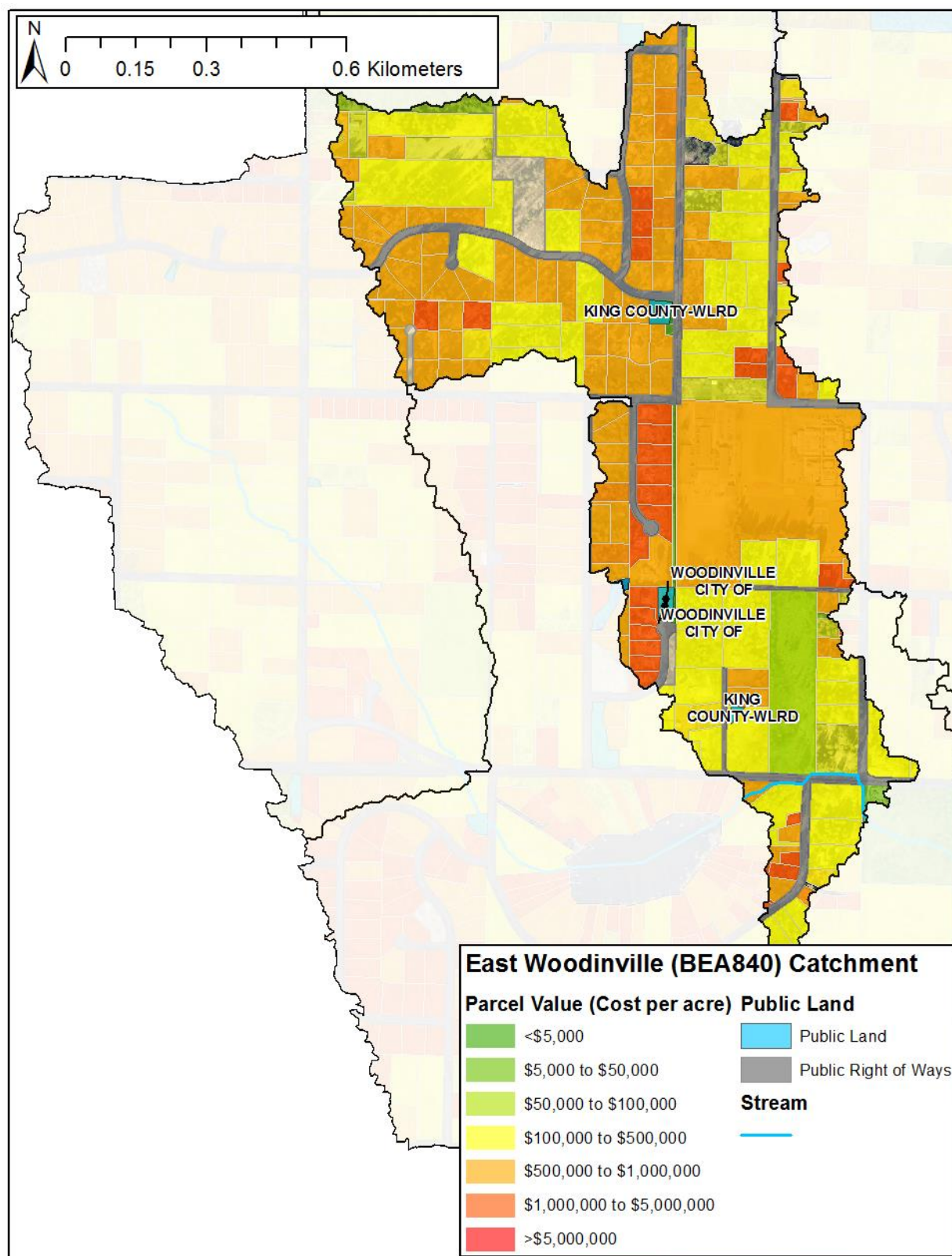


Figure 65. East Woodinville (BEA840) catchment parcel values and public lands.

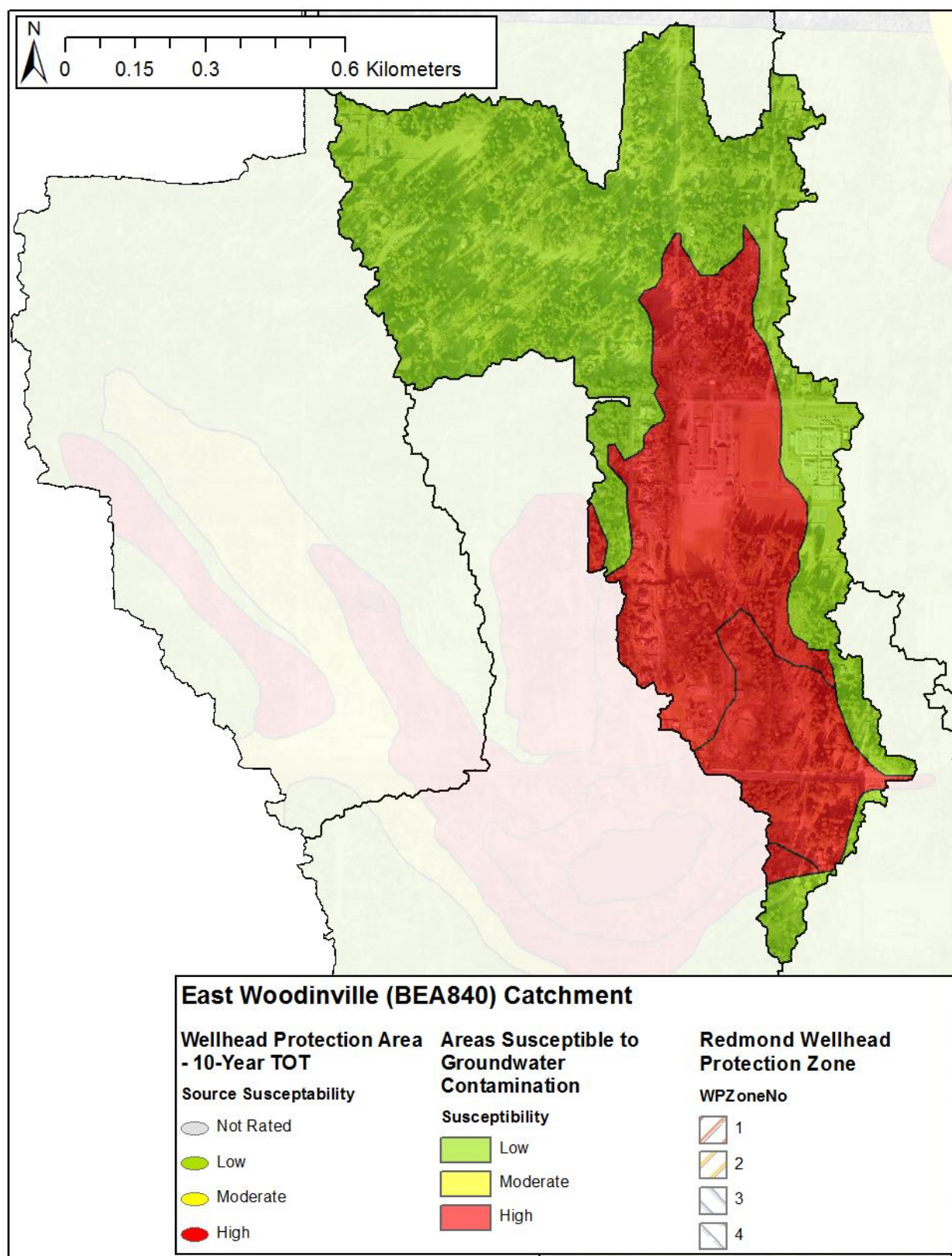


Figure 66. East Woodinville (BEA840) catchment groundwater protection areas.



## **6.2 BEA860 – Upper Cold Creek (Score: 73)**

The Upper Cold Creek catchment (BEA860) is 242 acres in area. The catchment is predominately low- to mid-density residential development with a small amount of commercial along Woodinville-Duvall Rd (Hilltop Commercial Center). The catchment drains into Lake Leota.

There are three stormwater facilities serving the Hilltop Commercial Center (Figure 63). Three other stormwater facilities receive flows from residential land use. It identified that these facilities be inspected and, if needed, updated to provide better storage and water quality treatment.

The installation of LID features throughout the catchment is identified. An incentive program may be used for LID installation for existing development. Construction of roadside bioswales is also identified along Woodinville-Duvall Rd and 156<sup>th</sup> Ave NE.

**Table 38. Available data for Upper Cold Creek (BEA860) catchment.**

Criteria	Data
<b>Existing water quality problems (Cold Creek and Lake Leota)</b>	<ul style="list-style-type: none"> <li>Inadequate temperature data were available. The creek went dry during some of the summer sampling period.</li> <li>Dissolved Oxygen (1 of 1 summer samples did not meet water quality standards)</li> <li>Fecal Coliform (the stream did not meet the geometric mean and 90th percentile water quality criteria)</li> <li>Lake Leota is moderately productive and phosphorus limited (King County, 2010)<sup>1</sup></li> </ul>
<b>Existing instream habitat problems</b>	No data
<b>B-IBI (WRIA8 Regression)</b>	Poor (21.0)
<b>Riparian land cover</b>	15% impervious 41% trees 10% shrub 3% pasture 29% other (water, bare area, grass, etc.)
<b>Public Lands</b>	1% public land
King County Roads	1126059153
King County Water and Land	9238510240 0226059172
<b>Horse and Livestock Lands</b>	None
<b>Right-of-Ways</b>	27 acres (included road surface) Woodinville-Duvall Rd 156 <sup>th</sup> Ave NE Several residential streets
<b>Property Value</b>	\$694,392 per acre
<b>Untreated Impervious Area</b>	16% of catchment is untreated impervious Drainage areas for stormwater facilities are not mapped.
<b>Existing Stormwater Facilities</b>	<ul style="list-style-type: none"> <li>RD Pond (PD0138) year built unknown – Wellington Hills</li> <li>RD Pond (PD0158) built in 2011 – Wellington Hills on 9238510240</li> <li>RD Pond (PD0127) year built unknown</li> <li>RD Pond (PD0112) built 2009 (Hilltop Commercial Center)</li> <li>Vault (VT0101) built 2009 (Hilltop Commercial Center)</li> <li>Vault (VT0129) built 2009 (Hilltop Commercial Center)</li> </ul>
<b>Easements</b>	None
<b>Groundwater</b>	The catchment has low to high susceptibility to groundwater contamination
<b>Stream Shade</b>	46% of the stream has less than 50% shading

**Table 39. Summary of Identified Strategies for Upper Cold Creek (BEA860) catchment.**

Strategy	Benefits
----------	----------

<sup>1</sup> [http://green2.kingcounty.gov/SmallLakes/Reports/Leota\\_WY09.pdf](http://green2.kingcounty.gov/SmallLakes/Reports/Leota_WY09.pdf)

	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X

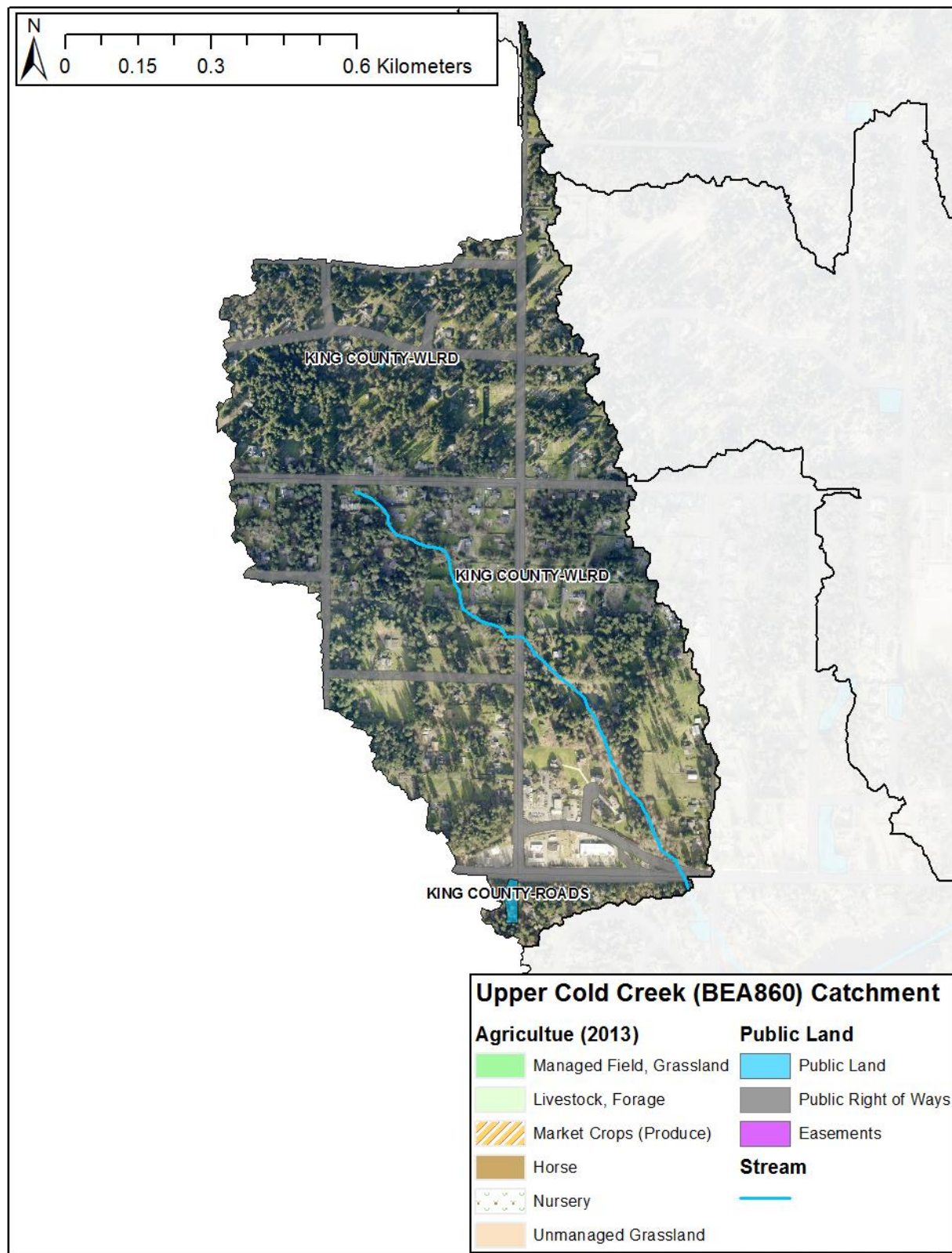


Figure 67. Upper Cold Creek (BEA860) catchment agricultural and public land.



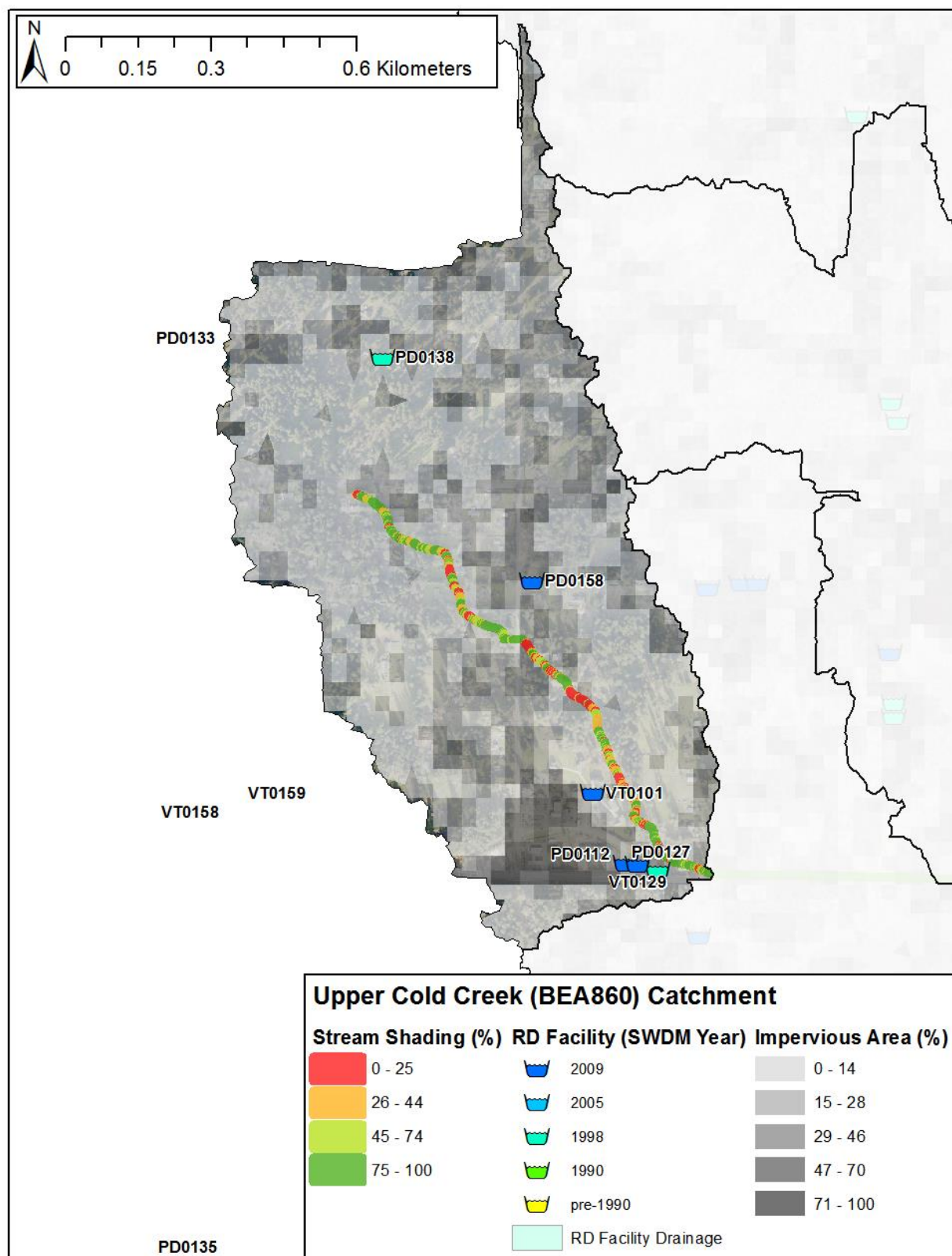


Figure 68. Upper Cold Creek (BEA860) catchment stream shading, impervious area, and RD facilities and their drainage area.

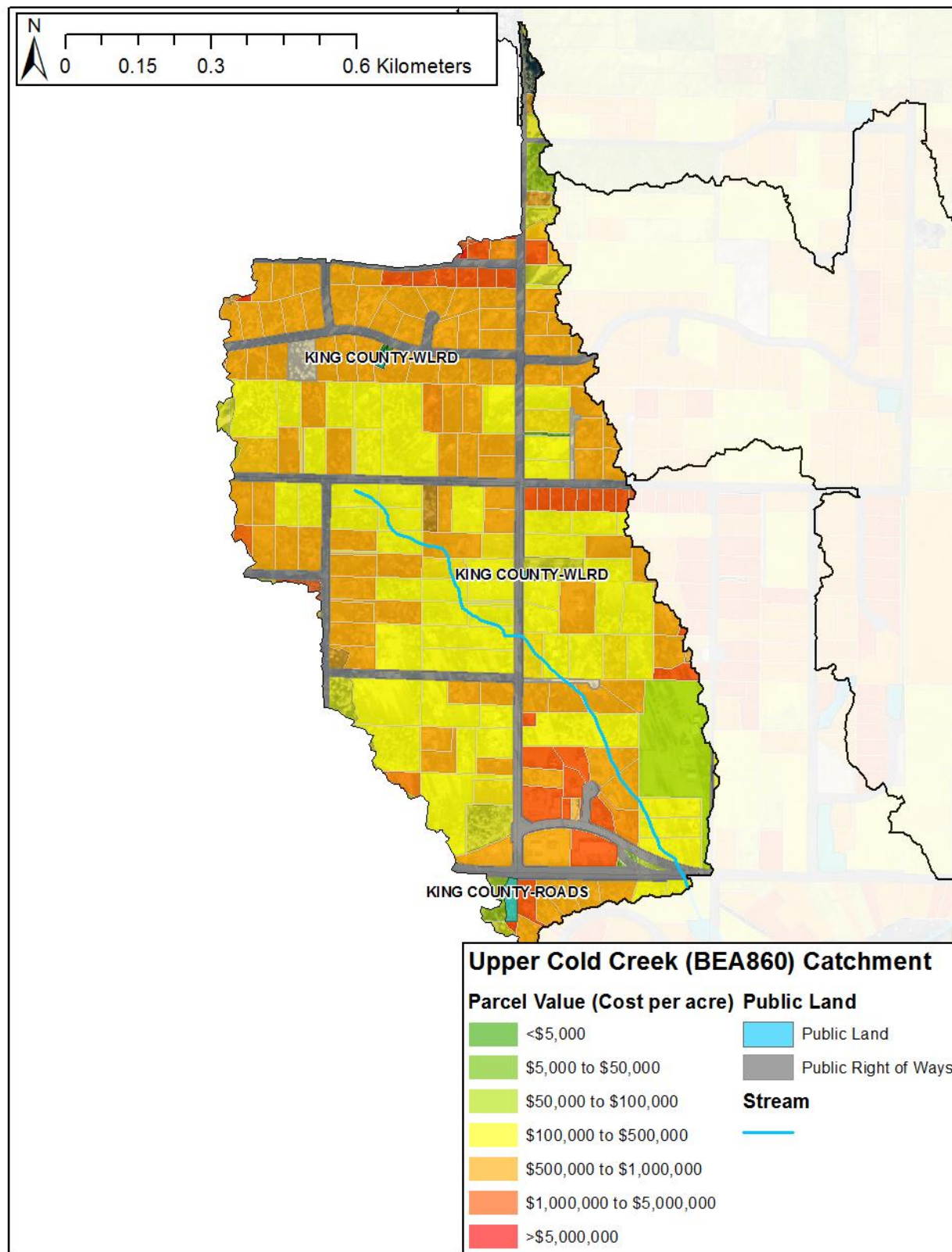


Figure 69. Upper Cold Creek (BEA860) catchment parcel values and public lands.

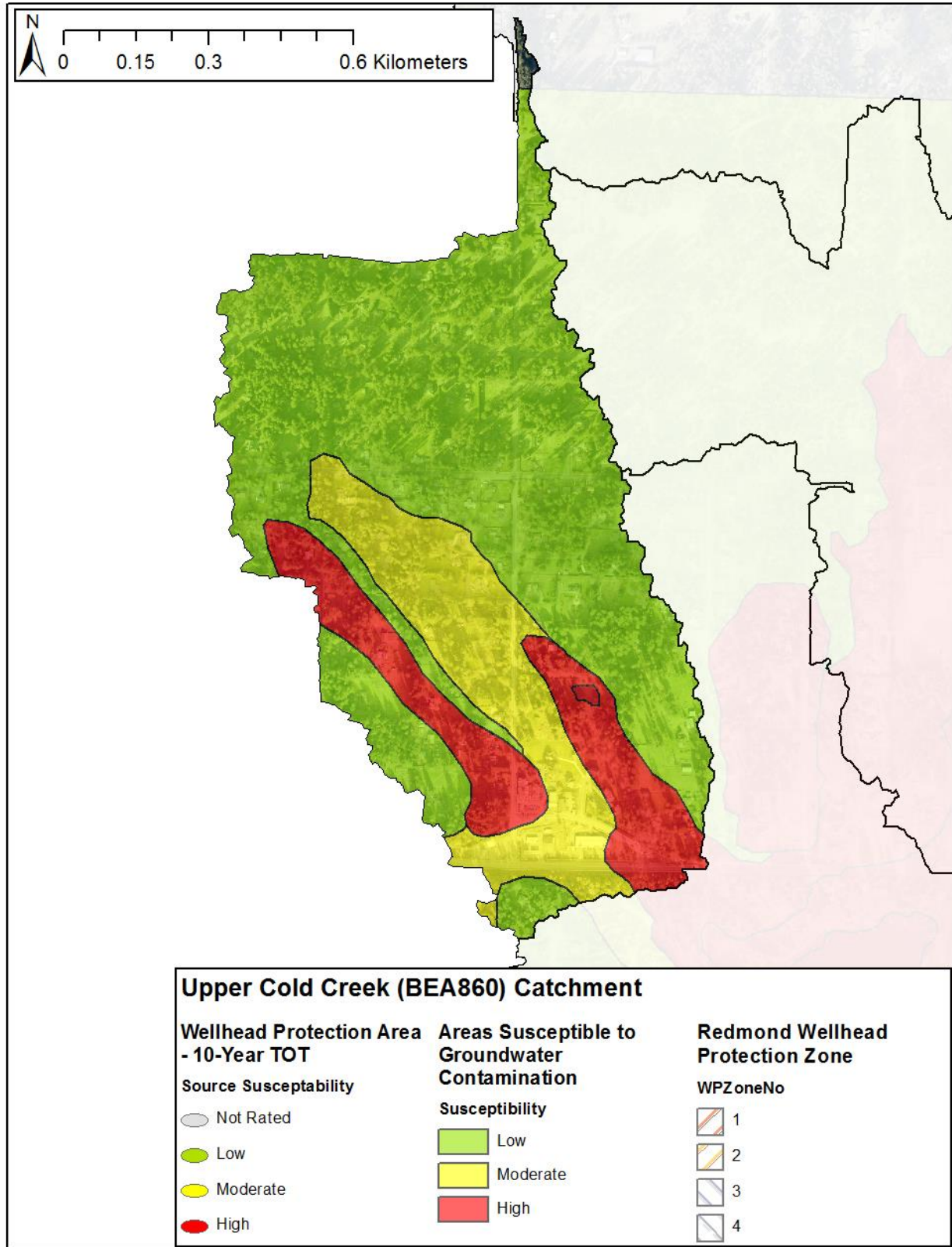


Figure 70. Upper Cold Creek (BEA860) catchment groundwater protection areas.



## 6.3 BEA850 – Lake Leota (Score: 63)

The Lake Leota (BEA850) catchment is located within Woodinville and drains to Cold Creek, which ultimately flows into Cottage Lake Creek. The catchment is 247 acres in area. The catchment is predominately low- to mid-density residential development, containing Lake Leota, a 10-acre natural lake.

The installation of LID features throughout the catchment is identified. An incentive program may be used for LID installation for existing development. Construction of roadside bioswales is also identified along 164<sup>th</sup> Ave NE, 195<sup>th</sup> Ave NE, NE 180<sup>th</sup> St, and Woodinville-Duvall Rd.

Encourage shoreline restoration along Lake Leota. Support septic inspection. Support lawn and garden lakeside best management practices (P-free fertilizers, dog waste pickup).

**Table 40. Available data for Lake Leota (BEA850) catchment.**

Criteria	Data
<b>Existing water quality problems (Cold Creek and Lake Leota)</b>	<ul style="list-style-type: none"> <li>Inadequate temperature data were available. The creek went dry during some of the summer sampling period.</li> <li>Dissolved Oxygen (1 of 1 summer samples did not meet water quality standards)</li> <li>Fecal Coliform (the stream did not meet the geometric mean and 90th percentile water quality criteria)</li> <li>Lake Leota is moderately productive and phosphorus limited (King County, 2010)<sup>2</sup></li> </ul>
<b>Existing instream habitat problems</b>	No data
<b>B-IBI (WRIA8 Regression)</b>	Fair (45.2)
<b>Riparian land cover</b>	8% impervious 21% trees 2% shrub 69% other (water, bare area, grass, etc.)
<b>Public Lands</b>	<1% public land
City of Woodinville	0226059014; 4277000130
King County Water and Land	4215250590 (retention pond)
<b>Horse and Livestock Lands</b>	None
<b>Right-of-Ways</b>	27 acres
<b>Property Value</b>	\$694,391 per acre
<b>Untreated Impervious Area</b>	16% of catchment is untreated impervious land Drainage areas for stormwater facilities are not mapped.
<b>Existing Stormwater Facilities</b>	<ul style="list-style-type: none"> <li>Private pond (PD0128) – year built unknown</li> <li>King County pond (PD0159) built 2011</li> </ul>

<sup>2</sup> [http://green2.kingcounty.gov/SmallLakes/Reports/Leota\\_WY09.pdf](http://green2.kingcounty.gov/SmallLakes/Reports/Leota_WY09.pdf)



Criteria	Data
	<ul style="list-style-type: none"> <li>Beverly Hills Estates vaults (VT0138 and VT0142)</li> </ul>
Easements	None
Groundwater	The catchment has low to high susceptibility to groundwater contamination
Stream Shade	46% of the stream has less than 50% shading Much of the catchment's flow path is through the open water of Lake Leota

**Table 41. Summary of Identified Strategies for Lake Leota (BEA850) catchment..**

Strategy	Benefits				
	Flow/ B-IBI	Temperature	Fecal Coliform	TSS/ Turbidity	Metals
Inspect and optimize the existing stormwater facilities	X			X	X
Incentivize LID installation on private land	X	X	X	X	X
Incentivize tree planting on private land	X	X		X	
Install roadside bioretention facilities in road right-of-way	X			X	X
Construct new regional facilities to meet need after LID installation	X	X	X	X	X
Shoreline restoration/stewardship along Lake Leota and outlet		X	X	X	

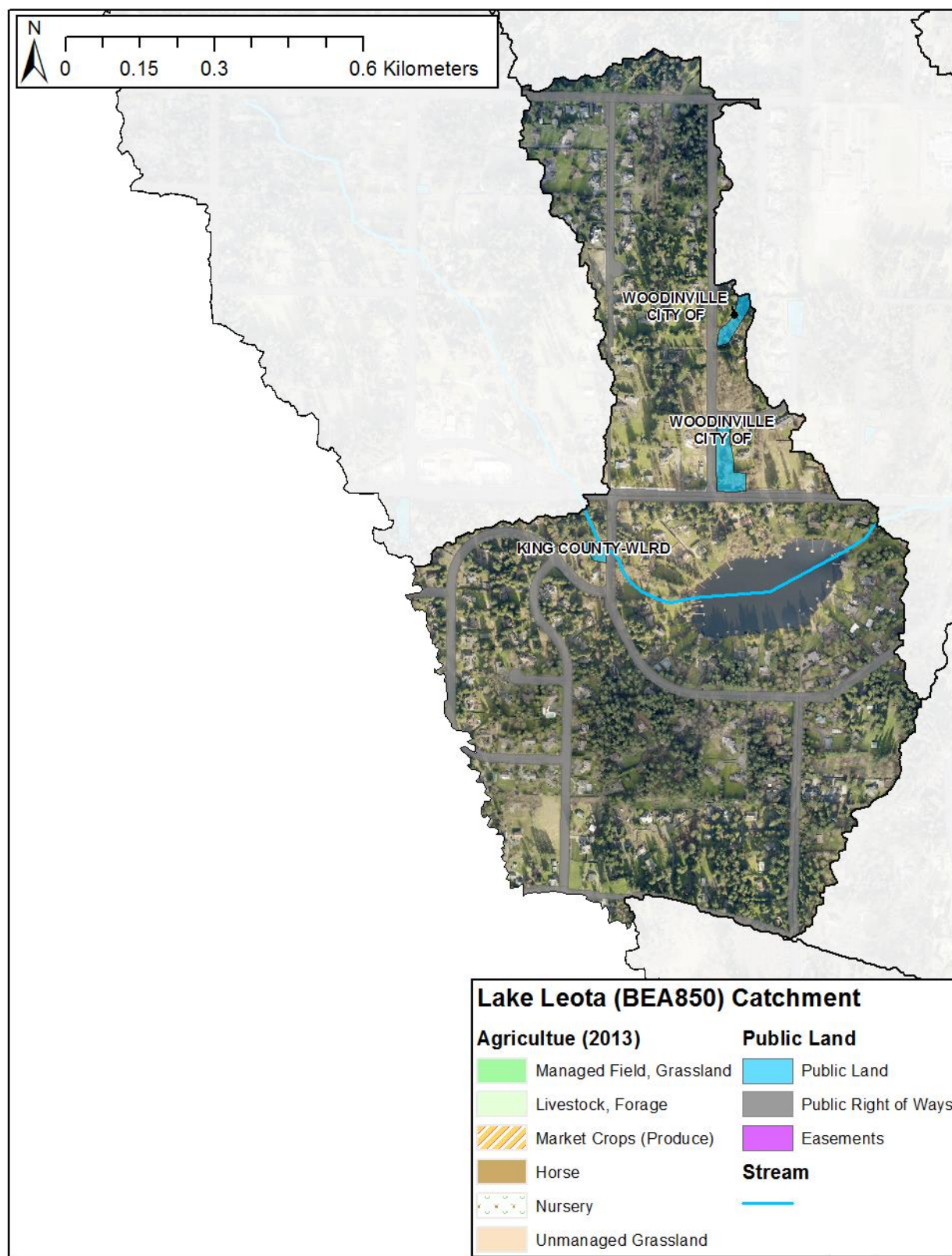


Figure 71. Lake Leota (BEA850) catchment agricultural and public land.

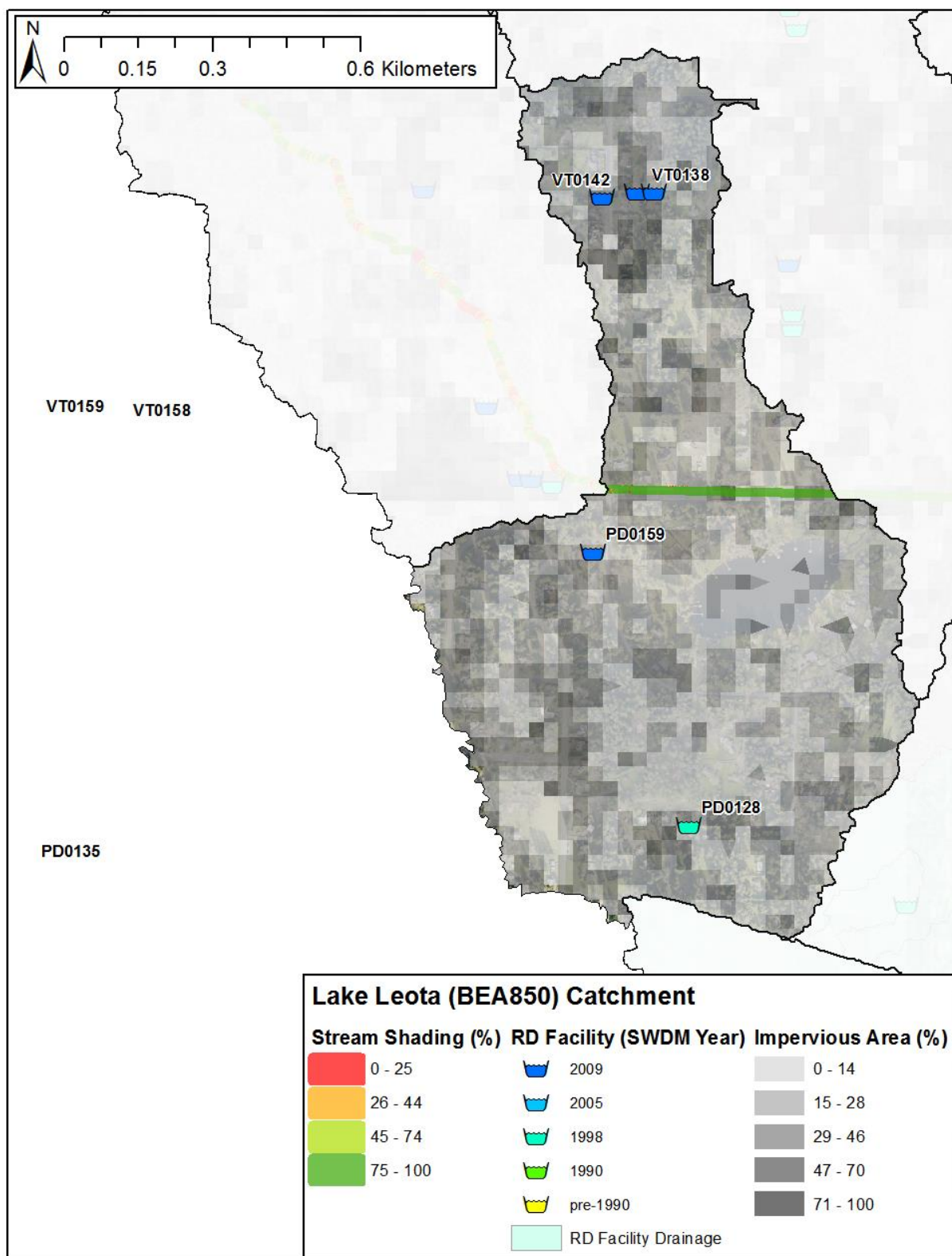


Figure 72. Lake Leota (BEA850) catchment stream shading, impervious area, and RD facilities and their drainage area.

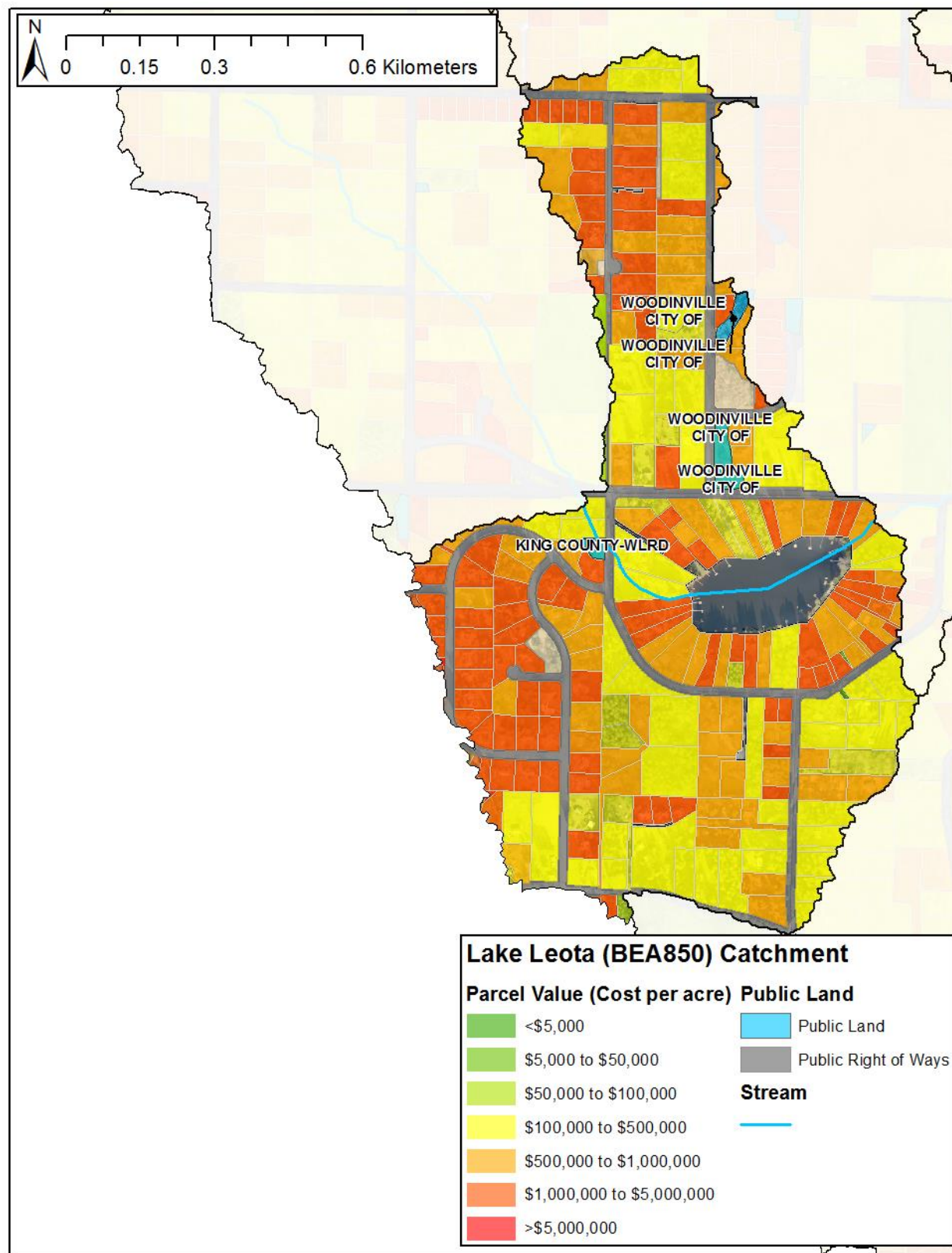


Figure 73. Lake Leota (BEA850) catchment parcel values and public lands.



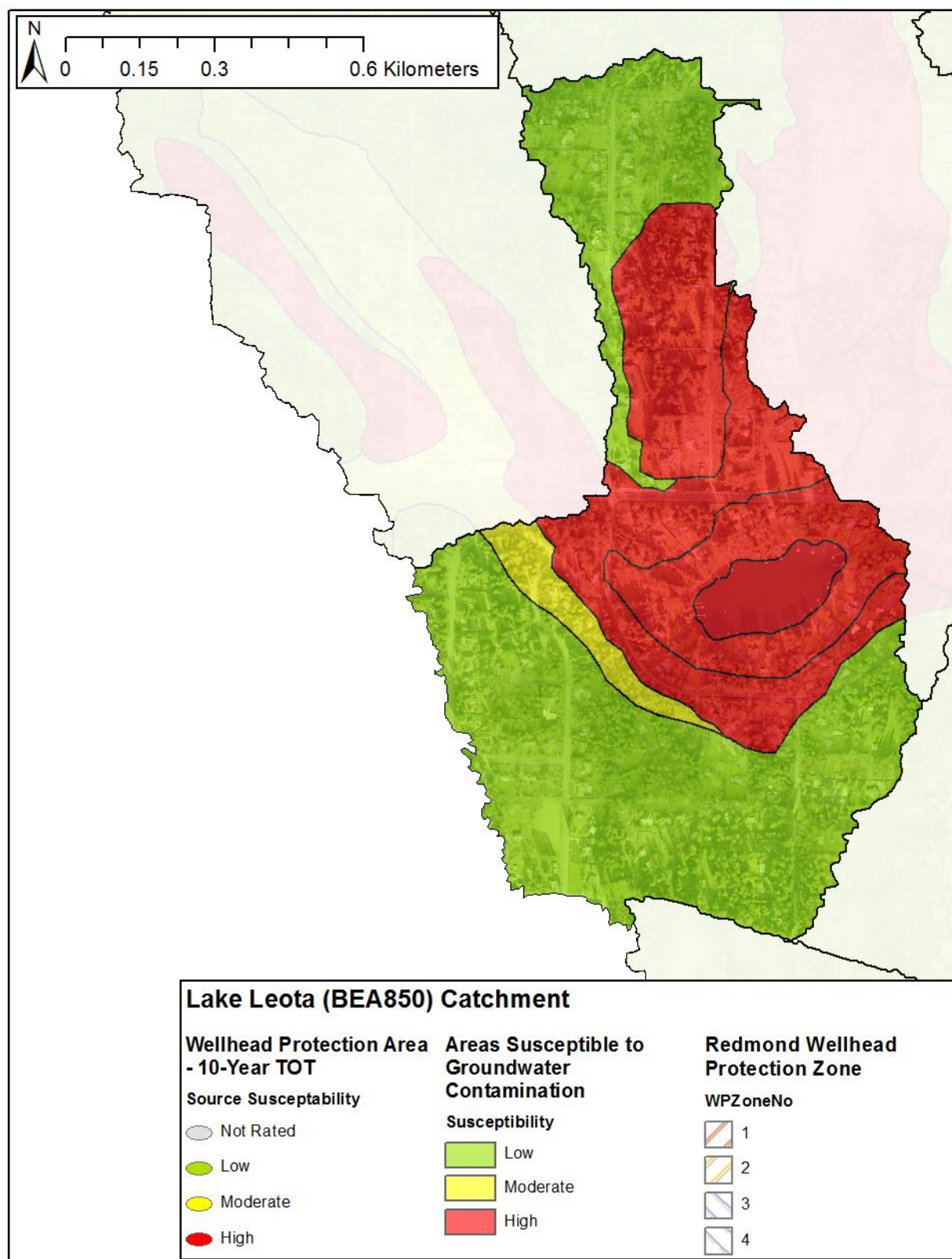


Figure 74. Lake Leota (BEA850) catchment groundwater protection areas.

## **7.0 REFERENCES**

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King County. 2017. Bear Creek Watershed-scale Stormwater Plan: Existing Water Quality Conditions. Prepared by Timothy Clark and Eric Ferguson, Water and Land Resources Division. Seattle, WA.

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# **APPENDIX B:**

## **Instream Habitat Project Identification and Prioritization**



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Table 13. Upper Bear Creek Restoration Project Prioritization (projects displayed in Figure 5). Project naming is a combination of sub-basin (i.e., Lower Bear Creek [LB], Cottage Lake Creek [C], or Upper Bear Creek [UB]) and project number. Projects within the Table are ranked by the Ranking Score column (highest to lowest). Abbreviations are as follows: RVS (Restoration Value Score), OFS (Opportunity and Feasibility Score), EDT (Ecosystem Diagnosis Treatment), BCLC (Bear/Cottage Lake Creeks), LWD (large woody debris). ....39



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## 1.0 INTRODUCTION

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Salmonids depend on various habitat types throughout their life-cycle to support individual survival as well as population sustainability (Bjornn and Reiser 1991, Roni et al. 2014). The suite of habitats and associated environmental conditions experienced throughout their life-cycle subsequently influence the abundance, productivity, distribution, and diversity of salmonid populations (McElhany et al. 2000). The quantity, quality, and connectivity of these habitats are thus inherently critical to salmonid survival and productivity (Roni et al. 2014). Since salmonid growth and rearing in freshwater habitats have the potential to influence survival at later stages, it is critical to protect and restore freshwater habitats.

As juvenile salmon grow and transition through early life stages, their habitat use and distribution appears to shift with different habitat types being used at different times of the year (King County 2017a). In order to support the continuum of early life stages, a variety of freshwater rearing habitats are needed throughout the Bear Creek study area. Freshwater habitat quantity, quality, and connectivity are inherently related to well-functioning riverine, floodplain, and riparian processes. Supporting these processes through protection and restoration strategies can promote the habitat conditions needed by juvenile salmonids.

Critical salmonid life stages are sustained by protecting areas where habitat conditions are closer to well-functioning as well as actively restoring areas where habitat conditions are degraded. Protection strategies aimed at conserving well-functioning areas in the Bear Creek watershed may include continued or further implementation of land-use policies that protect habitat areas including regulatory mechanisms such as comprehensive plans, critical areas ordinance, shoreline programs, zoning regulations, storm water management, and reduction of development impacts. Additional strategies aimed at protecting critical habitat areas include conservation easements and transfers/purchase of development rights, water rights and instream flow protection, best management practices and voluntary measures, as well as other strategies. Protection strategies are integral in ensuring that well-functioning area remain intact and help to minimize the net loss and degradation of available habitat areas.

In areas of the Bear Creek watershed where habitats have been degraded, restoration strategies should focus on habitat quantity, quality, variety, and connectivity as well as decreasing the pressures which degrade habitats. Restoration strategies suggested for the Bear Creek watershed include floodplain and wetland restoration/connection, off-channel and side-channel restoration/creation, tributary restoration/connection, large wood supplementation, riparian forest restoration, and road and bridge crossing improvements. These restoration strategies help to support and maintain riverine, floodplain, and riparian processes which in turn provide the habitats that support various salmon life stages. Details of how each strategy supports instream habitats and habitat-forming processes are included in Table 1. Riparian restoration is an integral element in Bear Creek conservation and restoration; however, discussion and prioritization of riparian strategies is not included in this Appendix but rather detailed in *Appendix D – Riparian Corridor Strategies*.

**Table 1. Restoration Strategies and Ecological Benefits.**

Restoration Strategy	Salmonid Ecological Benefits*
<b>Tributary Confluence Restoration</b>	Provides rearing habitats, high-flow and predator refuge, areas of high food resource availability, potential cold water refugia, increased connectivity to habitat areas, and increased confluence habitat heterogeneity.
<b>Wetland Connection</b>	Provides connection to rearing and overwinter habitats. Improves water quality, hydrology, primary productivity, organic matter retention, and food resources availability.
<b>Floodplain Connection</b>	Reconnects lateral and floodplain habitats important for rearing and refuge, allows channel migration, restores longitudinal connectivity, supports transport of nutrients and sediment. Improves water quality, hydrology, water residence time, overbank fine sediment deposition, primary productivity, and organic matter retention.
<b>Off-channel &amp; Side-Channel Creation</b>	Provides rearing and overwinter habitats, high-flow refuge, areas of food resource availability, spawning habitats, increases habitat heterogeneity and complexity.
<b>Large Woody Debris Addition</b>	Increases pool frequency/depth, woody debris, habitat heterogeneity and complexity, spawning gravel, sediment retention, and organic matter retention. Provides cover from predators, food resources, and promotes hyporheic exchange.
<b>Road/Bridge Crossing Improvements**</b>	Improves channel and floodplain connectivity, fish passage and colonization, water quality, hydrology, and reduces sediment supply.

\* Summarized from Roni et al. 2008, Rice et al. 2008, and Roni et al. 2014

\*\* Road/Bridge Crossing Improvements can be accomplished through various efforts and supports fish passage needs

Within the Bear Creek study area, one or more of the aforementioned restoration strategies are included in an **instream habitat project**. Determination of which restoration strategies were included within a given instream habitat project is discussed in *Section 2.1 and 2.2*. Additionally, *Sections 2.3 – 2.6* discuss an approach used to determine the prioritization and ranking of restoration projects across Bear and Cottage Lake creeks.

## **2.0 INSTREAM HABITAT STRATEGY SELECTION AND PROJECT IDENTIFICATION**

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### **2.1 Restoration Project Footprint Areas**

In order to determine the locations of habitat projects as well as the relative sizes of project areas, project footprints were determined for the mainstem of Bear and Cottage Lake creeks. A focus was given to mainstem channels since detailed data was not available for many tributaries and since fish-use analyses from 2016 were focused on mainstem channels (King County 2017a). The 100-year floodplain was used as the initial template for the boundaries of project footprint areas. These boundaries were adjusted to site-specific topographic, elevational, and floodplain features along the river corridor using LIDAR, orthophotography, and wetland data sets. These boundary adjustments were focused on aligning project footprint areas around infrastructures and landscape features as well as ensuring footprint areas included floodplain features such as wetlands and tributary confluences. The wetland data set used for these boundary adjustments came from the *Assessment of Bear Creek Watershed Wetlands* (King County 2017b). The upstream and downstream breaks in project footprints were based on road crossing, changes in land-use (e.g., public to private lands), and/or changes in specific restoration strategies. The upstream extents of all project delineation were based on the upstream extents of mapped floodplains as well as the upstream extents of salmonid use within the watershed.

### **2.2 Restoration Strategies and Habitat projects**

Restoration strategies suggested for the Bear Creek watershed include channel restoration, floodplain and wetland restoration/connection, off-channel and side-channel restoration/creation, tributary restoration/connection, large wood supplementation, riparian forest restoration (discussed in *Appendix D*), and road/bridge crossing improvements. These various restoration strategies were grouped into five broad categories including tributary confluence restoration, wetland connection, floodplain connection, off-channel and side-channel creation, and large woody debris addition. Road and bridge crossings were considered as a restoration strategy but were not included in specific project areas. Rather, these projects were identified across the mainstem of Bear and Cottage Lake creeks based on locations where road/bridge crossings intersected the mainstem channel and were subsequently included as a separate point data set.

Within the project areas delineated from *Section 2.1*, determination of specific restoration strategies was based on the relative proximity/adjacency of a project area to floodplain features, wetlands, and landscape modifications. Additionally, land-use and ownership was considered when determining potential restoration strategies within a project area. The selection and rationale of relevant restoration strategies are detailed in Table 2.



**Table 2. Determination of Restoration Strategies for Project Areas.**

<b>Restoration Strategy</b>	<b>Determination of Inclusion in a Restoration Project</b>	<b>Data Source</b>	<b>Important Limitations/ Caveats</b>
<b>Tributary Confluence Restoration</b>	<i>Proximity/adjacency to tributary confluences:</i> areas around tributary confluences help to support tributary restoration and connection.	King County Streams and Rivers (King County GIS library)	Some tributaries may not be included in the streams and river inventory.
<b>Wetland Connection</b>	<i>Proximity/adjacency to wetlands:</i> areas around wetlands will help support wetland connection, creation, and restoration.	Bear Creek combined wetlands (from 2017 <i>Assessment of Bear Creek Watershed Wetlands</i> )	Limitation of wetland inventory discussed in <i>Assessment of Bear Creek Watershed Wetlands</i> .
<b>Floodplain Connection</b>	<i>Available floodplain extents:</i> areas where the floodplain is less constricted and has a greater extent will provide more area for floodplain connection.	King County 100 Year Floodplains, LIDAR, orthophotography, Bear Creek combined wetlands	Corrections to the 100 year floodplain were made to account for infrastructures, landscape features, and floodplain features.
<b>Off-channel &amp; Side-Channel Creation</b>	<i>Proximity/adjacency to available floodplain extents:</i> floodplain areas may have topographic and geomorphologic characteristics that support channel migration which help to create and connect off-channel and side-channel features.	King County 100 Year Floodplains, LIDAR, orthophotography, Bear Creek combined wetlands	Corrections to the 100 year floodplain were made to account for infrastructures, landscape features, and floodplain features.
<b>Large Woody Debris Addition</b>	<i>Proximity/adjacency to available floodplain extent as well as areas in public ownership and/or areas with minimal infrastructure:</i> areas in public ownership or with minimal infrastructure may be best suited for large wood placement to ensure minimal risk of wood/river movement to infrastructures and public safety.	King County Public Lands Areas, King County 100 Year Floodplains, LIDAR, orthophotography, Bear Creek combined wetlands	Corrections to the 100 year floodplain were made to account for infrastructures, landscape features, and floodplain features.

Within the Bear Creek study area, one or more of the restoration strategies in Table 2 was included in an instream habitat project. Instream habitat projects were determined throughout the mainstem of Bear and Cottage Lake Creeks with a total of 65 instream restoration projects identified for the Bear Creek Study area. A few restoration projects included only one strategy; however, the majority of restoration projects included several strategies. An abbreviated list of projects and specific restoration strategies is included in Table 3 and the comprehensive list is included in Tables 7 – 13.

**Table 3. Select Instream Habitat Restoration Projects in the Bear Creek Study Area.**

Project	Sub-Basin	Location	Restoration Strategies
<b>LB3</b>	Lower Bear Creek	Downstream of NE 95 <sup>th</sup> St.	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
<b>LB4</b>	Lower Bear Creek	Between NE 95 <sup>th</sup> Street and NE Novelty Hill Rd.	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
<b>LB5</b>	Lower Bear Creek	Upstream of NE Novelty Hill Rd.	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
<b>C7</b>	Cottage Lake Creek	Upstream of NE 136 <sup>th</sup> St.	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
<b>C9</b>	Cottage Lake Creek	Adjacent to 194 <sup>th</sup> Ave NE	Floodplain Connection, Off-channel & Side-Channel Creation, LWD
<b>C20</b>	Cottage Lake Creek	Upstream of NE 165 <sup>th</sup> St.	Tributary Confluence Restoration, Wetland Connection, LWD Addition
<b>UB4</b>	Upper Bear Creek	Upstream of NE 127 <sup>th</sup> St.	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD
<b>UB11</b>	Upper Bear Creek	Upstream of NE 141 <sup>st</sup> St.	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD
<b>UB17</b>	Upper Bear Creek	Upstream of NE 155 <sup>th</sup> St.	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation

The cost of restoration projects in similarly sized creeks average about \$3,000,000 per river mile. Restoration projects identified for the mainstem Bear and Cottage Lake creeks range in estimated construction costs from \$90,000 to \$2,100,000 (see *Section 3.4* for specific project costs). These approximated construction costs do not include any related acquisition costs, so a separate approach was used to estimate acquisition costs. The acquisition costs for a given project were estimated based on the average cost-per-acre for private parcels within a project area. The cost was based on the acquisition of only the fraction of the parcels within the proposed project areas and does not include acquisition of outside areas or built improvements. Acquisition costs for projects estimated for the mainstem Bear and Cottage Lake creeks range from \$10,000 to \$1,000,000 (see *Section 3.4* for specific project costs).

## 3.0 INSTREAM PROJECT PRIORITIZATION

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In order to determine the prioritization of individual instream restoration projects, each project was scored and ranked. The process of scoring and ranking instream habitat projects is outlined in the following discussion. A schematic of instream habitat scoring and prioritization is included in Figure 1 and relevant data sets are discussed in *Section 3.4*. Instream habitat projects within the Bear Creek study area were prioritized based on two main scoring criteria including a **restoration value score** as well as an **opportunity/feasibility score**.

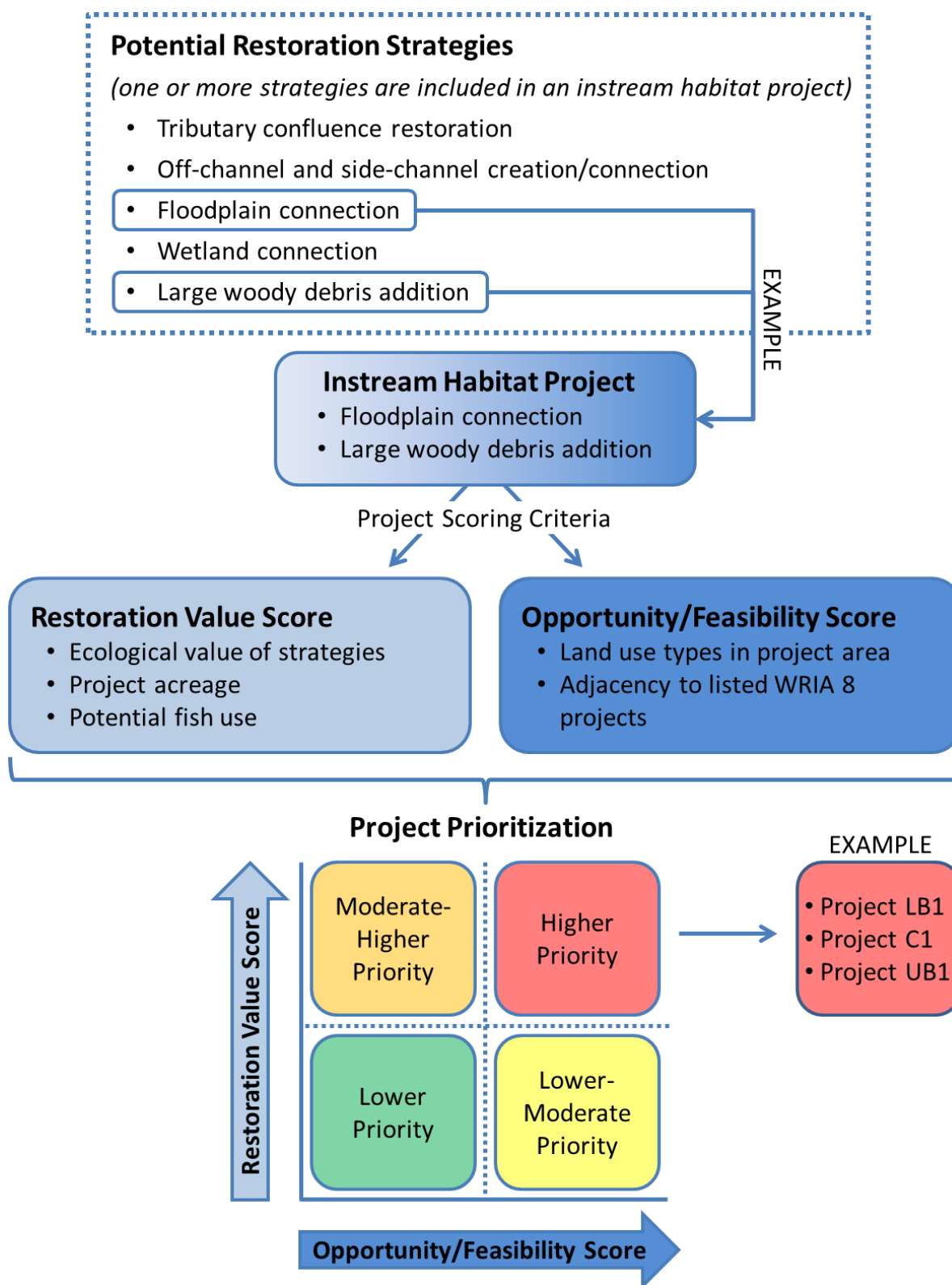


Figure 1. Schematic of instream habitat project scoring and prioritization for the mainstem of Bear and Cottage Lake creeks (detailed in Sections 3.1 – 3.4).



### 3.1 Restoration Value Score

The **restoration value score** for each instream project was based on three elements including: 1) the ecological value of individual restoration strategies included in the project area, 2) the acreage of a given project area, and 3) the potential likelihood of fish use within a given reach.

$$\text{Restoration Value Score} = \text{Ecological Value Score} * \text{Project Area} * \text{Potential Fish Use}$$

The ecological value of restoration strategies within a project area was based on the influence of a given strategy on habitat quality/quantity, variety, and connectivity. The scoring of individual restoration strategies is outline in Table 4. Scores for individual restoration strategies which were included within each project area were added up and resulted in a combined **ecological value score**. The scoring system was aimed at giving project areas more ecological value if several restoration strategies could be included in the project area (e.g., a project area with all five restoration strategies would have a combined score of 100 while a project area that only one restoration strategy would have a score of 15, 20, or 25).

**Table 4. Ecological Value Scores for Restoration Strategies in the Bear Creek Watershed.**

Restoration Strategy	Ecological Value Score	Rationale
<b>Off-channel &amp; Side-Channel Creation</b>	25	Off-channel and side-channel areas have the potential to provide year-around habitats for juvenile salmon. The availability and importance of these habitats for juvenile salmon rearing and foraging in Bear and Cottage Lake creeks has been noted by King County (2017a).
<b>Tributary Confluence Restoration</b>	20	Tributaries have the potential to provide year-around habitats for juvenile salmon and the importance of tributary confluences for rearing and refuge has been well documented.
<b>Wetland Connection</b>	20	Wetlands have the potential to provide year-around habitats with connectivity related to season, channel features, and floodplain connectivity. Wetlands are important for juvenile salmon rearing and flood refuge as well as helping to support riverine and floodplain processes.
<b>Large Woody Debris Addition</b>	20	Large woody debris is needed throughout the Bear Creek watershed and influences riverine and floodplain processes. Placement of large wood may be limited due to infrastructures and public safety so opportunistic areas of potential placement are a high priority.
<b>Floodplain Connection</b>	15	Floodplain habitat availability is seasonal and may not be available year-around. Areas of available and connected floodplain habitats can provide juvenile salmon with flow refuge and rearing during winter and spring.

Once an ecological value score was determined for a project area, the ecological value score was then multiplied by an area score for that project. **Project area scores** were determined by binning all of the potential restoration projects areas into three area classes: smaller, medium, or larger. Binning and scoring was based on separating the range of project acreages delineated from *Section 2.1* into thirds with the lowest third designated as smaller projects (score = 1), the middle third designated as medium projects (score = 2), and the top third designated as larger projects (score = 3). The scoring of project areas was based on the potential benefits of a given project acres to salmon habitats (i.e., larger project areas have greater benefits).

The product of the ecological value score and project area score was then multiplied by a potential fish use score. **Potential fish use** of a project was evaluated and scored based on the relative location of projects throughout the mainstem of Bear and Cottage Lake creeks. Projects in Lower Break Creek (downstream extent of the Bear Creek study area upstream to the confluence with Cottage Lake Creek) were given the highest potential fish use score (value = 3) since the vast majority of adult and juvenile salmon moving throughout the Bear Creek system will travel through habitats in Lower Bear Creek. Additionally, since Lower Bear Creek has the greatest amount of instream habitat degradation, the likelihood of restored habitats being utilized by juvenile salmonids may be high in Lower Bear Creek. Upper Bear Creek (confluence with Cottage Lake Creek to upstream extent of salmon use) and Cottage Lake Creek (confluence with Bear Creek to upstream extent of salmon use) are both utilized by adult and juvenile salmon; however, spawning densities of Chinook salmon are generally greater in Cottage Lake Creek. Subsequently, projects in Cottage Lake Creek were given a potential fish use score of 2 and projects in Upper Bear Creek were given a potential fish use score of 1.

Road and bridge crossings were not included in this project scoring system due to the difficulty in deterring potential project area extents as well as limited information on crossing conditions and the related degree of fish passage impairment. Rather than individually scoring and prioritizing road and bridge crossing projects, all projects of this type were highlighted as important and prioritized similarly across the watershed. These projects are important due to the impacts of road and bridge crossing on floodplain constriction, channel connectivity, and riverine-floodplain processes. The prioritization of road and bridge crossings improvements would be a beneficial programmatic strategy moving forward and could be based on the degree of fish passage impairment, location within the watershed, age of facility, and species presence.

## 3.2 Project Opportunity/Feasibility Score

In addition to a restoration value score, instream projects across the Bear Creek study area were also given an **opportunity/feasibility score**. The opportunity and feasibility of instream projects was determined based on two elements including: 1) the land-uses within a given project area and 2) the adjacency of instream projects to salmon habitat project locations listed in the Water Resource Inventory Area 8 (WRIA 8) Chinook Salmon

Conservation Plan (WRIA 8 Steering Committee 2005, WRIA 8 Salmon Recovery Council 2017).

***Opportunity/Feasibility Score = Land-Use/Designation Score + Adjacent WRIA 8 Project Locations***

The **land-use/designation** element of the opportunity/feasibility scores was calculated based on the percentage of a project area that was in land-use types and designations which may be conducive to restoration strategies (discussed below). Land-use types and designations were grouped into 4 broader bins including public ownership, easements and Public Benefit Rating System (PBRs), farm and agriculture, and non-farm/agriculture private ownership. Land-use types/designations that tend to be more opportunistic for restoration strategies include public ownership, easements and Public Benefit Rating System, as well as farm and agriculture. While areas in non-farm/agriculture private ownership can be opportunistic or feasible to habitat restoration, we were not able to accurately evaluate the degree to which these areas may or may not be supportive of restoration strategies.

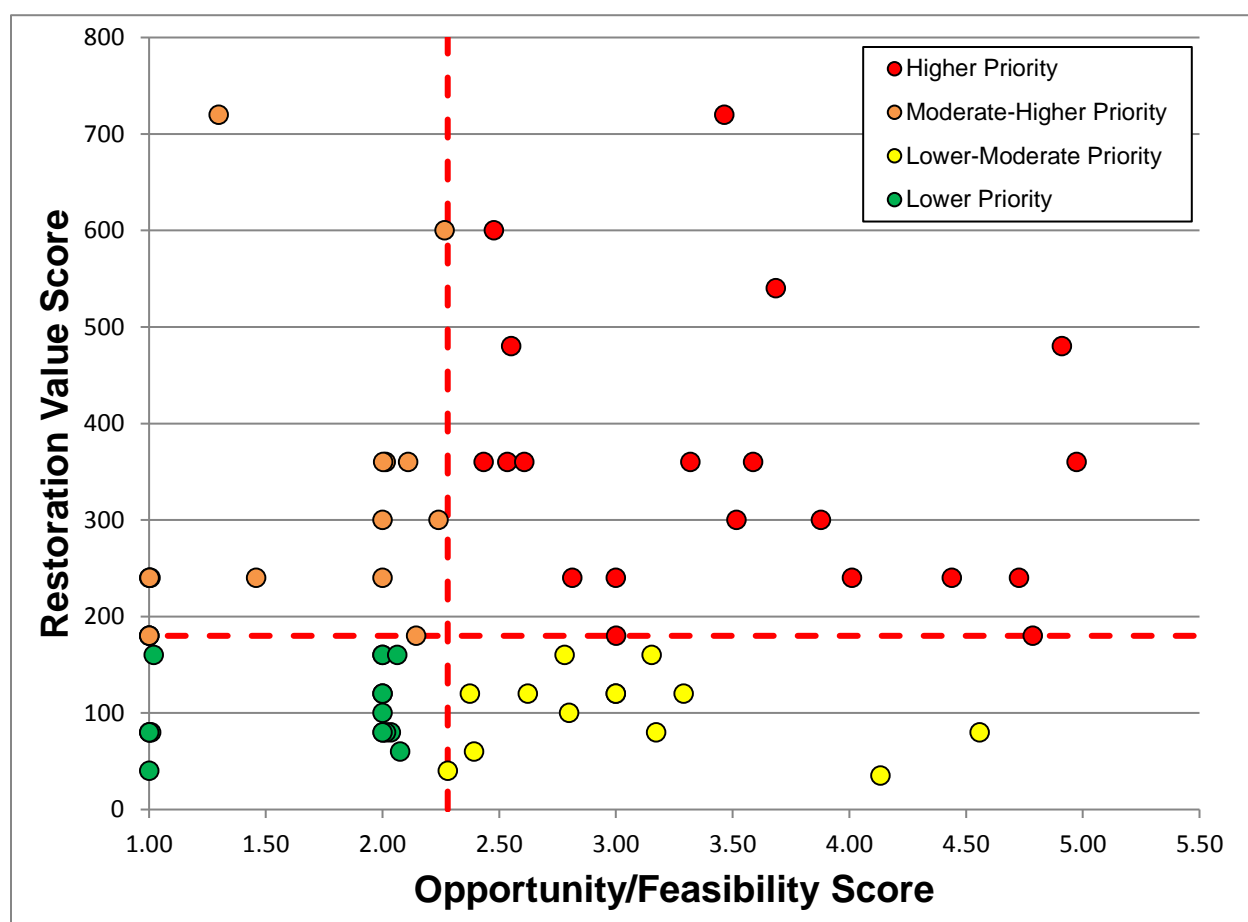
Areas in public ownership are considered to be the most opportunistic/feasible for restoration since these lands generally have fewer infrastructures, are highlighted as a priority from public outreach, and have Bear Creek project partner jurisdiction. Parcels with easements or conservation current-use taxation status (e.g., Public Benefit Rating System program) are considered to be the next most opportunistic/feasible land-use for restoration strategies. In the Bear Creek study areas, these parcels tend to still be in private ownership; however, their conservation status for habitat preservation makes these areas ideal locations for potential restoration or for further improvement to riverine conditions. Since infrastructures may still be present in these areas and ownership may not support certain instream restoration strategies, a correction factor was applied to the percentage of project areas in this land-use type/designation (dividing the acreage percentage by 2). Farm and agriculture was considered as the next most opportunistic land-use/designation type for restoration strategies. While areas in this designation are likely in current use for farm/agricultural purposes, these areas may provide restoration opportunities since parcels tend to be larger in area than private non-farm/agricultural parcels and generally have fewer infrastructures near water bodies. However, since these parcels are still in private ownership and may have conflicting land-use priorities (e.g., farmland preservation vs. habitat restoration) a correction factor was applied to the percentage of project areas that were in this land-use type/designation (dividing the acreage percentage by 3). Areas in solely non-farm/agriculture private ownership were considered to be the least opportunistic and feasible for restoration due to smaller parcel sizes, various private land owners, and higher occurrences of infrastructures. As previously mentioned, while these areas have the potential to be opportunistic or feasible for habitat restoration, the degree to which these areas may be supportive of restoration strategies is not easily determined. Across the land-use/designation bins, the opportunity/feasibility scores varied from 0 (project areas being in all non-farm/agriculture private ownership) to 1 (project areas being in all public ownership).

The adjacency of instream habitat project areas to **WRIA 8 project locations** was also included in the opportunity/feasibility score. The WRIA 8 salmon habitat project lists for Bear and Cottage Lake creeks include various projects aimed at addressing the conservation needs outlined in the WRIA 8 Chinook Salmon Conservation Plan (WRIA 8 Steering Committee 2005, WRIA 8 Salmon Recovery Council 2017). These projects include various strategies focused on removing pressures which degrade habitats, improving habitat and water quality conditions, protecting aquatic resource, and addressing land-use impacts and management strategies. This information provides a useful reference to various projects which have either been completed or proposed in the Bear Creek watershed. Projects on the WRIA 8 Salmon Conservation list have had some degree of vetting, either through salmon recovery forums, through previous planning efforts, or through communication with local jurisdiction, habitat enhancement groups, or private property owners. Subsequently, adjacency of Bear Creek instream projects to these listed WRIA 8 project locations was considered to increase the opportunity or feasibility of a given instream habitat project. Each WRIA 8 project that fell within or was adjacent to a Bear Creek instream habitat project area increased the opportunity/feasibility score of that given project area by 1 (+1 per project).

### **3.3 Prioritization Categories for Restoration Projects**

Once instream habitat projects were given a restoration value score and an opportunity/feasibility score, the projects were then prioritized by graphically evaluating the relative scores. The ranges of the restoration value scores and opportunity/feasibility scores were divided into 4 quadrant categories, with each quadrant-category indicating the relative project prioritization (Figure 2). Separation of quadrant categories was based on the 50th percentiles of the restoration value scores and the opportunity/feasibility scores for all habitat projects. Quadrant category designations include higher priority, moderate - higher priority, lower - moderate priority, and lower priority.





**Figure 2. Plot of Restoration Value Scores and Opportunity/Feasibility Scores for Instream Habitat Projects identified in the mainstem of Bear and Cottage Lake creeks.**

All of the 65 instream habitat projects identified for the mainstem of Bear and Cottage Lake creeks were prioritized. Twenty one restoration projects were categorized as higher priority with 10 projects being in Lower Bear Creek, 3 in Cottage Lake Creek and 7 in Upper Bear Creek (Figure 3-6). Projects that ranked as higher priority have the highest restoration value scores and the highest opportunity/feasibility scores. These projects should be the highest priority for restoration and protection in the Bear Creek watershed since they have the greatest value and opportunity. Higher priority projects would result in the restoration of ~5.8 river miles at an estimated construction and acquisition cost of ~\$17,370,000 and ~\$4,193,000, respectively.

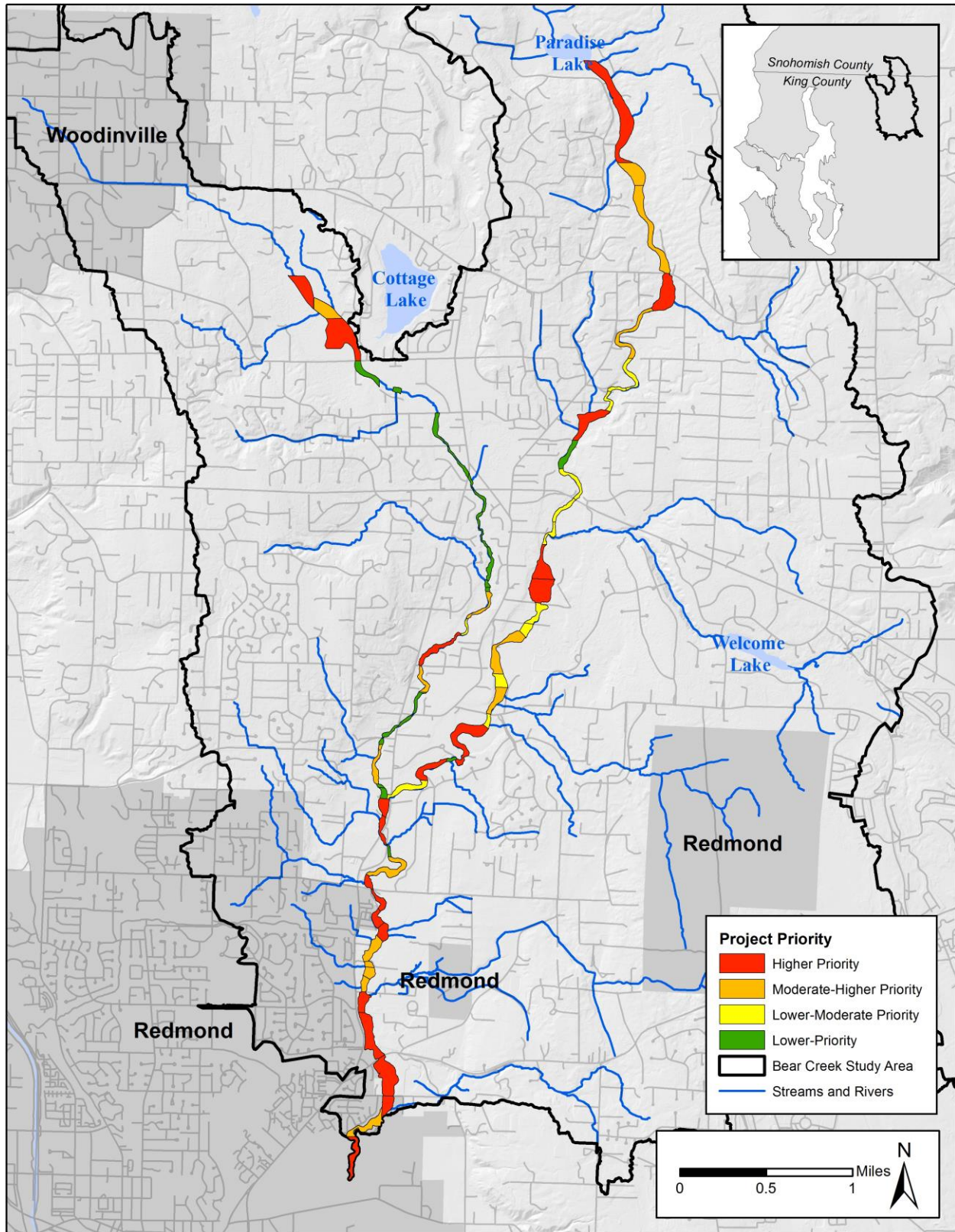
Fifteen restoration projects were categorized as moderate - higher priority with 7 projects being in Lower Bear Creek, 4 in Cottage Lake Creek and 5 in Upper Bear Creek (Figure 3-6). Moderate - higher priority projects have relatively high restoration value scores but lower opportunity/feasibility scores. These projects may require further private/public outreach as well as conservation/protection strategies (e.g., easements, PBRS, acquisition, etc.) prior to restoration to help increase opportunities and feasibility. Moderate - higher priority

projects would result in the restoration of ~3.8 river miles at an estimated construction and acquisition cost of ~\$11,370,000 and ~\$6,673,000, respectively.

Twelve restoration projects were categorized as lower - moderate priority with 2 being in Cottage Lake Creek and 11 in Upper Bear Creek (Figure 3-6). Projects that ranked as lower - moderate priority have low restoration value scores but relatively higher opportunity/feasibility scores. Since these projects may be opportunistic/feasible but have less value, it may make sense to implement these project in concert with highest priority projects (when funding is available) to increase project connectivity and to increase the relative size of higher priority project areas. Lower - moderate priority projects would result in the restoration of ~2.0 river miles at an estimated construction and acquisition cost of ~\$5,970,000 and ~\$1,784,000, respectively.

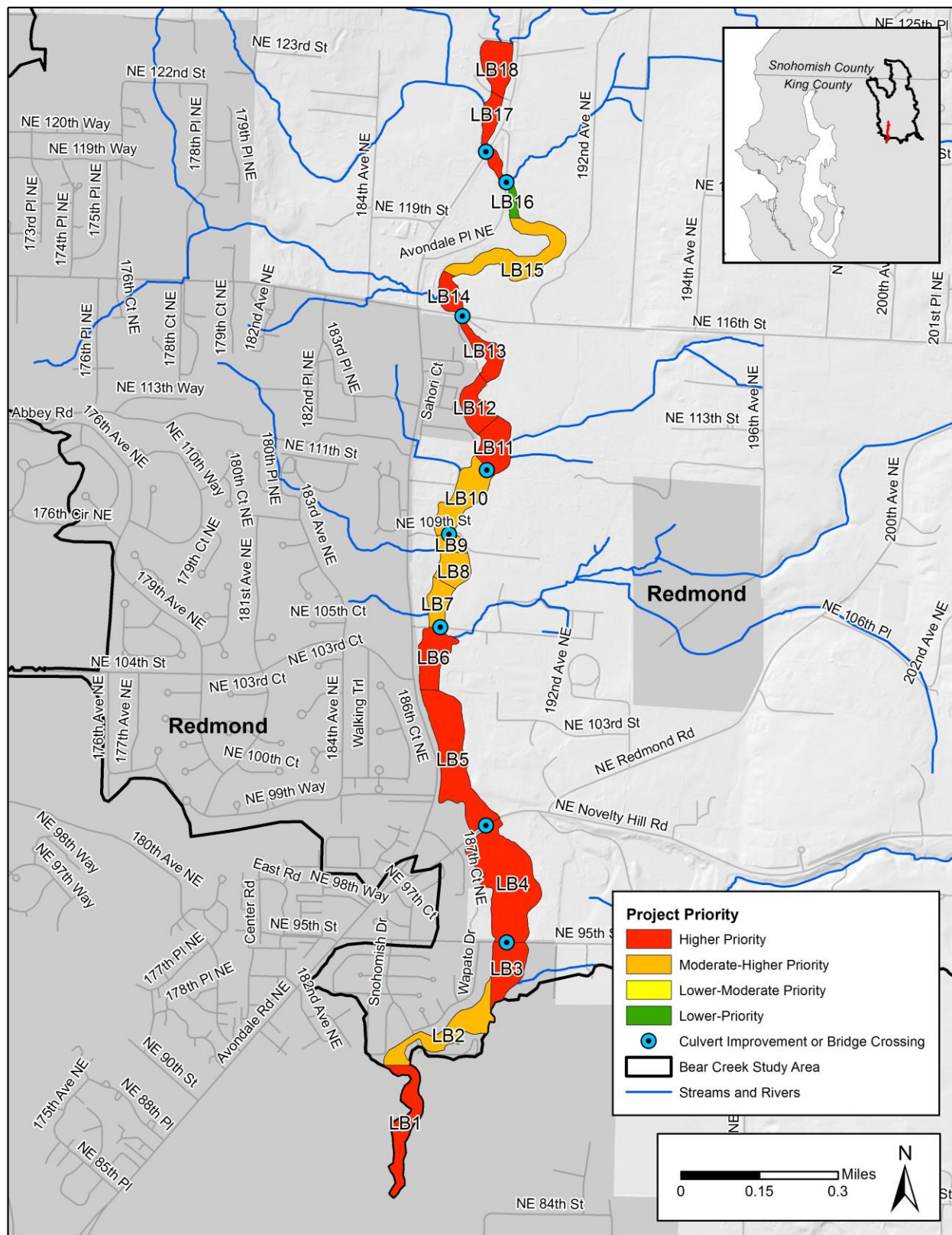
Seventeen restoration projects were categorized as lower priority with 1 projects being in Lower Bear Creek, 13 in Cottage Lake Creek and 2 in Upper Bear Creek (Figure 3-6). Lower priority projects have relatively lower restoration value scores and opportunity/feasibility scores. Since these project rank lower, they are a relatively low priority among all projects but may help supplement habitat needs when other prioritized projects have been addressed. Additionally, similar to moderate – higher priority projects, these lower priority projects may require further private/public outreach prior to implementation. Lower priority projects would result in the restoration of ~2.3 river miles at an estimated construction and acquisition cost of ~\$7,020,000 and ~\$4,173,000, respectively.

Across the mainstem of the Bear Creek study area, there were 31 identified road and/or bridge crossings (Figure 3-6). As discussed in *Section 2.3*, road and bridge crossings were not included in the project scoring system, but rather highlighted as important and prioritized similarly across the watershed.



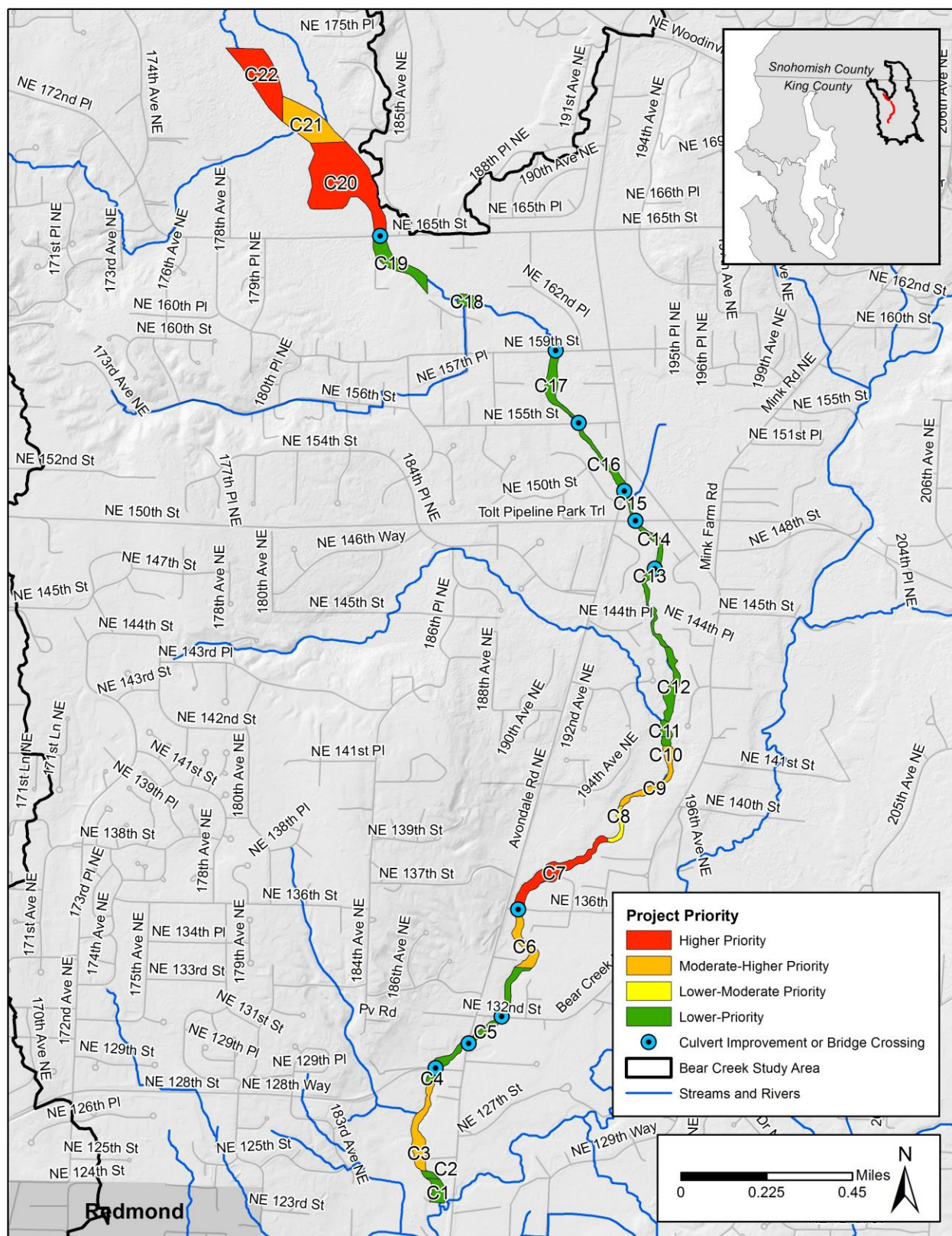
**Figure 3. Bear Creek Study Area Restoration Project Prioritization (specific project numbers as well as road/bridge crossing projects are included in Figure 4-6).**





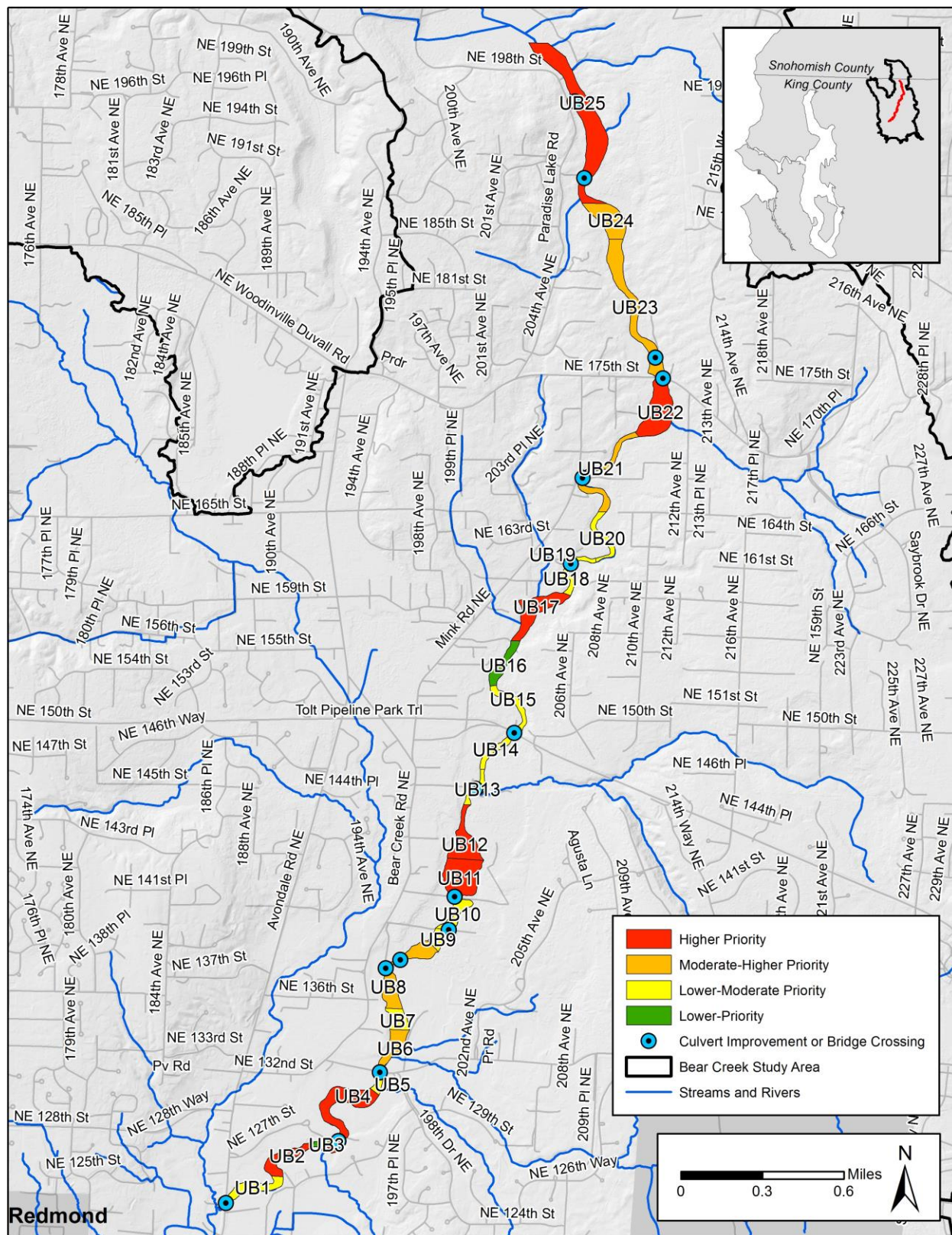
**Figure 4. Lower Bear Creek Restoration Project Prioritization (road/bridge crossing projects were not included in the prioritization scoring).**





**Figure 5. Cottage Lake Creek Restoration Project Prioritization (road/bridge crossing projects were not included in the prioritization scoring).**





**Figure 6. Upper Bear Creek Restoration Project Prioritization (road/bridge crossing projects were not included in the prioritization scoring).**

### 3.4 Restoration Project Ranking within Prioritization Categories and across Sub-Basin Areas

Within prioritization categories, we suggest that individual restoration projects should be ranked using an overall restoration value and opportunity/feasibility score (hereafter referred to as the **ranking score**). This ranking score is the product of the restoration value score and the opportunity/feasibility score (opportunity and feasibility scores were corrected [+1] to adjust for zero values). The ranking scores represent the relative priority of all restoration projects and projects with the highest ranking score should have the highest priority. In addition to this ranking, several supplemental scoring systems and data sets can be used to further inform prioritization and project designs. These additional scoring systems and data sets include Ecosystem Diagnosis Treatment rank, water quality and habitat problems score, and approximate project cost. Each additional information resource is discussed below.

The Ecosystem Diagnosis Treatment (EDT) ranks designate the relative potential of a reach to improve salmon performance (i.e., productivity, abundance, and life history diversity) based on habitat conditions in the reach and the exposure of Chinook life stages to those habitat conditions (WRIA 8 Steering Committee 2005, WRIA 8 Salmon Recovery Council 2017). Projects that fall within a designated reach receive that representative EDT rank score. The EDT ranks range from 1 to 14 with highest priority reaches ranking as 1. Since the EDT ranks correspond to reaches generally greater in length than instream habitat project areas, there are several reaches where multiple restoration projects fall within a single prioritization rank (e.g., all Lower Bear Creek projects group within the same EDT prioritization rank). Subsequently, we suggest only using the EDT ranks to further inform the relative prioritizations of Bear Creek ranking scores.

The water quality and habitat problems score shows the frequency of water quality and habitat problems that occur within a project area. Specific water quality and habitat problems are detailed in the supporting technical reports for the Bear Creek Watershed Management Study (King County 2017a, King County 2017b, King County 2017c, King County 2017d, King County 2017e). Project areas with higher values indicate a greater number of water quality and habitat problems. Since the frequency of water quality and habitat problems is highly dependent on the relative availability and extents of various data sets, we suggest only using this information to further inform the relative prioritizations of Bear Creek ranking scores. Understanding the specific water quality and habitat problems within a given project area will help to inform project design aimed at addressing specific issues.

As discussed in *Section 2.2*, the approximated cost of Bear Creek instream habitat projects was estimated based the cost of restoration projects in similarly sized creeks (~\$3,000,000 per river mile). Estimated restoration costs were based on the length of creek that ran through each instream habitat project area. Since these approximated restoration costs do

not include potential acquisition costs, a separate acquisition costs was also estimated for a given instream project area. The acquisition costs were based on the area-normalized assessed land value for private parcels within a project area. The estimated acquisition cost was based on the acquisition of only the fraction of the parcels within the proposed project areas and does not include acquisition of outside areas or built improvements.

Summary tables of estimated costs for instream habitat project are included in Table 5 and Table 6 (habitat projects are organized by prioritization category and sub-basin area). Instream habitat project rankings among prioritization categories and across sub-basins in the Bear Creek study area are included in Table 7 – Table 13. Tables 7 - 10 are organized by prioritization categories and Tables 11 - 13 are organized by sub-basin area. Within each respective Table, restoration projects are organized by the relative ranking score (highest scores listed first). All of the aforementioned supplemental scoring systems and information data sets are also included to further support project ranking/prioritization.

**Table 5. Summary of instream habitat projects by priority category.**

Prioritization Category	Sub-basin Area	Number of Projects	Estimated Restoration Cost	Estimated Acquisition Cost
<b>Higher</b>	Lower Bear Creek	11	\$7,260,000	\$1,971,000
	Upper Bear Creek	7	\$7,740,000	\$1,981,000
	Cottage Lake Creek	3	\$2,370,000	\$241,000
	<b>Sub Total</b>	<b>21</b>	<b>\$17,370,000</b>	<b>\$4,193,000</b>
<b>Moderate-Higher</b>	Lower Bear Creek	6	\$3,300,000	\$2,354,000
	Upper Bear Creek	5	\$5,610,000	\$2,359,000
	Cottage Lake Creek	4	\$2,460,000	\$1,960,000
	<b>Sub Total</b>	<b>15</b>	<b>\$11,370,000</b>	<b>\$6,673,000</b>
<b>Lower-Moderate</b>	Lower Bear Creek	0	\$0	\$0
	Upper Bear Creek	11	\$5,610,000	\$1,702,000
	Cottage Lake Creek	1	\$360,000	\$82,000
	<b>Sub Total</b>	<b>12</b>	<b>\$5,970,000</b>	<b>\$1,784,000</b>
<b>Lower</b>	Lower Bear Creek	1	\$240,000	\$64,000
	Upper Bear Creek	2	\$750,000	\$372,000
	Cottage Lake Creek	14	\$6,030,000	\$3,737,000
	<b>Sub Total</b>	<b>17</b>	<b>\$7,020,000</b>	<b>\$4,173,000</b>
<b>Grand Total</b>			<b>\$41,730,000</b>	<b>\$16,823,000</b>



**Table 6. Summary of instream habitat projects by sub-basin area.**

Sub-basin Area	Priority Category	Number of Projects	Estimated Restoration Cost	Estimated Acquisition Cost
<b>Lower Bear Creek</b>	Higher	11	\$7,260,000	\$1,970,000
	Moderate-Higher	6	\$3,300,000	\$2,354,000
	Lower-Moderate	0	\$0	\$0
	Lower	1	\$240,000	\$64,000
	<b>Sub Total</b>	<b>18</b>	<b>\$10,800,000</b>	<b>\$4,388,000</b>
<b>Upper Bear Creek</b>	Higher	7	\$7,740,000	\$1,981,000
	Moderate-Higher	5	\$5,610,000	\$2,359,000
	Lower-Moderate	11	\$5,610,000	\$1,702,000
	Lower	2	\$750,000	\$372,000
	<b>Sub Total</b>	<b>25</b>	<b>\$19,710,000</b>	<b>\$6,414,000</b>
<b>Cottage Lake Creek</b>	Higher	3	\$2,370,000	\$241,000
	Moderate-Higher	4	\$2,460,000	\$1,960,000
	Lower-Moderate	1	\$360,000	\$82,000
	Lower	14	\$6,030,000	\$3,737,000
	<b>Sub Total</b>	<b>22</b>	<b>\$11,220,000</b>	<b>\$6,020,000</b>
<b>Grand Total</b>			<b>\$41,730,000</b>	<b>\$16,820,000</b>

**Table 7. Higher Priority Restoration Projects. Project naming is a combination of sub-basin (i.e., Lower Bear Creek [LB], Cottage Lake Creek [C], or Upper Bear Creek [UB]) and project number. Projects within the Table are ranked by the Ranking Score column (highest to lowest). Abbreviations are as follows: RVS (Restoration Value Score), OFS (Opportunity and Feasibility Score), EDT (Ecosystem Diagnosis Treatment), BCLC (Bear/Cottage Lake Creeks), LWD (large woody debris).**

Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
LB4	720	3.46	2494.25	BCLC-R6-3-BB, BCLC-R6-7-BB	4	22.5	\$1,320,000	\$515,388	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
LB5	540	3.68	1989.83	BCLC-R6-4-BB, BCLC-R6-9-BB	4	21.8	\$1,200,000	\$966,719	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
LB3	480	3.91	1876.81	BCLC-R6-1-BB, BCLC-R6-2-BB, BCLC-R6-7-BB	4	19.0	\$390,000	\$9,912	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
C20	360	4.97	1790.41	BCLC-7-BB, BCLC-9-RB, BCLC-10-BB	8	18.4	\$720,000	\$28,723	Tributary Confluence Restoration, Wetland Connection, LWD Addition
LB11	600	2.48	1485.95	BCLC-R6-10-BB	4	10.4	\$360,000	\$0	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
LB6	600	2.27	1359.71	BCLC-R6-5-LB	4	19.0	\$480,000	\$89,146	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
LB13	360	3.59	1291.51	BCLC-R6-6-BB, BCLC-R6-10-BB	4	18.2	\$570,000	\$143,921	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
LB17	480	2.55	1224.63	BCLC-R6-11-BB	4	13.2	\$600,000	\$80,669	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
C7	360	3.32	1194.74	BCLC-3-BB, BCLC-4-BB	12	23.4	\$960,000	\$212,365	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation

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Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
UB25	300	3.88	1163.52	BCLC-R15-1-BB, BCLC-R15-2-BB		7.1	\$2,130,000	\$104,857	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
UB12	240	4.73	1134.29	BCLC-R9-1-BB, BCLC-R9-2-INS, BCLC-R10-1-BB	2	20.9	\$660,000	\$126,246	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
UB11	240	4.44	1065.20	BCLC-R8-2-BB, BCLC-R9-1-BB, BCLC-R9-2-INS	2	18.9	\$780,000	\$301,712	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
UB22	300	3.52	1054.65	BCLC-R13-1-BB, BCLC-R14-1-LB	9	18.2	\$780,000	\$351,875	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
LB18	360	2.61	938.79	BCLC-R6-11-BB	4	18.6	\$540,000	\$46,448	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation
LB1	360	2.53	912.56	BCLC-R4-1-BB	2	22.6	\$1,080,000	\$0	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
LB12	360	2.43	875.86	BCLC-R6-10-BB	4	11.8	\$420,000	\$79,431	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
C22	240	3.00	720.00	BCLC-10-BB		11.8	\$690,000	\$0	Wetland Connection, LWD Addition
LB14	180	3.79	681.47	BCLC-R6-8-INS, BCLC-R6-6-BB, BCLC-R6-11-BB	4	18.7	\$300,000	\$39,512	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation
UB4	240	2.81	675.19	BCLC-R7-3-BB	7	18.4	\$1,650,000	\$206,329	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
UB17	300	2.24	672.09	BCLC-R13-1-BB	14	9.2	\$930,000	\$466,681	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
UB2	180	3.00	540.16	BCLC-R7-1-BB, BCLC-R7-2-BB	7	12.7	\$810,000	\$423,302	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition

**Table 8. Moderate - Higher Priority Restoration Projects. Project naming is a combination of sub-basin (i.e., Lower Bear Creek [LB], Cottage Lake Creek [C], or Upper Bear Creek [UB]) and project number. Projects within the Table are ranked by the Ranking Score column (highest to lowest). Abbreviations are as follows: RVS (Restoration Value Score), OFS (Opportunity and Feasibility Score), EDT (Ecosystem Diagnosis Treatment), BCLC (Bear/Cottage Lake Creeks), LWD (large woody debris).**

Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
LB10	720	1.30	934.77		4	17.1	\$540,000	\$372,760	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
LB15	360	2.11	759.40	BCLC-R6-11-BB	4	18.8	\$1,230,000	\$538,092	Floodplain Connection, Off-channel & Side-Channel Creation
LB2	360	2.01	724.97	BCLC-R6-1-BB	4	22.5	\$900,000	\$889,138	Floodplain Connection, Off-channel & Side-Channel Creation
C21	360	2.00	720.99	BCLC-10-BB		11.9	\$390,000	\$988,202	Tributary Confluence Restoration, Wetland Connection, LWD Addition
UB6	300	2.00	600.00	BCLC-R8-4-BB	5	13.2	\$570,000	\$270,341	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
UB8	240	2.01	482.63	BCLC-R8-1-LB, BCLC-R8-3-LB, BCLC-R8-4-BB	5	19.4	\$1,200,000	\$742,063	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
C3	240	2.00	480.07	BCLC-2-BB	10	17.5	\$750,000	\$357,686	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation
UB21	180	2.14	385.85	BCLC-R13-1-BB	13	18.4	\$1,410,000	\$582,346	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
UB23	240	1.46	349.98		9	18.3	\$1,860,000	\$578,142	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
C6	240	1.01	241.40		12	22.5	\$600,000	\$238,167	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation



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Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
UB24	240	1.00	240.53			11.4	\$570,000	\$186,270	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
C9	240	1.00	240.00		11	21.3	\$720,000	\$376,305	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
LB7	180	1.00	180.00		4	16.0	\$300,000	\$238,683	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation
LB8	180	1.00	180.00		4	18.4	\$210,000	\$234,318	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
LB9	180	1.00	180.00		4	17.8	\$120,000	\$80,791	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition

**Table 9. Lower – Moderate Priority Restoration Projects. Project naming is a combination of sub-basin (i.e., Lower Bear Creek [LB], Cottage Lake Creek [C], or Upper Bear Creek [UB]) and project number. Projects within the Table are ranked by the Ranking Score column (highest to lowest). Abbreviations are as follows: RVS (Restoration Value Score), OFS (Opportunity and Feasibility Score), EDT (Ecosystem Diagnosis Treatment), BCLC (Bear/Cottage Lake Creeks), LWD (large woody debris).**

Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
C8	160	3.15	504.48	BCLC-3-BB, BCLC-4-BB	11	22.8	\$360,000	\$81,588	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
UB7	160	2.78	444.71	BCLC-R8-4-BB	5	17.9	\$270,000	\$109,028	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
UB14	120	3.29	394.82	BCLC-R10-1-BB, BCLC-R11-1-BB	1	19.3	\$570,000	\$274,551	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
UB10	120	3.00	360.00	BCLC-R8-2-BB, BCLC-R8-4-BB	5	19.5	\$450,000	\$191,100	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
UB20	120	2.62	314.67	BCLC-R13-1-BB	13	19.1	\$870,000	\$139,392	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
UB1	120	2.37	284.87	BCLC-R7-2-BB	7	17.9	\$900,000	\$283,345	Floodplain Connection, Off-channel & Side-Channel Creation
UB5	100	2.80	279.90	BCLC-R7-3-BB	7	18.2	\$240,000	\$39,796	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
UB15	80	3.17	253.76	BCLC-R11-1-BB, BCLC-R13-1-BB	14	19.9	\$780,000	\$233,940	Floodplain Connection, Off-channel & Side-Channel Creation
UB9	80	2.56	204.63	BCLC-R8-1-LB, BCLC-R8-3-LB, BCLC-R8-4-BB	5	18.5	\$270,000	\$29,310	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition

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Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
UB13	35	4.13	144.64	BCLC-R9-1-BB, BCLC-R9-2-INS, BCLC-R10-1-BB	1	22.1	\$480,000	\$149,909	Culvert Improvement or Bridge Crossing, Floodplain Connection, Tributary Confluence Restoration
UB18	60	2.39	143.55	BCLC-R13-1-BB	13	18.5	\$450,000	\$119,232	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
UB19	40	2.28	91.17	BCLC-R13-1-BB	13	19.4	\$330,000	\$132,388	Floodplain Connection, Off-channel & Side-Channel Creation

**Table 10. Lower Priority Restoration Projects. Project naming is a combination of sub-basin (i.e., Lower Bear Creek [LB], Cottage Lake Creek [C], or Upper Bear Creek [UB]) and project number. Projects within the Table are ranked by the Ranking Score column (highest to lowest). Abbreviations are as follows: RVS (Restoration Value Score), OFS (Opportunity and Feasibility Score), EDT (Ecosystem Diagnosis Treatment), BCLC (Bear/Cottage Lake Creeks), LWD (large woody debris).**

Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
C15	160	2.06	329.99	BCLC-6-INS	11	22.7	\$240,000	\$33,105	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
C10	160	2.00	320.00	BCLC-5-INS	11	18.9	\$90,000	\$88,064	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
C12	160	2.00	320.00	BCLC-5-INS	11	16.2	\$630,000	\$576,235	Floodplain Connection, Off-channel & Side-Channel Creation
C11	120	2.00	240.00	BCLC-5-INS	11	14.5	\$150,000	\$138,475	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation
C2	120	2.00	239.98	BCLC-2-BB	10	18.9	\$90,000	\$0	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
UB3	100	2.00	200.00	BCLC-R7-2-BB	7	8.9	\$180,000	\$51,540	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
C5	160	1.02	163.10		12	24.2	\$1,110,000	\$336,529	Floodplain Connection, Off-channel & Side-Channel Creation
C14	80	2.04	162.88	BCLC-6-INS	11	23.8	\$480,000	\$556,436	Floodplain Connection, Off-channel & Side-Channel Creation
C19	80	2.02	161.24	BCLC-7-BB	8	26.2	\$570,000	\$292,844	Wetland Connection



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Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
UB16	80	2.00	160.00	BCLC-R13-1-BB	14	17.3	\$570,000	\$320,793	Floodplain Connection, Off-channel & Side-Channel Creation
LB16	60	2.07	124.50	BCLC-R6-11-BB	4	13.1	\$240,000	\$63,570	Tributary Confluence Restoration
C4	120	1.00	120.00	BCLC-2-BB	10	23.2	\$150,000	\$52,738	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
C13	80	1.01	80.67		11	19.2	\$750,000	\$467,640	Floodplain Connection, Off-channel & Side-Channel Creation
C1	80	1.00	80.07	BCLC-2-BB	10	20.3	\$270,000	\$53,213	Floodplain Connection, Off-channel & Side-Channel Creation
C16	80	1.00	80.00		6	27.5	\$630,000	\$629,522	Floodplain Connection, Off-channel & Side-Channel Creation
C17	80	1.00	80.00		6	28.2	\$720,000	\$354,601	Wetland Connection
C18	40	1.00	40.00		6	21.8	\$150,000	\$157,882	Tributary Confluence Restoration

**Table 11. Lower Bear Creek Restoration Project Prioritization (projects displayed in Figure 3). Project naming is a combination of sub-basin (i.e., Lower Bear Creek [LB], Cottage Lake Creek [C], or Upper Bear Creek [UB]) and project number. Projects within the Table are ranked by the Ranking Score column (highest to lowest). Abbreviations are as follows: RVS (Restoration Value Score), OFS (Opportunity and Feasibility Score), EDT (Ecosystem Diagnosis Treatment), BCLC (Bear/Cottage Lake Creeks), LWD (large woody debris).**

Priority	Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
Higher	LB4	720	3.46	2494.25	BCLC-R6-3-BB, BCLC-R6-7-BB	4	22.5	\$1,320,000	\$515,388	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Higher	LB5	540	3.68	1989.83	BCLC-R6-4-BB, BCLC-R6-9-BB	4	21.8	\$1,200,000	\$966,719	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Higher	LB3	480	3.91	1876.81	BCLC-R6-1-BB, BCLC-R6-2-BB, BCLC-R6-7-BB	4	19.0	\$390,000	\$9,912	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Higher	LB11	600	2.48	1485.95	BCLC-R6-10-BB	4	10.4	\$360,000	\$0	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Higher	LB6	600	2.27	1359.71	BCLC-R6-5-LB	4	19.0	\$480,000	\$89,146	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition

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Priority	Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
Higher	LB13	360	3.59	1291.51	BCLC-R6-6-BB, BCLC-R6-10-BB	4	18.2	\$570,000	\$143,921	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Higher	LB17	480	2.55	1224.63	BCLC-R6-11-BB	4	13.2	\$600,000	\$80,669	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
Higher	LB18	360	2.61	938.79	BCLC-R6-11-BB	4	18.6	\$540,000	\$46,448	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation
Higher	LB1	360	2.53	912.56	BCLC-R4-1-BB	2	22.6	\$1,080,000	\$0	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Higher	LB12	360	2.43	875.86	BCLC-R6-10-BB	4	11.8	\$420,000	\$79,431	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
Higher	LB14	180	3.79	681.47	BCLC-R6-8-INS, BCLC-R6-6-BB, BCLC-R6-11-BB	4	18.7	\$300,000	\$39,512	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation
Moderate - Higher	LB10	720	1.30	934.77		4	17.1	\$540,000	\$372,760	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Moderate - Higher	LB15	360	2.11	759.40	BCLC-R6-11-BB	4	18.8	\$1,230,000	\$538,092	Floodplain Connection, Off-channel & Side-Channel Creation

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Priority	Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
Moderate - Higher	LB2	360	2.01	724.97	BCLC-R6-1-BB	4	22.5	\$900,000	\$889,138	Floodplain Connection, Off-channel & Side-Channel Creation
Moderate - Higher	LB7	180	1.00	180.00		4	16.0	\$300,000	\$238,683	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation
Moderate - Higher	LB8	180	1.00	180.00		4	18.4	\$210,000	\$234,318	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Moderate - Higher	LB9	180	1.00	180.00		4	17.8	\$120,000	\$80,791	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Lower	LB16	60	2.07	124.50	BCLC-R6-11-BB	4	13.1	\$240,000	\$63,570	Tributary Confluence Restoration



**Table 12. Cottage Lake Creek Restoration Project Prioritization (projects displayed in Figure 4). Project naming is a combination of sub-basin (i.e., Lower Bear Creek [LB], Cottage Lake Creek [C], or Upper Bear Creek [UB]) and project number. Projects within the Table are ranked by the Ranking Score column (highest to lowest). Abbreviations are as follows: RVS (Restoration Value Score), OFS (Opportunity and Feasibility Score), EDT (Ecosystem Diagnosis Treatment), BCLC (Bear/Cottage Lake Creeks), LWD (large woody debris).**

Priority	Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
Higher	C20	360	4.97	1790.41	BCLC-7-BB, BCLC-9-RB, BCLC-10-BB	8	18.4	\$720,000	\$28,723	Tributary Confluence Restoration, Wetland Connection, LWD Addition
Higher	C7	360	3.32	1194.74	BCLC-3-BB, BCLC-4-BB	12	23.4	\$960,000	\$212,365	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
Higher	C22	240	3.00	720.00	BCLC-10-BB		11.8	\$690,000	\$0	Wetland Connection, LWD Addition
Moderate - Higher	C21	360	2.00	720.99	BCLC-10-BB		11.9	\$390,000	\$988,202	Tributary Confluence Restoration, Wetland Connection, LWD Addition
Moderate - Higher	C3	240	2.00	480.07	BCLC-2-BB	10	17.5	\$750,000	\$357,686	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation
Moderate - Higher	C6	240	1.01	241.40		12	22.5	\$600,000	\$238,167	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
Moderate - Higher	C9	240	1.00	240.00		11	21.3	\$720,000	\$376,305	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Lower - Moderate	C8	160	3.15	504.48	BCLC-3-BB, BCLC-4-BB	11	22.8	\$360,000	\$81,588	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition

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Priority	Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
Lower	C15	160	2.06	329.99	BCLC-6-INS	11	22.7	\$240,000	\$33,105	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
Lower	C10	160	2.00	320.00	BCLC-5-INS	11	18.9	\$90,000	\$88,064	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Lower	C12	160	2.00	320.00	BCLC-5-INS	11	16.2	\$630,000	\$576,235	Floodplain Connection, Off-channel & Side-Channel Creation
Lower	C11	120	2.00	240.00	BCLC-5-INS	11	14.5	\$150,000	\$138,475	Tributary Confluence Restoration, Floodplain Connection, Off-channel & Side-Channel Creation
Lower	C2	120	2.00	239.98	BCLC-2-BB	10	18.9	\$90,000	\$0	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
Lower	C5	160	1.02	163.10		12	24.2	\$1,110,000	\$336,529	Floodplain Connection, Off-channel & Side-Channel Creation
Lower	C14	80	2.04	162.88	BCLC-6-INS	11	23.8	\$480,000	\$556,436	Floodplain Connection, Off-channel & Side-Channel Creation
Lower	C19	80	2.02	161.24	BCLC-7-BB	8	26.2	\$570,000	\$292,844	Wetland Connection
Lower	C4	120	1.00	120.00	BCLC-2-BB	10	23.2	\$150,000	\$52,738	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation

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Priority	Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
Lower	C13	80	1.01	80.67		11	19.2	\$750,000	\$467,640	Floodplain Connection, Off-channel & Side-Channel Creation
Lower	C1	80	1.00	80.07	BCLC-2-BB	10	20.3	\$270,000	\$53,213	Floodplain Connection, Off-channel & Side-Channel Creation
Lower	C16	80	1.00	80.00		6	27.5	\$630,000	\$629,522	Floodplain Connection, Off-channel & Side-Channel Creation
Lower	C17	80	1.00	80.00		6	28.2	\$720,000	\$354,601	Wetland Connection
Lower	C18	40	1.00	40.00		6	21.8	\$150,000	\$157,882	Tributary Confluence Restoration

**Table 13. Upper Bear Creek Restoration Project Prioritization (projects displayed in Figure 5). Project naming is a combination of sub-basin (i.e., Lower Bear Creek [LB], Cottage Lake Creek [C], or Upper Bear Creek [UB]) and project number. Projects within the Table are ranked by the Ranking Score column (highest to lowest). Abbreviations are as follows: RVS (Restoration Value Score), OFS (Opportunity and Feasibility Score), EDT (Ecosystem Diagnosis Treatment), BCLC (Bear/Cottage Lake Creeks), LWD (large woody debris).**

Priority	Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
Higher	UB25	300	3.88	1163.52	BCLC-R15-1-BB, BCLC-R15-2-BB		7.1	\$2,130,000	\$104,857	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Higher	UB12	240	4.73	1134.29	BCLC-R9-1-BB, BCLC-R9-2-INS, BCLC-R10-1-BB	2	20.9	\$660,000	\$126,246	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Higher	UB11	240	4.44	1065.20	BCLC-R8-2-BB, BCLC-R9-1-BB, BCLC-R9-2-INS	2	18.9	\$780,000	\$301,712	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Higher	UB22	300	3.52	1054.65	BCLC-R13-1-BB, BCLC-R14-1-LB	9	18.2	\$780,000	\$351,875	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Higher	UB4	240	2.81	675.19	BCLC-R7-3-BB	7	18.4	\$1,650,000	\$206,329	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Higher	UB17	300	2.24	672.09	BCLC-R13-1-BB	14	9.2	\$930,000	\$466,681	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation



*APPENDIX B: Instream Habitat Project Identification and Prioritization  
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Priority	Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
Higher	UB2	180	3.00	540.16	BCLC-R7-1-BB, BCLC-R7-2-BB	7	12.7	\$810,000	\$423,302	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Moderate - Higher	UB6	300	2.00	600.00	BCLC-R8-4-BB	5	13.2	\$570,000	\$270,341	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Moderate - Higher	UB8	240	2.01	482.63	BCLC-R8-1-LB, BCLC-R8-3-LB, BCLC-R8-4-BB	5	19.4	\$1,200,000	\$742,063	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Moderate - Higher	UB21	180	2.14	385.85	BCLC-R13-1-BB	13	18.4	\$1,410,000	\$582,346	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
Moderate - Higher	UB23	240	1.46	349.98		9	18.3	\$1,860,000	\$578,142	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Moderate - Higher	UB24	240	1.00	240.53			11.4	\$570,000	\$186,270	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Lower - Moderate	UB7	160	2.78	444.71	BCLC-R8-4-BB	5	17.9	\$270,000	\$109,028	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Lower - Moderate	UB14	120	3.29	394.82	BCLC-R10-1-BB, BCLC-R11-1-BB	1	19.3	\$570,000	\$274,551	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Lower - Moderate	UB10	120	3.00	360.00	BCLC-R8-2-BB, BCLC-R8-4-BB	5	19.5	\$450,000	\$191,100	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation

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Bear Creek Watershed Management Study*

Priority	Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
Lower - Moderate	UB20	120	2.62	314.67	BCLC-R13-1-BB	13	19.1	\$870,000	\$139,392	Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Lower - Moderate	UB1	120	2.37	284.87	BCLC-R7-2-BB	7	17.9	\$900,000	\$283,345	Floodplain Connection, Off-channel & Side-Channel Creation
Lower - Moderate	UB5	100	2.80	279.90	BCLC-R7-3-BB	7	18.2	\$240,000	\$39,796	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Lower - Moderate	UB15	80	3.17	253.76	BCLC-R11-1-BB, BCLC-R13-1-BB	14	19.9	\$780,000	\$233,940	Floodplain Connection, Off-channel & Side-Channel Creation
Lower - Moderate	UB9	80	2.56	204.63	BCLC-R8-1-LB, BCLC-R8-3-LB, BCLC-R8-4-BB	5	18.5	\$270,000	\$29,310	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Lower - Moderate	UB13	35	4.13	144.64	BCLC-R9-1-BB, BCLC-R9-2-INS, BCLC-R10-1-BB	1	22.1	\$480,000	\$149,909	Culvert Improvement or Bridge Crossing, Floodplain Connection, Tributary Confluence Restoration
Lower - Moderate	UB18	60	2.39	143.55	BCLC-R13-1-BB	13	18.5	\$450,000	\$119,232	Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation
Lower - Moderate	UB19	40	2.28	91.17	BCLC-R13-1-BB	13	19.4	\$330,000	\$132,388	Floodplain Connection, Off-channel & Side-Channel Creation

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Priority	Project	RVS	OFS	Ranking Score	Adjacent WRIA 8 Project(s)	EDT Rank	WQ/Habitat Problems Score	Restoration Cost	Acquisition Cost	Restoration Strategies
Lower	UB3	100	2.00	200.00	BCLC-R7-2-BB	7	8.9	\$180,000	\$51,540	Tributary Confluence Restoration, Wetland Connection, Floodplain Connection, Off-channel & Side-Channel Creation, LWD Addition
Lower	UB16	80	2.00	160.00	BCLC-R13-1-BB	14	17.3	\$570,000	\$320,793	Floodplain Connection, Off-channel & Side-Channel Creation

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## **APPENDIX C:**

# **Prioritization: Wetland Strategies**

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## 1.0 INTRODUCTION

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Wetlands provide a variety of ecological, water quality, and landscape services and functions. Washington Department of Ecology (Michaud 2001) elucidates why wetlands are important to the health of natural ecosystems, and these services and functions specifically include:

- protecting water quality by trapping sediments and retaining excess nutrients and other pollutants such as heavy metals.
- providing flood protection by holding the excess runoff after a storm, and then releasing it slowly, thereby maintaining streamflows.
- recharging groundwater systems/aquifers, which, in turn, provide water for drinking, irrigation, and maintenance of streamflow and lake and reservoir levels.
- providing habitat for species of birds, fish, mammals, reptiles, and amphibians that rely on wetlands for breeding, foraging, and cover.

All these functions contribute to the health of a watershed, and they are also all goals of this Bear Creek Watershed-scale Stormwater Management Plan (the Plan). In other words, many of the goals of the Plan, including improved water quality, improved flood protection, and better fish habitat, are also benefits that wetlands may provide. Therefore, protecting, enhancing, and in some cases creating wetlands are all potential best management practices (BMPs). A comprehensive local watershed management strategy includes wetland conservation and restoration because of the many watershed services wetlands provide (Wright et al. 2006).

Managing wetlands at the watershed scale can help minimize indirect impacts caused by urbanization. Impacts may include altered hydrology, increased pollutant loadings, and buffer encroachment. There are two general strategies available to improve, enhance, and conserve wetland conditions and functions in the Bear Creek watershed study area:

- Land conservation—protecting the wetlands and surrounding buffers by acquisition or easement.
- Wetland restoration—enhancing the function of existing or former wetlands by using different restoration techniques.

Each of these strategies is examined in detail in this report.

## 2.0 METHODS

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The “*Assessment of Bear Creek Watershed Wetlands*” (King County 2017b) conducted for the Plan includes an inventory of wetlands currently mapped in the study area from multiple data sources. The combined, merged wetland dataset from seven available data sources shows 327 wetland polygons<sup>1</sup> in the study area totaling 1,793 acres. That wetland data was used to analyze and identify wetland protection via conservation and restoration.

### 2.1 Land Conservation Strategies to Protect Wetlands

Wetland buffers in the watershed are protected by critical areas regulations. Regulatory buffer sizes were established based on the best available science for the protection of various wetland functions. Buffers range from 25 to 300 ft in the study area depending on the wetland category (or rating), type, and intensity of planned activity adjacent to the wetland. However, for the following reasons, land conservation is a viable alternative to relying solely on regulatory buffers to protect the wetland resources of the Bear Creek watershed:

- It is possible that established buffers are not always adequate to protect wetland functions.
- Some wetlands had been degraded prior to wetland regulations, and public ownership would facilitate restoration activities.
- Regulations are not always adhered to.
- Regulatory buffers may be reduced as a result of alterations exceptions under specific circumstances outlined in agency code.

Land conservation of wetlands is accomplished by one of the following means:

- Land acquisition: acquisition in fee, which provides full control of the land.
- Conservation easement: conveyance of development rights necessary for protection of specific conservation values from a property’s landowner to a municipality, land trust, or other nonprofit organization. The terms of easements vary, but generally speaking, in the areas covered by the easement, no new development may take place.
- Tax incentives: programs such as current use taxation programs in King County that offer an incentive (a property tax reduction) to landowners to voluntarily preserve open space on their property. Once enrolled, a participating property is assessed at

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<sup>1</sup> Polygons are a GIS feature class used to represent features and areas, such as wetlands. Because of how the original wetland datasets were combined and merged, a single wetland polygon does not necessarily represent a single wetland – it may be several wetlands in a wetland complex, or it may contain surrounding upland area, depending on the accuracy of the original dataset. Because referring to these areas as “wetlands” implies a greater level of accuracy than is present, they are sometimes referred to as “wetland polygons” in this analysis. See King County 2017b for more detailed discussion of the original wetland datasets.

a “current use” value, which is lower than the “highest and best use” assessment value that would otherwise apply to the property.

Of these three strategies, acquisitions and easements are the two examined in this Plan. Because tax incentive programs cannot be guaranteed in the long term, they were not included in this analysis. However, in many instances the landowner will likely never withdraw from the incentive program, because, for example, the parcel is too small to divide and the portion in the incentive program is wetland or stream riparian area. In these instances the protection is effectively permanent. The Waterways 2000 Program (King County 1996) mapped parcels in the Bear Creek watershed they recommended for tax incentive programs, and many of those parcels were subsequently enrolled. Programs such as the Public Benefit Rating System in King County are worthwhile and should be actively pursued as a valid conservation measure.

Land conservation, especially acquisition in fee, may result in additional lands for King County to manage. The implications of increasing the management requirements by King County is not addressed in this analysis.

### **2.1.1 Criteria for Selecting Wetlands for Conservation**

According to Cappiella et al. (2006), wetlands that are likely candidates for conservation are generally high quality wetlands that have high functional value and are in good condition or wetlands that provide some special social or economic value. There are other useful criteria available in addition to value and condition for prioritizing wetlands for conservation, although data is not always available for some or all of the wetlands in the study area. Table 1 outlines a set of criteria that may be used to prioritize land for conservation as well as provides notes on the availability of relevant data. Each of the criteria in Table 1 are discussed in more detail in Section 2.1.1.1.

**Table 1. Criteria for selecting wetlands for conservation strategies (adapted from Cappiella et al. 2006).**

Criteria		Priorities for Conservation	Availability of Data
Science-based criteria (descriptions in Section 2.1.1.1)	Type	Sensitive, locally rare, or difficult-to-replace wetland types. Prioritize Sphagnum bog and non-Sphagnum bogs over other wetland types.	Data available.
	Function	High for functions of interest (flood control, water quality, groundwater recharge, and habitat)	Wetland functional analysis not performed. No function data available.
	Condition	Good or excellent, as determined by preliminary estimate of wetland condition.	Data available for percent impervious surface, which is one indicator of condition.
	Connectivity	King County Wildlife Habitat Network intersects wetland or parcel associated with wetland.	Data available.
		Part of a wetland complex.	Limited data available, including distances and land cover between wetlands.
		Adjacent to other protected undeveloped open space (public lands, Tract parcels, Home Owners Associations (HOA) green space).	Data available.
Other criteria (descriptions in Section 2.1.1.2)	Location in watershed	Located in headwaters.	Data available.
	Development pressure	Defined as parcels that are not currently subdivided as small as zoning allows.	Data available.
	Special designation	Identified in riparian analysis (King County 2017a) or King County Land Conservation Initiative (which includes salmon recovery priorities).	Data available.
	Ownership	Willing landowner.	Willingness of landowners required but currently unknown

### 2.1.1.1 Ecological and other science-based criteria

Science-based criteria are used to identify the most valuable wetlands from an ecological perspective.

**Type.** Classifying wetlands as sensitive or non-sensitive to development and its effects, including stormwater runoff, provides a useful framework for not just managing stormwater inputs to different types of wetlands but also for prioritizing wetlands for conservation (Cappiella et al. 2006). Some wetlands are sensitive to any disturbance, and will become degraded with even low-level inputs of urban stormwater. This degradation is typically expressed as reduced diversity and abundance of plant or animal species. The most sensitive wetland type in the Bear Creek watershed study area are Sphagnum bogs. As discussed in King County (2017b), *Sphagnum*-dominated peat bogs are included in the King County Comprehensive Plan (Comp Plan) as a habitat of local importance because

they (a) support a unique plant and animal community, (b) have declined as a result of development, and (c) are a fragile ecosystem that can be easily destroyed but cannot be easily restored. Because bogs are the most sensitive wetland type in the watershed, they are therefore a high priority for conservation.

**Function.** Wetland functions include flood protection, retention of sediments and other particulates such as pollutants, maintaining streamflow, recharging groundwater, and provision of fish and wildlife habitat. Assessments of wetland functions generally measure the wetland's capacity to provide one or more specific functions (Cappiella et al. 2006). Wetland function is arguably the most important criteria to use to prioritize wetland conservation, but wetland functional assessments have not been conducted for the wetlands in the Bear Creek watershed.

**Condition.** Wetland condition describes how well the wetland is providing its functions (Cappiella et al. 2006). Wetland condition also affects how sensitive a wetland is to stormwater and other impacts. Landscape-scale estimates of wetland condition focus on identifying indicators of disturbance in and around wetlands. The assumption is that wetlands that have a greater number of disturbance indicators will have a more degraded condition (Cappiella et al. 2006). A variety of indicators can be used to estimate wetland condition, including hydrologic alterations, number of vegetation classes, buffer condition, and surrounding land cover. Other factors that may be used to derive disturbance indicators include: fragmentation, percent standing or open water, proximity to other wetlands, proximity to roads, road density, size and shape of wetland, population density, water quality impairments, Breeding Bird survey data, connectivity, wetland type, and more (NEIWPCC and RIDEM 2006). Connectivity and proximity to other wetlands are already being used as a criteria for prioritization in this analysis. Aside from impervious surface, most of the rest of the indicator data is not available, and when it is, it is only available from some of the wetland data sources.

Wetland condition likely degrades with increasing impervious cover and when urban land uses are dominant (Taylor et al. 1995). Amount of impervious surface per contributing drainage area for each mapped wetland was used as the indicator of condition for this analysis. Each wetland in the study area was labeled with the amount of impervious surface within 300 ft of its edge, as mapped in King County (2017b). Cappiella et al. 2006 suggest 300-500 ft. Three hundred feet was chosen because that size more than encompasses the largest possible regulated buffer size for a wetland in the study area (250 ft). Further, because the majority of mapped wetlands in the study area are within 500 ft of another wetland, using 300 ft will include less overlap of potential drainage area.

**Connectivity.** Wetlands that are connected to other wetlands and naturally vegetated areas such as forest provide valuable wildlife habitat and movement corridors. For this exercise, connectivity was evaluated in three ways:

- Whether a given wetland was part of a wetland complex.
- If a wetland is connected to King County's Wildlife Habitat Network.
- If a wetland is connected to other protected lands.



**Wetland Complex.** Groups of wetlands, called a wetland complex, may exhibit more wildlife diversity than isolated wetlands of similar sizes. Protection of wetland complexes is important to stem wetland isolation and habitat fragmentation. The King County Critical Areas Ordinance (CAO) uses a complicated set of criteria to identify a wetland complex. Those criteria are intended to be used during the permitting of relatively small areas, such as individual or small groups of parcels, when data may be collected in the field on many wetland parameters, including wetland category. When trying to determine the connectivity of several hundred wetlands using GIS, a simpler method is needed. For this exercise, the following criteria were used to consider a wetland part of a complex:

- wetland is not a farm field or any sort of wet field, and
- wetland is within 300 ft of another non-field wetland, and
- wetland is not severed from all nearby wetlands by any sort of road unless they are connected by a stream and the stream travels under the road, and
- wetlands are connected by either native vegetation or are within 50 ft of each other and are connected by some form of vegetation.

**Wildlife Habitat Network.** The King County Wildlife Habitat Network (WHN) is a network of contiguous vegetated corridors that are intended to link wildlife habitat with critical area buffers, priority habitats, trails, open space and other areas to provide for wildlife movement and alleviate habitat fragmentation. The WHN is defined and mapped in the King County Comp Plan, and it is regulated via the CAO. The WHN form one contiguous track or setback area that enters and exits properties where the network crosses the property boundary. To the maximum extent practicable, the WHN must be maintained at a width of 300 ft and not be less than 150 ft wide at any point.

**Other protected lands.** Parcel types that are assumed to provide protection to the wetlands and streams within them include:

- Publicly owned lands and conservation easements.
- Undeveloped, vegetated parcels that are associated with Home Owners Associations (HOA).
- “Tract” parcels, which are parcels held in undivided interest. It is possible some of these areas will not provide permanent protection; however, they appear to be vegetated areas mostly around streams and wetlands and associated with developments (similar to HOA green spaces).

These parcel types are also important because if most parcels around a wetland are either publicly owned or otherwise already in permanent protection, it may take relatively little effort to conserve the remaining parcels.

**Location in watershed.** Wetlands were identified as headwaters if a stream originates in the wetland. The most important geographic location for wetlands is in the headwaters. Headwaters streams and wetlands are important because they exert critical influences on the character and quality of downstream waters (Meyer et al. 2007; Alexander et al. 2007).

Headwater streams contribute to maintaining hydrologic connectivity and ecosystem integrity at regional scales (Freeman et al. 2007). The natural processes that occur in such headwater systems benefit humans by mitigating flooding, maintaining water quality and quantity, recycling nutrients, and providing habitat for plants and animals (Meyer et al. 2007).

A wetland may be divided in two by a road and still have both portions count as headwater wetlands. A wetland may be mapped “upstream” of the mapped stream (that is, the stream is not mapped as flowing out of the wetland), but if the topography and aerial imagery indicate the wetland likely drains the stream, it is included as a headwater wetland.

### **2.1.1.2 Other criteria**

Additional non-scientific criteria may be used to help prioritize wetlands for land conservation strategies. These criteria are intended to be applied to parcel data (see Section 2.1.2 on prioritizing parcels).

**Development pressure.** If wetlands are located in parcels that are vulnerable to subplanning, they are a higher priority than those that are not, because they may represent multiple houses, etc., in the future.

**Special designation.** Parcels and areas prioritized in other programs and analyses will be prioritized over parcels that are not. Some of these other programs and analyses include the riparian analysis (King County 2017a) and those parcels that are identified via the King County Conservation Lands Initiative, which includes parcels identified specifically for salmon recovery and other goals.

**Ownership.** Willingness of landowner to sell their property or participate in a conservation easement is necessary. No surveys have been conducted yet to determine which landowners are or would be in the future willing to participate in these types of land conservation actions, so to include that criteria might falsely imply acquisitions would be pursued regardless of willingness. Owner willingness would be addressed once priorities have been identified and funding secured.

## **2.1.2 Prioritizing for Wetland Conservation**

The criteria described above are all useful and valid for identifying the relative value of wetlands. In order to know where to start conservation efforts, the wetlands must be evaluated, and the parcels they are found on need to be prioritized. This section addresses prioritizing wetlands and the parcels associated with them.

### **2.1.2.1 Scoring wetlands**

The geospatial data file containing all mapped wetlands in the study area was attributed (labeled) with the following information, all of which are ecological criteria associated with the wetlands:

- If the wetland is a bog.

- The percentage of impervious land cover within 300 ft of the wetland.
- Whether the wetland was part of a wetland complex, as defined above.
- Whether the wetland was connected to the King County WHN.
- Whether the wetland is partially or fully on public lands, Tract parcels, or HOA green space parcels.
- Whether the wetland was located in the headwaters.

After the wetlands were attributed, the point system shown in Table 2 was applied to each of the wetlands. The scoring is based on the criteria in Table 1, and the questions derived from the criteria are the “Evaluation questions” in column one of Table 2.

**Table 2. Scoring system for prioritizing wetlands for conservation strategies. These points apply to wetlands.**

Evaluation questions	Land conservation score	Rationale for point assignment
Is the wetland a bog?	Yes = 100 No = 0	Because of the sensitive and relatively rare nature of bogs, the point value assigned for them is high enough to elevate them to a top priority.
Percent impervious land cover within 300 ft of the wetland?	0 = 30 <5% = 20 5-10% = 10 >10% = 0	No impervious surface within the buffer of a wetland should indicate a wetland in relatively better condition than those with buffers that do have impervious surface. Above 10% impervious surface in a wetland buffer area is assumed to degrade wetland condition.
Is the wetland part of a wetland complex?	Yes = 10 No = 0	Wetland connectivity is very important for wildlife survival and biodiversity. But because of the limitations of identifying wetland complexes geospatially, the scoring for wetlands defined herein as being in a complex is relatively low. Additionally, many of the single wetland polygons are actually wetland complexes.
Does the King County Wildlife Habitat Network (WHN) intersect the wetland or parcel associated with wetland?	Yes = 20 No = 0	Regulated connectivity increases the wildlife habitat value of the wetland.
Is the wetland already fully or partially protected (e.g., public lands, Tract parcels, HOA green space)?	Partially protected = 40 Fully protected = -100 Not protected = 0	If the wetland is partially protected, completing the level of conservation is considered highly desirable. If the wetlands is fully protected, it does not need further conservation, so the negative score serves to filter it out.
Is the wetland located in headwaters?	Yes = 20 No = 0	Headwaters of streams impact water quality, including water temperature. Lowering a headwater wetland's water temperature should also lower the stream water temperature.

### **2.1.2.2 Prioritizing parcels**

Because wetlands are contained within parcels and sometimes spread across many parcels, it is the parcels or the development rights to the parcels associated with the wetlands that would need to be purchased. Therefore, all relevant wetland scoring data discussed above and shown in Table 2 must be attached to the corresponding parcels.

Using orthoimagery in GIS, each wetland in the study area was visually examined in relation to parcel data. The following parcels were imported into a new “wetland conservation parcel” file:

- Undeveloped parcels in the study area that contained all or a part of a mapped wetland.
- Undeveloped forested parcels that were adjacent to parcels with wetlands.
- Parcels with development that also contained wetland and wetland buffer, if a conservation easement looked possible.

There were two main reasons that a parcel containing part or all of a mapped wetland might not be identified as a candidate for land conservation:

- A mapped wetland was clearly no longer present in the mapped location and had little chance of one being re-established (buildings, roads, or farm fields covered the entire polygon).
- The mapped wetland was a lake with residential development around the entire lakeshore.

Small parcels that were mostly developed but contained a sliver of wetland or wetland buffer were still generally included despite that (a) it may be cost prohibitive to try to purchase many of these properties for such the relatively small area of wetland protection, and (b) an easement would presumably make no difference with buffer regulations already in place. It is assumed that the scoring system used to prioritize parcels for conservation will put these parcels at the bottom of the list.

In a few instances, parcels adjacent to CAO wetlands were included, because although the mapped portion of the wetland did not extend into those parcels, it was clear it would have if the delineation had occurred on the adjacent properties.

In order to attach the wetland scores to the relevant parcels, the wetland data listed in Table 2 was intersected with the potential wetland conservation parcel file. For each criterion attributed to the wetlands, the highest value was assigned for any given parcel. For example, if two wetlands intersected one parcel, and one wetland was associated with the WHN but the other was not, the parcel would be attributed as being associated with the WHN, and it would get those 20 points.

Parcels in the potential wetland conservation parcel file were attributed with information associated with the criteria in Table 3. A parcel was attributed as to whether it is:

- Currently not subdivided as small as zoning allows.

- Identified as part of the riparian analysis (King County 2017a), King County Land Conservation Initiative, or similar program.
- Adjacent to public lands, Tract parcels, or HOA green space parcels.

After the parcels were attributed, the point system shown in Table 3 was applied to each parcel. The scoring is based on the criteria in Table 1, and the questions derived from the criteria are the “Evaluation questions” in column one of Table 3. Final prioritization for wetland conservation was based on the summation of all land conservation scores – the wetland-specific scores from Table 2 and the parcel-specific scores from Table 3.

**Table 3. Scoring system for parcels associated with wetlands. These points apply to parcels.**

Evaluation questions	Land conservation score	Justification for point assignment
Is the parcel currently not subdivided as small as it can be? That is, can the parcel be subdivided?	Yes = 10 No = 0	If the parcel associated with the wetland can be further subdivided, the development pressure is assumed to be higher than undividable parcels.
Are associated parcels identified as part of the riparian analysis (King County 2017a), King County Land Conservation Initiative, or similar program?	Identified by another program = 10 per occurrence	Assumes that if there are multiple values associated with preservation versus only one conservation target, parcel is more valuable from a conservation standpoint.
Are associated parcels adjacent to other protected undeveloped open space (e.g., public lands, Tract parcels, HOA green space)?	Yes = 10 No = 0	This attribute is already partially covered by tagging the wetland polygons for whether they are already protected. In some instances the parcels will be connected to protected lands when their associated wetlands are not. Parcels therefore also play an important role in overall connectivity.

## 2.2 Wetlands Restoration Strategies

Different agencies use different definitions for the same term or use different terms to define the same action. The Wetlands Subcommittee of the Federal Geographic Data Committee (see US EPA 2017) developed definitions for wetland restoration and related activities designed to aid agencies in accurately reporting wetland increases resulting from their program activities. This report adopts those definitions, which include:

**Restoration:** the manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to former or degraded wetland. For the purpose of tracking net gains in wetland acres, restoration is divided into:

- **Rehabilitation:** the manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural/historic functions of degraded wetland.



Rehabilitation results in a gain in wetland function, but does not result in a gain in wetland acres.

- **Re-establishment:** the manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former wetland. Re-establishment results in rebuilding a former wetland and results in a gain in wetland acres.

In general, wetland rehabilitation improves the functions of existing wetlands, whereas wetland re-establishment builds a wetland where one does not currently exist but did exist within the past 100-200 years. Wetlands may also be created to perform water quality functions; however, site selection for created wetlands was not in the scope of this report. Information regarding created wetlands is provided in Section 2.2.3.

## **2.2.1 Rehabilitation**

Goals associated with wetland rehabilitation are generally associated with the primary four functions of wetlands in the Bear Creek watershed: water quality improvement, flood water retention, groundwater recharge, or wildlife habitat. Rehabilitation results in a gain in wetland function but does not result in a gain in wetland acres. The terms rehabilitation and enhancement are often used interchangeably. Gwin et al. (1999) define enhancement as "the modification of specific structural features of an existing wetland to increase one or more functions based on management objectives, typically done by modifying site elevations or the proportion of open water. Although this term implies gain or improvement, a positive change in one wetland function may negatively affect other wetland functions."

Wetland rehabilitation is defined in this plan as planting native vegetation (trees and shrubs) in areas of the wetland and its buffer that are currently covered in grass, impervious surface, or some other non-native vegetation.

### **2.2.1.1 Identifying**

All 327 wetland polygons were visually examined in GIS, and notes were made as to indicators of degradation. Degraded wetlands generally fell into the following categories:

- The wetland contains reed canarygrass.
- The open-water wetland is mowed to the edge along all or some portion of the wetland.
- The area with a mapped wetland is in some form of agricultural use (pasture, livestock yard, etc.). Sometimes wet areas are visible, and other times they are not. No forest or other native vegetation is present.
- A mapped wetland partially contains lawn, driveway, buildings, or other form of non-native land cover.
- The wetland is fully or partially on a powerline corridor.
- A mapped wetland is a farm pond with livestock access.
- A mapped wetland is a stormwater pond.

- A mapped wetland is a pond on a golf course.
- No wetland is visible: the polygon contains a house, road, or other development, so wetland area has either been lost or it was never wetland to begin with.

### **2.2.1.2 Prioritizing**

Tree planting is assumed to improve water quality and wildlife habitat. Prioritizing wetlands for tree planting should therefore be done with improvements to water quality and wildlife habitat functions in mind. Prioritizing wetlands for rehabilitation is a multi-step approach:

- Polygons with wetlands clearly not present were removed from consideration.
- Any wetland polygons that appeared in 2015 aerial imagery to have no need for rehabilitation were removed from consideration. These wetland polygons did not fall into any of the categories listed in Section 2.2.1.1, and any vegetation present appeared to be native vegetation.
- For the final set of wetland polygons, a set of criteria indicating the functions and values of the wetlands were applied to score them for rehabilitation (Table 4). Points were also assigned for type of degradation present (reed canarygrass, mowed edges) as well as whether degradation was occurring on public lands.<sup>2</sup>

Final prioritization for tree planting around wetlands was based on the summation of the restoration scores shown in Table 4. The scoring is intended to indicate greatest potential to rehabilitate one or more wetland functions, prioritized by those wetlands that otherwise have the greatest value in terms of connectivity, the least amount of impervious surface, highest potential for improving water temperatures, and are most easily accessible (publicly owned, therefore most feasible). This information is intended to be used to get the most out of rehabilitation dollars.

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<sup>2</sup> Publicly owned lands get one score, and publicly owned lands with reed canarygrass and/or mowed water edges gets another score, guaranteeing a high score for those areas most ripe for rehabilitation projects. Because these lands are already publicly owned, it is assumed that permission to do rehabilitation activities would be easiest to obtain.

**Table 4. Criteria for prioritizing wetlands for rehabilitation strategies (adapted from Cappiella et al. 2006). [Points in each category and sub-category are additive.]**

Criteria	Evaluation questions	Restoration score	Notes / Assumptions
<b>Type</b>	Is the wetland a bog?	Yes = 40 No = 0	If a bog is damaged, it should be a priority for repair.
<b>Condition</b>	Percent impervious land cover within 300 ft of the wetland.	<5 = 20 5-10 = 10 >10 = 0	Wetlands with little to no impervious surface in their immediate draining area are assumed to be in better condition or have the potential for better condition once repaired.
<b>Connectivity</b>	Is the wetland along the King County Wildlife Habitat Network (WHN)?	Yes = 20 No = 0	Regulated connectivity increases the wildlife habitat value of the wetland.
	Is the wetland part of a wetland complex?	Yes = 10 No = 0	The wildlife habitat value is higher if wetlands are connected (part of a wetland complex), because amphibians and other wildlife are able to move between them.
<b>Location in watershed</b>	Is the wetland located in the headwaters?	Yes = 20 No = 0	Headwaters of streams impact water quality, including water temperature. Lowering a headwater wetland's water temperature should also lower the stream water temperature.
	Does the stream water temperature exceed the standards?	Yes = 20 No = 0	If the wetland is located along a stream reach with elevated water temperatures, it is assumed that tree planting may help alleviate the high water temperatures.

Table continued on next page.

Criteria	Question derived from criteria	Restoration score	Notes / Assumptions
<b>Gain in function</b>	Does the wetland have reed canarygrass present? Is the wetland mowed on some portion of its shoreline?  (These questions are intended to be surrogates for the following questions: Can water quality functions be improved? Can wildlife habitat functions be improved?)	Mowed = 20 Reed Canarygrass = 10	The two primary wetland-related problems that may be addressed with rehabilitation (tree planting) are lack of shade and invasive species. Planting trees along a shoreline is assumed to provide both water quality and wildlife benefits, hence the higher score for “mowed.” Even in the absence of an open-water component, replacing reed canarygrass with native vegetation will improve wildlife habitat.
	Is there water present?	Yes = 30 No = 0	This question addresses both feasibility and the impact a planting project will have. If the wetland is agriculture field full of reed canarygrass, planting trees will not results in cooling water temperatures. This element raises the priority for wetlands that have water present to some degree.
<b>Feasibility</b>	Is the wetland in need of rehabilitation on protected lands such as public land, HOA green space, Tract parcels, or conservation easements?	Yes = 30 Partial = 15	It is assumed that it will be much more feasible to conduct wetland restoration projects on public lands over private lands.
	This questions gets at whether the current land use is compatible with restoration.  The second part of this question, which further subdivides exactly what form of degradation is present, helps filter out which lands will benefit most from rehabilitation.	Mowed & fully located on public land = 30 RCG & fully located on public land = 20  Mowed & partially located on public land = 20 RCG & partially located on public land = 10	Because these rehabilitation projects are assumed to be associated with either invasive species (reed canarygrass) or lack of shade around wetland edges, these scores separate out wetlands with these types of degradation from all the other wetlands.

## **2.2.2 Re-establishment**

A change analysis was conducted in the “Assessment of Bear Creek Watershed Wetlands” (King County 2017b), which showed wetland loss that has occurred over the past 35 years. Additionally, 70 percent of the smaller wetlands delineated as part of the CAO permit process did not intersect with National Wetlands Inventory (NWI) or King County Wetland Inventory wetlands, and if that type of smaller wetland had been filled in the past, there would be no record of their potential historic presence whatsoever. It is almost certain that wetlands have been filled in the past; the number and acreage of filled wetlands are unknown. Finally, as part of the rehabilitation analysis above, 9 of the 327 wetland polygons were found to be not wetlands currently, and several (approximately 30) are currently agricultural fields with no open water component and some or all of the area with no native vegetation present. Although those fields may be technically wetlands (based on hydrology and soil conditions plus the obligate wetland species present, reed canarygrass), they have no wildlife habitat function, no flood storage capacity, and no groundwater recharge function greater than surrounding terrestrial landcover. All of these functions are provided by healthy wetlands and could be provided by re-established wetlands.

Wetland re-establishment is the rebuilding of a former wetland. Knowing the locations of former wetlands helps identify sites that may be suitable for wetland re-establishment (Cappiella et al. 2006), however, little to no data exists for the Bear Creek watershed that shows definitively where wetlands were located historically but are no longer present. Potential re-establishment sites can be identified using other data, such as former wetlands with effectively drained hydric soil map units, filled areas with no development (based on NWI data), impounded areas, excavated areas, and farmed wetlands Tiner (2005).

For this analysis, wetland polygons were intersected with soil data to identify all polygons that intersect mapped hydric soils. All wetland polygons showing open water were removed from consideration, because a wetland typically already exists in those locations or they are addressed above under “Rehabilitation.” Wetland polygons showing native vegetation were removed from consideration under the assumption they may be forested or scrub-shrub wetlands.

Because of the small number of potential sites and affected landowners (see Section 3.0 Results and discussion), it may not be necessary to prioritize them. It might be worthwhile to contact all the landowners to inquire about interest in creating a wetland feature on their property. If prioritization were needed, wetland polygons could be prioritized based on:

- Number of affected landowners (prioritize single landowners over multiple landowners)
- Proximity to stream or other wetlands.

## **2.2.3 Wetland Creation**

Natural wetlands should not be specifically used to treat stormwater runoff, as it increases the depth of temporary or permanent ponding in a wetland (Wright et al. 2006). Over time,



the altered hydrology transforms a natural wetland into a stormwater wetland with loss of biological diversity and functional value. Wetlands may be created for this purpose, and although wetland creation was not examined as a part of this analysis, this section presents a small amount of information on wetland creation to complement the other restoration BMPs examined in this report. Additional information on wetland creation may be found in Section 6.4.3 of the King County Surface Water Design Manual.

When wetlands are lost or degraded as a result of land development, the services they provide must often be replaced by water treatment and flood control infrastructure (Wright et al. 2006). Stormwater ponds and other facilities are a common tool to help deal with stormwater. Created wetlands can be built to serve the same water quality and quantity functions for stormwater controls and impacts. Because wetlands provide functions beyond what stormwater ponds typically provide, in some instances wetland creation may be a preferred alternative to stormwater facilities.

Wetland creation is defined as establishing a wetland where one had not existed in the past. The Wetlands Subcommittee of the Federal Geographic Data Committee uses the term Establishment to mean wetland creation. They define establishment as “the manipulation of the physical, chemical, or biological characteristics present to develop a wetland that did not previously exist on an upland or deepwater site. Establishment results in a gain in wetland acres” (US EPA 2017).

Constructed wetlands are treatment systems that use natural processes involving wetland vegetation, soils, and their associated microbial assemblages typically to improve water quality (US EPA 2017). Wetlands created to mimic the sediment and nutrient removal processes occurring in natural wetlands are designed based on holding or slowing the passage of effluent through the wetland, where a range of physical, chemical, and biological processes can operate to store, transform, or remove various pollutants (Cappiella et al. 2005).

Wetland creation occurs when a wetland is placed on the landscape on a non-wetland site (Lewis 1989). Typically, a wetland is created by excavation of upland soils to elevations that will support the growth of wetland species through the establishment of an appropriate hydrology (US EPA 2017).

## 3.0 RESULTS AND DISCUSSION

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This section includes results for the wetland polygons and associated parcels when applicable. Because this analysis is GIS-based, the results are limited by the accuracy and availability of disturbance indicators as well as the accuracy of the mapped wetland polygons. Outreach and field visits may be used to verify wetland hydrologic and habitat value.

### 3.1 Wetlands Identified for Conservation Strategies

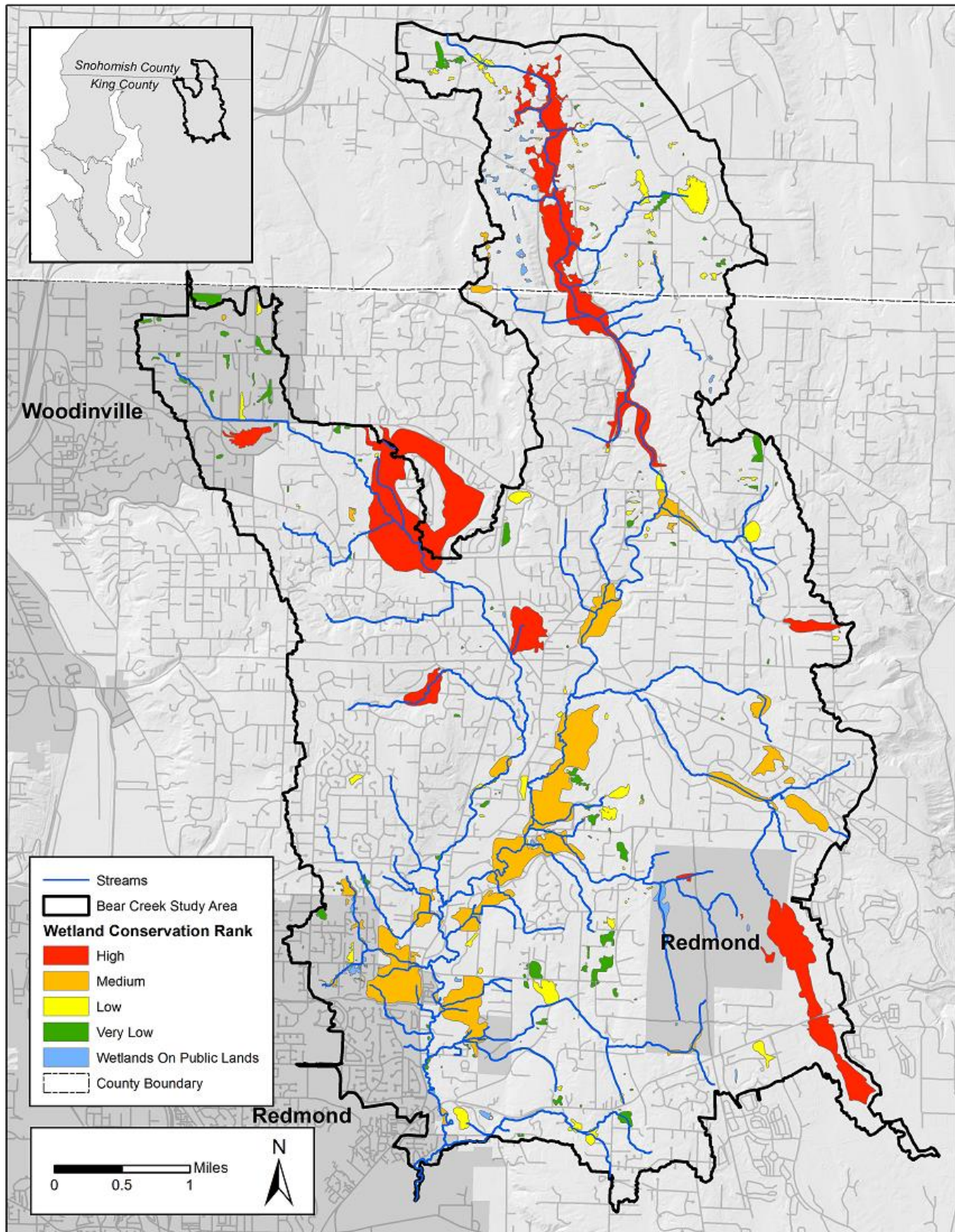
The wetland dataset used for this analysis included 327 mapped wetland polygons. Visual inspection of aerial photos revealed that 9 of the polygons were clearly not wetlands (buildings, roads, or relatively dry-appearing farm fields covered the entire polygon). Another 50 wetlands were already in public ownership or under some other form of permanent protection (Tract or HOA greenspaces). The distribution of the remaining 268 wetland polygons is as follows:

- King County: 168
- Redmond: 18
- Redmond and King County shared: 1
- Snohomish County: 54
- Snohomish County and King County shared: 1
- Woodinville: 25

The 268 wetland polygons had scores ranging from 0 to 200. Figure 1 indicates a ranking of high, medium, low, and very low, where:

- High = 100-200 points
- Medium = 50-80 points
- Low = 20-40 points
- Very Low = 0-10 points

Table 5 presents a sample of the final prioritization of the wetland polygons by jurisdiction. Lists of all parcel data will be provided to all partnering jurisdictions.



**Figure 1.** Prioritization of wetland polygons for conservation strategies (acquisition or easement). Note that some wetland polygons span across study area boundaries.

**Table 5. Sample of prioritized wetlands for conservation strategies by jurisdiction. [Points shown here do not include parcel-related points. Wetlands scoring the same points are ordered by size. The top five wetlands per jurisdiction are shown; the full lists will be given to the partner jurisdictions to aid in conservation implementation.]**

Jurisdiction	Wetland ID	Ranking	Acres	Headwaters	WHN	Bog	Already protected	Complex	Impervious category	Aerial photo interpretation notes
King County	39	High	55.33	Yes	Yes	Yes	Partial	Yes	11-20%	includes powerline corridor
	215	High	308.38			Yes	Partial	Yes	>20%	Lake; RCG; vegetated
	161	High	17.48			Yes	Partial	Yes	11-20%	Scrub-shrub; road cuts through
	153	High	25.73			Yes	Partial		>20%	Vegetated; including powerline
	165	High	45.36	Yes		Yes			>20%	forested; continues to next parcel
Redmond	94	High	90.89	Yes	Yes	Yes	Partial	Yes	5-10%	forested; in good shape
	87	High	0.31	Yes	Yes		Partial	Yes	0	Beaver pond, bigger than mapped
	72	High	3.24	Yes			Partial	Yes	0	forested
	107	High	2.79		Yes		Partial	Yes	0	Beaver pond, way larger than mapped
	53	Medium	1.81	Yes			Partial		11-20%	forested
Snohomish County	327	High	9.98	Yes			Partial	Yes	0	Beaver ponds with RCG
	269	Medium	2.31				Partial	Yes	0	Vegetated - scrubby; possibly way bigger
	261	Medium	0.58				Partial	Yes	<5%	Vegetated - forest and scrub
	294	Medium	0.48				Partial	Yes	<5%	Vegetated; road down center
	303	Medium	0.40				Partial	Yes	<5%	Scrub-shrub; larger than mapped
Snohomish Co. - King County*	323	High	284.84		Yes	Yes	Partial	Yes	5-10%	Is actually many wetlands; roads, RCG
Woodinville	213	High	17.70			Yes	Partial	Yes	>20%	Lake Leota - residential w/docks
	245	Medium	0.68				Partial		5-10%	Forested; landscaping. Wetland to east?
	221	Low	3.20				Partial		>20%	Several small scrub-shrub wetlands; development
	247	Low	1.75				Partial		11-20%	Vegetated; house, yard, driveway
	218	Low	0.17				Partial		>20%	forest & sidewalk - mismapped? no wetland?

Notes:

\*This is a large wetland complex that spans across county boundaries.

WHN = Wildlife Habitat Network

A total of 588 parcels were identified that were associated with the 268 wetland polygons:

- 107 undeveloped privately owned parcels containing all or part of a mapped wetland polygon.
- 462 developed residential parcels that might be candidates for conservation easements or partial acquisition because they contain part or all of a wetland.
- 19 undeveloped forested parcels directly adjacent to parcels with wetlands.
- 17 parcels with easements already in place.

The parcels were ranked for conservation by combining the wetland scores with points from parcel-specific criteria (see Section 2.1.2.2). The 588 parcels had scores ranging from 0 to 220. Parcels were ranked as high, medium, low, and very low, where:

- High = 160-220 points
- Medium = 80-150 points
- Low = 20-70 points
- Very Low = 0-10 points

Parcels that scored only 0 or 10 points are assumed to not be a priority for conservation. The analysis reveals the following data for parcels that scored at least 20 points for conservation:

- King County – 335 parcels out of 409 scored; points ranging from 20 to 220
- Redmond – 21 parcels out of 23 scored; points ranging from 20 to 80
- Snohomish County – 71 parcels out of 94 scored; points ranging from 20 to 210
- Woodinville – 22 parcels out of 62 scored; points ranging from 20 to 180

Undeveloped parcels are candidates for acquisition or easement; cost analyses assume acquisition, which is more costly. Parcels with development are assumed to be candidates for easements and not acquisitions, though there may be some circumstances when a developed parcel is purchased and any structures demolished.

Costs of acquisition were calculated by first obtaining the combined assessed land value and assessed improved value (value of improvements, such as houses) from King County parcel data and the combined market land value and market improved value from the Snohomish County parcel data. Next, a multiplier of 115 percent<sup>3</sup> was applied to those values to account for the difference between the assessed value and appraised value. Costs of easements were calculated by taking the assessed land value from King County parcel data and the market land value from the Snohomish County data and using a multiplier of

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<sup>3</sup> 15 percent is added to the assessed value because appraisals were running higher than assessed value by about 15 percent in 2015 and 2016.



40 percent<sup>4</sup>. Easement calculations assumed less than half the parcel would be put in easement.

For the cost analysis, in all instances where parcels in the riparian analysis in Section 7.3 overlapped parcels in this wetland analysis, they were removed from this wetland analysis.

A total of 126 parcels were identified for potential wetland acquisition (had no development). Sixty-four (64) of those parcels were also identified in the riparian analysis for acquisition. This wetland cost analysis for acquisition only includes the remaining 62 parcels.

Costs for acquisition for each partner jurisdiction are present in Table 6. Costs were separated out for priority basins in addition to the priority ranking described in this strategy. Total costs for acquisition in priority basins and remaining High and Medium ranked parcels would be approximately \$5,520,000.

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<sup>4</sup> 40 percent assumes the following: (a) the amount of the parcel that would be placed under easement would be less than 50 percent and more than 1 percent, and 25 percent is the average between 1 and 50, and (b) 15 percent is added to the 25 percent to account for the difference between assessed value and appraised value.

**Table 6. Cost estimates for all 62 parcels identified for potential acquisition. Priority catchments described in Section 4.2 are identified separately.**

Prioritization Ranking	Catchment	Cost	number of parcels
<b>King County</b>			
High	All others	\$1,431,000	4
Medium	BEA120	\$99,000	1
Medium	All others	\$2,650,000	9
Low	BEA120	\$86,000	1
Low	All others	\$5,271,000	10
Very Low	All others	\$3,705,000	9
Unknown	All others	\$1,750,000	3
<b>Redmond</b>			
Low	All others	\$7,626,000	5
Very Low	All others	\$1,000	2
<b>Snohomish County</b>			
High	BEA660	\$600	1
High	All others	\$1,000	1
Low	BEA660	\$488,000	2
Low	All others	\$156,000	2
Very Low	BEA660	\$264,000	1
Very Low	All others	\$264,000	1
Unknown	BEA660	\$289,000	3
Unknown	All others	\$601,000	3
<b>Woodinville</b>			
Low	All others	\$2,279,000	3
Very Low	BEA850	\$210,000	1

A total of 462 parcels had some development on them and thus were identified for potential wetland easements. One hundred and eighty-seven (187) of those parcels were also identified in the riparian analysis for easements. This wetland cost analysis for easements only includes the remaining 275 parcels. The total estimated value of the 275 parcels is approximately \$69,688,000.

Costs for easements for each partner jurisdiction are presented below in Table 7. Costs were separated out for priority basins in addition to the priority ranking described in this strategy. Total easement costs are estimated to be approximately \$41,053,000 if easements were purchased on all 275 parcels identified for potential easements, including those prioritized as Low and Very Low. Total costs for easements in priority basins and remaining High and Medium ranked parcels would be approximately \$12,104,000.

**Table 7. Cost estimates to for all 275 parcels identified for potential easements. Priority catchments described in Section 4.2 are identified separately.**

Prioritization Ranking	Catchment	Cost	number of parcels
<b>King County</b>			
High	All others	\$1,632,000	12
Medium	All others	\$6,835,000	48
Low	BEA120	\$205,000	2
Low	All others	\$8,362,000	55
Very Low	All others	\$7,396,000	58
<b>Redmond</b>			
Medium	All others	\$975,000	10
Low	All others	\$6,217,000	2
<b>Snohomish County</b>			
High	BEA660	\$410,000	5
High	All others	\$183,000	2
Medium	All others	\$112,000	1
Low	BEA660	\$581,000	6
Low	All others	\$1,437,000	17
Very Low	BEA660	\$252,000	3
Very Low	All others	\$618,000	8
Unknown	All others	\$58,000	1
<b>Woodinville</b>			
Low	BEA850	\$162,000	1
Low	All others	\$1,178,000	7
Very Low	BEA850	\$756,000	6
Very Low	All others	\$3,683,000	31

## 3.2 Wetlands Identified for Restoration Strategies

The primary focus of wetland restoration in this study is rehabilitation, which is defined as tree planting in this plan and discussed in Section 3.2.1. Re-creating wetlands where they were once likely located is discussed in the Section 3.2.2 on Re-establishment.

### 3.2.1 Rehabilitation

Of the 327 mapped wetland polygons, as discussed above, 9 were clearly no longer wetlands. Of the remaining 318 wetland polygons, 121 did not appear to need rehabilitation judging from aerial imagery (they appeared to only have native vegetation present in and around them). Of the remaining 198, 67 were identified as having reed canarygrass present, and 55 were mowed along at least some portion of the edge plus 3 appeared to be degraded from livestock access (for a total of 58 generally referred to as “mowed”). These 112 wetlands are potential targets for rehabilitation, which is defined

herein as planting native trees and shrubs. The distribution of the wetland polygons with reed canarygrass and/or mowed edges is as follows:

- King County: 89
- Redmond: 5
- Snohomish County: 14
- Snohomish County and King County shared: 1
- Woodinville: 3

Of the 58 wetlands identified as being mowed to the edge:

- 6 are fully on public property and 3 are partially on public property.
- 13 also have reed canarygrass.
- 5 are also in the riparian corridor (total of 8.4 acres in need of trees around the wetlands).
- 2 have concrete paving around some of the edges, and one has a gravel driveway.
- 5 are ponds on golf courses.

Of the 67 wetland polygons identified as having reed canarygrass present:

- 11 are fully on public lands, and 16 are partially on public property.
- 3 are beaver ponds, which pose extra challenges for tree plantings because they are so wet.
- 25 do not have an open-water component associated with them, and approximately 8 of these are farm fields with no other indication of a wetland present beyond the reed canarygrass.

Not including golf course ponds and lawns along residential lakes, approximately 34.5 acres could be planted in trees and shrubs around these “mowed” wetlands if all landowners cooperated 100 percent (Table 8).

Wetlands identified as benefiting from tree-planting were evaluated for restoration cost. The cost of tree-planting is assumed to be about \$30,000 per acre in 2018. The cost of restoring wetlands on public lands is estimated to be \$306,000 (Table 8). The total cost to restore wetlands on private lands (excluding any costs to acquire the land or easement to the land) is estimated to be \$2.95 million.

**Table 8. Acres of land, by jurisdiction and ownership, that would benefit from tree-planting restoration. Includes areas around wetlands mowed to the edge of the open-water component and areas covered in reed canarygrass. For areas that are mowed and have reed canarygrass present, acreage is included with mowed wetlands. Area in this table does not overlap with restoration areas identified in *Appendix D – Prioritization: Riparian Corridor Strategies*.**

Jurisdiction	Mowed to edge				Reed canarygrass			
	Total	Public	Private	Est. Cost	Total	Public	Private	Est. Cost
King	30.5	2.7	27.8	\$915,000	70.5	5.6	64.9	\$2,115,000
Snohomish	1.8	0.0	1.8	\$54,000	2.0	0	2.0	\$60,000

Redmond	1.6	1.6	0	\$48,000	1.5	0	1.5	\$45,000
Woodinville	0.6	0.3	0.3	\$18,000	0	0	0	\$0

Many of the wetlands that have reed canarygrass present but are not identified as being mowed to the edge are in stream riparian corridors, and there is no open water component to the wetland other than the stream. These riparian areas would benefit from tree planting. Many of these areas are captured in the riparian analysis (*Appendix D – Prioritization: Riparian Corridor Strategies*). Other areas with reed canarygrass but no “mowed edges” are farm fields. Planting trees in these farm fields would have terrestrial habitat benefits but likely very low benefits for wetland function. Reed canarygrass areas not associated with the riparian analysis, not included in the mowed estimates, and not including farm fields total approximately 74 acres and are shown in Table 8.

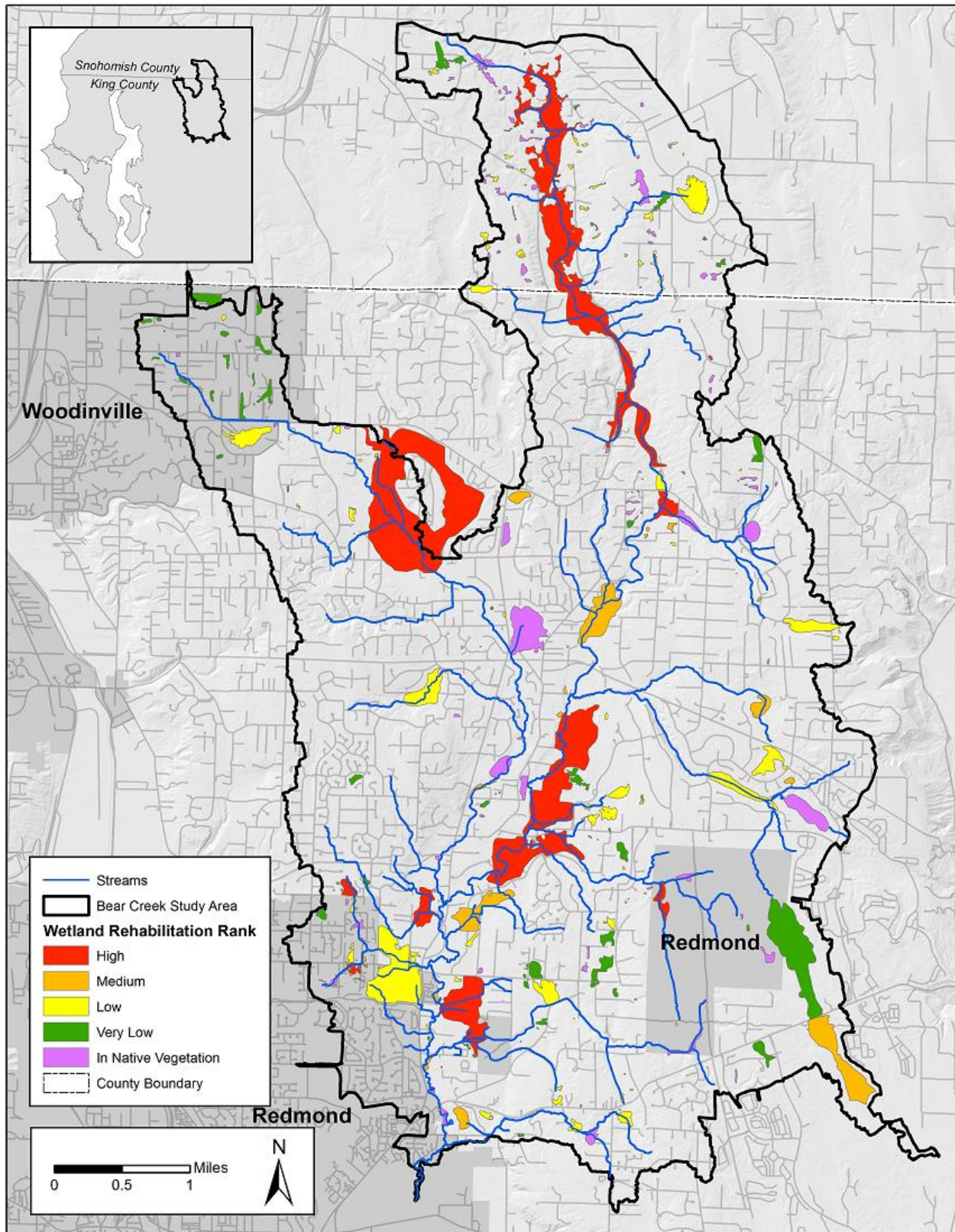
The remaining 85 wetland polygons showing some form of degradation other than being mowed to the edge or having reed canarygrass planted were also scored. Often these polygons are active farm fields, scrub-shrub wetlands severed by roads, and polygons with some portion native vegetation and some portion lawn. Although they were scored as part of the prioritization, in most cases there is very little to be done in terms of tree planting in these areas.

Figure 3 indicates a ranking of high, medium, low, and very low for wetland rehabilitation, where:

- High = 110-165 points
- Medium = 70-105 points
- Low = 20-65 points
- Very Low = 0-10 points

Table 9 provides a sample of the wetlands ranked highest for planting trees in each jurisdiction. All information generated from this analysis for tree planting will be provided to all of the partnering jurisdictions. They will make their choices how to proceed with tree planting and other wetland restoration.





**Figure 2.** Prioritization of wetland polygons for rehabilitation strategies (tree planting). Note that some wetland polygons span across study area boundaries.

**Table 9. Sample of prioritized wetlands for rehabilitation strategies by jurisdiction. [Wetlands scoring the same points are ordered by size. The top five wetlands per jurisdiction are shown; the full lists will be given to the partner jurisdictions to aid in implementation of tree planting projects.]**

Jurisdiction	Wetland ID	Points	Acres	Reed canarygrass	RCG & on Public Land	Mowed	Mowed & on Public Land	Aerial photo interpretation notes
King County	233	150	0.23	Yes	Yes	Yes	Yes	RCG in stormwater pond
	215	145	308.38	Yes	Yes			Lake; RCG; vegetated
	118	125	79.79	Yes	Yes			vegetated; some mismapping
	105	125	6.64	Yes	Yes			half is degraded RCG pasture
	113	120	0.13			Yes	Yes	Pond – stormwater
Redmond	103	140	9.94	Yes	Yes			Beaver ponds, many. RCG
	62	120	3.15	Yes	Yes			Pond; forest; scrub/shrub/tons RCG
	68	90	0.44	Yes	Yes			vegetated, including RCG
	61	90	0.23	Yes	Yes			degraded scrub-shrub with some RCG
	95	80	1.78					forested: half okay, half parklike
Snohomish County	327	125	9.98	Yes	Yes			Beaver ponds with RCG
	284	90	0.09	Yes	Yes			RCG; scrubby area - bigger than mapped
	288	80	25.05			Yes		degraded - Echo Lake - home along shore
	260	80	0.22			Yes		Pond - could use bigger buffer
	249	70	0.07	Yes		Yes		Pond - RCG buffer
Snohomish Co. – King County*	323	165	284.84	Yes	Mix			many wetlands; roads, RCG
Woodinville	240	110	0.06			Yes	Yes	Pond - fully mowed & mismapped
	223	70	0.43			Yes		Pond - two back yards; mowed
	213	95	17.70					Lake Leota - residential with docks
	219	40	0.08					vegetated; likely degraded on private land
	245	25	0.68					Forested; landscaping. Wetland to east?

\*This is a large wetland complex that spans across county boundaries.

### **3.2.2 Re-establishment**

There are 9 wetland polygons that fit the criteria for re-establishment. Six of the 9 polygons are on farm fields or pasture, and 2 of the polygons are actually in a single farm field. Two of the areas have reed canarygrass. These 9 wetland polygons intersect a total of 15 parcels, and none are publicly owned. All of the potential re-establishment sites are all in King County's jurisdiction.

These potential re-establishment sites could be evaluated further in the field to confirm assumptions based on mapping data and further evaluate restoration feasibility. As mentioned above, these locations may in some instances technically be wetlands, but they are providing little if any wetland function. Excavation combined with native vegetation planting would transform these sites from fields to wetlands with habitat value, flood storage, and groundwater recharge functions. It is very possible that the landowners with farm fields in active use will be reluctant to give up their fields for wetlands. The properties with potential re-establishment sites composed of reed canarygrass and shrubs may be more willing to allow wetland re-establishment on their properties. In all cases, the potential impacts of beavers should be evaluated if and when they were to move into the newly established ponds, and that information should be shared with cooperative landowners.

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# **APPENDIX D:**

## **Prioritization: Riparian Corridor Strategies**

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## 1.0 INTRODUCTION

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A riparian zone or riparian area is the interface between land and a river or stream. Natural riparian corridors provide an extremely wide range of highly valuable functions. Healthy riparian areas, defined as being vegetated in native trees and shrubs, provide several functions that help maintain good water quality by filtering nutrients, sediments, and pathogens before they reach waterways. In addition to being important habitats for a wide range of wildlife (Knutson and Naef 1997), they are also considered essential for sustaining wild fish populations (Naiman et al. 1993).

Specifically, healthy riparian areas are important because they:

- improve water quality by filtering pollutants
- reduce stream bank erosion
- increase instream shade, which decreases water temperatures, which in turn support the higher dissolved oxygen levels important to salmonids
- provide a source for the natural recruitment of large wood into streams to create channel complexity needed for salmonid refugia and protection from predators
- provide over-hanging vegetation, a source of food (invertebrates) for juvenile salmonids

These riparian functions contribute to the health of the watershed and its biodiversity, including fish populations. The decline of native salmonid populations in the Pacific Northwest has been largely attributed to habitat loss and degradation (Yeakley et al. 2014). Riparian corridors contribute to instream functions and are a key component to improve salmonid habitat. Ultimately, restoring riparian areas will contribute to the restoration of the watershed, including fish, wildlife, and vegetation communities.

The “*Assessment of Bear Creek Watershed Riparian Areas*” (King County 2017a) identified the current land cover in the riparian corridor study area<sup>1</sup> of the Bear Creek watershed. Two of the primary problems that interrupt the proper functioning of the riparian corridor were clearly in evidence: (1) lack of native vegetation, especially trees, and (2) a significant presence of invasive vegetation. There are two general strategies available to directly improve, enhance, and conserve riparian conditions in the Bear Creek watershed study area:

1. Restoration (planting native vegetation)
2. Land conservation (acquisition, easement, or incentive)

Using data from the King County (2017a) report and data generated for this report, each of these strategies is examined in detail in this report, which outlines methods for improving riparian conditions and prioritizes the locations for restoration and conservation. These strategies are not mutually exclusive, but the following analysis treats them separately.

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<sup>1</sup> All known stream extents within the Bear Creek watershed study area where Chinook, sockeye, coho, kokanee, and steelhead salmon, and cutthroat trout were recorded in the study area were included in this analysis, as described in King County 2017a.



## 2.0 RESTORATION STRATEGIES

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The riparian area can be improved and enhanced by planting native trees and shrubs in areas lacking shade and sometimes infested with invasive species. Benefits of planting trees in the riparian zone include:

- increased shade
- provide a source of large wood for the stream
- improved water quality
- reduced erosion potential
- reduced invasive species coverage

### 2.1 Identifying Lands in Need of Restoration

Before it is possible to identify areas in the watershed that could benefit from restoration planting, areas that could be planted (those areas not currently in native forest) were identified. Land cover that is not currently in native forest include:

- Shrub
- Non-forested wetland
- Pasture
- Other (much of this category is lawn and other grass surfaces as well as mud or other cleared area)
- Impervious surfaces (sometimes it's possible to remove roads or even buildings)

Those land cover types were all mapped in King County (2017a). Of those areas that could potentially be planted with trees (because they are not currently forested), the next step in identifying areas for potential tree planting was to determine what locations would provide the greatest benefit to the watershed if planted in native vegetation. The “vegetation criteria” used to help identify lands for potential planting projects include:

1. Whether the riparian zone has been cleared of native vegetation all the way to the stream edge or whether the stream is lacking shade in a given area.
2. Presence of invasive species.

All land cover polygons<sup>2</sup> in the riparian corridor study area were identified in King County (2017a) as to whether an area along a stream lacked shade and if the polygon had invasive species (reed canarygrass or Himalayan blackberry).

All polygons attributed as having no shade were intersected with the stream file to generate a line file that shows those reaches of streams and water bodies lacking of shade/native vegetation. Out of the 46.9 stream miles in the riparian study area, 17.3 miles (36.9 percent) were identified as lacking tree shade on one or both sides of the stream channel (though native shrubs are present in some locations) (King County 2017a).

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<sup>2</sup> Polygons are a GIS feature class used to represent features and areas, such as wetlands. Land cover was mapped in GIS in King County 2017a.

Land cover identified as having invasive species present is shown in Table 1 by type for the 200-ft riparian study corridor (200 ft on both sides of the stream center line). A buffer size of 200 ft on each side of the stream centerline was chosen as the width of the riparian corridor to be analyzed because a buffer this size will capture the area regulated as critical areas (165 ft in King County and 150 ft in Snohomish County) and generally capture the area regulated under Shoreline Management (200 ft)<sup>3</sup>. Figure 1 shows areas within the 165-ft riparian buffer identified as lacking trees or with invasive species or both.

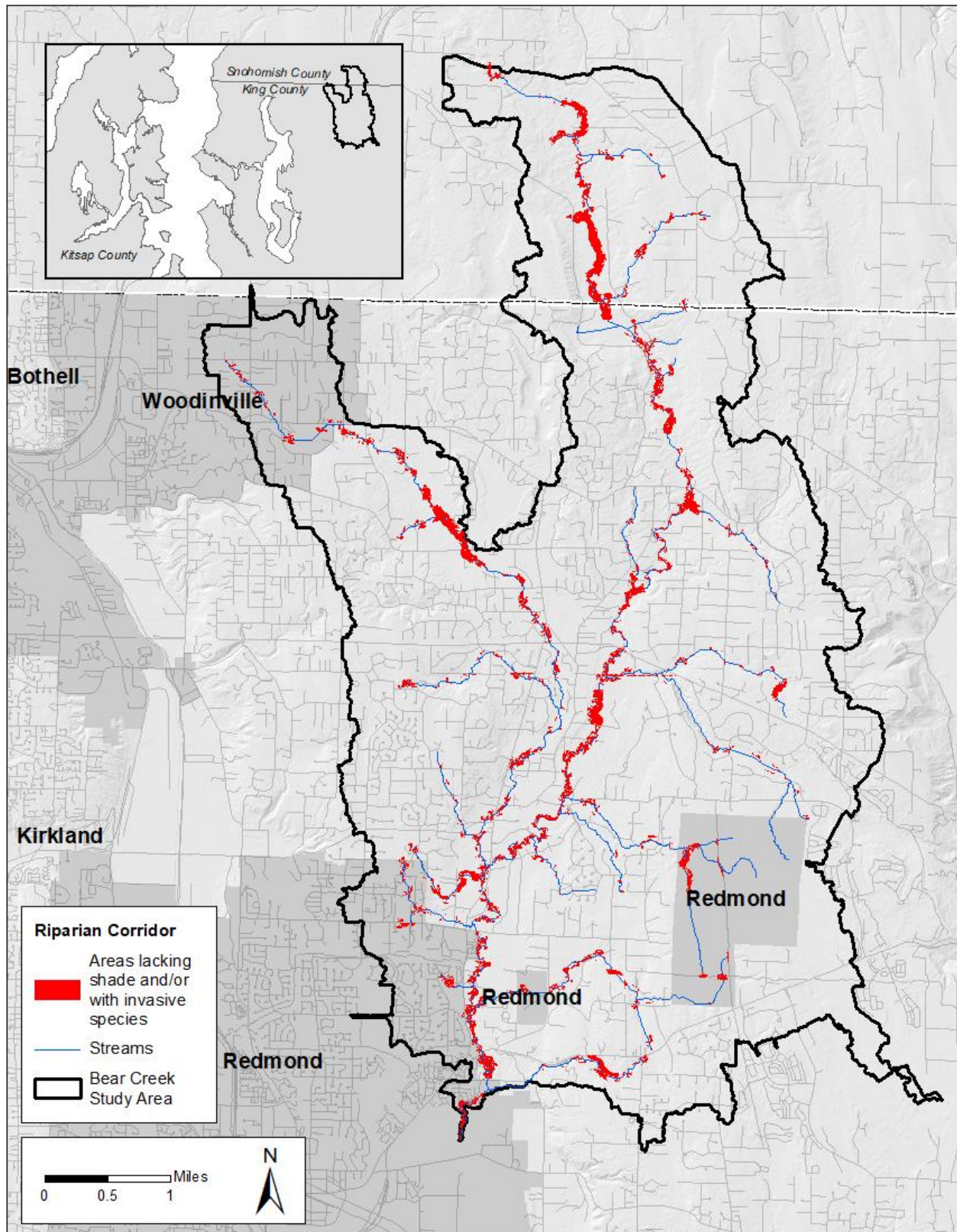
**Table 1. Land cover identified as having reed canarygrass or Himalayan blackberry present within 200 ft of the stream center line on both sides of the stream (King County 2017a).**

Land cover class	Area with invasive species (acres)	Total riparian study area in land cover class (acres)	Land cover class covered by invasive species (percent)
Non-forested Wetland	105.9	115.8	91.5
Other	15.1	265.3	5.7
Pasture	43.9	137.3	32.0
Shrub	158.5	394.5	40.2
<b>Total</b>	<b>323.3</b>	<b>912.9</b>	<b>35.4</b>

All parcels intersecting the riparian corridor were saved into a new file. Initially, all polygons with invasive species and areas lacking shade were intersected with the parcel file in order to identify which parcels contain areas in need of restoration. However, a lack of precision in this method resulted in some treeless areas being missed and other areas marked as treeless that had trees. For example, because polygons containing invasive species are often not entirely composed of invasive species, simply intersecting parcels with polygons containing invasive species results in a gross overestimate of which parcels have large areas of reed canarygrass.

All parcels in the riparian corridor were subsequently examined visually in GIS to identify those parcels lacking trees along streams or in stream buffers, regardless of the presence of invasive species. Parcels were attributed accordingly. A total of 371 parcels were identified as needing trees planted either along the stream or in the regulated riparian buffer.

<sup>3</sup> Because the riparian corridor file was created based on stream centerlines and not Ordinary High WaterMark (OHWM), the entire Shoreline Management regulated area is typically not fully within the 400 foot corridor. Therefore, if there were ever a specific request to study land cover within the Shoreline Management jurisdiction regulated area in the watershed, some portions of the study corridor would need to be expanded.



**Figure 1. Areas identified as either lacking trees or with invasive species or both (within the 165-ft riparian buffer).**

## 2.2 Prioritizing Lands for Native Vegetation Planting

Once the locations in the riparian corridor lacking trees or covered in invasive species are identified, they need to be prioritized for restoration. Other reports and studies have suggested ways to prioritize revegetation projects. The Green-Duwamish revegetation strategy (WRIA 9 Riparian Revegetation Work Group 2016) suggested the following types of sites should be considered highest priority for revegetation:

- Large parcels or multiple adjacent parcels with at least 1,000 km (3,200 ft) of stream or river;
- Areas that do not already have trees over more than 50 percent of the site within 150 ft of the stream or channel;
- Areas where plantings are most likely to be maintained in the future (e.g., publicly owned, conservation easements).

In order to potentially save costs on public involvement and project mobilization, Entranco (1994) recommended identifying strategic clusters of high priority stream parcels by considering:

- Parcels that are back to back and across the stream from each other, and
- Contiguous parcels with the same owner.

One large factor in restoration planning is landowner willingness. Because landowner willingness has not yet been surveyed, there is no way to map private landowner willingness using available GIS data or to use such information in the current analysis. If the site is on public land, it may be reasonably assumed that obtaining landowner approval/cooperation would be relatively likely for restoration activities like tree planting.

Taking the above information into consideration along with the goals of the Plan, criteria shown in Table 2 were determined to be the best and most useful criteria to use for prioritizing restoration tree planting. These criteria include areas that may benefit most from shade and riparian vegetation. The criteria also take into account the type of degradation present (reed canarygrass, mowed edges) and whether the degradation occurs on public lands. A point system was designed for the restoration criteria (Table 2) and applied to all parcels to prioritize areas for vegetation planting. Final prioritization for tree planting in the riparian corridor was based on the summation of the restoration scores.

**Table 2. Criteria and point system for prioritizing planting projects along streams in study area.**

Criteria	Points	Rationale
On public land	40	This criteria gets a high point value because of presumed agency cooperation.
Along Chinook-bearing waters	10	Trees planted here will eventually contribute to large wood in the streams.
Along headwater streams, defined as first-order streams (Strahler 1957)	10	Trees planted along the stream here help contribute to lower water temperatures at the stream's source.
Where water temperatures are known to exceed state standards for salmon streams (see King County 2017c)	10	Trees planted here help to lower or at least maintain water temperatures.
Along the Wildlife Habitat Network (WHN) (a regulated corridor that is ideally 300 ft wide and covered in native vegetation)	10	Trees planted here contribute to vegetated wildlife corridors.
No shade / mowed to edge of water	40	This criteria implicitly includes immediate proximity to stream and so gets a high point value.
Presence of invasive species	10	Reed canarygrass is an invasive monoculture that reduces biodiversity and native habitat. Parcels includes areas that lack shade <u>and</u> contain reed canarygrass or Himalayan blackberry, as identified in aerial imagery.

The rankings of high, medium, low, and very low for riparian restoration are defined as:

- High = 90-120 points
- Medium = 70-80 points
- Low = 20-60 points
- Very Low = 0-10 points

Parcels that scored only 0 or 10 points are assumed to not be a priority for restoration. This analysis reveals the following data for parcels that scored at least 20 points for riparian restoration (tree planting):

- King County – 262 parcels; points ranging from 20 to 120
- Redmond – 20 parcels; points ranging from 20 to 100
- Snohomish County – 13 parcels; points ranging from 20 to 60
- Woodinville – 16 parcels; points ranging from 20 to 80
- WSDOT – 1 parcel; 100 points

Lists of all parcel data will be provided to all partner jurisdictions.



Some parcels were examined but not ranked. Parcels that were fully vegetated are classified as “Vegetated.” Parcels whose riparian buffers were constructed because of houses or other development but whose remaining riparian buffer was vegetated are classified as “Vegetated small buffers.”

If needed (for King County because of the large number of parcels), a second tier of criteria may be applied for additional prioritization, which draws from the WRIA 9 Riparian Revegetation Work Group (2016) and Entranco (1994):

- A. Prioritize planting projects that cover the largest reaches. Give high priority to revegetating stretches of riparian area at least 100 ft long. Planting these relatively longer stream lengths would have a larger impact, all else being equal. The challenge with this method is if multiple land owners are involved. Table 3 illustrates the break-down of reach sizes where there is no shade on one or both sides of the stream. Some of the longest reaches run through wetlands and might not be good candidates for tree planting.

**Table 3. Stream reaches with no shade on one or both sides of the stream.**

Stream length (ft)	Number of reaches	Total feet	Total stream miles
>1000	10	17,544	3.3
500-1000	21	14,126	2.7
100-500	194	41,224	7.8
<100	621	20,467	3.9

- B. Prioritize planting projects that require permission of the fewest landowners. Parcel data may be used in combination with criteria to find those patches in need of revegetation that affect the fewest number of property owners. The benefit of this approach is that it would require the least number of willing landowners for planting.

## 2.3 Outreach

Education and outreach about the benefits of planting trees will be a critical component in encouraging landowners to plant trees. Because tree planting can be done voluntarily by landowners, the data generated in this study can be used for targeted outreach. Further, if incentive programs such as King County’s Public Benefit Rating System are available, landowners may be educated about such tax incentives, which provide a tax break when non-forested riparian buffers are planted in native vegetation.

Additionally, King County is tracking the number of trees being planted anywhere in the county as part of its Million Trees initiative<sup>4</sup>, and they have developed a mobile app where

<sup>4</sup> <http://www.kingcounty.gov/services/environment/stewardship/one-million-trees.aspx>

individuals doing plantings can report their numbers. Information about this initiative and the app can be shared with landowners, and the app can be used to help inform King County when landowners are doing their own riparian plantings.

## **2.4 Beaver Management**

Many new young trees and shrubs will be planted near streams when planting projects proceed as a part of this plan. Whenever tree planting restoration activities take place near water, there is a risk that beavers will move into the area. In these instances, beavers may cut some of the trees, build one or more dams, form one or more ponds, and establish an entirely new ecosystem. Beaver activity provides many environmental benefits, including flood control, groundwater recharge, pollution filtration, and habitat for a wide variety of fish and wildlife, including salmonids. Beaver may also present challenges for landowners, primarily related to flooding and tree cutting.

Solutions are frequently available to reduce or avoid flooding and help protect trees while allowing the beavers to remain on site. Beaver management in the Bear Creek Watershed will likely become increasingly important as Plan implementation progresses.

## 3.0 LAND CONSERVATION STRATEGIES

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A second method for retaining riparian function or making improvements to the riparian corridor entails the permanent conservation of lands. Riparian buffers in the watershed are protected by critical areas regulations established in all partner jurisdictions. Regulatory buffer sizes were established based on the best available science for the protection of riparian functions. Buffers in the riparian study area range from 150 to 165 ft on each side of the stream depending on the jurisdiction. However, for the following reasons, land conservation is a viable alternative to relying solely on regulatory buffers to protect the riparian areas of the Bear Creek watershed:

- Some riparian areas had been degraded prior to the establishment of regulations, and public ownership would facilitate restoration activities.
- Regulations are not always adhered to.
- Regulatory buffers may be reduced as a result of alterations exceptions under specific circumstances outlined in agency code.

Land conservation of riparian areas is accomplished by one of the following means:

- Land acquisition: acquisition in fee, which provides full control of the land.
- Conservation easement: conveyance of development rights necessary for protection of specific conservation values from a property's landowner to a municipality, land trust, or other nonprofit organization. The terms of easements vary, but generally speaking, in the areas covered by the easement, no new development may take place.
- Tax incentives: programs such as current use taxation programs in King County that offer an incentive (a property tax reduction) to landowners to voluntarily preserve open space on their property. Once enrolled, a participating property is assessed at a "current use" value, which is lower than the "highest and best use" assessment value that would otherwise apply to the property.

Of these three strategies, acquisitions and easements are the two examined in this Plan. Because tax incentive programs cannot be guaranteed in the long term, they were not included in this analysis. However, in many instances the landowner will likely never withdraw from the incentive program, because, for example, the parcel is too small to divide and the portion in the incentive program is wetland or stream riparian area. In these instances the protection is effectively permanent. The Waterways 2000 Program (King County 1996) mapped parcels in the Bear Creek watershed they recommended for tax incentive programs, and many of those parcels were subsequently enrolled. Programs such as the Public Benefit Rating System in King County are worthwhile and should be actively pursued as a valid conservation measure.

Land conservation, especially acquisition in fee, may result in additional lands for King County to manage. The implications of increasing the management requirements by King County is not addressed in this analysis.

Public ownership of undeveloped lands protects them from future development and more easily facilitates the retention (or improvement) of water quality and wildlife functions. Permanently undeveloped tracts of land can result in large vegetated areas that function as wildlife corridors in addition to performing water quality functions. Permanent protection can ensure areas that are larger than regulated buffers are retained in forest.

Conservation easements are used to ensure development does not occur in a particular location. Conservation easements may be placed on undeveloped parcels or on portions of developed parcels, regardless of the size of the property, although if the amount of undeveloped riparian area is smaller than the regulatory buffer, it may be assumed the regulations will keep the remaining portion undeveloped.

Land conservation can be used to protect the highest value lands from a stormwater perspective or an ecological perspective, or it can be used to acquire lands most in need of restoration. Both strategies are valid. Because this is a stormwater plan, the preferred strategy prioritizes those parcels with the highest stormwater and ecological value: undeveloped, forested riparian buffers.

### **3.1 Identifying Lands for Conservation**

The riparian corridor parcel dataset described in Section 2.1 was examined for potential conservation. Publicly owned parcels (136), Tract parcels (55), and Home Owners Associations (HOA) parcels (5) were removed from consideration for land conservation because they are already publicly owned or otherwise conserved. Parcels were also removed from consideration if an easement is already in place (13 parcels).

The remaining privately owned parcels were attributed as to whether they:

- lack trees along the stream
- lack trees in the regulated buffer
- are adjacent to public, Tract, and HOA parcels
- are along Chinook-bearing waters
- are along headwater streams, defined as first-order streams
- are along the WHN

Potential conservation parcels were put into one of the following categories:

- *Undeveloped*: may be forest, wetland, or grass. Parcels that appeared to be undeveloped in aerial imagery were verified as such by checking the parcel data for the assessed (King County) or market value (Snohomish County) of any improvements on the lot.
- *Potential Easement*: development is present on some portion of the parcel as well as the riparian corridor. Oftentimes an area larger than the regulated buffer is present

and undeveloped within the parcel. These parcels may warrant further examination during Plan implementation, as this designation (a) assumes acquisition and demolition of existing structures is undesirable when in fact that may be the best option in a specific location, and (b) assumes there is a compelling reason to purchase an easement when stream buffers are protected regulatorily.

- *Limited Options:*
  - Parcels with riparian corridors reduced in size and constrained by roads, driveways, or buildings (including houses).
  - Parcels covered with homes and relatively small yards (although it is possible to purchase lands with homes on them and demolish the buildings, this analysis assumes that is typically undesirable).
  - Parcels with only a very small portion of the parcel in the riparian buffer (can target for tree planting efforts, but assumes regulations protect buffer from development).

## **3.2 Prioritizing Lands for Conservation**

Once the parcels were fully attributed, points were applied to parcels based on the scoring system shown in Table 4. Criteria shown in Table 4 were determined to be the best and most useful criteria to use for prioritizing conservation of riparian parcels. Emphasis is placed on those areas already fully forested and undeveloped as well as those areas adjacent to lands already protected. This approach to land conservation focuses on acquiring and protecting the highest value lands from a stormwater and an ecological perspective. By protecting lands adjacent to lands already in protection, connectivity of conserved lands is increased. Final prioritization for conservation in the riparian corridor was based on the summation of the conservation scores.



**Table 4. Criteria and point system for prioritizing planting land conservation strategies in the study area.**

Criteria	Points	Notes
Adjacent to public, Tract, and HOA parcels	20	Parcels adjacent to parcels that are already protected increase the contiguously protected area and may fill in gaps in protected areas.
Along Chinook-bearing waters	10	Trees planted here will eventually contribute to large wood in the streams.
Along headwater streams, defined as first-order streams	10	Trees planted along the stream here help contribute to lower water temperatures at the stream's source.
Along the Wildlife Habitat Network	10	Trees planted here contribute to vegetated wildlife corridors.
Full regulated buffer is forested	30	No apparent restoration activities are needed; most cost-effective; zero wait time for tree-growth.
Parcel is undeveloped	30	No impervious surface present. Will not incur demolition costs.
Development pressure	20	Parcels that are not currently subdivided as small as they may be.
Special designation	10 per occurrence	Identified in wetland analysis (King County 2017b) or King County Land Conservation Initiative (which includes salmon recovery priorities).
Limited Options designation	-30	This designation is assigned to parcels that have little or no options for conservation under their current land cover. However, they may be desirable for large-scale efforts involving surrounding parcels. Therefore they are included but a negative score is assigned to them to de-prioritize them.

The rankings of low, medium, and high are defined as:

- High = 100-140 points
- Medium = 70-90 points
- Low = 20-60 points
- Very Low = 0-10 points

Of the 115 parcels identified as having “limited options,” 75 scored a negative number (from -10 to -30). Those 75 parcels are identified as “Limited Options,” and no action is identified for those parcels. The remaining 40 limited options parcels are included in the low and very low categories because they scored between 0 and 30 points.

Parcels that scored only 0 or 10 points are assumed to not be a priority for conservation. Of the 741 parcels that were scored, 524 scored at least 20 points for conservation. The analysis reveals the following data for parcels that scored at least 20 points for conservation:

- King County – 444 parcels; points ranging from 20 to 140
- Redmond – 16 parcels; points ranging from 20 to 110
- Snohomish County – 48 parcels; points ranging from 30 to 120
- Woodinville – 16 parcels; points ranging from 20 to 100

For those parcels that are developed and cannot be subdivided, conservation easements are a potential option. For those parcels that are developed and can be subdivided, both conservation easements and acquisition are options; however, piecemeal public ownership is often not desirable, so adding easements over time as landowners were willing may be more feasible.

Costs of acquisition were calculated by first obtaining the combined assessed land value and assessed improved value (value of improvements, such as houses) from King County parcel data and the combined market land value and market improved value from the Snohomish County parcel data. Next, a multiplier of 115 percent<sup>5</sup> was applied to those values to account for the difference between the assessed value and appraised value. Costs of easements were calculated by taking the assessed land value from King County parcel data and the market land value from the Snohomish County data and using a multiplier of 40 percent<sup>6</sup>. Easement calculations assumed less than half the parcel would be put in easement.

Costs for acquisition for each partner jurisdiction are presented in Table 5. Costs were separated out for priority basins in addition to the priority ranking described in this strategy. Total acquisition costs are estimated to be \$37,859,000 if all 128 parcels identified for potential acquisition were purchased, including those prioritized as Low and Very Low. Total costs for acquisition in priority basins and remaining High and Medium ranked parcels would be \$31,753,000.

**Table 5. Cost estimates for all 128 parcels identified for potential acquisition. Priority catchments described in Section 4.2 are identified separately.**

Prioritization Ranking	Catchment	Cost	number of parcels
<b>King County</b>			
High	BEA300	\$43,000	1
High	All others	\$10,087,000	28
Medium	All others	\$13,060,000	50

<sup>5</sup> 15 percent is added to the assessed value because appraisals were running higher than assessed value by about 15 percent in 2015 and 2016.

<sup>6</sup> 40 percent assumes the following: (a) the amount of the parcel that would be placed under easement would be less than 50 percent and more than 1 percent, and 25 percent is the average between 1 and 50, and (b) 15 percent is added to the 25 percent to account for the difference between assessed value and appraised value.

Low	BEA120	\$1,044,000	3
Low	BEA300	\$32,000	1
Low	All others	\$5,645,000	18
<b>Redmond</b>			
High	All others	\$1,611,000	1
Medium	All others	\$145,000	2
<b>Snohomish County</b>			
High	BEA640	\$363,000	1
High	BEA660	\$1,179,000	4
Medium	BEA660	\$572,000	3
Medium	All others	\$1,535,000	6
Low	BEA660	\$281,000	2
Low	All others	\$460,000	4
<b>Woodinville</b>			
High	BEA850	\$292,000	1
Medium	BEA850	\$1,114,000	2
Medium	All others	\$394,000	1

Costs for easements for each partner jurisdiction are present in Table 6. Costs were separated out for priority basins in addition to the priority ranking described in this strategy. Total easement costs are estimated to be \$210,682,000 if easements were purchased on all 538 parcels identified for potential easements, including those prioritized as Low and Very Low. Total costs for easements in priority basins and remaining High and Medium ranked parcels would be \$28,972,000.

**Table 6. Cost estimates for all 538 parcels identified for potential easements. Priority catchments described in Section 4.2 are identified separately.**

Prioritization Ranking	Catchment	Cost	number of parcels
<b>King County</b>			
High	All others	\$590,000	1
Medium	All others	\$16,389,000	41
Low	BEA120	\$3,125,000	6
Low	BEA300	\$1,571,000	5
Low	All others	\$109,785,000	290
Very Low	BEA120	\$1,710,000	8
Very Low	All others	\$34,435,000	111
<b>Redmond</b>			
Medium	All others	\$251,000	1
Low	All others	\$29,330,000	12
<b>Snohomish County</b>			
Medium	BEA660	\$444,000	2
Low	BEA640	\$201,000	1
Low	BEA660	\$3,058,000	17
Low	All others	\$1,728,000	8
Very Low	BEA660	\$624,000	4
Very Low	All others	\$793,000	6
<b>Woodinville</b>			
Low	BEA850	\$1,521,000	5
Low	All others	\$1,668,000	7
Very Low	All others	\$3,468,000	13

## 4.0 REFERENCES

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## **APPENDIX E: Public Engagement Summary**

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Comments on the Draft Bear Creek Watershed Management Study (Study) were received during the public comment period (February 21, 2018 through March 21, 2018) via an online questionnaire, email and handwritten submittals, and at the public meeting on March 7, 2018. The themes of these comments are listed in Table 1.

**Table 1. Themes of written and verbal comments at the Public Meeting 3 and from online and email submittals.**

Themes	How Addressed in the Study
Community members were excited about what they can do to help improve the watershed and reduce runoff through tree planting, reducing use of chemicals and rain barrels and volunteering to plant trees, etc.	Public engagement is a recommended strategy to train and supports local community members to effectively participate and impact the Study goals. The program will include methods to connect the community to funding and non-governmental organizations (NGOs) that support small projects and volunteers for stream monitoring. Chapters 4 to 7 of the Study present some non-structural strategies that the community members can participate in to help improve water quality and habitat in the watershed.
Provide general education and community awareness of the importance of the Bear Creek watershed, the value of a more natural looking streams and "backyard" areas, and how to get more involved.	As above, the Study recommends to educate the residents and visitors on the importance of the watershed through an outreach program. Efforts to conserve and restore lands to a more natural setting are a key recommendation of providing healthy habitat and clean water. These efforts may be through wetland, riparian and instream restoration efforts and conservation of healthy land located along the streams. Chapters 5 through 7 address these types of recommendations. In addition, community members will be able to be a part of this effort by planting trees on their own land or volunteering on local tree planting projects.
There were a few strong comments about the importance of future coordination when beginning to implement the Study with various stakeholders already involved with local conservation and restoration outreach and projects, communities and groups already actively partaking in local stormwater and water quality concerns, and residents wanting to partake in the outreach process of the Study once it is implemented. Some groups mentioned were Water Tenders, tribes, Forterra, Willowmoor community group, etc.	Various stakeholders and the public have been involved with partaking in workshops and providing comments (Appendix E of the Study documents this process). The Study recommends to continue with the Partners and to have an open approach with the various stakeholders and community interest groups. In addition, many complementary efforts where these relationships are already ongoing will help to further along the process for the stormwater management study.

Themes	How Addressed in the Study
Many people gave favorable opinions about stormwater ponds. They preferred natural looking ponds. Some expressed a desire to have community use of the area, clean and maintained areas, and concerns about safety for children.	Involvement of the local community in stormwater facility siting and design is a recommendation of the Study. Project managers are recommended to include local residents and incorporate their input.
Interest was expressed in getting technical assistance, design plans, and financial assistance to install raingardens. Some interest expressed in technical and financial assistance for a cistern, tree planting, and invasive plant removal.	A program with incentives, technical assistance, and rebates is recommended for green stormwater infrastructure on private land for private property owners to disconnect impervious surfaces from direct drainage systems and infiltrate or disperse runoff via small scale BMP (Chapter 4 of the Study).
One commenter asked when the strategies and catchments identified for after the near-term would be completed.	Following the completion of the identified near-term actions, it is recommended that the implementation plan be updated based on the successes and challenges found during the first 10 years.
One commenter questioned how the jurisdictions will use their authorities to improve stormwater management from new development? They also questioned why an in-lieu fee was proposed.	Existing stormwater code requirements ( <i>Stormwater Management Manual for Western Washington</i> or equivalent) are believed to adequately mitigate stormwater runoff as those sites. However, at locations where the adequate stormwater management controls are not feasible, the Study recommends that developers pay an in-lieu fee. The collection these fees would be used for regional stormwater facilities or habitat restoration.
A few members of audience at the public meeting expressed concern about the development growth and how this issue feeds back into the work done on the Study.	This was addressed in the <a href="#">public meeting</a> <sup>1</sup> . The City of Redmond and other jurisdictions have stormwater management programs that include stormwater fees as well as complementary efforts. All municipalities in Washington State are required to account for population growth and this is done as part of development of their Comprehensive Land Use plans. Stormwater mitigation for new development is 100 percent paid for by the developer.

<sup>1</sup> [https://your.kingcounty.gov/dnrp/library/water-and-land/watersheds/sammamish/BC-Stormwater-Plan-related/public3/BCP\\_public3\\_Notes.pdf](https://your.kingcounty.gov/dnrp/library/water-and-land/watersheds/sammamish/BC-Stormwater-Plan-related/public3/BCP_public3_Notes.pdf)

Themes	How Addressed in the Study
One commenter asked how the strategies aligned with the load allocations defined by the Bear Creek TMDL.	The load allocations from the TMDL and prioritized strategies were constructed under a different set of goals and with different models.
A few individuals expressed concerns about possible flooding from wetlands on neighboring properties.	Restoring vegetation around wetlands will not cause additional flooding.
A few individuals expressed concerns about the unintended impacts and damage caused by beavers to flooding of homes and roads.	There are a few different solutions that may allow property owners, vegetation, and the local beavers to all co-exist. There are various engineered solutions available for property owners to review on the King County (KC) <a href="https://www.kingcounty.gov/beavers">beaver management website</a> . <sup>2</sup>
There were a few members of the audience at the Public Meeting concerned about whether we would be assessing the conditions of land before we implemented these projects. There was a concern mentioned around unintentionally saturating the ground and causing landslides, diseased trees and in other cases trees that remove high volumes of water from the ground. Climate change was mentioned a few times with respect to increased stormwater.	In general, any future work will require feasibility assessments as there are many things to consider at each location. If a method is found to not be feasible, we must come up with another strategy. With respect to climate change, we noted that we are working with UW and the Climate Impacts Group, and have modelled the impacts for KC. This work is part of a later phase in another study.
One concern was expressed that a 165 ft buffer along the stream was too much.	This is a regulated critical area. (KCC 21A.24)

<sup>2</sup> <https://www.kingcounty.gov/beavers>



Themes	How Addressed in the Study
A property owner expressed concern about the unintended impacts by the public accessing streams when salmon are spawning.	As above, the Study recommends to educate the residents and visitors on the importance of the watershed through an outreach program.
One person questioned if there would be a special purpose district to fund the implementation of the Study.	This was addressed at the <a href="#">public meeting</a> <sup>3</sup> . There is no intent for new taxing districts.
Forterra suggested using their prioritization method of parcels for planting projects, conservation and strategic communication efforts.	The partners look forward to partnering with Forterra as part of the riparian and wetland conservation effort in Bear Creek. The project team values the prioritization method employed by Forterra and recommends their methods be evaluated and combined with the Study's method in future prioritization efforts.
One commenter questioned why Evans Creek and lower Bear Creek were excluded.	Evans Creeks and Bear Creek downstream of the confluence with Evans Creek were excluded from the Bear Creek Watershed Management Study. Their exclusion was to increase the feasibility of this novel effort for multi-jurisdictional watershed management. Expansion to Evans Creek and lower Bear Creek is recommended in future watershed planning efforts.

Efforts were made to reach a broad group of stakeholders and residents in the project area and to generate interest to partake in online forums, technical presentations, workshops, webinars, and community and public meetings included email notifications to group audiences, direct mailings, news releases, local print ads and notification through online webpages (articles, newsletters, event calendars, social media, and local news). Table 2 is a summary of these public engagement elements.

<sup>3</sup> [https://your.kingcounty.gov/dnrp/library/water-and-land/watersheds/sammamish/BC-Stormwater-Plan-related/public3/BCP\\_public3\\_Notes.pdf](https://your.kingcounty.gov/dnrp/library/water-and-land/watersheds/sammamish/BC-Stormwater-Plan-related/public3/BCP_public3_Notes.pdf)

**Table 2. Summary of public engagement elements.**

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
<b>PARTNER MEETINGS</b>					
Partners: King County (KC), Snohomish County, City of Redmond, City of Woodinville, Washington State DOT	<ul style="list-style-type: none"> <li>Determine specific engagement goals and messaging for each of the meetings, based on stakeholder input and Bear Creek Watershed Management Study (Study) status</li> <li>Ensure alignment and support for public and stakeholder engagement</li> </ul>	Monthly, beginning 02/2015 – 3/27/2018	Partners	n/a	3-10
<b>WEBINARS</b>					
<a href="#">Technical Webinar #1</a> <sup>4</sup>	<ul style="list-style-type: none"> <li>Update on existing conditions</li> <li>Share study findings on watershed modeling, land-use conditions, regulations and existing stormwater infrastructure and juvenile salmon habitat use</li> </ul>	11/15/2016	Partners, stakeholders (Bear Creek residents, NGOs <sup>5</sup> , tribes, state & local government)	Attendees mostly asked clarifying questions about technical and scientific data, methods to review and incorporate data, and understanding the differences between jurisdictions. There was a strong concern expressed about the methodology used on fish habitat survey and suggestions were given. Extensive follow up communication occurred post meeting on this topic.	45
<a href="#">Technical Webinar #2</a> <sup>6</sup>	<ul style="list-style-type: none"> <li>Update on existing conditions</li> <li>Share study findings on water quality, B-IBI, wetland and riparian land cover assessments</li> </ul>	12/12/2016	As above	Attendees asked clarifying questions about technical and scientific data, methods to review and incorporate data, and expressed interest in being able to review data. All data is publically available online.	25

<sup>4</sup> <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx#workshopd>

<sup>5</sup> non-governmental organizations

<sup>6</sup> <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx#workshope>

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
<b>WORKSHOPS</b>					
<a href="#">Technical Workshop #1</a> <sup>7</sup>	<ul style="list-style-type: none"> <li>• Introduce Study goals and the role of the Partners</li> <li>• To generate helpful information on the project goals and current conditions</li> <li>• To help build understanding among different perspectives among participants</li> <li>• Share information on Existing and Future Conditions, Regulations and Existing Stormwater Infrastructure, Strategies Under Consideration and Related Stormwater Management Efforts</li> </ul>	11/4/2015	Partners, stakeholders (Bear Creek residents, NGOs, tribes, state & local government)	Attendees expressed high importance of the project to their work and the community. There were strong suggestions that the Study include more than just stormwater regulations/constructed BMP solutions and focus on fish recovery and that it have measurable goals. Attendees provided pros and cons on strategies. A <a href="#">detailed summary</a> <sup>8</sup> is provided on the project document webpage.	27
<a href="#">Technical Workshop #2</a> <sup>9</sup>	<ul style="list-style-type: none"> <li>• Give update on example problems and solutions</li> <li>• Gather input from stakeholders through exercises</li> </ul>	3/29/2017	As above	Attendees asked clarifying questions about technical information on the key findings and solutions (including the process and criteria used to identify solutions). Table discussions provided a wide range of comments. A <a href="#">detailed summary</a> <sup>10</sup> is provided on the project document webpage.	36

<sup>7</sup> <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx#workshopa>

<sup>8</sup> <https://your.kingcounty.gov/dnrp/library/water-and-land/watersheds/sammamish/BC-Stormwater-Plan-related/Tech1-Notes.pdf>

<sup>9</sup> <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx#workshopf>

<sup>10</sup> [https://your.kingcounty.gov/dnrp/library/water-and-land/watersheds/sammamish/BC-Stormwater-Plan-related/tech2/tech2\\_notes.pdf](https://your.kingcounty.gov/dnrp/library/water-and-land/watersheds/sammamish/BC-Stormwater-Plan-related/tech2/tech2_notes.pdf)

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
<b>PUBLIC MEETINGS</b>					
<a href="#">Public Meeting #1</a> <sup>11</sup>	<ul style="list-style-type: none"> <li>• Introduction to project</li> <li>• Introduce process for developing the Study, gathering community input, and evaluating current conditions</li> <li>• Brief introduction to strategies under considerations.</li> </ul>	2/25/2016	Public, stakeholders and partners	Attendees asked clarifying questions about technical data and modeling methods. A few suggested more controls on development and clear cutting, having more stringent standards, and some had concerns about the costs. There was a suggestion towards more preservation and buffering of creeks. A <a href="#">detailed summary</a> <sup>12</sup> is provided on the project document webpage.	35
<a href="#">Public Meeting #2</a> <sup>13</sup>	<ul style="list-style-type: none"> <li>• Update on existing conditions</li> <li>• Share the study findings, i.e. specific water quality problems being addressed</li> <li>• Solicit input about potential toolbox of stormwater mitigation strategies</li> </ul>	10/13/2016	As above	Attendees mostly asked clarifying questions about technical and scientific data, costs and technical details of different strategies and gave feedback on various approaches. Attendees generally favored effective and integrated approaches. There was strong support for preservation and a desire to continue public engagement. A <a href="#">detailed summary</a> <sup>14</sup> is provided on the project document webpage.	36

<sup>11</sup> <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx#workshopb>

<sup>12</sup> <https://your.kingcounty.gov/dnrp/library/water-and-land/watersheds/sammamish/BC-Stormwater-Plan-related/Public1-Notes.pdf>

<sup>13</sup> <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx#workshopc>

<sup>14</sup> <https://your.kingcounty.gov/dnrp/library/water-and-land/watersheds/sammamish/BC-Stormwater-Plan-related/Public2/Public2-Notes.pdf>

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
<b>PUBLIC MEETINGS (continued)</b>					
<a href="#">Public Meeting #3</a> <sup>15</sup>	<ul style="list-style-type: none"> <li>• Presentation of draft Study</li> <li>• Share recommendations</li> <li>• Provide time for public comments</li> </ul>	3/7/2018	Public, stakeholders and partners	Attendees mostly asked detailed questions about recommendations (such as raingardens, drywells, ponds) and restoration methods, general questions about increased development and regulations, and generally gave favorable feedback on the outreach methods and recommendations. A summary of the themes of comments are presented in Table 1 of this Appendix. A <a href="#">detailed summary</a> <sup>16</sup> of the comments and questions during the question and answer period of Public Meeting is provided on the project document webpage.	74
<b>ONLINE FORUM</b>					
<a href="#">KC County Online Forum</a> <sup>17</sup>	<ul style="list-style-type: none"> <li>• Share Draft Study</li> <li>• Share recommendations</li> <li>• Seek comments on draft Study</li> </ul>	2/15/2018 - 3/21/2018	All	The comments from this forum were included in the summary in Table 1 of this Appendix. A <a href="#">detailed listing</a> <sup>18</sup> of the responses is provided on online forum webpage.	47 visitors, 3 responses

<sup>15</sup> <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx#workshopg>

<sup>16</sup> [https://your.kingcounty.gov/dnrp/library/water-and-land/watersheds/sammamish/BC-Stormwater-Plan-related/public3/BCP\\_public3\\_Notes.pdf](https://your.kingcounty.gov/dnrp/library/water-and-land/watersheds/sammamish/BC-Stormwater-Plan-related/public3/BCP_public3_Notes.pdf)

<sup>17</sup> <https://www.peakdemocracy.com/5976>

<sup>18</sup> <https://www.peakdemocracy.com/5976>



Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
<b>King County IN-PERSON PRESENTATIONS / CROSS PROMOTION EVENTS</b>					
American Public Works Association Stormwater Managers Committee WA Chapter	Technical presentation	9/18/2015	Technical water experts	n/a	~30
American Water Resources Association WA Chapter	Technical presentation entitled "Using SUSTAIN (and HSPF) to Maximize Efficiencies in the Management of Stormwater."	5/16/2017	Scientists, planners, engineers	n/a	~30
Bear Creek /Sammamish Valley Community Service Area	Attended meeting and give short statement and share related handouts.	11/2015 6/05/2017	Bear Creek & Sammamish Valley residents	n/a	~30, 45
City of Redmond Public Meeting for Monticello Creek (Firehouse #17)	Attended meeting and give short statement about the upcoming Public Meeting 2 on October 13, 2016.	9/22/2016	Redmond residents	n/a	~30
DNRP WLRD Science Seminars	Gave presentations on the Study project and study findings: " <a href="http://your.kingcounty.gov/dnrp/library/water-and-land/science/seminar-2016/S1-2-Juvenile-Chinook-Habitat-Bear-Creek-Kubo.pdf">Juvenile Chinook habitat use in the Bear Creek Watershed</a> <sup>19</sup> "; <a href="http://your.kingcounty.gov/dnrp/library/water-and-land/science/seminar-2017/S1-2-bear-creek-watershed-clark.pdf">Water Quality Status and Trends in Bear Creek</a> <sup>20</sup>	11/7/2016 11/2/2017	Local government, utilities, universities, public, NGOs	n/a	80 plus

<sup>19</sup> <http://your.kingcounty.gov/dnrp/library/water-and-land/science/seminar-2016/S1-2-Juvenile-Chinook-Habitat-Bear-Creek-Kubo.pdf>

<sup>20</sup> <http://your.kingcounty.gov/dnrp/library/water-and-land/science/seminar-2017/S1-2-bear-creek-watershed-clark.pdf>

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
<b>King County IN-PERSON PRESENTATIONS / CROSS PROMOTION EVENTS (continued)</b>					
Upper Bear Creek Community Unincorporated Area Council (Woodinville Library)	Gave short announcements about upcoming public meetings and gave project status updates.	2/23/2016 9/27/2016 3/28/2017 3/13/2018	Upper Bear Creek residents and stakeholders	n/a	15, ~15, 15, ~15
KC Water and Land Resources Division Science Section meeting	Presentations on the Study project and study findings	1/4/2017	Science Section employees	n/a	45
WRIA 8 Implementation Committee Meeting	Technical presentation “Bear Creek Watershed Stormwater Management Study” and update on status of project	9/1/2015 3/6/2018	Scientists, planners		72, 19
WRIA 8 Technical Committee Meeting	Technical presentation “Bear Creek Watershed Stormwater Management Study” and update on status of project	9/1/2015 2/14/2018	As above	n/a	Less than 72
WRIA 8 Salmon Recovery Council Meeting	Technical presentation on “ <a href="#">Juvenile Salmon Habitat Use in the Bear Creek Watershed</a> <sup>21</sup> ”; “ <a href="#">Draft Bear Creek Watershed Management Study</a> ” <sup>22</sup>	1/19/2017 3/15/2018	Scientists, planners, elected officials	n/a	41, 38

<sup>21</sup> [http://www.govlink.org/watersheds/8/committees/1701/W8\\_SRC\\_Bear\\_Creek\\_JK\\_1\\_19\\_17.pdf](http://www.govlink.org/watersheds/8/committees/1701/W8_SRC_Bear_Creek_JK_1_19_17.pdf)

<sup>22</sup> [http://www.govlink.org/watersheds/8/committees/1803/Bear\\_Creek\\_watershed\\_Plan\\_WRIA8Councilmeeting.pdf](http://www.govlink.org/watersheds/8/committees/1803/Bear_Creek_watershed_Plan_WRIA8Councilmeeting.pdf)

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
<b>PROJECT WEBPAGE UPDATES</b>					
Bear Creek Watershed Management Study project <a href="#">webpage</a> <sup>23</sup> populated and maintained	<ul style="list-style-type: none"> <li>• Update on process</li> <li>• Provide resources</li> </ul>	2015 and ongoing	All	n/a	n/a
Handouts, Notes and Presentations from <a href="#">Technical Webinar #1</a> <sup>24</sup> posted	<ul style="list-style-type: none"> <li>• Inform all on presentations shared at event</li> <li>• Submit for recordkeeping in KC TDRC library for future access</li> </ul>	11/15/2016	All	n/a	n/a
Handouts, Notes and Presentations from <a href="#">m Technical Webinar #2</a> <sup>25</sup> posted	As above	12/12/2016	All	n/a	n/a
Handouts, Notes and Presentations from <a href="#">Technical Workshop #1</a> <sup>26</sup> posted	As above	11/2015	All	n/a	n/a

<sup>23</sup> <http://www.kingcounty.gov/bearcreekstudy>

<sup>24</sup> <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx#workshopd>

<sup>25</sup> <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx#workshope>

<sup>26</sup> <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx#workshopa>

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
<b>PROJECT WEBPAGE UPDATES (continued)</b>					
Handouts, Notes and Presentations from <a href="#">Technical Workshop #2</a> <sup>27</sup> posted	<ul style="list-style-type: none"> <li>• Inform all on presentations shared at event</li> <li>• Submit for recordkeeping in KC TDRC library for future access</li> </ul>	3/29/2017	All	n/a	n/a
Handouts, Notes and Presentations from <a href="#">Public Meeting #1</a> <sup>28</sup> posted	As above	2/2016	All	n/a	n/a
Handouts, Notes and Presentations from <a href="#">Public Meeting #2</a> <sup>29</sup> posted	As above	10/2016	All	n/a	n/a
Handouts, Notes and Presentations from <a href="#">Public Meeting #3</a> <sup>30</sup> posted	As above	3/22/2018	All	n/a	n/a

<sup>27</sup> <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx#workshopf>

<sup>28</sup> <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx#workshopb>

<sup>29</sup> <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx#workshopc>

<sup>30</sup> <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx#workshopg>

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
<b>PROJECT WEBPAGE UPDATES (continued)</b>					
<a href="#"><u>Current Conditions reports</u></a> <sup>31</sup> posted	Update the public with posted reports: <ul style="list-style-type: none"> <li>• <a href="#"><u>Bear Creek Watershed-Scale Stormwater Plan: Existing Water Quality Conditions</u></a><sup>32</sup></li> <li>• <a href="#"><u>Analysis of Long-term Trends in Bear Creek Water Quality</u></a><sup>33</sup></li> <li>• <a href="#"><u>Assessment of Bear Creek Watershed Riparian Areas</u></a><sup>34</sup></li> <li>• <a href="#"><u>Assessment of Bear Creek Watershed Wetlands</u></a><sup>35</sup></li> <li>• <a href="#"><u>Bear Creek Watershed Juvenile Salmon Habitat Use</u></a><sup>36</sup></li> <li>• <a href="#"><u>Benthic Macroinvertebrate Status and Trends in the Bear Creek Study Area</u></a><sup>37</sup></li> <li>• <a href="#"><u>Stormwater Regulations and History Report</u></a><sup>38</sup></li> </ul>	5/2017 6/2017 10/2017	All	n/a	n/a

<sup>31</sup> <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx>

<sup>32</sup> <http://your.kingcounty.gov/dnrp/library/2017/kcr2874/kcr2873.pdf>

<sup>33</sup> <http://your.kingcounty.gov/dnrp/library/2017/kcr2875/kcr2874.pdf>

<sup>34</sup> <http://your.kingcounty.gov/dnrp/library/2017/kcr2876/kcr2875.pdf>

<sup>35</sup> <http://your.kingcounty.gov/dnrp/library/2017/kcr2876/kcr2876.pdf>

<sup>36</sup> <http://your.kingcounty.gov/dnrp/library/2017/kcr2877/kcr2877.pdf>

<sup>37</sup> <http://your.kingcounty.gov/dnrp/library/2017/kcr2878/kcr2878.pdf>

<sup>38</sup> <https://your.kingcounty.gov/dnrp/library/2017/kcr2937/kcr2937.pdf>



Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
<b>PROJECT WEBPAGE UPDATES (continued)</b>					
Draft Study posted	<ul style="list-style-type: none"> <li>• Provide draft Study for public review</li> <li>• Inform on upcoming Public Meeting 3 date and location, share agenda, related FAQ</li> <li>• Submit for recordkeeping in KC TDRC library for future access</li> </ul>	2/21/2018 - 4/4/2018	All	n/a	n/a
<a href="#">Final Study</a> <sup>39</sup> posted	<ul style="list-style-type: none"> <li>• Notify public of submitted Study</li> <li>• Submit for recordkeeping in KC TDRC library for future access.</li> </ul>	4/4/2018	All	n/a	n/a
<b>EMAIL CAMPAIGNS</b>					
KC employee email distribution list	Inform on Technical Workshop 2.	3/2017	KC employees	n/a	10,000 plus

<sup>39</sup> <https://www.kingcounty.gov/services/environment/watersheds/sammamish/bear-creek/bear-creek-stormwater-plan/documents.aspx>

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
<b>EMAIL CAMPAIGNS (continued)</b>					
Partners and stakeholders email list	Inform on project updates, meeting notifications, news items and other milestones through Save the Date, Invite and Reminder emails.	02/2016 10/2016 3/2017 4/2017 5/2017 2/15/2018 4/4/2018	Partners, stakeholders (Bear Creek residents, NGOs, tribes, state and local government)	n/a	160
KC DNRP Executive's Weekly Summary Report	Updates of significant milestones to the KC DNRP and WLRD management teams.	10/2016 11/2016 3/2017 2/13/2018 3/16/2018 4/3/2018	KC DNRP management team, WLRD staff	n/a	400 plus
<a href="http://www.kingcoconet.org/">KC EcoNet</a> <sup>40</sup> and STORM NET	As above	2/21/2018	Stakeholders that collaborate to improve environmental and community health	n/a	800 plus

<sup>40</sup> <http://www.kingcoconet.org/>

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
<b>HARD COPY DISTRIBUTION</b>					
Direct mailer " <a href="#">How healthy is Bear Creek?</a> " <sup>41</sup> and handout at Public Meeting 2	<ul style="list-style-type: none"> <li>• Inform on watershed planning process and provide resources for all interested parties</li> <li>• Given to City of Redmond and Woodinville for distribution</li> <li>• Provided at: Woodinville Library, Woodinville City Hall, Redmond City Hall, Maltby Community Club, Redmond Senior Center, Kiosk—Redmond Watershed, KC Trails, Paradise Valley Conservation Area, and Equestrian trails</li> <li>• Posted online</li> </ul>	9/26/2016 10/13/2016	Bear Creek residents and homeowners, Partners (for distribution within their communities)	n/a	11,039
<a href="#">Postcard mailer and "Save the Date" handout</a> <sup>42</sup> at Public Meeting 2	As above	As above	As above	n/a	As above

<sup>41</sup> <http://your.kingcounty.gov/dnrp/library/water-and-land/watersheds/sammamish/BC-Stormwater-Plan-related/BCP-Brochure.pdf>

<sup>42</sup> [https://your.kingcounty.gov/dnrp/library/water-and-land/watersheds/sammamish/BC-Stormwater-Plan-related/public2/BCP\\_Public-2\\_handout.pdf](https://your.kingcounty.gov/dnrp/library/water-and-land/watersheds/sammamish/BC-Stormwater-Plan-related/public2/BCP_Public-2_handout.pdf)

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
<b>HARD COPY DISTRIBUTION (continued)</b>					
Postcard mailer "Save the Date" for Public Meeting 3	<ul style="list-style-type: none"> <li>• Inform on Public Meeting information</li> <li>• Inform on public comment period</li> <li>• Inform on where to review draft Study and where to submit comments</li> </ul>	2/16/2018	Bear Creek residents and homeowners, Partners (for distribution within their communities)	n/a	11,366
Bear Creek Watershed Management <a href="#">Study Summary</a> <sup>43</sup>	Eight page summary of the Study shared with officials, public meeting attendees, and the online public	2/16/2018 3/7/2018	As above	n/a	100 plus
<b>PRINT ADS</b>					
Woodinville Weekly (English and Spanish) and posted in online newsletter	<ul style="list-style-type: none"> <li>• Posting relevant and interesting project updates/meeting notices</li> <li>• Broadcasting updates to website</li> </ul>	10/7/2016	All	n/a	22,537

<sup>43</sup> <https://your.kingcounty.gov/dnrp/library/2018/kcr2955.pdf>

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
<b>King County MEDIA RELEASE</b>					
KC DNRP Media Release (Spanish for the 2018 releases)	<ul style="list-style-type: none"> <li>• Posting relevant, and interesting project updates and meeting notices</li> <li>• Broadcasting updates to webpage</li> <li>• Encourage partners to reshare</li> <li>• Inform residents of upcoming events and deliverables</li> <li>• Notify through Redmond Reporter, Woodinville Weekly, Redmond Patch, Woodinville Patch, Seattle Times, Everett Herald, The Snohomish Tribune, City of Redmond, City of Woodinville, Snohomish County</li> </ul>	10/2016 <a href="#">2/21/2018</a> <sup>44</sup> <a href="#">3/6/2018</a> <sup>45</sup>	All	n/a	All
<b>King County ONLINE POSTINGS</b>					
KC Main page and events calendar	As above	2/21/2018	All	n/a	n/a
KC DNRP Green Blog	As above	<a href="#">10/10/2016</a> <sup>46</sup>	All	n/a	50 views

<sup>44</sup> <https://www.kingcounty.gov/depts/dnrp/newsroom/newsreleases/2018/February/21-Bear-Creek-watershed-plan.aspx>

<sup>45</sup> <https://www.kingcounty.gov/depts/dnrp/newsroom/newsreleases/2018/March/06-bear-creek-espanol.aspx>

<sup>46</sup> <https://kingcountygreen.com/2016/10/10/how-healthy-is-bear-creek-its-time-to-find-out/>



Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
<b>King County ONLINE POSTINGS (continued)</b>					
KC Main and DNRP Twitter " <a href="#">What's Up with Stormwater</a> " <sup>47</sup> (2016) page postings	As above	10/10/2016 <a href="#">2/21/2018</a> <sup>48</sup>	All	n/a	n/a
KC DNRP Facebook English pages	As above	<a href="#">10/13/2016</a> <sup>49</sup>	All	n/a	n/a
KC DNRP Facebook Spanish pages	As above	<a href="#">10/13/2016</a> <sup>50</sup>	All	n/a	n/a
Puget Sound Starts Here online posting	As above	<a href="#">3/6/2018</a> <sup>51</sup>	All	n/a	n/a
Unincorporated Areas (UA) Community News post	As above	<a href="#">10/2016</a> <sup>52</sup> <a href="#">11/2016</a> <sup>53</sup> <a href="#">2/16/2018</a> <sup>54</sup>	Bear Creek residents	n/a	n/a

<sup>47</sup> <https://twitter.com/KCDNR/status/785614255106043905>

<sup>48</sup> <https://twitter.com/KCDNR>

<sup>49</sup> <https://www.facebook.com/events/1260259020672096>

<sup>50</sup> <https://www.facebook.com/events/261898370878291/>

<sup>51</sup> <https://www.facebook.com/events/108969273246171/>

<sup>52</sup> <http://your.kingcounty.gov/dnrp/newsletters/ua-news-102016.htm>

<sup>53</sup> <http://your.kingcounty.gov/dnrp/newsletters/ua-news-112016.htm>

<sup>54</sup> <https://aqua.kingcounty.gov/dnrp/newsletters/ua-news.htm>

Elements	Purpose	Date	Audience	Summary of Feedback or Questions	# of Attendees or notices sent
<b>OTHERS ONLINE POSTINGS</b>					
City of Redmond "Focus on Redmond" article	As above	<a href="#">10/20/2016</a> <sup>55</sup>	Redmond residents	n/a	n/a
NextDoor calendar posting	Inform on date and location of Public Meeting 2	10/20/2016	Bear Creek residents	n/a	n/a
Woodinville Weekly calendar posting	As above	<a href="#">2/15/2016</a> <sup>56</sup> <a href="#">10/05/2016</a> <sup>57</sup> <a href="#">10/10/2016</a> <sup>58</sup> <a href="#">2/13/2017</a> <sup>59</sup> <a href="#">2/21/2018</a> <sup>60</sup>	Woodinville residents	n/a	200-2000 weekly
Woodinville Wire News calendar posting	As above	10/1/2016 <a href="#">2/21/2018</a> <sup>61</sup>	Woodinville residents	n/a	n/a

<sup>55</sup> <https://issuu.com/cityofredmond/docs/2016-fall-focus-web>

<sup>56</sup> <http://www.nwnnews.com/index.php/news-features/news-2/12644-learn-about-the-bear-creek-watershed-scale-stormwater-plan>

<sup>57</sup> <http://www.nwnnews.com/index.php/community/community-events/13710-bear-creek-watershed-water-quality-planning-public-meeting>

<sup>58</sup> <http://www.nwnnews.com/index.php/community/community-events/13722-community-meeting-oct-13-on-bear-creek-watershed-stormwater-plan>

<sup>59</sup> <http://www.nwnnews.com/index.php/news-features/news-2/14456-upper-bear-creek-community-council-public-forum>

<sup>60</sup> [http://nwnnews.com/index.php/community/events#/event/7018698-bear-creek-watershed-management-study-public-meeting?radius\\_miles=25&location=98072-woodinville&sections=all&date=2018-03-06](http://nwnnews.com/index.php/community/events#/event/7018698-bear-creek-watershed-management-study-public-meeting?radius_miles=25&location=98072-woodinville&sections=all&date=2018-03-06)

<sup>61</sup> [http://www.icontact-archive.com/OBEMGylzLCWqkIFL1bHj2u1\\_UNMkjiHs?w=3](http://www.icontact-archive.com/OBEMGylzLCWqkIFL1bHj2u1_UNMkjiHs?w=3)

# **APPENDIX F: Identified Structural Stormwater Strategies for Entire Study Area**

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## 1.0 INTRODUCTION

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The Permit-defined objective of watershed-scale stormwater planning is to identify a stormwater management strategy or strategies that would result in hydrologic and water quality conditions that fully support “existing uses,” and “designated uses,” as those terms are defined in WAC 173-201A-020, throughout the stream system. Poor water quality (temperature, dissolved oxygen, fecal coliform bacteria, turbidity, and toxicants) and altered hydrology in the Bear Creek study area are significant factors in causing the stream and its tributaries to not meet their designated uses (King County, 2017).<sup>1</sup> With the exception of temperature and dissolved oxygen, overall water quality in the Bear Creek watershed appears to be improving since the 1970s. Current fecal coliform concentrations indicate a potential risk to human health, but the concentrations have decreased over the past three decades. Temperature and dissolved oxygen levels are not conducive for salmonids (as represented by violations of the state water quality standards), and long-term trends have indicated that conditions have worsened over the past four decades. The average qualitative Benthic Index of Biotic Integrity (B-IBI) score in the study area is considered “fair.” The “flashiness” of a stream has been linked to poor macroinvertebrate health as measured by B-IBI. Both water quality and quantity concerns may be improved through stormwater management and treatment.

Stormwater best management practices (BMPs) include both low impact development (LID) type facilities, such as pervious pavement or bioretention systems, and more traditional facilities, such as stormwater detention and treatment. LID BMPs generally address stormwater impacts near the source, and traditional facilities are more regional in nature, serving larger areas further away from the source. The impacts of stormwater BMPs are most readily modeled and comprised the primary component of the SUSTAIN optimization model scenarios.

SUSTAIN optimization modeling was used to determine the number and type of structural strategies required to achieve instream targets (Table 7 in Section 2.2 of the main document) for water quality and flow metrics for all catchments (see King County [2018]<sup>2</sup> for a description of how the structural strategies were modeled). The structural stormwater strategies identified for the prioritized catchments and for the entirety of the study area are presented below.

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<sup>1</sup> King County. 2017. Bear Creek Watershed-scale Stormwater Plan: Existing Water Quality Conditions. Prepared by Timothy Clark and Eric Ferguson, Water and Land Resources Division. Seattle, WA.

<sup>2</sup> King County. 2018. Watershed Model Development for Bear Creek Stormwater Retrofit Planning Project. Prepared by Scott Miller and Jeff Burkey, Water and Land Resources Division. Seattle, WA.



## **2.0 IDENTIFIED STRUCTURAL STRATEGIES FOR THE ENTIRE STUDY AREA**

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The modeled stormwater solution to meet Permit-defined objectives in the entire study area is estimated to cost about \$1.11 billion dollars or an average of \$43 million per square mile (dollar amounts are non-discounted 2017 dollars). This includes all costs incurred by public institutions and private firms and individuals. Tables 1 through 4 summarize the identified number of BMPs by jurisdiction and individual catchment. Table 5 summarizes a more detailed cost for each jurisdiction by categorizing types of expenditures into capital dollars, operation and maintenance dollars, and replacement dollars accounting for end-of-life in terms of both publicly-incurred and privately-incurred.

The total estimated costs (non-discounted 2017 dollars) for all catchments by expenditure are:

- Capital - \$710 million
- O&M - \$248 million (\$5.4 million per year when all facilities are in-place)
- Replacement - \$173 million over the course of 100 years

The stormwater costs are further differentiated between assumed burdens between public (dollars collected via taxes and fees) and private (expenses paid for by development and property owner LID maintenance).

- Public expense - \$781 million
- Private expense - \$350 million

**Table 1. Summary of stormwater BMP type and storage identified by catchment for King County (Priority basins shown in bold).**

Catchment	Cost (\$M)		Area	Bioretention	Roadside Bioretention Ditch	Cistern	Permeable Pavement	Gravity Well	Infiltration Pond	Dry+Wet Pond	Wet pond
	Capital	O&M	(acres)	(inches of storage)				Units / acre	(inches of storage)		
BEA020	\$0.43	\$0.01	10.6	0.042	0.050	0.020	0.104	0.094	0.232	0.000	0.175
BEA030	\$5.48	\$0.07	135.3	0.047	0.023	0.015	0.110	0.118	0.128	0.132	0.124
BEA040	\$3.96	\$0.04	106.0	0.036	0.027	0.020	0.057	0.132	0.163	0.168	0.018
BEA050	\$4.96	\$0.07	147.7	0.010	0.060	0.013	0.123	0.183	0.000	0.040	0.151
BEA060	\$8.01	\$0.14	172.1	0.060	0.055	0.018	0.311	0.046	0.143	0.034	0.249
BEA070	\$1.81	\$0.04	45.6	0.114	0.050	0.014	0.181	0.110	0.054	0.000	0.041
BEA120	\$6.43	\$0.09	241.1	0.048	0.008	0.004	0.066	0.025	0.041	0.172	0.093
BEA130	\$2.81	\$0.05	60.9	0.086	0.055	0.018	0.172	0.164	0.041	0.000	0.183
BEA140	\$5.30	\$0.06	136.3	0.050	0.012	0.007	0.065	0.081	0.072	0.218	0.164
BEA150	\$3.03	\$0.03	119.1	0.030	0.009	0.008	0.051	0.059	0.041	0.149	0.094
BEA160	\$0.75	\$0.01	30.3	0.035	0.042	0.011	0.055	0.033	0.000	0.196	0.061
BEA170	\$4.64	\$0.06	129.3	0.031	0.031	0.018	0.162	0.093	0.134	0.046	0.158
BEA180	\$2.06	\$0.02	138.3	0.016	0.003	0.012	0.040	0.036	0.054	0.043	0.067
BEA200	\$13.88	\$0.18	321.0	0.033	0.025	0.018	0.256	0.022	0.100	0.314	0.133
BEA210	\$2.59	\$0.02	59.3	0.022	0.018	0.026	0.121	0.152	0.042	0.000	0.439
BEA220	\$0.96	\$0.02	196.5	0.009	0.007	0.031	0.003	0.010	0.000	0.030	0.000
BEA230	\$1.97	\$0.03	43.9	0.034	0.056	0.010	0.301	0.114	0.112	0.000	0.255
BEA240	\$5.68	\$0.11	99.8	0.061	0.096	0.023	0.309	0.040	0.025	0.416	0.149
BEA245	\$9.51	\$0.16	117.4	0.142	0.055	0.026	0.474	0.102	0.210	0.152	0.317
BEA250	\$43.42	\$0.59	493.3	0.011	0.096	0.017	0.768	0.187	0.000	0.505	0.336
BEA260	\$3.67	\$0.03	68.3	0.039	0.004	0.019	0.242	0.132	0.325	0.000	0.273
BEA270	\$2.21	\$0.02	115.5	0.014	0.015	0.021	0.038	0.078	0.021	0.051	0.097
BEA275	\$6.52	\$0.07	225.3	0.033	0.006	0.028	0.056	0.058	0.000	0.079	0.273
BEA280	\$7.90	\$0.14	125.5	0.152	0.026	0.006	0.198	0.056	0.216	0.236	0.119
BEA290	\$5.14	\$0.09	163.1	0.044	0.040	0.017	0.128	0.043	0.045	0.218	0.034

*APPENDIX F: Identified Structural Stormwater Strategies for Entire Study Area  
Bear Creek Watershed Management Study*

Catchment	Cost (\$M)		Area	Bioretention	Roadside Bioretention Ditch	Cistern	Permeable Pavement	Gravity Well	Infiltration Pond	Dry+Wet Pond	Wet pond
	Capital	O&M	(acres)	(inches of storage)				Units / acre	(inches of storage)		
BEA300	\$2.04	\$0.03	62.7	0.049	0.013	0.007	0.105	0.048	0.315	0.000	0.030
BEA310	\$2.11	\$0.03	131.0	0.022	0.011	0.017	0.029	0.069	0.038	0.000	0.071
BEA315	\$1.34	\$0.01	175.6	0.002	0.004	0.003	0.013	0.034	0.042	0.034	0.000
BEA320	\$0.62	\$0.01	212.0	0.006	0.001	0.001	0.023	0.005	0.000	0.000	0.018
BEA325	\$0.66	\$0.01	195.4	0.005	0.002	0.001	0.011	0.005	0.025	0.000	0.010
BEA330	\$1.57	\$0.01	99.7	0.002	0.005	0.007	0.111	0.040	0.000	0.060	0.112
BEA335	\$2.07	\$0.02	127.3	0.008	0.010	0.006	0.065	0.047	0.000	0.047	0.132
BEA350	\$22.39	\$0.21	543.1	0.022	0.028	0.008	0.056	0.096	0.127	0.262	0.158
BEA360	\$4.52	\$0.08	184.1	0.035	0.041	0.060	0.081	0.033	0.013	0.064	0.142
BEA370	\$6.81	\$0.05	213.9	0.019	0.007	0.015	0.095	0.192	0.035	0.111	0.044
BEA380	\$7.22	\$0.07	99.9	0.075	0.010	0.014	0.094	0.030	0.049	0.773	0.317
BEA390	\$9.22	\$0.08	140.8	0.057	0.013	0.018	0.145	0.206	0.105	0.253	0.357
BEA400	\$2.60	\$0.04	86.1	0.069	0.021	0.018	0.058	0.070	0.086	0.069	0.065
BEA410	\$0.41	\$0.01	21.7	0.074	0.002	0.020	0.101	0.000	0.000	0.000	0.086
BEA420	\$3.76	\$0.04	155.0	0.019	0.020	0.007	0.032	0.039	0.080	0.153	0.096
BEA430	\$3.59	\$0.11	653.5	0.009	0.023	0.012	0.013	0.005	0.008	0.027	0.000
BEA450	\$3.42	\$0.04	363.6	0.016	0.003	0.011	0.017	0.014	0.000	0.098	0.005
BEA460	\$4.63	\$0.06	232.2	0.010	0.013	0.030	0.107	0.017	0.000	0.128	0.128
BEA480	\$2.34	\$0.02	130.5	0.010	0.006	0.006	0.025	0.000	0.038	0.136	0.143
BEA490	\$3.55	\$0.06	355.7	0.022	0.006	0.015	0.022	0.031	0.021	0.000	0.037
BEA500	\$15.35	\$0.12	251.2	0.071	0.005	0.012	0.033	0.287	0.177	0.024	0.326
BEA510	\$7.31	\$0.05	145.1	0.050	0.005	0.015	0.027	0.276	0.051	0.082	0.257
BEA525	\$9.87	\$0.07	132.8	0.038	0.013	0.011	0.058	0.121	0.186	0.849	0.112
BEA530	\$14.25	\$0.18	366.1	0.045	0.026	0.003	0.075	0.022	0.088	0.324	0.137
BEA540	\$7.14	\$0.08	124.1	0.052	0.025	0.019	0.098	0.048	0.139	0.144	0.585
BEA550	\$5.57	\$0.10	178.9	0.088	0.011	0.024	0.062	0.017	0.055	0.133	0.094

APPENDIX F: Identified Structural Stormwater Strategies for Entire Study Area  
Bear Creek Watershed Management Study

Catchment	Cost (\$M)		Area	Bioretention	Roadside Bioretention Ditch	Cistern	Permeable Pavement	Gravity Well	Infiltration Pond	Dry+Wet Pond	Wet pond
	Capital	O&M	(acres)	(inches of storage)				Units / acre	(inches of storage)		
BEA570	\$19.45	\$0.15	298.3	0.040	0.012	0.025	0.098	0.194	0.240	0.099	0.474
BEA580	\$7.58	\$0.07	175.3	0.010	0.031	0.016	0.031	0.046	0.225	0.135	0.372
BEA590	\$6.98	\$0.04	223.0	0.011	0.003	0.004	0.040	0.143	0.088	0.027	0.225
BEA600	\$7.70	\$0.05	202.9	0.029	0.006	0.005	0.008	0.138	0.000	0.205	0.248
BEA700	\$13.23	\$0.20	236.9	0.110	0.020	0.032	0.228	0.097	0.208	0.125	0.126
BEA710	\$12.90	\$0.22	187.3	0.139	0.048	0.027	0.294	0.096	0.026	0.317	0.229
BEA720	\$3.49	\$0.04	83.3	0.047	0.038	0.035	0.060	0.096	0.059	0.285	0.112
BEA725	\$4.47	\$0.07	62.3	0.166	0.035	0.028	0.186	0.177	0.040	0.190	0.269
BEA730	\$20.00	\$0.21	342.0	0.073	0.014	0.012	0.058	0.091	0.036	0.503	0.234
BEA740	\$10.88	\$0.15	160.5	0.045	0.075	0.032	0.340	0.118	0.015	0.444	0.278
BEA760	\$6.70	\$0.08	242.0	0.019	0.024	0.040	0.127	0.074	0.020	0.049	0.192
BEA770	\$10.79	\$0.16	217.8	0.064	0.050	0.043	0.132	0.069	0.170	0.245	0.128
BEA780	\$11.18	\$0.14	130.8	0.113	0.037	0.024	0.248	0.107	0.264	0.363	0.398
BEA800	\$5.08	\$0.03	352.5	0.008	0.001	0.002	0.020	0.057	0.042	0.101	0.016
BEA820	\$7.58	\$0.08	248.6	0.048	0.003	0.003	0.013	0.048	0.030	0.119	0.247
BEA830	\$1.74	\$0.02	253.0	0.010	0.004	0.005	0.015	0.012	0.059	0.000	0.015

All costs are in 2017 dollars, no discount or inflation rate applied.

**Table 2. Summary of stormwater BMP type and storage identified by catchment for Snohomish County (priority basins shown in bold).**

Catchment	Cost (\$M)		Area	Bioretention	Roadside Bioretention Ditch	Cistern	Permeable Pavement	Gravity Well	Infiltration Pond	Dry+Wet Pond	Wet pond
	Capital	O&M	(acres)	(inches of storage)				Units / acre	(inches of storage)		
BEA610	\$4.17	\$0.02	212.9	0.013	0.005	0.003	0.021	0.160	0.023	0.028	0.017
BEA620	\$3.83	\$0.03	46.1	0.038	0.003	0.005	0.072	0.043	0.748	0.514	0.202
BEA625	\$3.88	\$0.02	103.5	0.009	0.002	0.005	0.016	0.135	0.024	0.401	0.072
BEA630	\$4.94	\$0.04	168.3	0.021	0.004	0.001	0.013	0.006	0.015	0.458	0.044
BEA640	\$2.32	\$0.01	55.2	0.009	0.005	0.008	0.020	0.145	0.313	0.215	0.034
BEA650	\$1.75	\$0.02	50.3	0.036	0.002	0.006	0.033	0.020	0.000	0.472	0.074
BEA660	\$16.81	\$0.09	1168.3	0.006	0.003	0.004	0.025	0.111	0.002	0.020	0.041
BEA665	\$3.03	\$0.03	184.8	0.027	0.001	0.003	0.009	0.016	0.000	0.161	0.060
BEA670	\$5.60	\$0.04	185.1	0.009	0.010	0.007	0.018	0.049	0.000	0.417	0.070
BEA690	\$4.18	\$0.02	175.6	0.005	0.007	0.001	0.047	0.159	0.042	0.068	0.053

All costs are in 2017 dollars, no discount or inflation rate applied.

**Table 3. Summary of stormwater BMP type and storage identified by catchment for Redmond (priority basin shown in bold).**

Catchment	Cost (\$M)		Area	Bioretention	Roadside Bioretention Ditch	Cistern	Permeable Pavement	Gravity Well	Infiltration Pond	Dry+Wet Pond	Wet pond
	Capital	O&M	(acres)	(inches of storage)				Units / acre	(inches of storage)		
BEA010	\$25.06	\$0.07	44.2	0.198	0.068	0.154	0.212	0.158	0.167	0.000	0.463
BEA080	\$26.80	\$0.08	69.0	0.018	0.077	0.094	0.663	0.188	0.215	0.602	0.135
BEA100	\$21.88	\$0.07	62.9	0.129	0.034	0.029	0.324	0.048	0.000	0.283	0.237
BEA110	\$2.44	\$0.00	64.1	0.001	0.000	0.007	0.000	0.437	0.000	0.000	0.000
BEA190	\$47.53	\$0.20	169.5	0.148	0.026	0.075	0.397	0.147	0.000	0.350	0.132
MON	\$73.90	\$0.09	358.8	0.001	0.016	0.000	0.000	0.020	0.000	0.827	0.000

All costs are in 2017 dollars, no discount or inflation rate applied.



**Table 4. Summary of stormwater BMP type and storage identified by catchment for Woodinville (priority basin shown in bold).**

	Cost (\$M)		Area	Bioretention	Roadside Bioretention Ditch	Cistern	Permeable Pavement	Gravity Well	Infiltration Pond	Dry+Wet Pond	Wet pond
Catchment	Capital	O&M	(acres)	(inches of storage)				Units / acre	(inches of storage)		
BEA840	\$3.87	\$0.06	255.1	0.034	0.003	0.010	0.035	0.024	0.068	0.047	0.022
BEA850	\$5.04	\$0.03	246.7	0.012	0.003	0.002	0.016	0.049	0.210	0.024	0.053
BEA860	\$6.21	\$0.05	242.0	0.018	0.010	0.003	0.041	0.066	0.173	0.123	0.023

All costs are in 2017 dollars, no discount or inflation rate applied.

**Table 5. Summary of stormwater structural costs for identified BMPs in the entire study area.**

Table 6: Summary of Stormwater Structural Costs for Identified DRI 6 in the Entire State						
Jurisdiction	Dollar Type	Source	Cost (\$M)			
			1-10 yrs	11-20 yrs	21-100 yrs	Total
King County	Capital	Private	\$0.5	\$3.5	\$27.8	\$31.8
		Public	\$7.9	\$45.3	\$362.2	\$415.4
	O & M	Private	\$0.2	\$1.8	\$135.5	\$137.5
		Public	\$0.1	\$0.7	\$69.7	\$70.4
	Replacement	Private	\$0.0	\$0.4	\$72.0	\$72.4
		Public	\$0.0	\$0.0	\$61.6	\$61.6
	Total Private		\$0.8	\$5.6	\$235.3	\$241.7
	Total Public		\$8.0	\$46.0	\$493.4	\$547.4
Snohomish County	Capital	Private	\$0.8	\$0.2	\$1.4	\$2.3
		Public	\$18.4	\$3.3	\$26.5	\$48.2
	O & M	Private	\$0.2	\$0.6	\$8.9	\$9.6
		Public	\$0.1	\$0.3	\$4.1	\$4.5
	Replacement	Private	\$0.0	\$0.5	\$3.7	\$4.2
		Public	\$0.0	\$0.0	\$17.1	\$17.1
	Total Private		\$0.9	\$1.2	\$14.0	\$16.2
	Total Public		\$18.4	\$3.6	\$47.8	\$69.8
Redmond	Capital	Private	\$54.5	\$1.0	\$7.7	\$63.2
		Public	\$19.4	\$12.8	\$102.2	\$134.4
	O & M	Private	\$0.0	\$0.2	\$13.4	\$13.7
		Public	\$0.1	\$0.3	\$5.6	\$6.0
	Replacement	Private	\$0.0	\$0.0	\$7.6	\$7.6
		Public	\$0.0	\$0.0	\$4.9	\$4.9
	Total Private		\$54.5	\$1.2	\$28.8	\$84.5
	Total Public		\$19.5	\$13.1	\$112.8	\$145.4
Woodinville	Capital	Private	\$0.3	\$0.0	\$0.3	\$0.6
		Public	\$4.8	\$1.1	\$8.7	\$14.5
	O & M	Private	\$0.0	\$0.2	\$4.3	\$4.6
		Public	\$0.0	\$0.1	\$1.6	\$1.7
	Replacement	Private	\$0.0	\$0.1	\$2.7	\$2.8
		Public	\$0.0	\$0.0	\$2.6	\$2.6
	Total Private		\$0.3	\$0.3	\$7.4	\$7.9
	Total Public		\$4.8	\$1.2	\$12.9	\$18.9
All Partners	Capital	Private	\$56.1	\$4.7	\$37.2	\$97.9
		Public	\$50.5	\$62.5	\$499.6	\$612.5
	O & M	Private	\$0.4	\$2.8	\$162.1	\$165.4
		Public	\$0.3	\$1.4	\$81.0	\$82.6
	Replacement	Private	\$0.0	\$1.0	\$86.0	\$87.0
		Public	\$0.0	\$0.0	\$86.2	\$86.2
	Total Private		\$56.5	\$8.3	\$285.5	\$350.3
	Total Public		\$50.7	\$63.8	\$666.9	\$781.4
Total		\$107.2	\$72.1	\$952.4	\$1,131.7	

All costs are in 2017 dollars, no discount or inflation rate applied.

# **APPENDIX G:**

## **Potential Strategy Implementation Schedule and Budget**

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## 1.0 INTRODUCTION

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The Study has identified a potential suite of strategies that if implemented are expected to result in achieving the targets for instream flow metrics and water quality as defined in the Permit. The Study has also identified several instream, riparian, and wetland habitat improvement strategies. The main body of the Study contains a schedule and cost estimates for potential near-term strategies. This appendix identifies the schedule and provides cost estimates for mid- and long-term strategies.

The schedule and budget below is organized by near-term, mid-term, and long-term actions within each of the partner jurisdictions. The identified suite of projects and programs in the Study, if fully implemented, are expansive and expensive. A 100-year horizon was selected in consideration of the financial and political feasibilities of the identified potential strategies. Yet, as the time horizon expands, so does uncertainty. New and improved technologies and techniques, shifting economic and political scenes, and changing individual behaviors and values are expected over a 100-year period. The long-term nature of the watershed management stresses the importance of adaptive management to better track, handle, and incorporate new information.

The first phase of the Study (first 10 years) initiates the non-structural programs expected to be maintained throughout the 100-year Study and, in many cases, beyond. The near-term phase also includes the many structural elements: stormwater control projects in the identified high priority catchments and habitat restoration projects throughout the watershed. Development and implementation of a monitoring program, a fecal bacteria source control study, an agricultural BMP assessment, and a flow-transfer feasibility study are also recommended for the near-term.

The mid-term phase (year 11 to 20) includes implementation of many of the structural strategies identified, as well as continuation of the non-structural strategies initiated in the near-term. The long-term phase (year 21 to 100) includes maintenance and enhancement of non-structural strategies and continued structural strategy construction as funding allows. Monitoring, evaluation, and strategy adaption are integrated throughout all phases of implementation.

The budgets detailed in this appendix represent costs associated with projects and programs in addition to those already in place. This is useful for defining the level of additional funding that would be needed if projects and programs were fully implemented to meet watershed goals.

The metric targets are expected to be achieved following the full implementation of the strategies identified in the Study (Table 1). Model output indicates that the targets for dissolved copper and zinc are met under with or without Study implementation, with the exception of one model domain for copper during one year where multiple exceedances were simulated. Construction of the structural stormwater strategies detailed in Section 4.3 is expected to result in meeting the B-IBI target. Riparian tree planting, as identified in

Section 7.3 and in the modeling report, is not expected to result in meeting the temperature target. Temperatures were found to exceed standards under the future mitigated and the fully forested scenarios, even with the adjustment for microclimate cooling. Tree shading, however, will provide substantial shading and result in colder water temperatures and is a recommended strategy.

Bacteria concentrations are extremely variable and difficult to predict. The calibration of the watershed model resulted in general agreement between the observed and simulated concentrations, although with a low bias. Under both the future built-out and the mitigated scenarios, water quality standards were not exceeded based on modeled results (i.e., less than 10 percent of the samples were above 100 CFU/100 mL and a geometric mean under 50 CFU/100 mL). However, given the known underestimation of the model and the number of the simulated storm events resulting in fecal coliform levels over 100 CFU/100 mL, the project team predicts, in spite of modeled results, that water quality standards will not be met in the future without mitigation. The Study recommends the non-structural source control strategy as defined in Section 4.4. The source control strategy is expected to result in more cost-effective and earlier mitigation than expected with future build-out and built stormwater infrastructure controls.

**Table 1. Achievement of modeled metrics targeted with and without Study implementation.**

Parameter	Future Build-out Under Current Code	Future Build-out with Study Implementation
Dissolved Copper	NO*	YES
Dissolved Zinc	YES	YES
Temperature	NO	NO**
Fecal Coliform	NO***	YES***
B-IBI	NO	YES

\*Copper exceeded in one model domain over the course of one modeled year multiple times.

\*\*Temperature exceeds thresholds under fully forested conditions and with consideration of microclimate cooling.

\*\*\*Fecal coliform levels are expected to exceed standards without implementation of a source control program in addition to stormwater mitigation.

To meet the Permit-defined modeled targets, the analysis shows Partners could implement the identified structural stormwater strategies and the identified pollution source control nonstructural strategies. While not expected to result in full compliance with the water quality standards for temperature, temperature issues would be alleviated by planting the riparian area to at least a 65-foot buffer, totaling about 600 acres of new plantings on top of what identified in Section 7.3. Planting 600 acres is estimated to cost \$18.3 million without consideration of land acquisition or easement costs.

Instream habitat, 165-foot riparian corridor, and wetland restoration and preservation strategies would not affect the achievement of Permit-defined targets. These strategies



were not part of the modeled solutions needed to meet the NPDES permit targets. These strategies, however, are expected to result in the achievement of the watershed goals defined in Chapter 2 and the support the designated and existing uses of Bear Creek.

## 2.0 POTENTIAL SCHEDULE FOR SELECTED STRATEGIES

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The identified schedule and cost for implementing the Study is summarized in Tables 2 to 5 for the respective partner jurisdictions: King County, Snohomish County, City of Redmond, and City of Woodinville.

In the mid-term phase (year 11-20), King County may focus on coordinating the implementation of projects associated with the prioritized stormwater catchments, instream habitat, riparian, and wetland projects. The remaining three prioritized stormwater catchments may be completed in the mid-term. Ten percent of the higher priority instream habitat projects may be completed. King County may plant trees on remaining half (50 percent) of the prioritized riparian corridors located on public land during the mid-term.

During the mid-term phase, the Snohomish County, Redmond, and Woodinville may continue focusing on the prioritized catchments (see Chapter 4 and *Appendix A: Prioritization: Water Quality and Quantity Strategies*) that total to approximately 10 percent of the total cost estimate for stormwater. The cities of Redmond and Woodinville may implement their tree planting incentive program, focusing on riparian corridors.

In the long-term phase (year 21-100), jurisdictions may continue to implement the programs initiated in the near-term, revising them as appropriate through adaptive management. The Study is expected to be notably different by the end of the proposed timeline from its initial conception. Incorporation of new technologies, new monitoring data, and changes in watershed goals are recommended as the Study is adaptively managed. The emphasis will be to ensure it is effective.

**Table 2. King County Watershed Study potential implementation schedule.**

Category	Description	Near-term Action (Years 1-10)	Mid-term action (Years 11-20)	Long-term action (Beyond 20)
Program	Public Engagement/ Education Program	Develop Public Engagement/ Education Program	Implement public engagement and education	
		<b>\$100,000 over 2 years</b>	<b>\$50,000/year</b>	<b>\$50,000/year</b>
	LID Incentive Program	Develop LID Incentive Program	Install LIDs on participating private properties	
		<b>\$100,000 over 2 years to develop \$2M/year over 5 years to implement</b>	<b>\$9M/year</b>	<b>\$9M/year</b>
	In-lieu fee Program	Develop In-lieu fee Program	Direct in-lieu fees to high priority projects	
		<b>\$100,000 over 2 years</b>	<b>No Cost</b>	<b>No Cost</b>
	Monitoring and Assessment Management Plan	Develop Monitoring Plan	Monitor and evaluate results	
		<b>\$50,000 over 2 years</b>	<b>\$100,000/year</b>	<b>\$100,000/year</b>
	Tree Planting Incentive Program	Tree Planting Incentive Program	Plant trees on willing private property	
		<b>\$50,000 over 2 years</b>	<b>\$50,000/year</b>	<b>\$50,000/year</b>
	Fish Passage Study	Complete Inventory of Fish Barriers		
		<b>\$100,000 over 2 years</b>		
Structural Projects	Construct Stormwater Facilities	Build new facilities in priority catchments	Build new facilities in priority catchments	Build new facilities in remaining catchments
		<b>\$846,000/year</b>	<b>\$4.9M/year</b>	<b>\$4.9M/year</b>
	Evaluate and Optimize Existing Stormwater Facilities	Evaluate/optimize in priority catchments	Evaluate/optimize in priority catchments	
		<b>No Additional Cost</b>	<b>No Additional Cost</b>	

Category	Description	Near-term Action (Years 1-10)	Mid-term action (Years 11-20)	Long-term action (Beyond 20)
	Instream Habitat Projects	Construct high priority projects	Construct high priority projects	Construct remaining priority projects
		<b>\$343,000/year over 5 years</b>	<b>\$386,000/year</b>	<b>\$394,000/year</b>
	Remove Fish Passage Barriers		Remove priority barriers	Remove remaining barriers
			<b>\$50,000/year</b>	<b>\$50,000/year</b>
	Riparian Restoration	Acquire/ease and preserve high priority areas		
		<b>\$91,000/year over 5 years</b>	<b>\$235,000/year</b>	<b>\$235,000/year</b>
	Wetland Restoration	Acquire/ease and preserve high priority areas		
		<b>\$19,000/year over 5 years</b>	<b>\$32,000/year</b>	<b>\$32,000/year</b>
Studies, Analyses	Flow Transfer Program (Done in First 5 Years)	Study program feasibility		
		<b>\$50,000 over 2 years</b>		
	Agricultural BMP Program	Assess existing regulation and incentive programs		
		<b>\$50,000 over 2 years</b>		
	Fecal Bacteria Source Tracking Study	Follow-up IDDE work for TMDL by King County SWS		
		<b>\$60,000/year over 5 years</b>		
Watershed Coordination and Strategy Administration	Program Management	Watershed Coordinator holds Committee meetings, prepares reports, oversees grants, and supervises staff		
		<b>\$30,000/year</b>	<b>\$30,000/year</b>	<b>\$30,000/year</b>
	Update Watershed Study	Update every 10 Years		
		<b>\$200,000</b>	<b>\$200,000</b>	<b>\$200,000</b>

All costs are in 2017 dollars, no discount or inflation rate applied.

**Table 3. Snohomish County Watershed Study potential implementation schedule.**

Category	Description	Near-term Action	Mid-term action	Long-term action
Structural Projects	Construct Stormwater Facilities	Build new facilities in priority catchments		
		<b>\$1.9M / year</b>	<b>\$349,000 / year</b>	<b>\$349,000 / year</b>
Studies and Analyses	MAMP (or equivalent)	Monitor and Evaluate Results		
		<b>\$9,000 / year last 5 years</b>	<b>\$9,000 / year</b>	<b>\$9,000 / year</b>
Watershed Coordination and Strategy Administration	Watershed Committee Participation	Participate in bi-annual watershed committee coordination meetings		
		<b>\$10,000 / year</b>	<b>\$10,000 / year</b>	<b>\$10,000 / year</b>
	Update Watershed Study	Update every 10 Years		
		<b>\$9,000</b>	<b>\$9,000</b>	<b>\$9,000</b>

All costs are in 2017 dollars, no discount or inflation rate applied.

**Table 4. City of Redmond Watershed Study potential implementation schedule.**

Category	Description	Near-term Action	Mid-term action	Long-term action
Structural Projects	Construct Stormwater Facilities	Complete Monticello Creek Restoration Plan	Build new facilities in priority catchments	
		<b>\$7.3M / year</b>	<b>\$1.4M / year</b>	<b>\$1.4M / year</b>
Implement Programs	Tree Planting Program	Plant trees on willing private property		
		<b>\$7,000 / year</b>	<b>\$16,000 / year</b>	<b>\$16,000 / year</b>
Studies and Analyses	MAMP (or equivalent)	Monitor and Evaluate Results		
		<b>\$10,000 / year (last 5 years)</b>	<b>\$10,000 / year</b>	<b>\$10,000 / year</b>
Watershed Coordination and Strategy Administration	Watershed Committee	Participate in bi-annual watershed committee coordination meetings		
		<b>\$10,000 / year</b>	<b>\$10,000 / year</b>	<b>\$10,000 / year</b>
	Update Watershed Study	Update every 10 Years		
		<b>\$10,000</b>	<b>\$10,000</b>	<b>\$10,000</b>

All costs are in 2017 dollars, no discount or inflation rate applied.

**Table 5. City of Woodinville Watershed Study potential implementation schedule.**

Category	Description	Near-term Action	Mid-term action	Long-term action
Structural Projects	Construct Stormwater Facilities	Build new facilities in priority catchments		
		<b>\$500,000 / year</b>	<b>\$112,000 / year</b>	<b>\$112,000 / year</b>
	Tree Planting Incentive Program	Program Development	Plant trees on willing private property	
		<b>\$19,000 / year last 5 years</b>	<b>\$5,100 / year</b>	<b>\$5,100 / year</b>
Studies and Analyses	MAMP (or equivalent)	Monitor and Evaluate Results		
		<b>\$6,000 / year</b>	<b>\$6,000 / year</b>	<b>\$6,000 / year</b>
Watershed Coordination and Strategy Administration	Watershed Committee	Participate in bi-annual watershed committee coordination meetings		
		<b>\$10,000 / year</b>	<b>\$10,000 / year</b>	<b>\$10,000 / year</b>
	Update Watershed Study	Update every 10 Years		
		<b>\$6,000 / year</b>	<b>\$6,000 / year</b>	<b>\$6,000 / year</b>

All costs are in 2017 dollars, no discount or inflation rate applied.



### 3.0 SUMMARY OF ESTIMATED COSTS FOR FULL IMPLEMENTATION OF SELECTED STRATEGIES

Table 6 summarizes the estimated costs of the Study's elements during the different phases of the Study if the recommendations were fully implemented. Cost estimates are based on based on the best available information for instream habitat project costs (\$3M per mile), tree planting costs (\$30K per acre), stormwater structural strategy (construction, maintenance, and replacement) costs, property acquisition costs, and program management costs.

Table 6. Watershed Study budget summary.

Jurisdiction	Expense Type	Cost Incurred by Juris. or Private Indiv./Entity	Near-Term Actions (\$M)	Mid-term Actions (\$M)	Long-term Actions (\$M)	Total Watershed Study (\$M)	
			Year	Year	Year	Year	
			10-Jan	20-Nov	21-100	1-100	
King County	Capital	Private	\$0.55	\$3.48	\$27.81	\$31.83	
		Public	\$7.91	\$45.28	\$362.21	\$415.40	
	O & M	Private	\$0.23	\$1.76	\$135.47	\$137.46	
		Public	\$0.09	\$1.04	\$100.06	\$101.20	
	Replacement	Private	\$0.00	\$0.36	\$72.03	\$72.39	
		Public	\$0.00	\$0.00	\$61.55	\$61.55	
	Habitat	Public	\$3.22	\$7.54	\$60.96	\$71.72	
	Programs		\$2.57	\$2.46	\$19.20	\$24.23	
	Studies		\$1.05	\$1.00	\$8.00	\$10.05	
	Acquisitions		\$8.39	\$26.51	\$218.86	\$253.75	
	Total Private		\$0.78	\$5.60	\$235.31	\$241.68	
	Total Public		\$23.23	\$83.83	\$830.83	\$937.90	
Snohomish County	Capital	Private	\$0.76	\$0.17	\$1.37	\$2.31	
		Public	\$18.36	\$3.32	\$26.52	\$48.20	
	O & M	Private	\$0.16	\$0.59	\$8.90	\$9.65	
		Public	\$0.12	\$0.44	\$8.18	\$8.74	
	Replacement	Private	\$0.00	\$0.48	\$3.73	\$4.21	
		Public	\$0.00	\$0.00	\$17.12	\$17.12	
	Habitat	Public	\$1.32	\$0.41	\$3.32	\$5.05	
	Programs		\$0.11	\$0.11	\$0.87	\$1.09	
	Acquisitions		\$9.22	\$0.88	\$7.06	\$17.17	
	Total Private		\$0.93	\$1.24	\$14.00	\$16.16	
	Total Public		\$29.13	\$5.17	\$63.08	\$97.38	
Redmond	Capital	Private	\$54.34	\$1.09	\$7.74	\$63.17	

*APPENDIX G: Potential Strategy Implementation Schedule and Budget  
Bear Creek Watershed Management Study*

Jurisdiction	Expense Type	Cost Incurred by Juris. or Private Indiv./Entity	Near-Term Actions (\$M)	Mid-term Actions (\$M)	Long-term Actions (\$M)	Total Watershed Study (\$M)	
			Year	Year	Year	Year	
			10-Jan	20-Nov	21-100	1-100	
	O & M	Public	\$19.44	\$12.78	\$102.22	\$134.44	
		Private	\$0.16	\$0.64	\$17.10	\$17.89	
		Public	\$0.10	\$0.39	\$7.69	\$8.18	
	Replacement	Private	\$0.00	\$0.00	\$7.65	\$7.65	
		Public	\$0.00	\$0.00	\$4.93	\$4.93	
	Habitat	Public	\$0.05	\$0.17	\$1.37	\$1.59	
	Programs		\$0.16	\$0.21	\$1.68	\$2.05	
	Acquisitions		\$0.00	\$3.50	\$27.99	\$31.48	
	Total Private		\$54.50	\$1.72	\$32.49	\$88.71	
	Total Public		\$19.76	\$17.04	\$145.88	\$182.68	
	Woodinville	Capital	Private	\$0.25	\$0.04	\$0.30	\$0.59
			Public	\$4.79	\$1.08	\$8.66	\$14.54
		O & M	Private	\$0.04	\$0.18	\$4.35	\$4.57
Public			\$0.05	\$0.19	\$3.12	\$3.36	
Replacement		Private	\$0.00	\$0.06	\$2.72	\$2.78	
		Public	\$0.00	\$0.00	\$2.60	\$2.60	
Habitat		Public	\$0.09	\$0.07	\$0.57	\$0.73	
Programs			\$0.34	\$0.17	\$1.33	\$1.83	
Acquisitions			\$4.06	\$1.41	\$11.26	\$16.73	
Total Private		\$0.30	\$0.28	\$7.36	\$7.94		
Total Public		\$9.33	\$2.92	\$27.53	\$39.78		
ALL PARTNERS	Capital	Private	\$55.91	\$4.77	\$37.22	\$97.90	
		Public	\$50.51	\$62.45	\$499.61	\$612.57	
	O & M	Private	\$0.60	\$3.16	\$165.80	\$169.56	
		Public	\$0.36	\$2.06	\$119.05	\$121.48	
	Replacement	Private	\$0.00	\$0.90	\$86.13	\$87.03	
		Public	\$0.00	\$0.00	\$86.21	\$86.21	
	Habitat	Public	\$4.69	\$8.20	\$66.21	\$79.10	
	Programs		\$3.18	\$2.95	\$23.08	\$29.20	
	Studies		\$1.05	\$1.00	\$8.00	\$10.05	
	Acquisitions		\$21.66	\$32.30	\$265.17	\$319.13	
	Total Private		\$56.50	\$8.83	\$289.15	\$354.49	
	Total Public		\$81.45	\$108.96	\$1,067.33	\$1,257.74	

Public: Cost incurred by public institutions

Private: Cost incurred by private developers, firms, or individuals

All costs are in 2017 dollars, no discount or inflation rate applied.

# **APPENDIX H:**

## **Permit Crosswalk**

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**Table H-1. Permit requirements crosswalk.**

Permit Reference Number	Permit Requirement	How Addressed	Document(s) Location
S5.C.5.c.iv.(1)	An assessment of existing hydrologic, biologic, and water quality conditions and an assessment of the current status of the aquatic community in the study area.	King County met this requirement with is review of data; stormwater quality sampling of base flows and storm flows; continuous flow monitoring; macroinvertebrate data collection for the purposes of estimated current B-IBI scores, assessed the aquatic community conditions, assessed riparian corridor conditions, and assessed wetland conditions.	Summarized in Chapter 3 of this Study  King County, 2017b King County, 2017c King County, 2017d King County, 2017e
S5.C.5.c.iv.(2)	A compilation and/or generation of maps of the study area to identify the existing distribution and totals of general soil types, vegetative land cover, impervious land covers, MS4s and non-regulated public stormwater systems (if applicable). Maps shall be sufficient to allow construction of a rainfall/runoff model representation of the study area. Maps must also identify areas within the study area appropriate for special attention in regard to hydrologic and water quality impacts.	King County met this requirement with its development and/or updating of existing maps to support hydrologic/hydraulic and water quality modeling of the study area.	King County, 2018
S5.C.5.c.iv.(3)	Permittee shall use the existing conditions assessment in S5.C.5.c.iv.(1) and the maps described in S5.C.5.c.iv.(2), and calibrate a continuous runoff model to reflect the existing hydrologic, water quality, and biologic (as represented by B-IBI score) conditions.	King County met this requirement with its development of a HSPF continuous hydrologic model that was calibrated to existing conditions.	King County, 2018

Permit Reference Number	Permit Requirement	How Addressed	Document(s) Location
S5.C.5.c.iv.(4)	Permittee shall use the calibrated model to estimate hydrologic changes from the historic condition; predict the future hydrologic, biologic, and water quality conditions at full build-out under the existing comprehensive land use management plan for the study area.	King County met this requirement with its use of the calibrated HSPF model to estimate changes in hydrologic conditions, B-IBI scores, and water quality concentration of the pollutant parameters listed in the Permit between historical forested conditions and future land use conditions. Future land use development was assumed to include stormwater mitigation BMPs meeting current standards. B-IBI correlation evaluation was conducted and DeGasperi metrics were used based on WRIA 8 dataset.	King County, 2018
S5.C.5.c.iv.(5)	If the estimation in S5.C.5.c.iv.(4) predicts water quality standards will not be met, the Permittee shall use the calibrated watershed model to evaluate stormwater management strategies to meet the standards.	King County met this requirement with its use of the calibrated HSPF model in combination with a SUSTAIN model, to evaluate a combination of structural and non-structural measures that if implemented were projected to meet water quality standards for bacteria, copper, zinc and turbidity. Even under modeled fully forested conditions, exceedances of the temperature standards were observed.	King County, 2018
S5.C.5.c.iv.(5) continued	Stormwater Strategies to be evaluated must include: • Changes to development-related codes, rules, standards, and plans	King County met this requirement with its evaluation of future (2050) land use development and evaluation of limiting the impervious area on developed lands. King County also evaluated strategies for implementing changes to exemption requirements, raising LID standards, and instating an in-lieu fee program.	Chapter 4 of this Plan and King County, 2018.
S5.C.5.c.iv.(5) continued	Stormwater Strategies to be evaluated must include: • Potential future structural stormwater control projects	King County met this requirement with its evaluation of strategies for implementing potential future structural control projects. SUSTAIN was used in combination with the calibrated HSPF model to optimize combinations of structural projects.	Chapter 4 of this Study.
S5.C.5.c.iv.(6)	An implementation plan and schedule, including: potential future actions to implement the identified stormwater management strategies, responsible parties, estimated costs, and potential funding mechanisms.	King County met this requirement in this Watershed Management Plan, which includes a implementation plan and schedule with the required elements: potential future action to implement the identified stormwater management strategies, responsible parties, estimated costs, and potential funding mechanisms. Also an adaptive management strategy is defined to guide implementation of the potential future actions under the proposed implementation plan.	Chapters 11 and 12 and Appendix G of this Study.



<b>Permit Reference Number</b>	<b>Permit Requirement</b>	<b>How Addressed</b>	<b>Document(s) Location</b>
S5.C.5.c.iv.(7)	A public review and comment process, at a minimum, focused on the draft watershed-scale stormwater plan. The public review must allow for public comment from all governmental entities with jurisdiction within the study area.	King County met this requirement with its planning process, which has included ongoing coordination with a technical stakeholder group, the Muckleshoot Indian Tribe, and members of the public. A public comment period was held from January 24 to February 14, 2018.	The public outreach process is summarized in Section 1.4 and Appendix E.
S5.C.5.c.v	The watershed-scale stormwater planning process, as documented in the scope of work and schedule, may include an evaluation of strategies to preserve or improve other factors that influence maintenance of the existing and designated uses of the stream.	King County has included several evaluations of current conditions and potential strategies to improve riparian, wetland, and instream habitat that are expected to influence maintenance of the existing and designated uses of Bear Creek.	King County, 2017c King County, 2017d King County, 2017e Chapters 4, 5, 6, 7, and 8 of this Study.

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## **APPENDIX I: Snohomish County Comments**

*The Coordination Plan developed by King County, Snohomish County, City of Redmond, City of Woodinville, and the Washington State Department of Transportation, requires that, if requested by a non-lead Permittee, King County will include additional information, dissenting opinions, conclusions, and/or alternative approaches submitted to King County by non-lead Permittees as appendices. Snohomish County has requested to submit this appendix to the Bear Creek Watershed Management Study.*

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## **Bear Creek Watershed Management Study – Snohomish County Comments**

### **Background of this Appendix**

This Appendix was prepared by Snohomish County as part of its participation in the Bear Creek Watershed Management Study, in accordance with the Coordination Plan for the project that was adopted by all project partners.

This project was groundbreaking in its level of detail and technical specifications. All project partners understood from the outset that we needed an efficient decision-making process to complete the project on the tight schedule imposed by the NPDES Phase I municipal stormwater permit (the Permit). We also realized that there were going to be many important technical, planning, and policy issues on which reaching consensus would be at best a very slow process. At the same time, each project partner had to stand behind the final product as its own submittal to Ecology to satisfy its Permit requirement.

To meet all these constraints, the partners agreed, through the Coordination Plan, that King County would consider all input and comments provided by project partners, but that King County had “final and unilateral authority on decisions regarding implementation of the Scope of Work for the Bear Creek Watershed-Scale Stormwater Plan.” In exchange for this authority, King County would “include additional information, dissenting opinions, conclusions, and/or alternative approaches submitted to King County by non-lead Permittees as an appendix or appendices to the final watershed plan.”

### **Relationship of Permit requirement for watershed-scale stormwater planning to requirements for Structural Stormwater Controls Program (Permit Special Condition S5.C.6)**

The 2013 Permit requirement for watershed-scale stormwater planning (Special Condition S5.C.5.c) is discussed in detail in the main body of this study. It is important to note that this Permit requirement derived from a previously existing Permit requirement: Special Condition S5.C.6 - Structural Stormwater Controls. This condition has appeared in continually refined forms in the 1995, 2007, and 2013 Permits. As currently set forth in the 2013 permit, its objective is to prevent or reduce impacts to waters of the state caused by discharges from the municipal separate storm sewer system (MS4), with the goal of addressing impacts that are not adequately controlled by the other required actions of the Stormwater Management Program (Special Conditions S5.C.1 – S5.C.5 and S5.C.7 – S5.C.10).

Under Special Condition S5.C.6 as it is written in the 2007 and 2013 Permits, a permittee is required to develop a list of projects that meet certain criteria, and report each year on the status of implementing those projects. However, these Permits did not establish a metric by which compliance would be measured, let alone establish a quantified minimum level of effort in terms of that metric. The watershed-scale stormwater planning under 2013 Permit Special Condition S5.C.5.c was created by Ecology as an initial means to determine the total level of Structural Stormwater Controls Program effort required in a watershed to meet, under future build-out conditions, water quality standards in the receiving water for

dissolved copper, dissolved zinc, temperature, and fecal coliform, and B-IBI scores that correlate to hydrologic metrics representing “the historic condition” in the watershed.

### **Snohomish County comments on the Bear Creek Watershed Management Study**

Determining actions needed for NPDES Structural Stormwater Controls Program. As noted in the main body of the report, King County added some additional goals to the project beyond those set forth in the 2013 Permit, primarily restoration of salmonid habitat and wetland restoration / protection. These goals are reflected in the recommended actions. However, King County did not identify the subset of those actions that constitute the minimum needed to meet the environmental targets set forth in the 2013 Permit. This is not a flaw in the study results, but it adds a necessary additional step if one wanted to use the study to determine a long-term Structural Stormwater Controls Program for the Bear Creek watershed that would meet future iterations of Permit Special Condition S5.C.6.

### **Issues for use of questions for future consideration**

Applicability of study results to other watersheds. The watershed-scale stormwater plans produced for Bear Creek and Little Bear Creek each cost over \$3M, required thousands of staff hours, and took over 3 years to complete. Snohomish County has well over a dozen watersheds that are similar to the watersheds studied. A key question since the outset has been “how applicable are such study results to other watersheds with similar characteristics?” Determining those results (and study methods) that are applicable among watersheds will save huge amounts of money and will accelerate the pace of watershed protection. A critical next step in the realm of watershed-scale stormwater planning is to determine those issues for which results from one watershed can be applied to other watersheds. As noted above, if one wanted to determine applicability of the Bear Creek Study to other watersheds vis a vis requirements of the NPDES Permit, one would first have to determine the set of study results and recommendations required for Permit compliance in the Bear Creek watershed.