JUNE 2020

NATURAL INFRASTRUCTURE ASSESSMENT

CITY OF SNOQUALMIE

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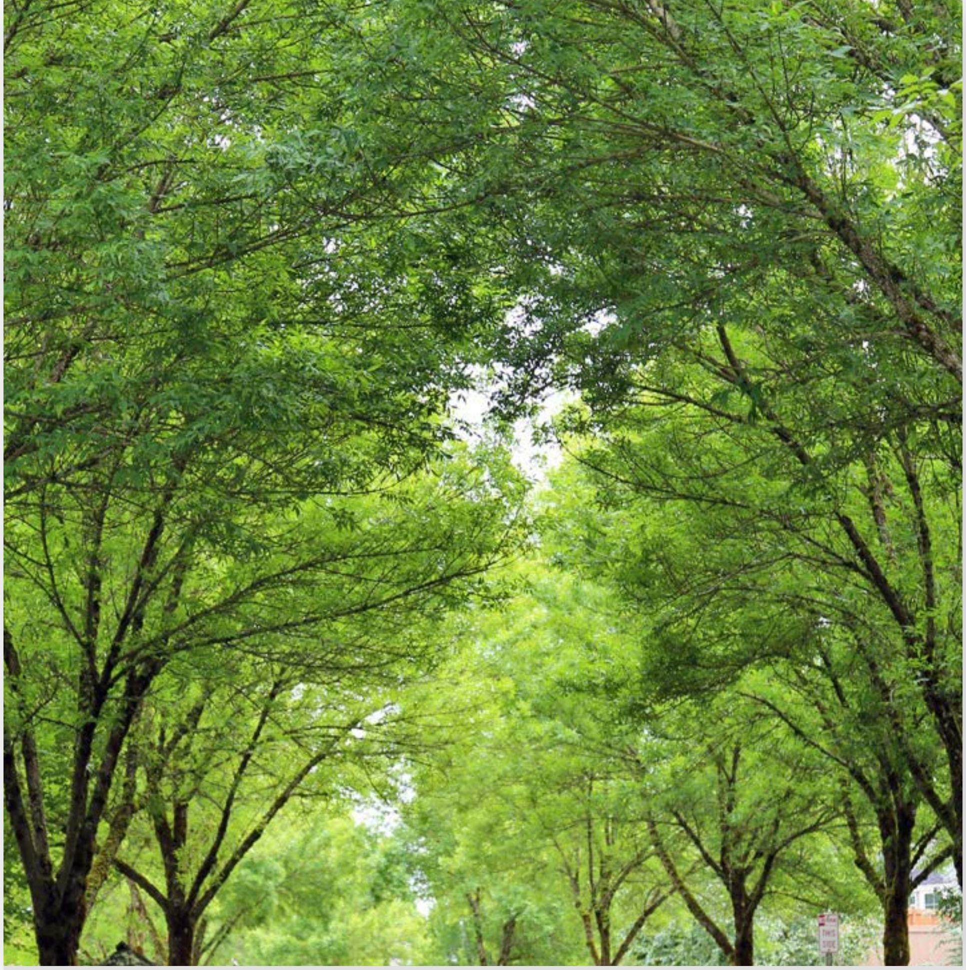
Prefered Citation:
City of Snoqualmie , Natural Infrastructure Assessment, 2020



ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

VALUING SNOQUALMIE'S NATURAL INFRASTRUCTURE

The Snoqualmie Natural Infrastructure Assessment establishes the stormwater retention, water quality and climate stability values of Snoqualmie's urban forest. Using geographically referenced land cover and a proven Ecosystem Service Valuation method, this assessment analyzes the natural infrastructure benefits delivered by the City's urban forest to the community at-large. Recommendations and resources are also provided. This assessment supports sustainable program development and improvements to the City's overall environmental and human health.

Urban forests provide extensive infrastructure benefits, which are often unvalued. This Assessment provides data to inform land managers and City leadership on the value, effective management and funding for maintaining and enhancing the City's urban forest resource. Assessment results focus on the substantial extent and value of Snoqualmie's natural infrastructure:

1. Snoqualmie's public forest resources encompass over 70% of the City's total owned lands.
2. City forest resources provide ecosystem services that return benefits to the environment and health of the residents who live in and around Snoqualmie.
3. Three key ecosystem services are evaluated through this assessment. Results show that public forests in the City generate a range of approximately $5.8 million (M) to $7.3M in evaluated goods and services each year.

TOTAL ANNUAL VALUE OF ECOSYSTEM SERVICES PROVIDED BY THE CITY-OWNED PORTION OF SNOQUALMIE'S URBAN FOREST:

Ecosystem Service	Low	High
Stormwater Retention	$5,760,484	$7,079,149
Carbon Sequestration	$45,820	$81,213
Water Quality	$57,472	$147,305
Total	**$5,863,776**	**$7,307,668**

+70%

OF CITY OWNED LANDS ARE FOREST

$5.8M TO $7.3M

ANNUAL DOLLAR VALUE (IN MILLIONS) OF EVALUATED GOODS AND SERVICES GENERATED BY PUBLIC FORESTS

NATURAL INFRASTRUCTURE IN ECONOMIC DECISION MAKING

In addition to providing ecosystem service values for stormwater retention, water quality and climate stability, The Keystone Concept (TKC) team presents a suite of opportunities for the City of Snoqualmie to consider in managing and investing in their natural infrastructure.

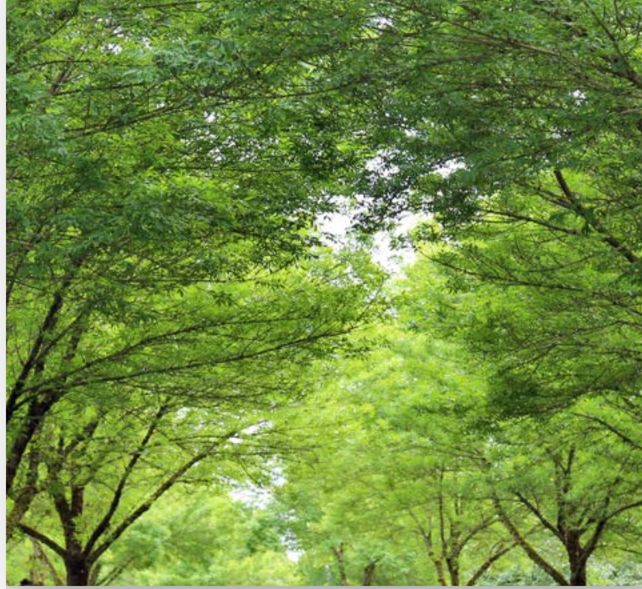
IMMEDIATE OPPORTUNITY

Apply future stormwater fee funding to the City urban forestry program in a manner proportionate to the values established by this Natural Infrastructure Assessment and regional examples in the Herrera Environmental Consultants Technical Memorandum (Appendix F).

ADDITIONAL OPPORTUNITIES

These opportunities, listed in no priority, will take additional time, funding and staff resources to materialize:

- Explore City Forest Credits and King County Forest Credits carbon credit programs to fund tree planting and preservation projects (Appendix E Resources to Support Snoqualmie's Urban Forestry Program).
- Update current land cover and urban tree canopy GIS database in order to reflect land cover and land use changes that have occurred over the last 5 years.
- Evaluate additional Ecosystem Services provided by Snoqualmie's forest resources, including recreation and tourism among other services.
- Investigate King County Transfer of Development Rights (TDR) programs to enhance infrastructure preservation in high priority landscapes.
- Build a FEMA disaster declaration plan, based on Ecosystem Service Valuation, that captures ecosystem service values for any future city disaster declarations.
- Establish an Interlocal Watershed Investment District.



WHEN ACCOUNTING FOR ECOSYSTEM SERVICES VALUE RESULTS SHOW THAT PUBLIC FORESTS IN THE CITY OF SNOQUALMIE GENERATE

$158M TO $195M OVER 50 YEARS

Jeanne Hansen Park Trail

INTRODUCTION: VALUING SNOQUALMIE'S NATURAL INFRASTRUCTURE

In January 2020, the City of Snoqualmie partnered with King Conservation District (KCD) and The Keystone Concept team (The Keystone Concept (TKC), Ecosystem Sciences and Equilibrium Economics), collectively the Project Team, to assess the ecosystem services provided by Snoqualmie's urban forest.

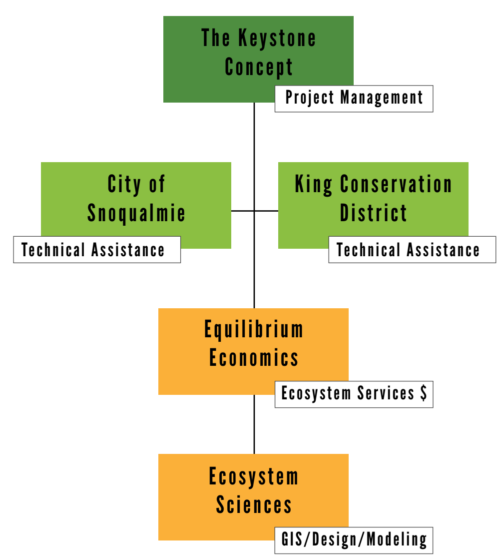
The resulting Snoqualmie Natural Infrastructure Assessment (Assessment) is a comprehensive and proven urban forest valuation for stormwater retention, climate stability and water quality for all lands within the boundary of the city.

Members of TKC Team have collaborated on several urban forest assessments, ecosystem service valuations and stormwater modeling projects across the United States, including in the Western US and Pacific Northwest. Projects relevant to this assessment include: Puget Sound Urban Tree Canopy and Stormwater Management Technical Report; Colorado's South Platte Watershed Natural Capital Resource Assessment; and the Ada County, Idaho Subwatershed Plan – Americana and Main Street Subwatersheds. The collaborative approach of the TKC team, in concert with KCD and City of Snoqualmie, ensures the most current and proven scientific ecosystem service valuation approach to build this assessment, tools and recommendations to benefit the City of Snoqualmie's programs and natural resources for many years to come.

The Assessment is informed by data and recommendations identified as priorities in City policy and planning documents, including: Snoqualmie 2032, the city's comprehensive plan (December 2014); and the Snoqualmie Urban Forest Strategic Plan (June 2014).

The Assessment was built in-partnership with KCD's Urban Forestry Program, a replicable partnership leveraging local guidance and expertise yielding a high return on City investment. Assessment results can inform city policy decisions and potential new funding mechanisms that will reduce overall infrastructure costs and ultimately sustain the city's urban forestry program, the Green Snoqualmie Partnership, and quality of life in Snoqualmie.

Project Team



CITY OF SNOQUALMIE'S NATURAL INFRASTRUCTURE

What is Natural Infrastructure?

Natural infrastructure consists of the minerals, energy, plants, animals, and ecosystems found on Earth that provide a flow of natural goods and services. Ecosystems perform natural functions (such as intercepting rainfall and preventing soil erosion) and provide goods and services that humans need to survive (e.g., a clean water supply and reduction of downstream flooding). The benefits that humans receive from nature, many of which are generally taken for granted, are known as ecosystem goods and services.

The ecosystems providing natural goods and services (Natural Infrastructure) within Snoqualmie are initially defined by the local land cover. Land cover is the type of vegetation, built environment (road, building, sidewalk etc.) rock or water that encompass an area. For this project land cover was mapped for the City of Snoqualmie using GIS data provided by City staff. Figure 1 depicts the land cover of the City of Snoqualmie (the City). Appendix A – Natural Infrastructure outlines the data sources and data processing used to develop Figure 1.

Snoqualmie's land cover types are summarized by acreage in Table 1, describing the City's Natural Infrastructure. Forest is the most abundant land cover type encompassing over 2,600 acres and accounting for 55% of the total land area. Impervious and irrigated vegetation both encompass over 700 acres, accounting for 15% of the land area (Table 1).

HYDROLOGY

Development of Snoqualmie Ridge included stormwater design features to partially mitigate the effects of new pollution-generating impervious surfaces. Stormwater ponds, swales and other features are used to remove pollutants from runoff before discharging to local water bodies. Most Snoqualmie Ridge stormwater features treat runoff for water quality only, and do not provide for flow control or retention to reduce high runoff rates typically associated with developed areas. Instead, most areas of the Snoqualmie Ridge development take advantage of a flow control exemption which allows for peak flows to be discharged directly to the Snoqualmie River through high-flow bypass pipes. Although this configuration helps to protect smaller streams from excessive erosion and scour, it does little to mitigate the increased volume of runoff to the Snoqualmie River that the forest environment otherwise provides.

TABLE 1. CITY OF SNOQUALMIE LAND COVER TYPES

Major Land Cover	Acreage			Description
	Public	Private	ROW	
Bare soil or dry veg	52	359	27	Limited vegetation or bare ground
Forest	1,150	1,365	150	Tree Canopy (coniferous and deciduous)
Impervious	51	478	206	Hardscape, roads, buildings, parking lots etc.
Irrigated Vegetation	256	440	17	Lawns, landscaped areas, ball fields, parks etc.
Open Water	30	162	1	River, streams, lakes, ponds, emergent wetlands
Shrub	57	71	2	Non-tree riparian, brush, non-tree woody veg.
Total	**1,596**	**2,875**	**403**	

Rain that falls on Snoqualmie's land can either be absorbed (i.e. infiltrate) into the ground or runs overland (i.e. run-off) into local streams, the Snoqualmie River, or other local water bodies. The rate at which absorption or run-off occurs is based on the land cover (i.e. impervious surface or natural infrastructure) and the intensity at which rain is falling.

Quantifying the rate at which ecosystems or natural infrastructure absorb or allow run-off is termed stormwater modeling. Understanding stormwater is vital for flood risk reduction, which in turn impacts environmental and human health. The built environment, such as roads, contributes pollutants to water bodies like the Snoqualmie River, degrading water quality and habitat for aquatic species such as salmonids. Conversely natural infrastructure, such as forests, reduce stormwater runoff by infiltration and tree canopy capture. Natural infrastructure, when compared to the built environment, contributes less run-off (reduces stormwater quantity), promotes infiltration (replenishes groundwater), and reduces pollutant loads (limits surface water interaction) to local water bodies and recharges groundwater.

This assessment is informed by two stormwater modeling approaches (as further described in Appendix A): The Rational Method and the Hydrologic Simulation Program Fortran (HSPF) model.

- The Rational Method was used to establish volumes of stormwater runoff for each landcover type within the project area
- The HSPF model outputs, provided by the City and Northwest Hydraulic Consultants, were used to further refine the ecosystem service valuation to determine values of stormwater mitigation within the City

Table 2 below shows the peak runoff per land cover type for the City of Snoqualmie, separating results in privately owned areas, public lands (city-owned), and the volume of stormwater associated with streets, Snoqualmie's Right-of-Way (ROW). For a 2-yr storm event the City of Snoqualmie generates a peak discharge of 176 cubic feet per second (cfs). In general, the runoff results follow typical patterns; vegetated areas intercept rain and allow it to infiltrate into the soil, while impervious or compacted areas intensify runoff as minimal interception and infiltration occur. For example, for the entire land area for the City of Snoqualmie (public and private), impervious areas encompass only 15% of the land area, but account for 47% of the runoff. Conversely, forested areas encompass roughly 55% of the land area, but only account for 19% of the runoff.

TABLE 2. RUNOFF VOLUMES PER LAND COVER TYPE CITY OF SNOQUALMIE (2-YR EVENT).

Major Land Cover	Total Acreage	2-yr Event Peak Discharge (cfs) [% Total Discharge]		
		Public Area	Private Area	ROW Area
Bare soil or dry veg	438	1.3 [4%]	9.7 [7%]	0.7 [3%]
Forest	2,665	14.4 [42%]	18.9 [13%]	1.9 [7%]
Impervious	736	5.8 [17%]	77.0 [55%]	23.2 [88%]
Irrigated Vegetation	713	8.0 [23%]	14.3 [10%]	0.5 [2%]
Open Water	193	3.8 [11%]	20.4 {14%]	0.1 [0%]
Shrub	129	1.1 [3%]	1.3 [1%]	0.0 [0%]
Total	**1,596**	**34.3 [100%]**	**141.6 [100%]**	**26.4 [100%]**

STORMWATER RUNOFF

IMPERVIOUS AREAS ENCOMPASS ONLY 15% OF THE LAND AREA, BUT ACCOUNT FOR 47% OF THE RUNOFF

- CONVERSELY -

FORESTED AREAS ENCOMPASS 55% OF THE LAND AREA, BUT ONLY ACCOUNT FOR 19% OF THE RUNOFF

KEY STORMWATER FINDINGS

In general, the City owned parcels generate significantly less runoff than non-city owned parcels, 34 cfs and 142 cfs respectively.

FORESTED AREAS ARE CRITICAL FOR MANAGING STORMWATER

Forest encompasses 72% of publicly owned land area within the City and accounts for 42% of the runoff. Conversely, the impervious cover type encompasses only 3.2% yet accounts for 17% of the runoff.

If there is a significant conversion of natural land cover to impermeable surfaces, greater flooding will occur, requiring more investment in built infrastructure.

FORESTED AREAS AND STREET TREES ARE VALUABLE IN MITIGATING THE VOLUME OF STORMWATER WITHIN CITY RIGHT-OF-WAY

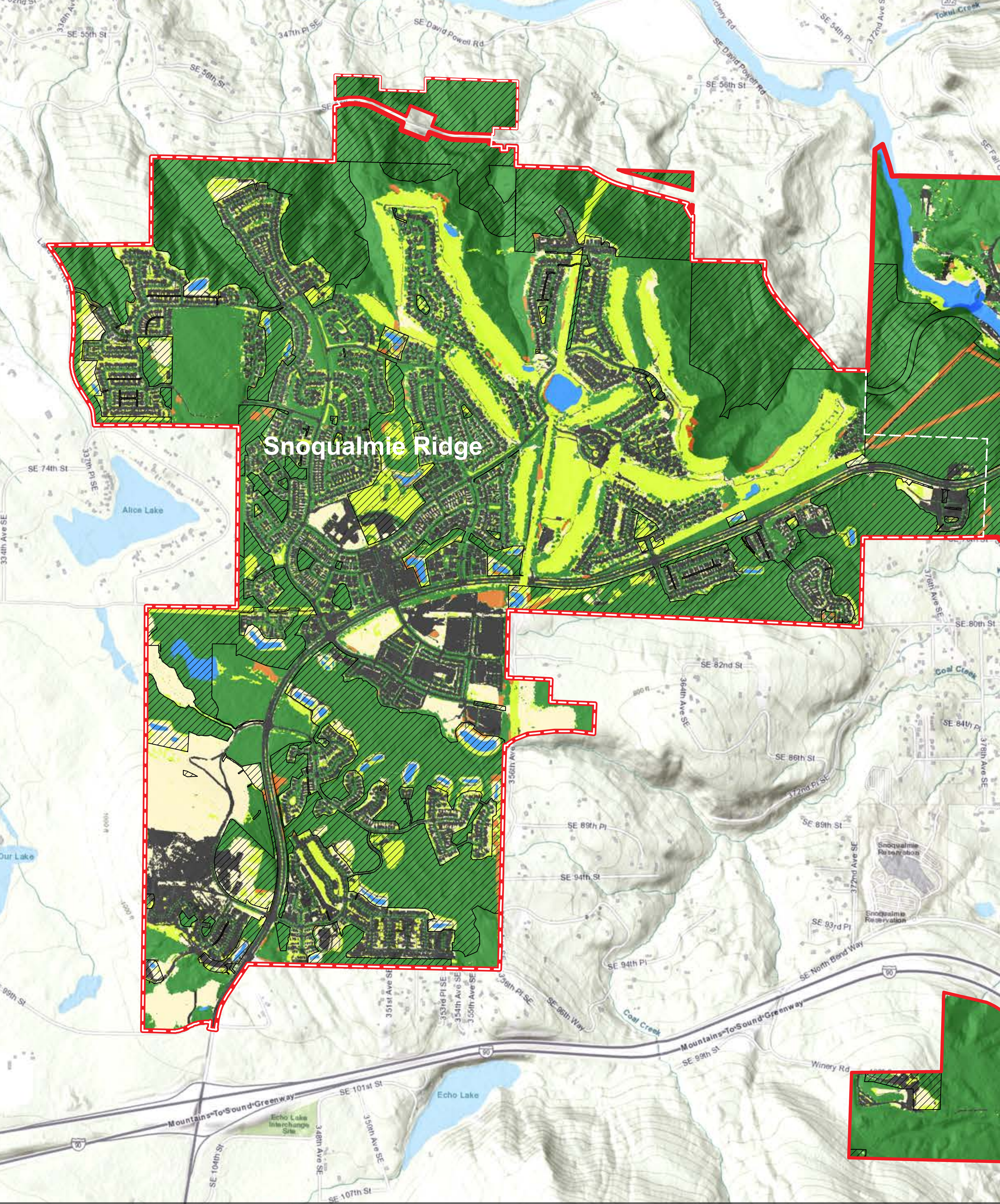
Most stormwater is associated with streets and over 400 acres of City land area that is dedicated to ROW.

ROW generates a significant volume of stormwater as the area is dominated by the impervious land cover class (51%). Such a high area of impervious cover leads to proportionately high runoff volumes, as 88% of the runoff within the ROW is generated from the impervious cover class.

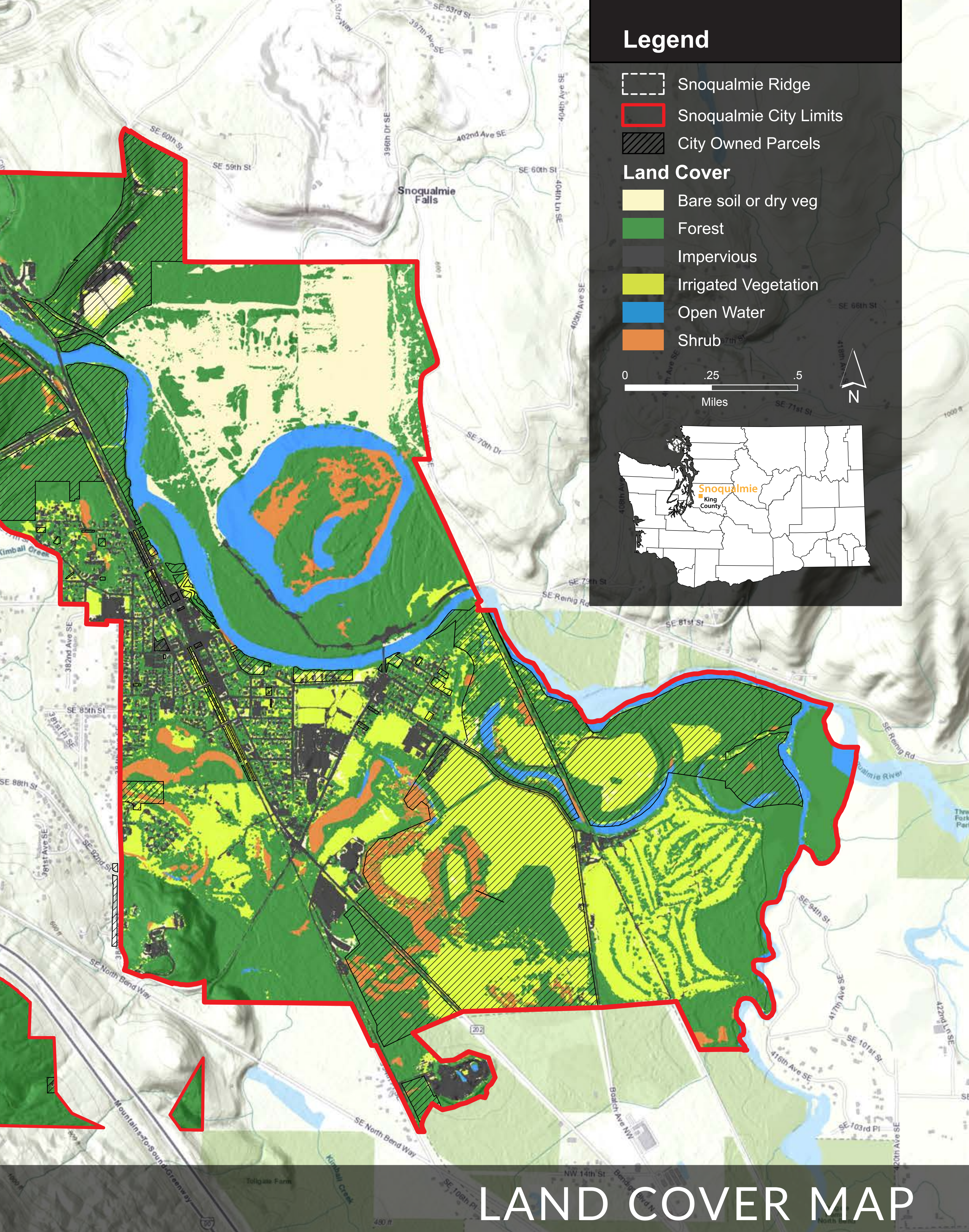
Conversely, Forest (primarily street trees) encompasses 37% of the ROW and accounts for only 7% of the runoff.

FORESTS SAVE TAXPAYER MONEY

The City manages over 1,300 acres of forested land (including street tree areas in ROWs). These forests are working for the local community by absorbing rainwater that may otherwise flow over streets and into local streams and rivers, which may lead to, or exacerbate, temperature, erosion, sediment or other pollutant problems.



CITY OF SNOQUALMIE



LAND COVER MAP

CITYWIDE APPRAISAL OF NATURAL INFRASTRUCTURE: ECOSYSTEM SERVICES

Clean air, clean water, healthy food, flood risk reduction, waste treatment, and stable atmospheric conditions are all examples of ecosystem services. Without natural infrastructure, we would not have the benefit of these services, which are in fact the basis of economic activity.

Likewise, the health of the City's forest affects threatened species, the integrity and stabilization of riverine slopes, and water quality of the Snoqualmie River. Refer to Appendix B for a complete overview of all ecosystem services and the standards to define, identity and classify them.

Community Park and Neighboorhood

ECOSYSTEM SERVICES

Whether in the outskirts of the City or downtown, Snoqualmie's forests provide a suite of ecosystem services. This report focuses on forest ecosystem services, though grasslands, shrubs, and even soils also sequester carbon, retain stormwater, and filter pollutants from runoff. Forest ecosystem services save the City money in many ways, such as by reduced water treatment costs, reduced risk of flood damage, and increased tourism from recreation opportunities. Recognizing these savings and extra revenues will help Snoqualmie realize the value of preserving, maintaining, and enhancing the urban forest. The following section outlines how this value can be recognized and accounted for throughout the City.

Ecosystem service valuation (ESV) assigns a dollar value to goods and services provided by a given ecosystem. This allows for management policies to be considered in terms of their ability to improve ecological processes that produce valuable ecosystem goods and services.

ESV is a natural appraisal method that calculates the economic value of ecological goods and services by transferring quantitative estimates, often monetary values, from existing literature to a comparable study area. As in a house or business appraisal, ESV sums the value of various attributes (number of rooms in a house, or different assets in a business) and establishes the value based on closely related comparable valuations. All valuation appraisals include a degree of uncertainty. A house appraisal will have several comparables that range in value, though a single value is often chosen. ESV is a well-accepted and commonly applied methodology in economics, particularly for ecosystem service valuation. It has been accepted by academics, private industry, as well as federal, state and local governments.

As an example, in June of 2013, FEMA approved Mitigation Policy FP-108-024-01 (FEMA, 2013), based on values developed using this methodology, for use in all hurricane and flood disaster mitigation across all 50 states. ESV has become the go-to approach for valuation delivering for decision-makers a timely and cost-effective way to value ecosystem services and natural infrastructure (Wilson and Hoehn, 2006).

CLEAN AIR, CLEAN WATER, HEALTHY FOOD, FLOOD RISK REDUCTION, WASTE TREATMENT, AND STABLE ATMOSPHERIC CONDITIONS ARE ALL EXAMPLES OF ECOSYSTEM SERVICES

When data for a study site is more robust (as is the case for Snoqualmie) a specific ESV analysis, called function transfer, can be used. The Snoqualmie Assessment uses function transfer to estimate ecosystem services provided by urban and rural forests for the City.

For more information on Function Transfer, and its use in this study, see Appendix C.

STORMWATER RETENTION: STORMWATER CAPTURED BY SNOQUALMIE'S FORESTS

This section details the approach of estimating the amount of stormwater captured by each acre of forest and calculates the monetary benefits provided by the captured stormwater. To arrive at an annual dollar value per acre stormwater retention, the volume of stormwater retained by forests was combined with a marginal cost of stormwater infrastructure

This study was limited to valuing the stormwater retention of a 2-year 24-hour storm, as described above. Figure 2 provides more detail on what each component includes. For more information on the use of marginal cost, see Appendix C.

As described above, this study utilizes the King County Rational Method to determine the peak runoff from a defined land area (watershed, park, parcel etc.). As peak runoff is then used to determine pipe-sizing and storage magnitude for stormwater infrastructure, the same method was used in this study to estimate the avoided cost of water storage infrastructure due to storage provided by forests. This becomes the proxy value of forested green infrastructure for Snoqualmie, where inputs for calculating this value are summarized in Table 3. Details on calculations in this table are provided in Appendix C.

Table 3 shows that the total value of stormwater retention provided by Snoqualmie forests is approximately \$11.8M to \$14.5M for every 2-year 24-hour storm alone.

TABLE 3. TOTAL VALUE OF STORMWATER RETAINED BY SNOQUALMIE FORESTS ($/2-YEAR STORM)

Ownership Type	Total Acres of Forest (acre)	Unit Water Volume Retained (cf/acre)	Total Water Volume Retained (cf)	Marginal Water Storage Market Value ($/cf)	Total Value of Water Storage by Forests ($)
Private	1,365	5,339	7,287,360	$0.83 - $1.02	$6,048,508 - $7,433,107
Public	1,150		6,139,534		$5,095,813 - $6,262,324
ROW	150		800,809		$664,671 - $816,825
Total	**2,665**		**14,227,702**		**$11,808,993 - $14,512,256**

TABLE 4: TOTAL ANNUAL VALUE OF CARBON SEQUESTRATION BENEFITS OF SNOQUALMIE FORESTS

Ownership Type	Acres by Ownership	Total Carbon Sequestration Value Low($/yr)	Total Carbon Sequestration Value High ($/yr)
Public w/ ROW	1,300	$45,819.72	$81,213.42
Private	1,365	$45,380.75	$57,456.80
Total	**2,665**	**$91,200**	**$138,670**

TABLE 5: TOTAL VALUE OF WATER QUALITY BENEFITS OF SNOQUALMIE FOREST

Forest Ownership Type	Acres	Value of Nutrient/Compound Reduction ($/Acre/Year)		Value of Nutrient/Compound Reduction ($/Acre/Year)	
		Low	High	Low	High
Public	1,300	$44.18	$113.24	$57,471.98	$147,304.85
Private	1,365			$60,308.47	$154,574.97
Total	**2,665**			**$117,780.45**	**$301,879.83**

This report models this one storm, which does not account for larger, less frequent storms that have the potential to devastate cities. Therefore, this is an underestimate of the full stormwater retention benefit provided by Snoqualmie forests. Why a range? The value provided by the City's natural assets, or the cost required to replace this value, does not easily translate to a specific type of infrastructure, but likely a suite of options. A range provides greater certainty that the unit value of stormwater retention benefits the City and is captured within this range.

While we assume the stormwater benefit averages to approximately $6.95M each year, the 2-year 24-hour storm does not occur in this interval. Under normal conditions, scientists estimate that the probability of this storm occurring is approximately 50% in any given year, which suggests the storm can occur more frequently than twice a year. In fact, the effects of climate change suggest that this size of storm will occur more frequently in the future, likely resulting in a re-defining of the 2-year storm event in the future.

CLIMATE STABILITY: CARBON STORED AND SEQUESTERED BY SNOQUALMIE'S FORESTS

This section outlines the annual value of sequestered carbon by forests within the City of Snoqualmie. Sequestered carbon biomass provides economic value by contributing to climate stability. Each year, trees, shrubs, and grasslands sequester carbon which would otherwise be released into the atmosphere.

To arrive at an annual dollar value per acre of carbon sequestration, total carbon biomass was combined with dollar values for each ton of carbon sequestered. Figure 3 provides more detail on what each component includes.

Appendix C provides details on the data sources used in each component shown in Figure 3. Table 4 summarizes the total value of carbon sequestration. Table 4 shows that the total value of carbon sequestration provided by Snoqualmie forests is approximately $91,200 to $138,670 each year.

Carbon Stock: Carbon stock refers to stored carbon sequestered over time. In forests, carbon is typically stored in the biomass, but also to a lesser extent in dead wood and litter. The ability to store carbon depends on the condition of the forest (age and health) and the management practice. Poorly managed or unhealthy forests can rerelease carbon back into the atmosphere and/or have lower storage ability compared to healthy and well managed forests.

Carbon stocks represent historic carbon capture and therefore it will not be used in the calculations of future asset value presented in this report. However, recognizing total carbon biomass would help guide development and management decisions that minimize the amount of carbon released into the atmosphere. Development of land resulting in the cutting of forest stands and disposal of the timber releases carbon into the atmosphere, imposing a cost on society through increased GHG emissions. Appendix C calculates the amount of stored carbon in the City of Snoqualmie's forests, and shows the value of this stored carbon.

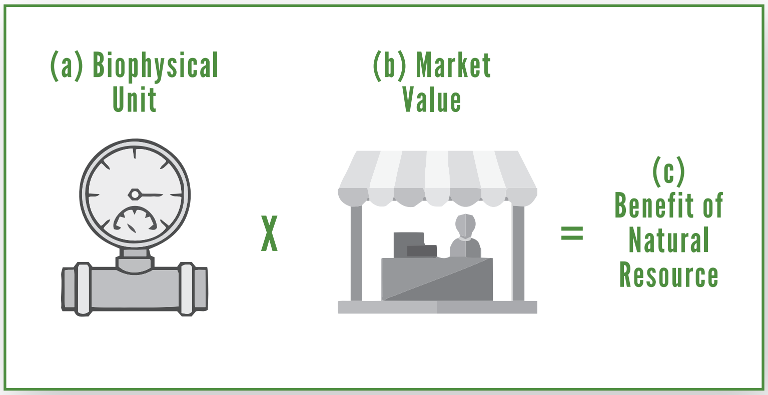


Figure 01

GENERAL EXAMPLE FUNCTION TRANSFER

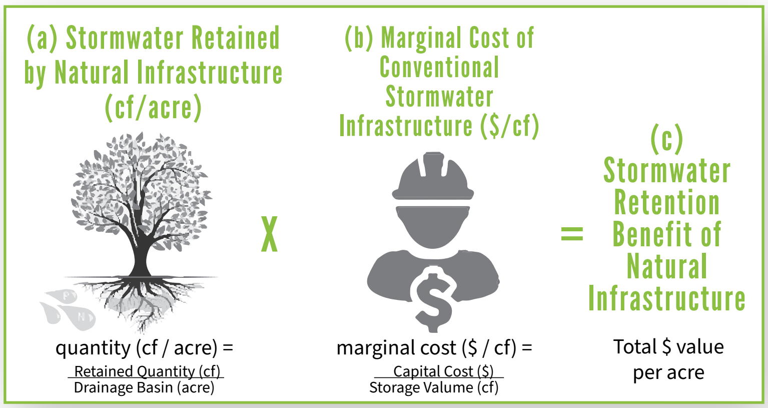


Figure 02

CALCULATING THE STORMWATER RETENTION BENEFITS

Marginal cost is the per-unit cost of a capital project or enhancement. In the case of stormwater infrastructure, the marginal cost reflects the total cost of, for instance, a detention basin, divided by the amount of stormwater the basin can store. This becomes useful when investing in multiple projects of varying size and cost, where the use of marginal cost offers an apples-to-apples comparison.

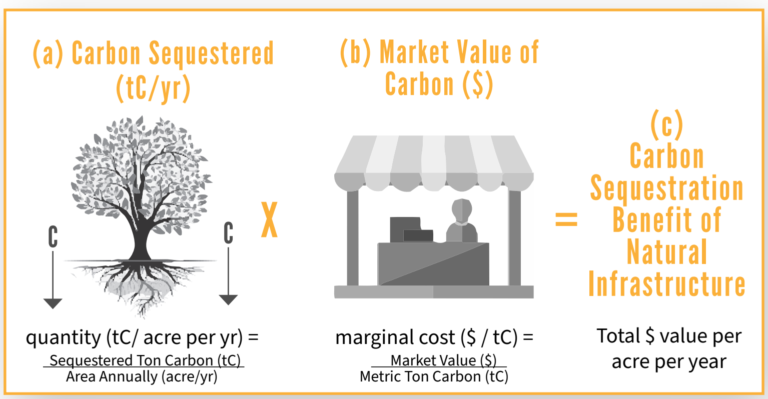


Figure 03

CALCULATING CARBON SEQUESTRATION BENEFITS

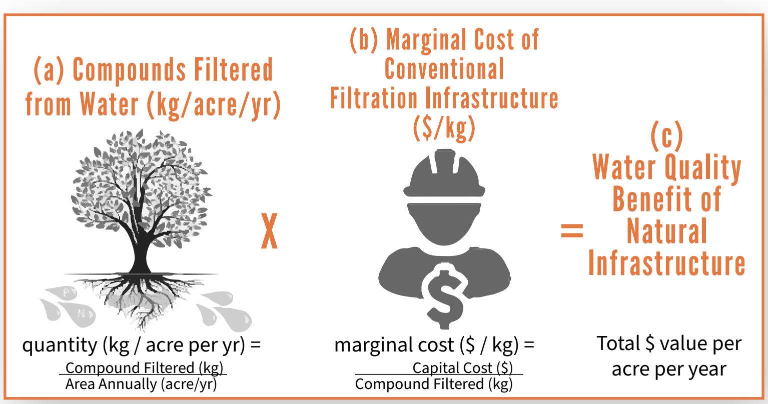


Figure 04

CALCULATING WATER QUALITY BENEFITS

WATER QUALITY: WATER FILTERED BY URBAN AND RURAL FORESTS

Natural ecosystem processes have the ability to remove elements from the water column that may be toxic to humans or impactful to downstream habitat. For example, forests adjacent to the Snoqualmie River buffer roadside surface water runoff by collecting oils, heavy metals, and other particles. Forests remove a variety of pollutants and purify water, although regulations might still require mechanical filtration for further purification.

To arrive at an annual dollar value per acre of water filtration provided by forests, local estimates of nutrients and other compounds removed from water by an acre of forest was combined with the marginal cost of water treatment with conventional infrastructure. Figure 4 (previous page) provides more detail on what each component includes.

Among the nutrients and compounds in scope for this analysis are the reduction of nitrogen, phosphorus, and total suspended solids from water runoff. Table 5 (previous page) combines each nutrient filtered by the City of Snoqualmie forest with selected market value to arrive at the annual value of water quality each year. Appendix C provides data sources on each input used and how the values below were calculated.

TABLE 6: TOTAL ANNUAL ECOSYSTEM SERVICE VALUE OF SNOQUALMIE FORESTS

Forest Ownership Type	Stormwater Retention		Carbon Sequestration		Water Quality	
	Low	High	Low	High	Low	High
Public	$5,760,484	$7,079,149	$45,820	$81,213	$57,472	$147,305
Private	$6,048,508	$7,433,107	$45,381	$57,457	$60,308	$154,575
Total	**$11,808,993**	**$14,512,256**	**$91,200**	**$138,670**	**$117,780**	**$301,880**

TABLE 7: TOTAL ASSET VALUE BY DISCOUNT RATE

2.75%		0%	
$324,451,278	$403,683,451	$600,898,684	$747,640,311
$324,451,278	**$403,683,451**	**$600,898,684**	**$747,640,311**


Upper Snoqualmie Ridge

ASSET VALUE OF FOREST ECOSYSTEM SERVICES

When all natural infrastructure benefits are valued as assets and brought into the light of economic decision-making, these cost-effective goods and services are more likely to be retained, continuing to provide real returns to citizens, private companies, and government.

As demonstrated above, the ecosystem services valued in this report are an underestimate of the full value provided by City of Snoqualmie forests. Nonetheless, the following sections show the value of stormwater retention, water quality, and carbon sequestration of Snoqualmie's forests amount to a multimillion-dollar asset.

TOTAL ANNUAL ECOSYSTEM SERVICE VALUE OF SNOQUALMIE FORESTS

The above sections presented three ecosystem services in dollars per acre per year. Combining with the total acreage of forest provided above, Table 6 (previous page) summarizes the total annual ecosystem service value for forests across the entire City.

Results show that forests in the City of Snoqualmie generate about $12M to $15M (US dollars, 2020) in goods and services every year. When accounting for only the publicly-owned forests, total ecosystem service value generates about $5.8M to $7.3M (Table 6).

These are economic benefits provided to the City's residents each year and will continue to be provided in perpetuity if Snoqualmie forests are well managed and remain healthy. When considering the value being provided year over year, as an annual flow of value, a net present value, analogous to an asset value, can be calculated.

ASSET VALUE OF FOREST ECOSYSTEM SERVICES OVER 50 YEARS

An ecosystem produces a flow of valuable services over time, like a traditional capital asset. This analogy can be extended to calculating the asset value through net present value of the future flows of ecosystem services, just as the asset value of a capital asset (such as a power plant or bridge) can be calculated as the net present value of its expected future benefits. Like bridges, roads and many other built assets, ecosystems are generally not sold on the market. Thus, this calculation is an estimate of asset value without a potential for sale. However, it is useful for revealing the scope and scale of the economic value of Snoqualmie's forests.

Calculating an asset's net present value implies the use of a discount rate. The range of values used as discount rates varies greatly across federal agencies and applications. There is no standard across the board. This analysis uses 2.75%, the current rate for federal water projects (NRCS, 2018), as it is federally accepted for water projects. Appendix D discusses the use of discount rates in capital asset valuation and the justification for using this discount rate. The forest ecosystem services were calculated above in annual or biannual dollars. Table 7 (previous page) shows how each ecosystem service accrues value over time with the use of discount rates.

Results show that forests in the City of Snoqualmie generate about $324M to $404M (US dollars, 2020) in goods and services over 50 years using a 2.75% discount rate. These are economic benefits provided to people. From this annual flow of value, a net present value, analogous to an asset value, can be calculated. When accounting for public land only, Snoqualmie forests generate about $158M to $195M over 50 years.

CONCLUSION: NATURAL INFRASTRUCTURE IN ECONOMIC DECISION MAKING

As established in this report, Snoqualmie's natural systems provide immense value to the citizens of Snoqualmie and the natural environment. This natural infrastructure does not depreciate or fall apart like built capital assets. In fact, natural systems can even appreciate in value over time, being comprised of living and growing organisms. Of course, natural systems are only renewable if they are protected against degradation, development, unsustainable extraction, and other impacts. As long as Snoqualmie's natural infrastructure is not degraded or depleted below its ability to renew itself, this flow of value will likely continue into the future.

As a municipality, Snoqualmie has one of the highest per capita natural infrastructure values in the Pacific Northwest. Based on the findings of the Project Team, the City has an incredibly valuable natural infrastructure which should be considered in funding allocation and policy development.

SNOQUALMIE HAS ONE OF THE HIGHEST PER CAPITA NATURAL INFRASTRUCTURE VALUES IN THE PACIFIC NORTHWEST

TABLE 8: STEWARDSHIP & OPPORTUNITIES FOR CITY OF SNOQUALMIE
(FURTHER DETAIL IN APPENDIX G)

OPPORTUNITY	DESCRIPTION	ACTION
Stormwater fees fund urban forestry	Using the stormwater values from this assessment and local examples from Herrera's Stormwater Tech Memo (Appendix F), use a portion of City stormwater fees to fund the urban forestry program	Staff recommendation and Council approval of funding levels in biennial budget discussions
City Forest Credits projects fund urban forestry program	Develop City Forest Credits projects (planting and/or preservation) in partnership with local corporate funders, and potentially King County's Forest Carbon Program	Develop and implement a City-wide City Forest Credits Program
Land cover and urban tree canopy GIS database update	Update the City's current land cover and urban tree canopy GIS database to reflect current land use and land cover conditions	Plan for, budget and complete an updated land cover and urban tree canopy assessment in the next 5 years
Evaluate and value additional ecosystem services	Evaluate the value of the City's recreation and tourism resources	Plan for, budget and complete an Ecosystem Services Assessment of the city's recreation and tourism resources in a future budget cycle
Investigate King County Transfer of Development Rights opportunities (TDR Programs)	Investigate, in partnership with King County, opportunities for increasing density and conservation within existing growth management policies in the City	Invest in a City-wide TDR Program that will incentivize smart growth and generate funding for City programs
Build a FEMA Disaster Plan Declaration	Investigate FEMA Mitigation Policy FP- 108-024-01 in June of 2013 (Federal Emergency Management Agency, 2013) and evaluate opportunity for City to incorporate ecosystem service values in disaster mitigation plans	Update City's current disaster planning policies to incorporate ecosystem service values. These values will justify millions of dollars in mitigation funding if/ when future natural disasters occur within the City
Establish an Interlocal Watershed Investment District	Investigate, in collaboration with Water Resource Inventory Area (WRIA) #7, the opportunity for a regional taxing district that rewards Snoqualmie for stormwater mitigation provided by City's natural infrastructure	In partnership with WRIA #7, develop an Interlocal Watershed Investment District that incentivizes stormwater mitigation through the use of natural infrastructure

NATURAL INFRASTRUCTURE STEWARDSHIP

Through this assessment, the TKC team provides a robust and scientifically proven analysis of the City's natural infrastructure and its ecosystem service value. Using the outputs from this analysis, the TKC team collaborated with technical experts in a variety of arenas (stormwater, urban forestry, land use) and City staff to develop potential policy and funding recommendations for the City to consider in sustaining the urban forestry program.

APPENDICES

APPENDIX A: CHARACTERIZATION OF SNOQUALMIE LAND COVER AND HYDROLOGY MODELING

LAND COVER DATA SOURCES AND ASSUMPTIONS

The land cover GIS dataset (feature class) is the combination of four existing datasets, or feature classes.

1. 2012 Urban Tree Canopy Data (Plan-it Geo)
2. 2013 King County Forest Landscape Assessment Tool (FLAT) (2013)
3. 2015 Tree Canopy Update (Plan-it Geo)
4. King County's Sensitive Area Ordinance Wetlands

All data was provided to Ecosystem Sciences by Phil Bennett (City of Snoqualmie Parks Department) and Brendon Ecker (City of Snoqualmie, GIS Analyst). The four land cover feature classes were merged in GIS to create one seamless land cover layer for the City of Snoqualmie. Figure 6 describes the hierarchical process for creating the Major Land Cover layer:

1. Tree Canopy 2015 defined the tree canopy,
2. 2012 UTC determined the land cover type for areas not covered by Tree Canopy 2015,
3. FLAT (Forest Landscape Assessment Tool) Land Cover Management Units added specificity to the existing Land Cover feature class by defining Deciduous vs. Coniferous (sub Land Cover type) and other specificity to existing classes, for example hardscape (impervious) vs. landscape (irrigated vegetation). Combining the first three feature classes covered most of the City.

<u>Data Limitations:</u> Portions of the "Mill Site" were not mapped in the previous 3 feature classes and thus this area was blank after combining the first three feature classes. To fill in the "Mill Site" portion that did not have land cover associated with them, the City of Snoqualmie provided the King County SAO Wetlands shapefile. This shapefile covered most of the remaining area. The wetland shapefile was updated (heads-up digitized) with the Major Land Cover type that the wetland area covered. One large polygon was added to the final land cover layer. A large "Bare soil or dry veg" polygon was added to the final land cover layer. This area covers the non-vegetated (not developed) area in the Northeast corner of the City of Snoqualmie, just north of Lake Borst (Figure 5).

Merging of multiple land cover sets to make one land cover layer for the City of Snoqualmie involved cross-walking (making one consistent land cover legend) each of the datasets into one dataset. The cross walking resulted in six major land cover types. Table 9 describes the land cover types and provides the acreage and percent of Snoqualmie each cover type encompasses. Forest is the most abundant land cover type encompassing over 2,600 acres and accounting for 54% of the landscape. Impervious and Irrigated Vegetation both encompass over 700 acres and each account for roughly 15% of the land area (Table 9). The land cover described in Table 9 form the Natural Infrastructure ecosystems of the City of Snoqualmie.

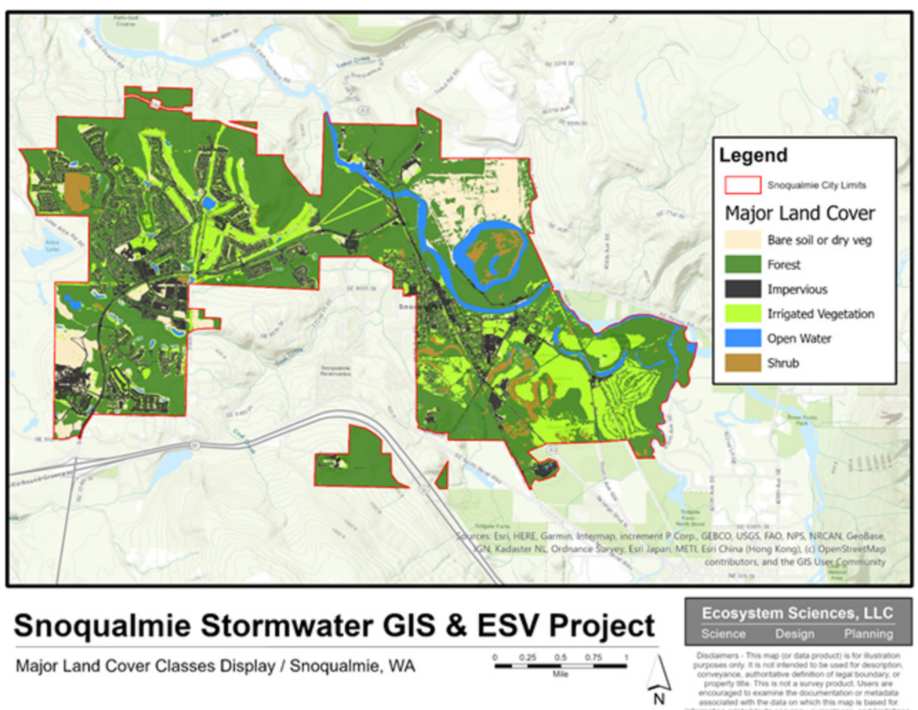


FIGURE 5. MAJOR LAND COVER CITY OF SNOQUALMIE (ANALYSIS EXTENT)

Additional GIS Data: To determine the runoff per ownership in the City of Snoqualmie, the City provided a feature class (Phil Bennett and Brendon Ecker) that delineated City Owned areas (Figure 5). This feature class was unioned with the Land Cover feature class. This new feature class was used to determine the runoff associated with City Owned areas and non-City owned areas.

Stormwater Hydrology Modeling Approach and Data

Generally speaking, rain that falls on Snoqualmie's land can either be absorbed (i.e allowed to infiltrate) into the ground or runs overland (i.e. run-off) into local streams, the Snoqualmie River, or other local water bodies. The rate at which absorption or run-off occurs is based on the land cover (i.e. natural infrastructure) and the intensity at which rain is falling. Quantifying the rate at which ecosystems, or natural infrastructure, absorb or allow run-off is termed stormwater modelling, especially within an urban environment like the City. Understanding stormwater is vital to aquatic health, as the built environment (e.g roads) contributes pollutants to local water bodies, such as the Snoqualmie River. Pollutants degrade water quality and habitat for aquatic species such as salmonids.

TABLE 9. LAND COVER TYPES CITY OF SNOQUALMIE (ACREAGE, %, AND DESCRIPTION)

Land Cover	Acres	% Area	Description
Bare soil or dry Vegetation	438.3	9.0%	Limited vegetation or bare ground
Forest	2,665.5	54.7%	Tree Canopy (coniferous and deciduous)
Impervious	735.8	15.1%	Hardscape, roads, buildings, parking lots etc.
Irrigated Vegetation	713.4	14.6%	Lawns, landscaped areas, ball fields, parks etc.
Open Water	193.1	4.0%	River, streams, lakes, ponds, emergent wetlands
Shrub	129.3	2.7%	Non-tree riparian, brushy veg., non-tree woody veg.
Total	**4,875.5**	**100.0%**	

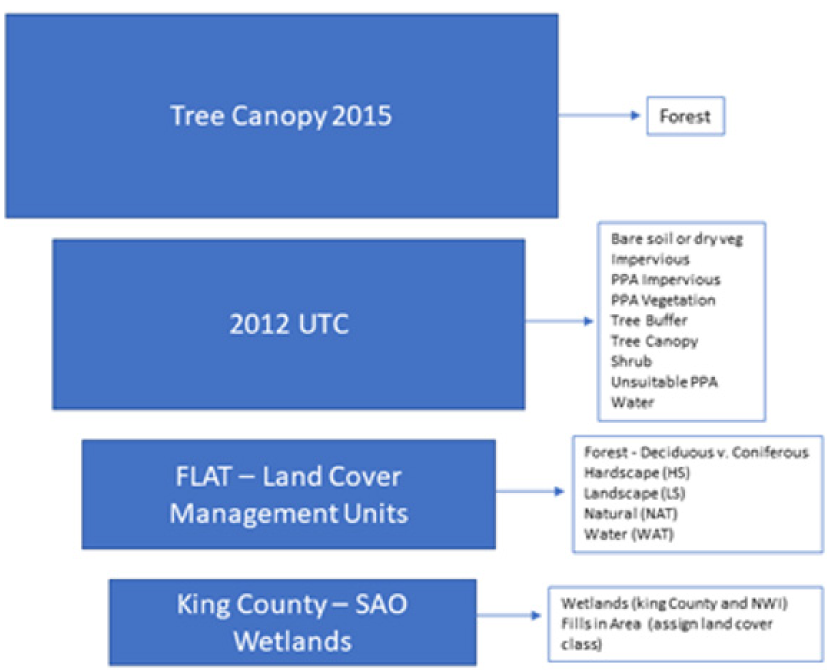


FIGURE 6 FEATURE CLASSES AND HIERARCHY USED TO CREATE THE LAND COVER FEATURE CLASS

Conversely, natural infrastructure, such as Forests, reduce stormwater runoff by infiltration and canopy capture (rain that falls on leaves). Natural infrastructure, when compared to the built environment (impervious areas), contributes less run-off (reduces stormwater quantity), promotes infiltration (replenishes groundwater), and reduces pollutant loads (limited surface water interaction) to local water bodies.

The King County Surface Water Design Manual provides specific guidance on modeling stormwater dynamics (King County 2016). King County employs the Rationale Method to determine the peak runoff from a defined land area (watershed, park, parcel etc.). Peak runoff is then used to determine pipe-sizing for stormwater infrastructure. For this analysis, the Rationale Method is employed to compare runoff from different land cover types.

The Rationale Method computes peak runoff Q(cfs) using the following equation (King County 2016):

QR = C*Ir*A

QR = peak flow (CFS) for a storm of return frequency R

C = estimated runoff coefficient (ratio of rainfall that becomes runoff)

Ir = peak rainfall intensity (inches/hour) for a storm return frequency R

A = drainage subbasin area (acres)

C – Runoff Coefficient: The King County Surface Water Design Manual provides runoff coefficient values for pertinent land cover types found within the County. Table 10 lists the Land Cover Type, its associated King County Surface Water Design Manual associated land cover type and its Runoff Coefficient (King County 2016).

Ir – Peak Rainfall Intensity: As mentioned above, this study focused modeling efforts on the 2-year 24-hour storm. The Ir for the 2-yr event for Snoqualmie = 0.125 inches/hr (3.0 inches/24 hours).

Acreage (A): Acreage is determined by the GIS shapefile. The initial analysis focuses on the entire City of Snoqualmie. Subsequent analysis, such as public vs. private, entails breaking the city up into distinct sub-basins, and thus acreage (in GIS) needs to be recalculated each time that a different analysis unit is created.

Stormwater Modeling Results 2-yr Return Frequency Storm Event

Table 11 below presents the peak runoff per land cover type for the City of Snoqualmie. For a 2-yr event storm the City of Snoqualmie generates a peak discharge of 175.9cfs. In general, the runoff results follow typical patterns; vegetated areas intercept rain and allow it to infiltrate into the soil, while impervious or compacted areas exacerbate runoff as minimal interception and infiltration occur. For example, Impervious areas encompass only 15% of the City of Snoqualmie, but account for 47% of the runoff. Conversely, Forested areas encompass roughly 55% of the City, but only account for 19% of the runoff. Open water is highlighted in red to indicate that rain that falls on natural "open water" areas, such as rivers and streams in the project area, is not typically "runoff." Rain that falls on stormwater ponds in the project area, will at some point "runoff" into the system. In short, "Open Water" runoff volumes should be viewed in the context that not all rain that falls on "Open Water" is runoff.

TABLE 10. KING COUNTY RUNOFF COEFFICIENT PER LAND COVER TYPE

Land Cover	King County General Land Cover	C
Bare soil or dry veg	Pasture	0.2
Forest	Dense Forest	0.1
Impervious	Pavement and roofs	0.9
Irrigated Vegetation	Lawns	0.25
Open Water	Open water	1
Shrub	Light forest	0.15

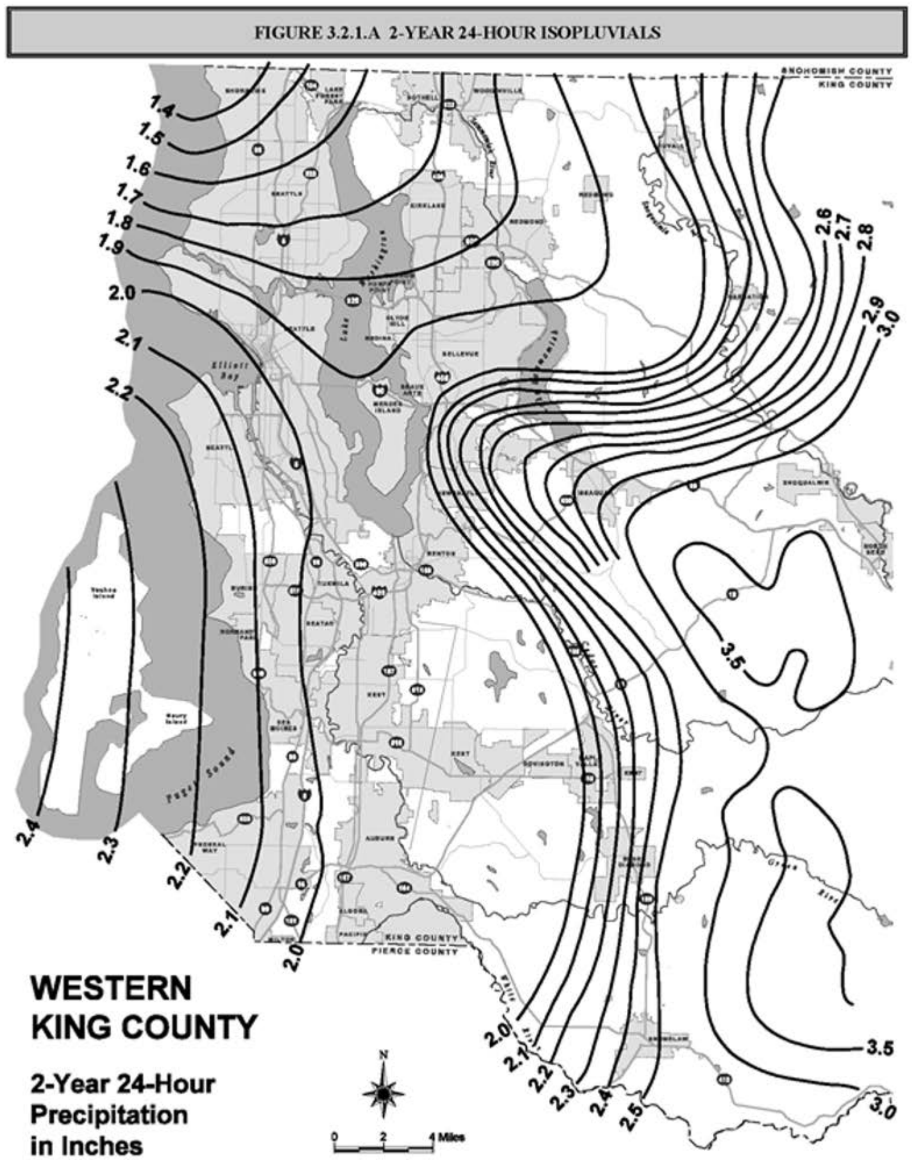


FIGURE 7. FROM KING COUNTY SURFACE WATER DESIGN MANUAL (2016) 2-YEAR 24-HOUR ISOPLUVIALS

TABLE 11. RUNOFF VOLUMES PER LAND COVER TYPE CITY OF SNOQUALMIE (2-YR EVENT)

Major Land Cover	Acres	% Area	2-yr Event Peak Discharge (CFS)	Total Cubic Feet (1 hr)	% Discharge
Bare soil or dry veg	438.3	9.0%	11.0	3,9451	6.2%
Forest	2,665.5	54.7%	33.3	119,947	18.9%
Impervious	735.8	15.1%	82.8	298,016	47.1%
Irrigated Vegetation	713.4	14.6%	22.3	80,259	12.7%
Open Water	193.1	4.0%	24.1	86,928	13.7%
Shrub	129.3	2.7%	2.4	8,726	1.4%
Total	4,875.5	100.0%	175.9	633,328	100.0%

Public (City Owned) v. Private (Non-City Owned) To determine the runoff per ownership in the City of Snoqualmie, the City provided a feature class (Phil Bennett and Brendon Ecker) that delineated City Owned areas (Figure 8). This feature class was joined with the Land Cover feature class. This new feature class was used to determine the runoff associated with City Owned areas (Table 12) and non-City owned areas (Table 13). In general, the City Owned parcels generate significantly less runoff than non-city owned parcels, 34.4cfs and 141.6cfs respectively. Forest encompasses 72% of the city-owned area and accounts for 42% of the runoff (Table 12). Conversely, the Impervious cover type encompasses only 3.2% yet accounts for 17% of the runoff. To compare, during a 2-yr storm event, an acre of City-Owned Forest accounts for 0.0125cfs, while an acre of Impervious 0.113cfs, a nine-fold increase. Forested areas are very important for managing stormwater.

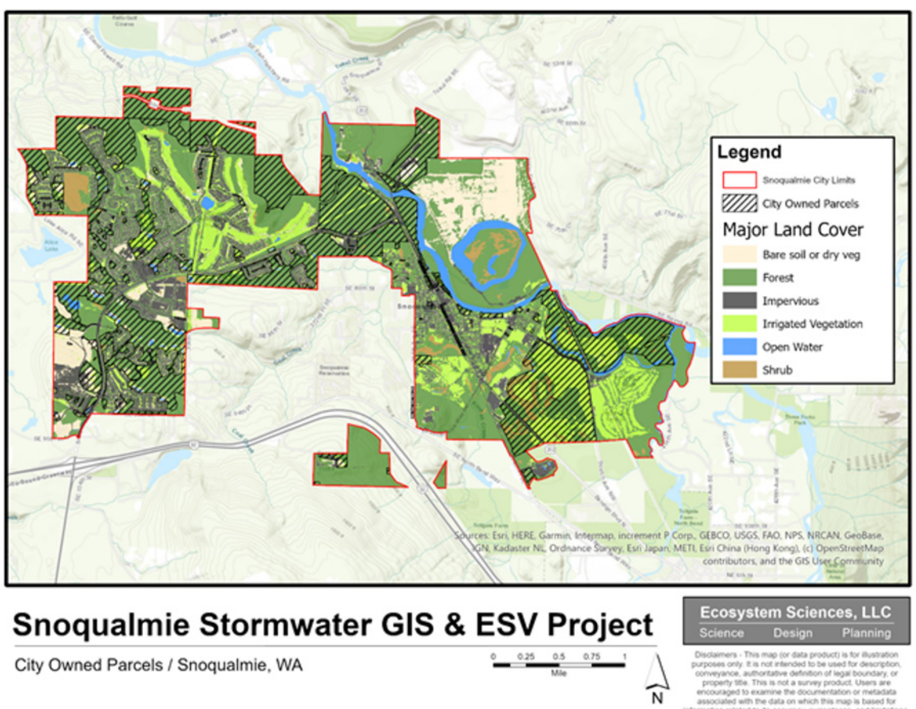


FIGURE 8. CITY OF SNOQUALMIE CITY OWNED PARCELS AND MAJOR LAND COVER

Right-of-Way (ROW): Most stormwater is associated with streets. To quantify the volume of stormwater associated with streets, Snoqualmie's Right-of-Way (ROW) was analyzed. The City of Snoqualmie provided a ROW feature class. This feature class was used to clip the Land Cover feature class. This new feature class was used to determine the runoff associated within the ROW (Table 14). Similar to the other analyses within this report, the ROW generates a significant volume of stormwater as the area is dominated by the impervious land cover class (51%). Such a high area of impervious cover leads to high runoff volumes, as 88% of the runoff within the ROW is generated from the impervious cover class (Table 14). Conversely, Forest (primarily street trees) encompasses 37% of the ROW and accounts for only 7% of the runoff (Table 14). In short, forested areas and street trees are valuable in ameliorating the volume of stormwater generated within the Snoqualmie's ROW.

Preliminary Summary of runoff characteristics for the City of Snoqualmie to compliment land cover assessment being completed by Ecosystem Sciences.

Northwest Hydraulic Consultants is developing a Hydrologic Simulation Program Fortran (HSPF) model of the City of Snoqualmie to support the City's Stormwater Mater Plan (SMP) efforts. The model currently utilizes USGS Regional Runoff calibration parameters (Dinicola, 1990) and is being calibrated to local flow data collected on D-Creek and E-Creek during the winter of 2019. When complete the model will include most City managed flow control facilities and flow diversions. The flow summary provided below relies on unit area runoff rates (i.e. it does not reflect the detailed model routing information that is under development) and is intended to provide a high level look at runoff within the

City that is consistent with the hydrologic modeling approach being used for the stormwater plan. Once complete the SMP will provide flow quantile summaries for each basin in the City that reflect detailed flow routing and bypass modeling.

It is worth noting that approximately 60% of the City's developed area lies within areas served by direct discharge conveyance systems that route storm flows around sensitive creeks and discharge directly to the Snoqualmie River. On Snoqualmie Ridge the North High Flow Bypass (NHFB) and the East High Flow Bypass (EHFB) convey all high flows north and east off of the Ridge, while allowing base flows to continue to flow to the smaller streams and wetlands. In the Historic Downtown planning area there are a series of smaller stormwater outfalls that convey all runoff to the river. Table 15 has divided the impervious area by a 60/40 ratio into "unmitigated, routed directly to Snoqualmie River" and "mitigated, routed to streams" categories. The mitigated impervious category is assumed to have a 2-year peak runoff response similar to forest cover, which was included in the 1998 flow control design standard applied at the time that portion of Snoqualmie Ridge was developed. The unmitigated runoff routed to the Snoqualmie River reflects no attenuation from flow control facilities.

Area listed above came from Table 3 of the Ecosystem Sciences PDF. '% of Peak Runoff' has also been reported in a similar manner, reflecting the % of the peak hour of runoff contributed by each land cover area based on the simulated unit area runoff rates.

Overall, Natural Infrastructure, such as forests, provides significant ecosystem services, especially related to stormwater. Promoting infiltration of rainwater, as opposed to promoting runoff (e.g. roads), improves groundwater reserves (through infiltration) and reduces total volume of stormwater and pollutant loads to local water bodies.

TABLE 12. 2-YR EVENT RUNOFF ASSOCIATED WITH CITY OF SNOQUALMIE OWNED (PUBLIC) PARCELS

Major Land Cover	Acres	% Area	2-yr Event Peak Discharge (CFS)	Total Cubic Feet (1 hr)	% Discharge
Bare soil or dry veg	52.1	3.3%	1.3	4,688	3.8%
Forest	1,150.5	72.0%	14.4	51,772	41.9%
Impervious	51.4	3.2%	5.8	20,832	16.9%
Irrigated Vegetation	256.4	16.0%	8.0	28,846	23.3%
Open Water	30.3	1.9%	3.8	13,618	11.0%
Shrub	57.4	3.6%	1.1	3,873	3.1%
Total	**1,598.1**	**100.0%**	**34.3**	**123,630**	**100.0%**

TABLE 13. 2-YR EVENT RUNOFF ASSOCIATED WITH NON-CITY OF SNOQUALMIE OWNED (PRIVATE) PARCELS

Major Land Cover	Acres	% Area	2-yr Event Peak Discharge (CFS)	Total Cubic Feet (1 hr)	% Discharge
Bare soil or dry veg	386.3	11.8%	9.7	34,763	6.8%
Forest	1,515.0	46.2%	18.9	68,175	13.4%
Impervious	684.4	20.9%	77.0	277,184	54.4%
Irrigated Vegetation	457.0	13.9%	14.3	51,413	10.1%
Open Water	162.9	5.0%	20.4	73,285	14.4%
Shrub	71.9	2.2%	1.3	4,853	1.0%
Total	**3,277.4**	**100.0%**	**141.6**	**509,673**	**100.0%**

TABLE 14. 2-YR EVENT RUNOFF ASSOCIATED WITHIN THE RIGHT-OF-WAY (ROW) CITY OF SNOQUALMIE

Major Land Cover	Acres	% Area	2-yr Event Peak Discharge (CFS)	Total Cubic Feet (1 hr)	% Discharge
Bare soil or dry veg	26.5	6.6%	0.7	2,381	2.5%
Forest	150.3	37.4%	1.9	6,764	7.1%
Impervious	205.8	51.2%	23.2	83,347	87.8%
Irrigated Vegetation	16.7	4.1%	0.5	1,874	2.0%
Open Water	0.9	0.2%	0.1	414	0.4%
Shrub	1.8	0.4%	0.0	121	0.1%
Total	**401.9**	**100.0%**	**26.4**	**94,901**	**100.0%**

TABLE 15

Major Land Cover	Acres (from E.S. PDF)	% of Total Area	Citywide HSPF Model		Rational Method from E.S. PDF	
			2-year Event Peak [1-hour average] Discharge (cfs)	% of Peak Runoff	2-year Event Peak Discharge (cfs)	% of Peak Runoff
Bare soil or dry veg	438.3	9%	64	11%	11	4%
Forest	2636.2	54%	37	7%	33	13%
Impervious (unmitigated, routed directly to Snoqualmie River)	441.42	9%	215	38%	82.8	32%
Impervious (mitigated, routed to streams)	294.28	6%	43	8%		
Irrigated Vegetation	721.9	15%	105	19%	22.6	9%
Open Water	193.2	4%	94	17%	24.1	9%
Shrub	149.6	3%	5	1%	2.8	1%
Total Area	**4874.9**	**100%**	**562**	**100%**	**259**	**100%**

APPENDIX B: OVERVIEW OF ECOSYSTEM GOODS AND SERVICES

In 2001, an international coalition of over 1,360 scientists and experts from the United Nations Environmental Program, the World Bank, and the World Resources Institute assessed the effects of ecosystem change on human well-being. A key goal of the assessment was to develop a better understanding of the interactions between ecological and social systems, and in turn to develop a knowledge base of concepts and methods that would improve our ability to "…assess options that can enhance the contribution of ecosystems to human well-being" (UNEP, 2005) This study produced the landmark Millennium Ecosystem Assessment, which classifies ecosystem services into four broad categories according to how they benefit humans. These categories are as follows:

- Provisioning goods and services provide physical materials and energy for society that vary according to the ecosystems in which they are found. Forests produce lumber, agricultural lands supply food, and rivers provide drinking water.
- Regulating services are benefits obtained from the natural control of ecosystem processes. Intact ecosystems keep disease organisms in check, maintain water quality, control soil erosion or accumulation, and regulate climate.
- Supporting services include primary productivity (natural plant growth) and nutrient cycling (nitrogen, phosphorus, and carbon cycles). These services are the basis of the vast majority of food webs and life on the planet.
- Information services are functions that allow humans to interact meaningfully with nature. These services include providing spiritually significant species and natural areas, natural places for recreation, and opportunities for scientific research and education.

TABLE 16: TWENTY-ONE ECOSYSTEM SERVICES

Service	Economic Benefit to People
Provisioning	
Energy and Raw Materials	Providing fuel, fiber, fertilizer, minerals, and energy
Food	Producing crops, fish, game, and fruits
Medicinal Resources	Providing traditional medicines, pharmaceuticals, and assay organisms
Ornamental Resources	Providing resources for clothing, jewelry, handicraft, worship, and decoration
Water Storage	Providing long-term reserves of usable water via storage in lakes, ponds, aquifers, and soil moisture
Regulating	
Air Quality	Providing clean, breathable air
Biological Control	Providing pest, weed, and disease control
Climate Stability	Supporting a stable climate at global and local levels through carbon sequestration and other processes
Stormwater Retention	Preventing and mitigating natural hazards such as floods, hurricanes, fires, and droughts
Pollination and Seed Dispersal	Pollinating wild and domestic plant species via wind, insects, birds, or other animals
Soil Formation	Accumulating soils (e.g. via plant matter decomposition or sediment deposition in riparian/coastal systems) for agricultural and ecosystem integrity
Soil Quality	Maintaining soil fertility and capacity to process waste inputs (bioremediation)
Soil Retention	Retaining arable land, slope stability, and coastal integrity
Water Quality	Removing water pollutants via soil filtration and transformation by vegetation and microbial communities
Water Capture, Conveyance, and Supply	Regulating the rate of water flow through an environment and ensuring adequate water availability for all water users
Ultraviolet Radiation Reduction	Forest canopy can reduce exposure to harmful UV light from the sun
Temperature Regulation	Shade provided by forests can reduce local temperatures and provide energy savings
Supporting	
Habitat	Providing shelter, promoting growth of species, and maintaining biological diversity
Nutrient Cycling	Movement of nutrients through an ecosystem by biotic and abiotic processes. Supports retention in the biosphere and the soil organic layer
Information	
Aesthetic Information	Enjoying and appreciating the scenery, sounds, and smells of nature
Cultural Value	Providing opportunities for communities to use lands with spiritual, religious, and historic importance
Science and Education	Using natural systems for education and scientific research
Recreation and Tourism	Experiencing the natural world and enjoying outdoor activities
Artistic Inspiration	Using nature as motifs in art, film, folklore, books, cultural symbols, architecture, and media

APPENDIX C: USING FUNCTION TRANSFER TO MEASURE STORMWATER RETENTION REPLACEMENT COST

Compared to Benefit transfer, function transfer method typically provides better accuracy because it can be calibrated to the specific site conditions. Function transfer requires knowledge of the values of the independent variables for the proposed site of interest and assumes that the statistical relationship between the dependent and independent variables is the same between the study and proposed sites (Rosenberger and Loomis, 2003). For this study, data availability allowed for the use of function transfer to monetize three ecosystem services in the City of Snoqualmie: Stormwater retention, carbon sequestration, and water quality. The following provide more detail on the approach taken for each.

Using Construction Marginal Costs to Derive a Market Values for Stormwater and Filtration Ecosystem Services

The costs of different engineered stormwater retention and water filtration facilities are well known, as are the water retention and filtration capacities of natural systems in the Northwest. Using function transfer to value water ecosystem services is a widely accepted approach conducted throughout the US (Nordman et al. 2018). To arrive at stormwater retention and water quality ecosystem service values, this analysis uses function transfer to estimate replacement cost, or the cost required to replace the City's natural infrastructure with built capital. The remainder of this section on how the market value was selected and how this is the "right size" for the City of Snoqualmie.

Traditional methods of controlling stormwater flow and filtering water is achieved through the construction of infrastructure such as drainage basins, pipes, culverts, and other flow and storage systems, as well as filtration systems. Without the natural infrastructure provided by urban and rural forests, either flooding increases or capital investments are required to replace these services. Stormwater systems, for example, are constructed, improved, and retrofitted over time, making it difficult to estimate the value of stormwater control systems across an entire city. Therefore, we rely on the marginal cost of stormwater infrastructure costs, or the cost per unit of water retained.

Multiple research efforts by private firms, non-profits, and government entities have established data libraries and archives of capital infrastructure projects in the US (RSMeans, 2009; CNT, 2009). This information provides a means of calculating the marginal cost of stormwater and water filtration infrastructure.

$$\text{Marginal Cost (\$/cf)} = \frac{\text{Stormwater Construction Cost (\$)}}{\text{Storage Volume (cf)}}$$

A robust list of capital projects allows for the selection of right-sized infrastructure projects that are comparable to a given scenario. Accordingly, we find that this approach allows for the derivation of a marginal cost that is suited to the characteristics of the same scenario.

The following two sections detail how the marginal cost of capital infrastructure are used to value stormwater retention and water quality respectively.

Details on Calculating Stormwater Retention Benefit of Snoqualmie Forests

Table 3 shows a value of 5,339 cf per acre retained by City of Snoqualmie forests. This value suggests that, during the 24 hour 2-year storm where 3 inches (or 10,891 cf per acre) of rain falls, approximately 49% of the rainfall is captured by forests. Compared to an impervious surface (parking lot) where nearly none of the water is retained as it becomes surface water runoff.

This was derived using information provided by the consultant Northwest Hydraulic Consultants using the Hydraulic Simulation Program Fortran (HSPF) model to support the City of Snoqualmie developing the Stormwater Master Plan. The model showed that, over the course of a year, City of Snoqualmie forest cover rendered approximately 2.5 acre-ft per acre per year of stormwater runoff, as compared to impermeable surfaces which produce 5.1 acre-ft per acre per year. The difference (2.5 acre-ft per acre per year, or a 49% reduction) demonstrates the benefit provided by forests compared to impermeable surfaces. Using this factor, we assumed this same reduction in the 24 hour 2-year storm scenario, where 10,891 cf per acre reduces to approximately 5,339 cf per acre.

Market Value: Stormwater infrastructure is not one size fits all. Depending on the type of infrastructure selected, the per unit cost of stormwater mitigated varies. For example, a water detention basin requires limited construction versus more advanced assets like a bioretention system. Both structures may provide similar storage capacity but are designed for much different purposes and at different costs. Table 17provides a wide sampling of stormwater infrastructure projects from a single study, showing a range of costs and capacities (Ballestero et al., 2005). The study discussed how more expensive projects targeted water quality performance goals in addition to providing some quantity of stormwater abatement.

Each value in the table above was amortized, meaning the cost of the capital infrastructure project was spread out over an estimated 30-year lifespan, discounted at 5%. Additionally, dollar values were converted to today's 2020 dollar rate.

Criteria for Selection for City of Snoqualmie: To design or establish a baseline stormwater project, there is a requirement that the outlet flows be controlled to avoid peak flows that exceed the capacity of the existing stormwater infrastructure. The most common and inexpensive approach to this is construction of one or more detention basins. This study used, as the baseline, a detention basin designed with outlet flows that did not exceed 20 cfs. This assumption established a "cap" on the size of the infrastructure project and was based on the fact the study area does not include a contiguous 130 acre of natural infrastructure. A common release rate standard requires an outlet no higher than 0.15-cfs per acre of development, which was used to calculate the assumed 20 cfs design standard (USGS, 2009).

Using a detention basin designed to the parameters discussed above, the marginal cost of capital was then derived. The values selected and used in the monetization of stormwater benefits were adopted from

King County and shown in Table 17 above. When reviewing the King County report that provided the dollar values, the description of "medium density residential" and "low-density residential" matched best with the density and conditions of the City of Snoqualmie, relative to the other studies and associated locations listed in Table 17.

Following the formula presented in Figure 2 above, each input used to calculate the value of stormwater benefit is outlined below:

Part A - Stormwater Retained by Snoqualmie Forests: The peak rate of water runoff retained by Snoqualmie urban and rural forests was calculated above. This and other information are used to calculate the total volume of water retained by these forests, found to be approximately 5,339 cf per acre under a 2yr 24hr storm. Appendix C provides detail on how this was calculated.

Part B - Marginal Cost of Stormwater Infrastructure: Deriving marginal cost values for the City of Snoqualmie was completed by collecting local geophysical data (i.e. average rainfall, average storm size and frequency) and comparing this to relevant municipal stormwater infrastructure cost data, similar to existing stormwater projects the City of Snoqualmie published in historic 10-yr capital plans (City of Snoqualmie, 2017). Stormwater values were found to be approximately $0.83 to $1.02 per cf. Appendix C details the process of selecting marginal cost values, including data sources.

Details on Calculating Water Quality Benefits of Snoqualmie Forests

Calculating water quality benefits provided by City of Snoqualmie forests is broken down in the steps below:

Part A - Compounds Filtered from Water: Hill et al. published in 2013 analyzed water quality benefits provided by forests adjacent and near headwater streams and catchments in Washington State (Hill et al. 2013). The study calculated the rate of nutrient and compound reduction (nitrogen, phosphorus, total suspended solids filtration) in kilograms per hectare per year, which were converted to kilograms per acre per year in Table 18 below.

TABLE 17. SAMPLE STORMWATER INFRASTRUCTURE PROJECT COST RATIOS

Infrastructure Type	Ratio ($/cf)	Study
Retention Basin (Low)	$0.75	USEPA, 2009
Retention Basin (High)	$1.49	USEPA, 2009
Wet Pond - Medium Density Residential	$0.83	King County, 2012
Wet Pond - Low Density Residential	$1.02	King County, 2012
Detention Basin	$1.09	CNT, 2009
Detention Basin	$0.70	CNT, 2009
Large Detention Basin	$2.29	Barr 2011
Bioretention System	$6.36	Ballestero, 2005
Surface Sand Filter	$11.69	Ballestero, 2005

The Hill et al. study used nine data collection points at and downstream of headwater streams on the west side of the cascade mountains. This was collected as a part of the EPA's National Rivers and Streams Assessment with catchment attributes related to the reduction of nitrogen, phosphorus, and total suspended solids. The study used this data to develop ecological production functions related to the delivery of ecosystem services from headwater catchments.

The study conducted a statistical analysis, calculating mean values for several catchment attributes including annual precipitation and runoff, sedimentation rates, in addition to nutrient reduction rates. All values were statistically significant.

Part B - Marginal Cost of Filtration Infrastructure: Over the last two decades, ample research has been conducted on the costs associated with nitrogen, phosphorus, and total suspended solids removal from riverine water sources. One of the adopted market values came from the US EPA document Water Quality Trading Toolkit for Permit Writers (USEPA 2009). Table 19 shows the market values adopted for nitrogen, phosphorus, and total suspended solids filtration. The selection of these values among others provided in a literature review is discussed in Appendix C.

TABLE 18: NUTRIENT OR COMPOUND REDUCTION

Nutrient/Compound	Reduction Rate	Study
(kg/ha/yr)	Reduction Rate (kg/acre/yr)	USEPA, 2009
Nitrogen Fixation	33.6	13.6
Phosphorus Fixation	1.4	0.6
Total	**46.8**	**19.0**

TABLE 19: MARKET VALUE OF NUTRIENT/COMPOUND REDUCTION

Compound	Market Value ($/kg)		Source
	Low	High	
Nitrogen	$3.13	$5.88	USEPA, 2015
Phosphorus	$2.61	$57.66	USEPA, 2015
Total Suspended Solids	$0.03	$0.13	USEPA, 1998

TABLE 20: LIST OF MARKET VALUES FOR THE COST OF NUTRIENT REDUCTION

Source	Compound	Value ($/kg)	Note
EPA Toolkit	Nitrogen	$3.13 - $5.88	Municipal waste treatment
EPA Toolkit	Phosphorus	$2.61 - $57.66	Municipal waste treatment
Sano et al. 2004	Phosphorus	$14.87 - $47.71	Reservoir treatment
Randall et al. 1999	Nitrogen	$0.57 - $4.25	Wastewater treatment plant
Wiedeman 2000	Nitrogen	$2.56	Wastewater treatment plant
Faeth 2000	Phosphorus	$8.20 - $18.88	
USGPO 1986	Total Suspended Solids	$0.17	Publicly owned treatment works (BOD and TSS)
USEPA 1998	Total Suspended Solids	$0.03 - $0.13	Urban Stormwater w/ Treatment

TABLE 20: LIST OF MARKET VALUES FOR THE COST OF NUTRIENT REDUCTION

Forest Type	Forest Type Specific	Acres	Estimated Sequestered Carbon (tons/acre/year)	
			Low	High
Coniferous	Hemlock-Sitka Spruce	151.0	2.544	2.544
Coniferous	Douglas Fir	421.3	2.726	2.726
Coniferous	Mixed Species	778.7	2.544	2.726
Deciduous	Alder-Maple	542.2	2.135	2.135
Deciduous	Aspen-Birch	0.1	0.853	0.853
Deciduous	Elm-Ash-Cottonwood	1.2	0.714	0.714
Deciduous	Mixed Species	771.5	0.714	2.135

Not only are municipalities and utilities interested in costs to treat public drinking water sources, but federal and state entities provide data on the costs of nutrient reduction informing permitting costs and guidelines. As a result, multiple institutions had attempted to understand the value of nutrient and compound reduction in public waters. Table 20 below provides a list of market values from a literature review, highlighting those from the EPA selected for this study.

The values selected for this study include the EPA Toolkit values for nitrogen and phosphorus, as well as a separate study from the EPA for TSS. These were chosen based on review of the documents showing the most recent and relevant market values. Relevance was determined with the need to select non-agricultural nutrient reduction costs in order to avoid overestimating market value. Additionally, more recent studies reflect more accurate market conditions for public works construction.

Limitations of Approach: The water quality analysis in this report accounted for a few well studied nutrients or compounds traditionally filtered by conventional infrastructure. In an urban context, stormwater runoff produces multiple water quality concerns, several of which were not assessed specifically in this report. Sedimentation, road oils and salts, and other common urban heavy metals were not specifically assessed and were therefore omitted.

Details on Calculating Carbon Sequestration and Stock Benefits of Snoqualmie Forests

Following the formula provided in Figure 3, carbon benefits provided by City of Snoqualmie forests are broken down in the steps below:

Part A - Carbon Sequestered by Snoqualmie Forests: Multiple studies were used to estimate carbon sequestration of Snoqualmie forests. Each study was used to collect carbon biomass data, matching values in annual metric tons of carbon sequestered per acre to vegetation types found specifically in the Central Cascade region. Table 21 below lists the taxonomy of forest type groups that exist within City limits, providing their corresponding acreage, carbon biomass, and data sources

The range above represents how mixed forests may contain multiple forest species, and thus varying carbon sequestration rates. Appendix C shows how each species identified above breaks down by ownership, and what assumptions were made in estimating the amount carbon sequestered each year.

TABLE 22: CARBON SEQUESTRATION RATES BY OWNERSHIP TYPE

Ownership Type	Forest Type	Forest Type Specific	Acres	Seq Carbon Low	Seq Carbon High
Private	Coniferous	Cedar-Hemlock-Sitka Spruce	2.4	2.355	2.355
Private	Coniferous	Douglas Fir	23.2	2.248	2.248
Private	Coniferous	Mixed Species	739.2	2.248	2.355
Private	Deciduous	Alder-Maple	10.5	2.135	2.135
Private	Deciduous	Aspen-Birch	0.1	0.853	0.853
Private	Deciduous	Elm-Ash-Cottonwood	11.1	0.714	0.714
Private	Deciduous	Mixed Species	578.8	0.714	2.135
Public	Coniferous	Cedar-Hemlock-Sitka Spruce	148.554951	2.355	2.355
Public	Coniferous	Douglas Fir	398.112014	2.248	2.248
Public	Coniferous	Mixed Species	39.503788	2.248	2.355
Public	Deciduous	Alder-Maple	406.18677	2.135	2.135
Public	Deciduous	Aspen-Birch	0	0.853	0.853
Public	Deciduous	Elm-Ash-Cottonwood	115.488283	0.714	0.714
Public	Deciduous	Mixed Species	42.741397	0.714	2.135
ROW	Coniferous	Cedar-Hemlock-Sitka Spruce	0.01518	2.355	2.355
ROW	Coniferous	Douglas Fir	0.231067	2.248	2.248
ROW	Coniferous	Mixed Species	36.308849	2.248	2.355
ROW	Deciduous	Alder-Maple	0.132136	2.135	2.135
ROW	Deciduous	Aspen-Birch	0	0.853	0.853
ROW	Deciduous	Elm-Ash-Cottonwood	1.040686	0.714	0.714
ROW	Deciduous	Mixed Species	112.565249	0.714	2.135

Sequestration rates were taken from multiple studies (Smith et al. 2006; Liu et al. 2013; Heath et al. 2003). These studies calculated sequestration rates and carbon storage of several types of forests throughout the US. Tree species located in Snoqualmie were matched with the most closely related forest type. The following assumptions were made on the selection: Average age of deciduous urban trees (25 years), average age of rural coniferous trees (70 years), management regime of forest (reforestation - regrowth after clearcut).

Part B - Market Value of Carbon: Dozens of carbon values already exist in the US markets.. As of Q1 2020, the California Carbon Auctions market trading at $17.84 per ton of carbon (California Air Resources Board, 2020). This value was adopted for this report, in addition to another that comes from City Forest Credit (CFC), an organization that established a carbon offset market and urban forest carbon protocol for community forests. A recent CFC carbon transaction in King County at $22.00 per ton of carbon not only establishes a local carbon market value, but also highlights the opportunity for a funding mechanism for the City of Snoqualmie.

There exist multiple US carbon markets. In addition to those used in this report, several others have been established, some estimating the social cost of carbon. The social cost of carbon is defined as at attempt to be a comprehensive estimate of climate change damages and includes, among other things, changes in net agricultural productivity, human health, property damages from increased flood risk and changes in energy system costs, such as reduced costs for heating and increased costs for air conditioning (USEPA, 2016). The Center for Environmental Quality's Interagency Working Group on the Social Cost of Carbon published a 2011 report showing that carbon costs approximately $46.05 to 142.33 per metric ton (Interagency Working Group on Social Cost of Carbon, 2013).

Carbon Stock Calculations

The value of carbon stocks in Snoqualmie's forests is calculated by combining the price of carbon with peer reviewed estimates of carbon stocks for Snoqualmie's forest types. Part A and B following Figure 3.

Part A - Carbon Stock in Snoqualmie forests: Multiple studies were used to estimate carbon stock of Snoqualmie forests. These studies reported carbon biomass allowing for the matching of values in metric tons of carbon stored per acre to vegetation types found specifically in the Central Cascade region with monetary values provided above. Table 23 below lists the taxonomy of forest type groups that exist within City limits, providing their corresponding acreage and carbon biomass.

TABLE 23: CARBON STOCK BY FOREST TYPE

Forest Type	Forest Type Specific	Estimated Carbon Stock (tC/acre)	
		Low	High
Coniferous	Cedar-Hemlock-Sitka Spruce	237.9	237.9
Coniferous	Douglas Fir	242.8	242.8
Coniferous	Mixed Species	237.9	242.8
Deciduous	Alder-Maple	264.6	264.6
Deciduous	Aspen-Birch	117.1	117.1
Deciduous	Elm-Ash-Cottonwood	132.3	132.3
Deciduous	Mixed Species	132.3	264.6

TABLE 24: CARBON STOCK BY OWNERSHIP TYPE

Ownership Type	Acres by Ownership	Total Carbon Stock Value	
		Low ($/yr)	High ($/yr)
Private	1,365	$4,690,093	$7,548,323
Public	1,300	$5,237,195	$6,918,738
Total	2,665	9,927,288	14,467,061

Part B - Market Value: Market values used were the California Carbon Auctions market trading at $17.84 per ton of carbon, as well as a recent CFC carbon transaction in King County at $22.00 per ton of carbon.

Part C - Snoqualmie Forest Carbon Stock Value: Table 24 combines each species' carbon biomass with the above selected market value to arrive at the total value of carbon stock.

APPENDIX D: OVERVIEW AND USE OF DISCOUNT RATES

When the value of natural systems is brought to light, it shows that investments in restoration and conservation have the capacity to provide good rates of return. Benefit/cost analysis and rate of return calculations were initiated after the 1940s to examine investments in built capital assets which were expected to be productive for a few decades until they required replacement. Natural systems do not depreciate or fall apart like built capital assets.

In fact, natural systems can even appreciate in value over time, being composed of living and growing organisms. Of course, natural systems are only renewable if they are protected against degradation, development, unsustainable extraction, and other impacts. As long as the natural infrastructure of the City of Snoqualmie is not degraded or depleted below its ability to renew itself, this flow of value will likely continue into the future.

Discounting can be adjusted for different types of assets and is designed to reflect the following:

- Time preference of money. This is the value that people put on something for use now, as opposed to the value they assign for that use or income at a later date.
- Opportunity cost of investment. A dollar in one year's time has a present value of less than a dollar today, because a dollar today can be invested for a positive return in one year.
- Depreciation. Built assets such as roads, bridges and levees deteriorate and lose value due to wear and tear. Eventually, they must be replaced.

Discounting has limitations that may result in under- or overestimates when applied to natural infrastructure. Using a discount rate assumes that the benefits humans reap in the present are more valuable than the benefits provided to future generations, or even to this generation in just a few years into the future. Natural infrastructure assets should be treated with lower discount rates than built capital assets because they tend to appreciate over time, rather than depreciate. The City of Snoqualmie is providing more water, to more people, for a greater total value than it provided 50 or 100 years ago. Unlike a factory that is 50 years old, a protected watershed will appreciate in value if it remains mostly intact and experiences an increase in demand for its services. Additionally, most of the benefits that a natural asset such as forests provides reside in the distant future, whereas most of the benefits of built capital reside in the near-term, with few or no benefits provided into the distant future. Both types of assets are important to maintain a high quality of life, but each operates on a different time scale. It would be unwise to treat human time preference for a forest like it were a building, or that of a building as if it were a disposable coffee cup. Thus, a low discount rate better reflects the asset value of the City of Snoqualmie's natural assets.

The net present value of the City's forest ecosystem services was calculated using two discount rates over 50 years: 2.75% and 0% percent. The discount rate of 0% percent reflects the fact that human population and future development will degrade the City's ecosystems and reduce their ability to provide ecosystem services if they are not adequately protected. This process is analogous to depreciation of a built capital asset. Federal agencies like the Army Corps of Engineers use a 2.75% percent discount rate for water resource projects (Powers, 2013).

The cut-off date of 50 years is arbitrary. Clearly, far greater value yet resides for the many generations who should benefit from the watershed well beyond the 50-year point, assuming the watershed is adequately protected. Currently, the value of economic assets is generally not considered beyond 50 years. This study follows that tradition. With no cut-off for value, any renewable resource would register an infinite value. However, the value of watersheds does extend far beyond a 50-year period, and better tools for capturing that value are being developed by economists.

APPENDIX E: RESOURCES TO SUPPORT URBAN FORESTRY PROGRAM

KING COUNTY PROGRAMS

King County offers a diversity of programs that can support City of Snoqualmie in your goal of developing and sustaining a thriving urban forestry program that maintains healthy and thriving natural infrastructure.

- Transfer of Development Rights
- In lieu fee mitigation
- Land Conservation Initiative
- Forest Carbon

King Country Program Contacts:

Michael Murphy
Transfer of Development Rights and In Lieu Fee Mitigation
Water and Land Resources Division
Department of Natural Resources & Parks
(206) 477-4781
Michael.Murphy@kingcounty.gov

Kathleen Farley Wolf
Forestry Program
King County Department of Natural Resources & Parks
201 S Jackson Street, Suite 600
Seattle, WA 98104
(206) 477-4363
kfarleywolf@kingcounty.gov

CITY FOREST CREDITS

City Forest Credits is a non-profit, third-party verified city forest carbon registry based out of Seattle, WA. This program has protocols and funding partners that could be very valuable in supporting sustainable growth of Snoqualmie's urban forestry program.

Mark McPherson
Executive Director & Founder
999 Third Ave #4600
Seattle, WA 98104
(206) 470-7696
mark@cityforestcredits.org

Liz Johnston
Director
liz@cityforestcredits.org

APPENDIX F: STEWARDSHIP AND OPPORTUNITIES FOR CITY OF SNOQUALMIE

Through this assessment, the TKC team provides a robust and scientifically proven analysis of the City's natural infrastructure and its ecosystem service value. Using the outputs from this analysis, the TKC team collaborated with technical experts in a variety of arenas (stormwater, urban forestry, land use) and City staff to develop potential policy and funding recommendations for the City to consider in sustaining the urban forestry program. The following discussion expands on priorities for implementation outlined in Table 8 of this report.

STORMWATER FEES Use stormwater fees to fund the urban forestry program based on values set in this Natural Infrastructure Assessment and regional examples established in the Herrera Environmental Consultants Tech Memo (Appendix G).

ACTIONS The Herrera Report provides a thorough analysis of 11 municipalities, in the PNW and across the US. The data gathered includes recommendations for: municipal codes, ordinances and council to support stormwater utility rates tied to urban forest planning. Recommendations include:

- Establish a stormwater fee rate structure based on local data and regional examples

ADDITIONAL OPPORTUNITIES

CITY FOREST CREDITS Explore City Forest Credits and King County Forest Credits carbon credit programs to fund tree planting and preservation projects (Appendix E)

ACTIONS The City Forest Credits Program provides verified third-party certified carbon credits available for tree planting and preservation projects. We recommend, Snoqualmie staff partner with City Forest Credits (and potentially King County) to develop a pilot project for City Forest Credit certification. If proven fruitful in securing credits and a carbon funder, this project could be the beginning of a long-term sustainable funding source for Snoqualmie's Urban Forestry Program.

- Example: Treasure Valley City Forest Credits Program

UPDATE CURRENT LAND COVER AND URBAN TREE CANOPY GIS DATABASE

ACTION Update current land cover and urban tree canopy GIS database – As recommended in Snoqualmie's Urban Forest Management Plan, and throughout the process of completing this assessment, an updated and more robust land cover mapping and urban tree canopy GIS database will be valuable to inform more accurate and beneficial data for the City's Urban Forestry Program.

EVALUATE RECREATION AND TOURISM ECOSYSTEM SERVICE VALUES In discussions with staff, while analyzing potential ecosystem services to value through this assessment, there was an interest in better understanding the value of recreation and tourism.

ACTION Snoqualmie staff can develop budget requests to support funding of a robust ecosystem services valuation for recreation and tourism within the City.

KING COUNTY TRANSFER OF DEVELOPMENT RIGHTS (TDR) PROGRAMS Investigate programs to enhance infrastructure preservation in high priority landscapes

ACTIONS Meet with King County staff, identify potential lands for conservation / preservation and pursue opportunities to capitalize on economic opportunities in preserving land from potential future development.

FEMA DISASTER DECLARATION PLAN A city-wide plan, based on the ecosystem service valuation platform, captures values for any future city flood disaster mitigation planning.

BACKGROUND & ACTIONS The United States Federal Emergency Management

Agency (FEMA) became the first federal agency to adopt ecosystem service valuation in formal policy. Faced with rising natural disaster costs and climate uncertainty, FEMA approved Mitigation Policy FP- 108-024-01 in June of 2013 (Federal Emergency Management Agency, 2013), which allows the inclusion of ecosystem services in benefit-cost analysis for acquisition projects. This policy is being applied for all flood disaster mitigation in all 50 states, for all private residential, business, public utility, city, county, and state impacted infrastructure. Under this policy, FEMA applies ecosystem service values nationwide.

On May 13, 2016, FEMA expanded the application of ecosystem services to all FEMA project types, including fire and drought. FEMA now allows restoration of streams and floodplains that mitigate the effects of drought and wildfire. Actions such as reforestation, soil stabilization, and flood diversion are now eligible. These wildfire and drought related mitigation activities are applicable to both the Hazard Mitigation Grant Program (following disaster declaration), as well as the Pre-Disaster Mitigation program.

While competitive at varying degrees, states and counties are able to apply for both funding sources. This suggests that the values derived in this report can be applied and used in Benefit Cost Analysis when applying for HMA grants following a disaster. For example, if a fire were to occur within the City of Snoqualmie boundary, King County or the City of Snoqualmie could use the ecosystem services values calculated in this report to improve the Benefit Cost Analysis ratio if a HMA grant were applied for. This FEMA policy represents an important acknowledgement of the importance of ecosystem services loss in the event of disaster and provides an opportunity for funding to recover from such an event.

INTERLOCAL WATERSHED INVESTMENT DISTRICT

BACKGROUND & ACTIONS Consider this problem: In one Washington State watershed (WRIA 9), 16 stormwater districts invest significantly to pipe water more efficiently into creeks and rivers as impermeable surface increases, while a county-wide flood district attempts to invest in flood risk reduction. City funded infrastructure is contributing to higher downstream peak flows and flood risks while the County's funding is increasingly devoted to larger levees and levee repairs. There's an "infrastructure conflict" and a vicious cycle of increasing flood damage and infrastructure (levee) costs.

Planning at a watershed level, it would be reasonable for downstream cities and the Snohomish County to pay for part of the City of Snoqualmie's green infrastructure stormwater costs because they receive flood risk reduction benefits. Unlike traditional stormwater systems that push more water downstream, the City of Snoqualmie green infrastructure reduces downstream peak flows.

The City of Snoqualmie is in Water Resource Inventory Area #7. Improving the WRIA 7 structure to include tax district funding transfers for services would increase income to Snoqualmie as a city higher in the watershed that provides significant green infrastructures for downstream communities.

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APPENDIX G: HERRERA ENVIRONMENTAL CONSULTANTS TECHNICAL MEMO

HERRERA

TECHNICAL MEMORANDUM

Date: August 14, 2017

To: King Conservation District, K4C-KCD Sustaining Urban Forests Working Group

From: Rebecca Dugopolski, PE, Herrera Environmental Consultants

Subject: Stormwater Utility Rates Supporting Urban Tree and Urban Forest Planning, Planting, and Management

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CONTENTS

APPENDICES

TABLES

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PORTLAND, OR | MISSOULA, MT | OLYMPIA, WA | BELLINGHAM, WA

Introduction

The King County-Cities Climate Collaboration (K4C) is a collaboration of King County and 13 cities that are working on enhancing the effectiveness of local government climate and sustainability action. K4C program areas include green building, using and producing renewable energy, sustainability outreach and education, and alternative transportation. King Conservation District (KCD) and a subset of K4C cities developed a working group focused on sustaining urban forests. The K4C-KCD Sustaining Urban Forests Working Group (which includes KCD, City of Snoqualmie, City of Normandy Park, City of Burien, City of Sammamish, and recently the City of Kirkland) was interested in developing an ordinance and code language that included urban tree and urban forest planning, planting, and management as a viable stormwater program component, to authorize expenditure of stormwater or surface water utility rates on urban tree and urban forest planning, planting, and management. This memorandum summarizes approaches taken by other Pacific Northwest and East Coast jurisdictions related to this topic and includes an implementation plan for developing municipal code language revisions. This memorandum is organized into the following sections:

- Background
- Documents Reviewed
- Summary of Findings
- Urban Forestry and Stormwater Program Budget Comparison
- Recommendations
- Implementation Plan
- Work Products (attachments):
    - Code Template
    - Ordinance Template
    - Council Report Template

Background

City and County stormwater or surface water utility funds support a wide variety of activities related to stormwater management, but are often not well documented in the City/County municipal code language. Several cities and counties are interested in providing clarity to rate payers regarding the broad range of stormwater management activities that are supported by their stormwater/surface water utility rate.

The cities participating in this working group are required to comply with the National Pollutant Discharge Elimination System (NPDES) Phase II Municipal Stormwater Permit, which includes requirements for public education and outreach, public involvement and participation; illicit discharge detection and elimination; controlling runoff from new development, redevelopment, and construction sites; and municipal operations and maintenance. The NPDES Phase II Municipal Stormwater Permit also includes measures to minimize loss of native vegetation as one of the three primary goals to be addressed during the integration of low impact development (LID) principles into local development-related codes, rules, standards, and enforceable documents that was recently completed by most of the Phase II permittees.

The *2012 Stormwater Management Manual for Western Washington* (SWMMWW), prepared by the Washington State Department of Ecology (Ecology) and amended in 2014, recognizes the importance of preserving native vegetation and retaining trees to provide stormwater flow control benefits such as interception, transpiration, and increased infiltration. Jurisdictions that adopt Ecology's 2012 SWMMWW, as amended in 2014, must allow provisions for providing a flow control credit for retained and newly planted trees. The flow control credit is applied only to trees that meet setback requirements, are protected during construction activities, are viable for long-term retention (i.e., in good health and compatible with proposed construction), and have a canopy overhanging proposed or existing impervious surfaces.

The goal of this project was to review municipal code language and supporting documents from several Pacific Northwest jurisdictions and East Coast jurisdictions with strong urban forestry programs and funding to determine how the linkage between stormwater/surface water utility funding; habitat restoration; and urban tree and urban forest planning, planting, and management is currently being made. This information, and working sessions with the working group, was used to develop a set of work products that can be implemented by those in the working group as well as by other interested jurisdictions in the Pacific Northwest.

Documents Reviewed

Municipal code language and Urban Forest Management Plans from the following jurisdictions were reviewed:

- City of Redmond, Washington
- City of Vancouver, Washington
- City of Everett, Washington
- City of Kirkland, Washington

- City of Tacoma, Washington
- City of Longview, Washington
- City of Portland, Oregon
- City of Fairview, Oregon
- City of Gresham, Oregon
- City of Milwaukee, Wisconsin
- Baltimore County, Maryland

Summary of Findings

City of Redmond, Washington

The City of Redmond's Urban Forestry program operates with a $435,000 per year budget for maintenance and management activities for trails, street trees, support facilities, restoration-related activities, and support to volunteers (T. Kluver, personal communication, March 28, 2017). The City's Tree Fund is managed by an interdepartmental team composed of staff from Parks and Recreation, Planning and Community Development, and the Natural Resources Division of Public Works. The Tree Fund can be used for planting trees, planting preparation, and work to save existing canopy trees threatened by invasive species.

The City of Redmond does not include specific language regarding Urban Forestry as part of their Stormwater Management Utility code (Chapter 13.18); however, their 20-year Forest Management Plan (Green Redmond Partnership 2009) includes the following language:

- "Much of the funding that the Natural Resources Division uses for stream buffer restoration and volunteer events comes from the Stormwater Fund, which is maintained by a standard fee levied on all Redmond residents and businesses as a fee per impervious unit. It is managed by Natural Resources and can be used for stormwater issues, outreach and education, planning, research, or maintaining water quality related to stormwater."
- "The Stormwater Fund can be used for stormwater issues, education, planning, research, or maintaining water quality relating to stormwater. This funding could potentially be directed toward stream or wetland restoration in parks where stormwater management is a concern."

City of Vancouver, Washington

Funding for the City of Vancouver's Urban Forestry Program comes from surface water management fees (97 percent) and compensatory mitigation via a Tree Fund (3 percent) (C. Ray, personal communication, July 6, 2016).

The City of Vancouver does not include specific language regarding Urban Forestry as part of their Stormwater Management – Regulations and Charges code (Chapter 14.09); however, their Urban Forestry Management Plan (Vancouver 2007) includes the following language:

- "In a renewed effort to not only protect the dwindling urban forest but also significantly restore canopy coverage, City Council approved a funding program for Urban Forestry in 2004, utilizing a portion of its surface water management fees in recognition of the green infrastructure and stormwater management benefits of trees."
- "Currently, Public Works supports Urban Forestry through dedication of a portion of the City's surface water management fees. These funds are used specifically to provide City services related to canopy restoration: coordination of contractor and volunteer tree planting efforts, outreach and education to promote environmental stewardship, and enhanced customer service. The use of this funding source is in recognition of the importance of the urban forest for stormwater management functions, water quality protection, and Clean Water Act, Clean Air Act, and Endangered Species Act compliance."

City of Everett, Washington

The City of Everett's Urban Forestry program is currently funded by the Parks Department operating budget; however, one of the long-term funding sources that will be evaluated as part of the 20-Year Forest Management Plan (Green Everett Partnership 2013) includes:

- "Financial nexus establishment between the management of forested parkland as stormwater management infrastructure and for other ecosystem services related to utility infrastructure."

The City of Everett does not currently list allowable expenditures of their surface water management rate in their municipal code (Chapter 14.60).

City of Kirkland, Washington

The City of Kirkland does not include specific language regarding Urban Forestry as part of their Surface Water Utility code (Chapter 15.56); however, their 20-year Forest Restoration Plan (Green Kirkland Partnership 2008) includes the following language:

- "The Surface Water Utility (SWU) is part of the Public Works Department. SWU interests intersect with Green Kirkland Partnership forest restoration efforts that directly contribute to water quality, stormwater management and habitat, especially near streams. Parks will collaborate with SWU when planning restoration events along streams. In return, SWU will provide guidance and support, continue public outreach and education on the importance of forested natural areas to water quality and other Public Works programs, engage volunteers in a water quality monitoring program for lakes and streams such as Forbes Lake, Totem Lake, and Forbes Creek, and conduct city-funded riparian and fish passage habitat improvements."

- Consider increasing "… fees or rates for utility ratepayers for management of forested natural areas as stormwater management (and other ecosystem services) infrastructure."

The City of Kirkland's Surface Water Utility currently supports a half-time (20 hours per week) Urban Forestry position ($47,558) and 50 percent of a full-time Field Arborist position (D. Powers, personal communication, July 13, 2016).

City of Tacoma, Washington

The City of Tacoma's Urban Forestry Program is funded through the storm and surface water sewerage charge. The Storm and Surface Water Sewerage Charge code (Chapter 12.08) does not include specific language regarding Urban Forestry; however, the City's website lists the following as supported by the City's surface water rate:

- Protection of Commencement Bay, Puget Sound and their tributaries from polluted runoff
- Operation and maintenance of stormwater structures, including 500 miles of pipe, 22,000-plus catch basins (storm drains), four pump stations and numerous detention ponds/structures protecting the area from flooding
- Innovative stormwater treatment systems
- Stormwater system inspections and monitoring
- Habitat restoration in wetlands, tidelands and uplands

The City of Tacoma's Tree Coupon Program for residential trees is also supported by the City's surface water rate. The Tree Coupon Program began in 2011 and is now in its fourth season (2015–2016).

City of Longview, Washington

The City of Longview's Urban Forestry Program operates with a $1,191,560 budget; $750,000 (63 percent) of which comes from the Storm Water Utility fund (C. Nedved, personal communication, September 22, 2016).

The City of Longview does not include specific language regarding Urban Forestry as part of their Stormwater Utility code (Chapter 15.80). The municipal code broadly states that the "storm water utility shall have authority and responsibility … for planning, design, construction, maintenance, administration, and operation of all city stormwater conveyances and facilities."

City of Portland, Oregon

The City of Portland's Urban Forestry Program is funded primarily through the general fund and grants; however, a portion of the Bureau of Environmental Services' "Grey to Green Initiative" uses sewer and stormwater fees to fund natural area acquisition and watershed revegetation, including tree planting (Portland State University 2010).

The City of Portland defines stormwater management services in their municipal code (Chapter 17.36) as the following:

- "Stormwater Management Services" means services and actions used to collect, convey, detain, retain, treat or dispose of stormwater. These services include managing stormwater runoff from public streets, mitigating flooding, preventing erosion, improving water quality of stormwater runoff, collecting and conveying stormwater runoff from private properties when runoff exceeds the capacity of private facilities to manage stormwater onsite, mitigating impacts to natural habitats caused by stormwater runoff, and protecting properties and natural habitats from hazardous soils and materials that are discharged from private properties and public rights-of-way."

City of Fairview, Oregon

The City of Fairview funds their Urban Forestry Program through stormwater fees and the City's general fund (Portland State University 2010). Urban forestry is not explicitly listed as an approved use for the storm drainage utility fund in the City's municipal code (Chapter 13.30); however, the language included in the City's code may be a useful model for this project. The City's Storm Drainage Utility Fund section of the municipal code states the following:

- "… money in the drainage utility fund shall be used for planning, design, construction, operation, maintenance and administration of storm drainage facilities, including repayment of indebtedness, and for all expenses for the operation and management of the storm drainage utility. Expenditures from this fund need not be identified to any particular revenue source."

City of Gresham, Oregon

The City of Gresham funds their Urban Forestry Program through stormwater fees, development fees, and grants (Portland State University 2010). The 2007–2008 operating budget for urban forestry was $600,000 (Portland State University 2010). Urban forestry is not explicitly listed as an approved use for the stormwater drainage utility fund in the City's municipal code (Chapter 3.60); however, the language included in the City's code may be a useful model for this project. The City's Storm Drainage Utility Fund municipal code states:

- "Money in the stormwater utility fund shall be used for planning, designing, and constructing the public stormwater system; for the regulation, maintenance, and administration of the public stormwater system; for providing all stormwater services, including the repayment of any indebtedness incurred before or after the effective date of this ordinance; and for all expenses related to the operation and management of the stormwater utility."

- Stormwater service is defined as "the operation of the city's stormwater utility in providing programs and facilities for maintaining, improving, regulating, collecting, and managing stormwater quantity and quality within the city's service area. This includes meeting regulatory requirements for protecting, monitoring, and reporting on water quality and on species listed under the Endangered Species Act."

City of Milwaukee, Wisconsin

The City of Milwaukee has been identified as a leader in funding their urban forestry program through its stormwater management fee (Gulick, undated). The City approved a small increase to their stormwater management fee and earmarked it for the urban forestry program. Urban forestry is not explicitly listed as an approved use for the stormwater management charge in the City's municipal code (Chapter 309); however, the language included in the City's code may be a useful model for this project. The City's Stormwater Management Charge municipal code states:

- "In order to protect the health, safety and welfare of the public, the common council establishes a storm water management charge to support operation and maintenance of the storm water management components of the city sewerage system. The city may use storm water management charge revenues to, without limitation by reason of enumeration, acquire, construct, lease, own, operate, maintain, extend, expand, replace, clean, dredge, repair, conduct, manage and finance such facilities as are deemed to be proper and reasonably necessary for management of storm water and other surface water discharge within the city. The common council further finds that those elements of the storm water management system that provide for the collection and disposal of storm water are of benefit to all real property within the city of Milwaukee, including property not presently served by that system. The costs of operating and maintaining the storm water management system and financing necessary repairs, replacement, improvements and extensions of the system should, to the maximum extent possible, be allocated in direct relationship to contributions of storm water to the system."

Baltimore County, Maryland

Baltimore County's Urban Forestry Program receives funding through the stormwater remediation fee (Article 34, Title 4) does not include specific language regarding Urban Forestry; however, the County's website lists the following activities as supported by the stormwater remediation fund:

- Street sweeping
- Storm drain cleaning
- Stormwater facility inspection, maintenance and upgrades
- Shoreline stabilization
- Urban canopy tree planting
- Reforestation
- Stream restoration
- Monitoring, planning and programs

Urban Forestry and Stormwater Program Budget Comparison

Table 1 was developed to compare the Urban Forestry Program budget, Stormwater/Surface Water Utility budget, Stormwater/Surface Water Utility rate for single-family residential properties, and population for cities where funding information was readily available and through personal communication with a few local jurisdictions.

Table 1. Urban Forestry and Stormwater/Surface Water Program Budget Comparison.

City	Urban Forestry Program Annual Budget	Storm/ Surface Water Utility Operating Budget (2015–2016)[a]	Storm/Surface Water Utility Single-Family Residential Rate (2016)	Population (2010 Census)
Redmond, WA	$435,000[b]	$29,941,265	$16.56	54,144
Vancouver, WA	$653,864[c]	$25,434,839	$8.79	161,791
Kirkland, WA	Not applicable; however does support 1 FTE[d]	$23,888,452	$16.87	48,787
Longview, WA	$1,191,560[e]	$6,484,000	$10.09	36,848
Gresham, OR	$600,000[f]	$6,025,910	$10.34	105,594

[a] Note: Operating budget does not include funding for Capital Improvement Program (CIP) projects.

[b] Source: T. Kluver, personal communication, March 28, 2017.

[c] Source: C. Ray, personal communication, July 6, 2016.

[d] Source: D. Powers, personal communication, July 13, 2016.

[e] Source: C. Nedved, personal communication, September 22, 2016.

[f] Source: Portland State University 2010.

Recommendations

Based on the jurisdictional code review for this memorandum, no specific examples linking urban forestry and stormwater utilities were found in the municipal code. Although urban forestry or associated components were not specifically listed as an allowable expenditure for the stormwater utility fee in the municipal code language, several Urban Forest Management Plans, studies, or jurisdictional websites listed the activities summarized in Table 2 as allowable stormwater utility expenditures related to urban forestry. None of the municipal code language reviewed explicitly prohibited stormwater utility fees being used to support urban forestry programs.

Table 2. Allowable Storm and Surface Water Expenditures Related to Urban Forestry.

Activity	Redmond, WA	Vancouver, WA	Kirkland, WA	Tacoma, WA	Portland, OR	Baltimore County, MD
Public Outreach and Education	X	X	X			
Stream or Wetland Restoration (Riparian Planting)	X	X	X	X		X
Watershed Revegetation					X	
Natural Area Acquisition					X	
Reforestation						X
Tree Planting		X		X	X	X

Code language from the City of Fairview, Oregon; City of Gresham, Oregon; or the City of Milwaukee, Wisconsin, were considered as potential models for listing allowable uses of a stormwater utility fee. All three jurisdictions provided a list of allowable uses (although fairly general in nature) for the stormwater utility fund.

Implementation Plan

The working group developed a set of implementation tools that can be modified and tailored to specific City/County needs. The three implementation tools developed as part of this project and included as appendices to this memorandum include:

1. Code Template
2. Ordinance Template
3. Council Report Template

The working group is also developing supporting tools to assist City/County staff with communicating and proposing the code, ordinance, and council report to decision makers and citizens in their communities.

Code Template

The code template developed for this project is included as Appendix A. Two levels of municipal code were developed: minimum recommended language and expanded language. The minimum recommended language includes a shorter purpose statement, a streamlined list of regulatory requirements, and fewer stormwater management services than the expanded language. It was anticipated that this more streamlined code may be easier for some City/County councils to review and approve. The expanded language includes a more robust purpose statement, a more detailed list of regulatory requirements, and additional stormwater management services. Additional items in the expanded language are shown in blue text to highlight the differences between the two code templates.

Alternate terminology (City versus County, Stormwater versus Surface Water Utility Fund) is included in brackets in both code examples. Yellow highlighted text should be filled in by the City or County with the appropriate municipal code section reference. Both code templates include recommended language and terminology, but should be tailored by the City/County for consistency with terminology used by that jurisdiction.

Ordinance Template

The ordinance template developed for this project is included as Appendix B. A single ordinance was developed that includes two optional whereas statements for a more robust ordinance. Similar to the code template, alternate terminology is included in brackets; yellow highlighted text should be filled in by the City or County; and light blue text designates expanded language. The City/County will need to provide a local definition of urban tree and urban forest planning, planting, and management. A whereas statement was also included for each City/County to add specific tailored language regarding the importance of urban tree protection and management in their jurisdiction (e.g., Tree City USA designation, adoption of an Urban Forestry Management Plan).

Council Report Template

Several jurisdictions in the working group typically provide a short council report or memorandum along with request for code changes. A one-page council report was also developed for this project to serve this purpose and is included as Appendix C. Similar to the code template and ordinance, alternate terminology is included in brackets; yellow highlighted text should be filled in by the City or County; and light blue text designates expanded language. Each of the statements in the council report could be expanded upon for a longer council report or memorandum. For a more technical memorandum, specific values regarding tree leaf canopy rainfall retention could be added from a Stormwater Magazine article titled “Give Me the Numbers: How trees and urban forest systems really affect stormwater runoff” published in the October 2016 issue (Teague and Kuehler 2016). Specific information regarding local requirements and the importance of trees could be added for an expanded council report or memorandum.

REFERENCES

Green Everett Partnership. 2013. Green Everett Partnership 20-Year Forest Management Plan. Prepared by the City of Everett Parks and Recreation Department, Forterra, and American Forestry Management, Inc. March 2013.

Green Kirkland Partnership. 2008. 20-Year Forest Restoration Plan. Prepared by the City of Kirkland, Cascade Land Conservancy, and King Conservation District. March 2008.

Green Redmond Partnership. 2009. 20-Year Forest Management Plan. Prepared by the City of Redmond Parks and Recreation Department, Cascade Land Conservancy, and International Forestry Consultants. April 2009.

Gulick, J. Undated. Funding Your Urban Forest Program. A Guide for New and Seasoned City Foresters. City Trees.

Portland State University. 2010. Regional Urban Forestry Assessment and Evaluation for the Portland-Vancouver Metro Area. Prepared by Audubon Society of Portland and Portland State University's Department of Environmental Science and Management. June 2009, revised June 2010.

Teague, A. and E. Kuehler. 2016. Give Me the Numbers: How trees and urban forestry systems really affect stormwater runoff. Stormwater Magazine. October 5, 2016.

Vancouver. 2007. City of Vancouver Urban Forestry Management Plan. Prepared by the City of Vancouver and Conservation Technix, Inc. December 2007.

APPENDIX A

Code Template

CODE TEMPLATE

STORMWATER UTILITY RATES SUPPORTING
URBAN TREE AND URBAN FOREST PLANNING, PLANTING, AND MANAGEMENT

Minimum Recommended Language

[*Alternate terminology is included in brackets*]

XX.XX.XXX Stormwater [*or Surface Water*] Utility Fund

A. In order to protect the health, safety, and welfare of the public; collect, convey, manage, and mitigate the quantity and quality of stormwater runoff; and meet the regulatory requirements of the National Pollutant Discharge Elimination System municipal stormwater permit, a Stormwater *[or Surface Water]* Utility Fund has been established to support City [*or County*] stormwater management activities.

B. The City *[or County]* may use Stormwater [*or Surface Water*] Utility fund revenues for planning, design, construction, operations and maintenance, replacement, and administration of the public stormwater system. Stormwater management services include, but are not limited to, public education and outreach; illicit discharge detection and elimination; stormwater site plan review; construction inspections; stormwater facility inspections; habitat restoration; and urban tree and urban forest planning, planting, and management.

Expanded Language

[*Additional terms are shown in blue text, alternate terminology is included in brackets*]

XX.XX.XXX Stormwater [*or Surface Water*] Utility Fund

A. In order to protect the health, safety, and welfare of the public; collect, convey, manage, and mitigate the quantity and quality of stormwater runoff; mitigate flooding; prevent erosion; and meet the regulatory requirements of the National Pollutant Discharge Elimination System municipal stormwater permit, Clean Water Act, Clean Air Act, Endangered Species Act, Shoreline Master Program, and the City [*or County*] critical areas ordinance; a Stormwater *[or Surface Water]* Utility Fund has been established to support City [*or County*] stormwater management activities.

B. The City *[or County]* may use Stormwater [*or Surface Water*] Utility fund revenues for planning, design, construction, operations and maintenance, replacement, acquisition, and administration of the public stormwater system. Stormwater management services include, but are not limited to, public education and outreach; illicit discharge detection and elimination; stormwater site plan review; construction inspections; stormwater facility inspections; design and installation of innovative treatment systems to reduce urban stormwater pollutant concentrations and runoff volumes; stormwater monitoring; street sweeping; shoreline stabilization; habitat restoration; urban tree and urban forest planning, planting, and management; and urban tree canopy assessment and monitoring.

APPENDIX B

Ordinance Template

ORDINANCE TEMPLATE

STORMWATER UTILITY RATES SUPPORTING URBAN TREE AND URBAN FOREST PLANNING, PLANTING, AND MANAGEMENT

ORDINANCE NO. XXXX

AN ORDINANCE of the City of XXX [*or County*], Washington, amending XXX to list specific activities that can be supported by the City [*or County*] Stormwater *[or Surface Water]* Utility Fund.

WHEREAS, the Stormwater *[or Surface Water]* Utility Fund supports a wide variety of activities related to stormwater management; and

WHEREAS, the City [*or County*] wants to provide clarity to rate payers regarding the broad range of stormwater management activities that are supported by their Stormwater *[or Surface Water]* Utility rate; and

WHEREAS, the City [*or County*] is required to comply with the National Pollutant Discharge Elimination System (NPDES) Phase II *[or Phase I]* Municipal Stormwater Permit, which includes requirements for public education and outreach; public involvement and participation; illicit discharge detection and elimination; controlling runoff from new development, redevelopment, and construction sites; and municipal operations and maintenance; and

[optional: **WHEREAS**, the NPDES Phase II *[or Phase I]* Municipal Stormwater Permit and included measures to minimize loss of native vegetation as one of the three primary goals to be addressed during the integration of low impact development principles into local development-related codes, rules, standards, and enforceable documents]

[*optional:* **WHEREAS**, the Washington State Department of Ecology recognizes that urban trees provide environmental benefits such as energy conservation, improved air quality, carbon sequestration, reduced heat island effect, pollutant removal, and habitat preservation or formation; and]

WHEREAS, the Washington State Department of Ecology Stormwater Management Manual for Western Washington recognizes the importance of preserving native vegetation and retaining trees to provide stormwater flow control benefits such as interception, transpiration, and increased infiltration; and

WHEREAS, several Pacific Northwest jurisdictions have recognized the importance of trees in relation to stormwater benefits and have designated a portion of their Stormwater *[or Surface Water]* Utility Fund to support urban tree and urban forest planning, planting, and management,

WHEREAS, several Pacific Northwest jurisdictions have recognized the impacts from stormwater runoff on surface water quality and have designated a portion of their Stormwater *[or Surface Water]* Utility Fund to support habitat restoration [*optional:* and shoreline stabilization] activities,

WHEREAS, the City [*or County*] defines urban tree and urban forest planning, planting, and management as XXX

WHEREAS, the City [*or County*] recognizes the importance of urban tree and urban forest planning, planting, and management [*optional:* through its Tree City USA designation and the adoption of an Urban Forestry Management Plan [*or Forest Management Plan, Forest Restoration Plan*]]

NOW, THEREFORE, THE CITY [*or County*] **COUNCIL OF XXXX, WASHINGTON DOES HEREBY ORDAIN AS FOLLOWS:**

Amend Chapter XX of the City [*or County*] **code. Chapter XX is hereby amended as follows:**

[*insert Stormwater Utility Rates Supporting Urban Forest Planning, Planting, and Management code template with preferred language here*]

APPENDIX C

Council Report Template

COUNCIL REPORT TEMPLATE

TO: XXXX, City *[or County]* Council

FROM: [name], [department]

DATE: [date]

SUBJECT: Stormwater *[or Surface Water]* Utility Rates Supporting Urban Tree and Urban Forest Planning, Planting, and Management

Background

The 2012 Stormwater Management Manual for Western Washington (SWMMWW), prepared by the Washington State Department of Ecology (Ecology) and amended in 2014, recognizes the importance of preserving native vegetation and retaining trees to provide stormwater flow control benefits such as interception, transpiration, and increased infiltration. In addition, the K4C-KCD Sustaining Urban Forests Working Group (comprising King Conservation District [KCD] and the Cities of Snoqualmie, Normandy Park, Burien, and Sammamish) supports the adoption of municipal code language that identifies urban forestry programs as a viable stormwater *[or surface water]* utility program component and, by extension, authorizes expenditure of stormwater *[or surface water]* utility funding on habitat restoration and urban tree and urban forest planning, planting, and management.

Analysis

Jurisdictions that adopt Ecology's 2012 SWMMWW, as amended in 2014, must allow provisions for providing a flow control credit for retained and newly planted trees. The flow control credit is applied only to trees that meet setback requirements, are protected during construction activities, are viable for long-term retention (i.e., in good health and compatible with proposed construction), and have a canopy overhanging proposed or existing impervious surfaces.

The 2012 Low Impact Development Technical Guidance Manual for Puget Sound stated that the annual stormwater reduction benefits from urban trees (dollars per gallon on construction and maintenance of stormwater facilities) ranged from approximately $37,000 to $496,000.

Urban trees have been shown to retain greater rainfall volume than trees in forests due to the greater leaf area of open-grown trees. Urban trees can retain as much as 80 percent of rainfall in regions with relatively light rainfall intensity and volume, such as the Pacific Northwest. Tree leaf canopy also delays the passage of water to the ground for less intense rainfall events from minutes to hours. Urban tree canopy assessment can help to determine the quantitative benefits of the existing tree canopy cover and set goals for future local ordinances, regulations, and comprehensive planning efforts.

Several jurisdictions in the Pacific Northwest, including Redmond, Vancouver, Tacoma, and Longview, Washington, and Gresham, Fairview, and Portland, Oregon, have recognized the importance of trees in providing stormwater benefits and currently support all or a portion of their urban forestry programs through stormwater/surface water utility rates.

Recommendation

The [department] recommends that the City [*or County*] Council approve Ordinance XXXX and encourages the Mayor/Commissioners to sign.

Budget

No funding is associated with this ordinance. However, the benefits of the City's [*or County's*] existing tree canopy could be further studied to help establish a baseline for quantifying the benefits of future urban tree and urban forest planning, planting, and management.

NATURAL INFRASTRUCTURE ASSESSMENT

CITY OF SNOQUALMIE
38624 SE RIVER ST
PO BOX 987
SNOQUALMIE, WA 98065

JUNE 2020