Technical Memorandum

City of Bellevue Watershed Management Plan Management Strategies and Prioritization Foundational Memorandum 3a

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Project name: Bellevue Watershed Management Plan

Project no: W3X94610

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1. Introduction and Purpose

The City of Bellevue (City) is developing the Watershed Management Plan (WMP) to improve the health of its streams over the next 20 years. The WMP development process is using a stepwise process that builds on information obtained from each proceeding step to ensure the final plan is comprehensive, makes the best use of new and existing data and information, and reflects the community's values and goals. This stepwise process is shown in Figure 1.

All the work performed to develop these components of the WMP will be informed by a conceptual model the City has developed that describes the primary effects of urban runoff on stream health (Figure 2). This model shows the linkages between specific sources of stress on stream health or limiting factors (e.g., stormwater runoff) and the consequences, impacts, and outcomes that collectively contribute to degraded stream health. For more information on the WMP development process and the results of assessing the limiting factors, see the watershed assessment reports prepared as part of this WMP planning effort (Herrera 2021; Herrera 2022; Jacobs 2021b; Jacobs 2022a) and the figures showing limiting factors by subbasin included in Attachment A of this memorandum.

The purpose of this memorandum is to document the process and the results of prioritizing watersheds and their respective subbasins for stream health improvement. The City has limited resources to apply to stream health improvement. This process intends to direct City investments[1] to those areas where streams show low to moderate levels of impairment. These streams are expected to benefit more quickly as a result of management actions to improve their health (Washington State Department of Commerce 2018). This information will be used to focus WMP investments where the investments will provide the most benefit to streams for each dollar spent.

Foundational Element Memorandum #3 (Herrera 2020) documented the overall approach for prioritizing subbasins for this WMP effort. This memorandum goes further and summarizes previous work and details the methods and results of prioritizing watersheds and their subbasins for actions by the assignment of management strategies. This memorandum also describes how these management strategies will be used in both the Watershed Improvement Plan and the WMP.

[1] Investments include capital projects, programs, policy/code changes, and maintenance practices that are part of the City's toolbox of actions to improve stream health. Capital projects are the highest cost investments and generally drive the discussion on City investments.

This memorandum is organized into the following sections:

- Summary of Previous Work on Subbasin Prioritization
- Assignment of Management Strategies
- Utilizing this Assignment of Management Strategies in the Watershed Improvement Plan and in the WMP

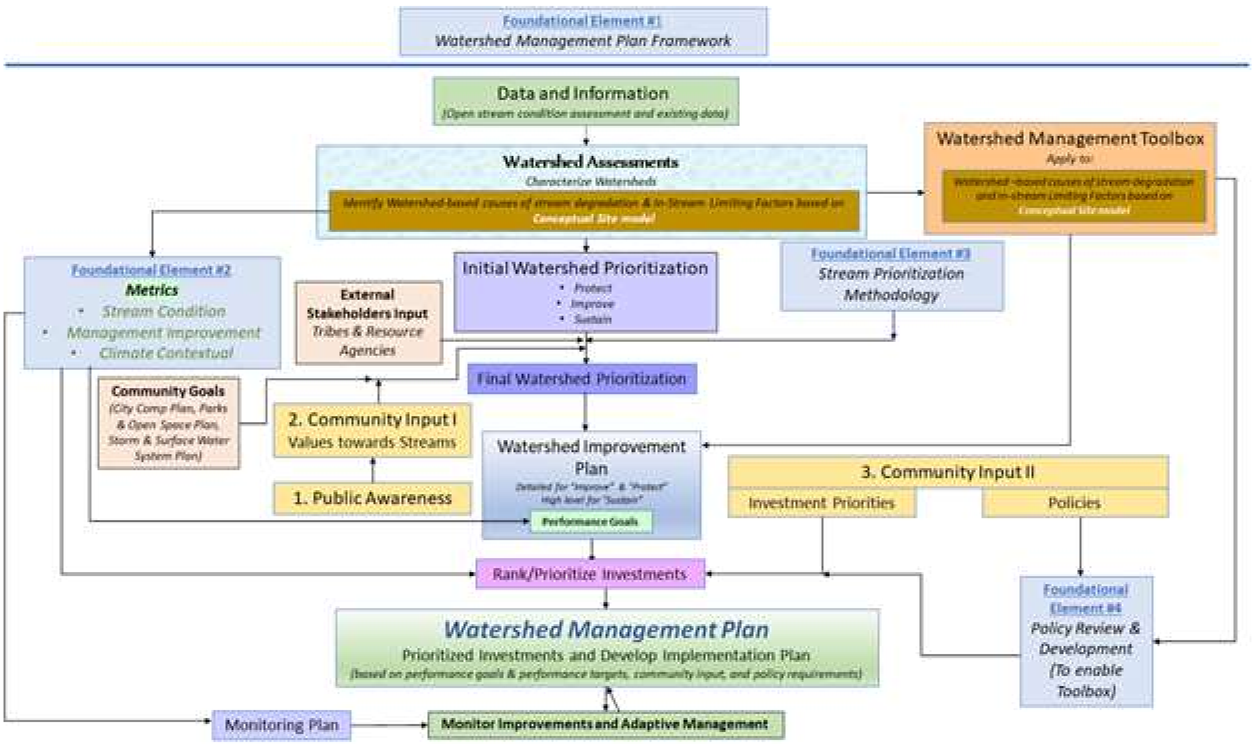

Figure 1 – Watershed Management Plan Development Process

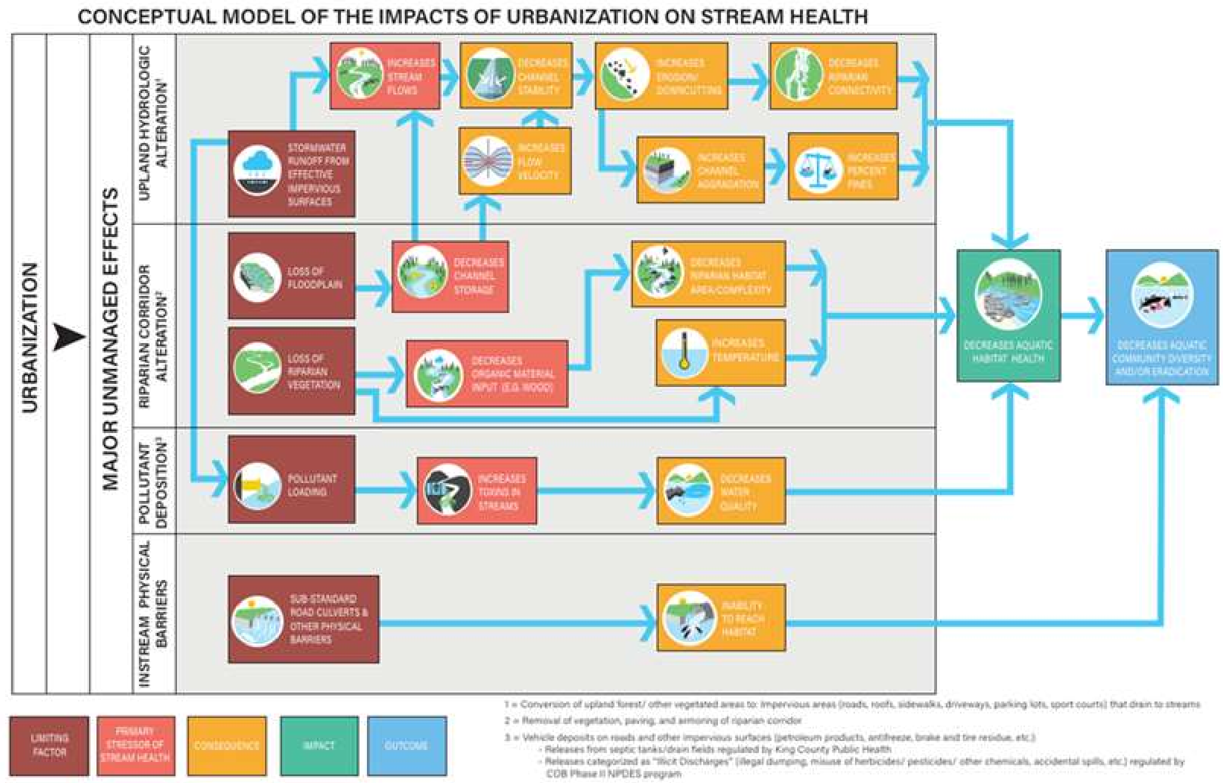

Figure 2. Conceptual Model for the Impacts of Urbanization on Stream Health.

2. Summary of Previous Work on Prioritization

The purpose of prioritizing subbasins and/or watersheds is to focus investments for watershed health improvement that maximize return on (or benefit from) that investment. Foundational Element Memorandum #3 (Herrera 2020) documented the overall approach for prioritizing subbasins for use in this WMP effort. That memorandum summarized existing guidance and requirements related to watershed management planning in the region. It also provided a high-level summary of the information and data that are available to inform the City's subbasin prioritization process. That Foundational Element Memorandum #3 also identified the specific steps the City has used to complete this process.

To support watershed management planning efforts within the region, the following guidance documents have been developed by state agencies or local jurisdictions and have been used to inform the City's prioritization process:

- Puget Sound Characterization. Volume 1: The Water Resources Assessments (Water Flow and Water Quality) (Stanley et al. 2011)
- City of Redmond, Washington: Citywide Watershed Management Plan (Herrera 2013)
- Building Cities in the Rain: Watershed Prioritization for Stormwater Retrofits (Washington State Department of Commerce 2018)

In addition to these guidance documents, the Washington State Department of Ecology (Ecology) has established requirements for watershed management planning through the Stormwater Management Action Planning (SMAP) provision of *Western Washington Phase II Municipal Stormwater Permit*[2] (Ecology 2019*)*. Because of the timing of the SMAP requirements, this subbasin prioritization documented in this Memorandum will be used to inform determination of the SMAP basin and subsequent deliverables to meet the City's SMAP requirements.

The guidance documents described above recommend that the prioritization process incorporate data and information at a regional scale (e.g., Puget Sound Characterization) supplemented with local, watershed-specific information and data where available. One of the key sources of that data and information is the City's Open Stream Condition Assessment (OSCA) program, which included information-gathering in fish-bearing streams within the City, representing 19 of the 27 subbasins. This OSCA information, as well as data and information from other sources including the City's GIS database, was used to develop Watershed Assessment Reports (ARs). One AR was developed for each of the 4 watersheds in the City, covering all 27 subbasins. The outcome of the ARs was the identification of limiting factors for each subbasin. These limiting factors tied back to the major unmanaged effects of urbanization as shown in the Conceptual Model (Figure 2).

Foundational Element Memorandum #3 outlined the following guiding principles to ensure that the prioritization will provide the maximum benefit to stream health:

- Prioritize subbasins with moderate levels of stream impairment. Watersheds with moderate levels of impairment are expected to respond most quickly to rehabilitation efforts and thus provide benefit quicker.
- Prioritize subbasins where regional efforts are also focused.
- Prioritize subbasins where the City has the most opportunity for implementing watershed rehabilitation efforts on City-owned property. Watershed rehabilitation efforts on private property can be more difficult and costly.
- Prioritize subbasins with existing infrastructure that can be optimized through modifications or retrofits to improve performance. Construction of new infrastructure can be complicated or prohibitive due to issues related to technical feasibility, cost, regulatory constraints, and public acceptance.
- Prioritize subbasins where there are opportunities to provide additional community benefits beyond those for stream health.

The Puget Sound Characterization established four management strategy categories for determining a subbasin's relative suitability and value for rehabilitation: Restoration, Protection, Conservation, and Development. The City refined these management strategies for use in its prioritization process:

- **Protect –** Subbasins assigned this management strategy category are the most pristine and least degraded. Therefore, they require substantially less investment compared to more degraded watersheds and warrant management strategies that provide a high level of protection to maintain existing conditions. Investments in 'protect' subbasins would be made opportunistically (such as land acquisition) and/or in partnership with other entities.
- **Improve –** Subbasins in this category have moderately impaired water bodies but have the most potential to benefit from investments. The near-term focus for these watersheds will be management strategies that emphasize improvement measures such as stormwater facility retrofits, programmatic approaches, and stream corridor improvements that have the potential to provide measurable benefits relatively quickly.

[2] Also known as the NPDES MS4 permit (National Pollution Discharge Elimination System – Municipal Separate Storm Sewer System)

- **Sustain –** Subbasins in this category have water bodies with more substantial impairment and therefore are expected to require a greater investment with a longer response time. Therefore, the near-term focus for these subbasins will be the implementation of applicable regulation and perhaps some investments that prevent further impairment. After investments in the “Protect” and “Improve” areas are completed, the “Sustain” subbasins will “move up the list” for potential additional investments.

In the spring of 2020, the City (with support from Jacobs and Herrera) performed an initial prioritization of subbasins to aid in advancement of the ARs and WMP effort. An initial stream condition rating and management strategy assignment was given to the City’s 27 subbasins. (See Foundational Element Memorandum #3 for the results of this initial prioritization.) At the time, it was determined that a refined prioritization would occur later in the WMP process once the ARs were complete and limiting factors determined. The next section of this Memorandum describes the approach and results of that refined prioritization process.

3. Assignment of Management Strategies

Fundamental to prioritization of subbasins is the assignment of management strategies of protect, improve, and sustain described earlier in this Memorandum. This section describes the approach and results of this effort, along with a description of how this assignment of management strategies informed subbasin prioritization. First, subbasins were characterized in terms of relative stream degradation. Then, subbasins were compared in terms of their relative potential for return on investment (ROI). Potential ROI in this document is generally defined as the City’s relative ability to improve stream health, based on dollars invested. More detail on the potential ROI will be presented in Section 3.2. Next, these two inputs were considered along with institutional knowledge to assign a management strategy.

Figure 3 shows a theoretical assignment of management strategies based on the overall intent of the guidance documents described in Section 2. It shows the level of stream degradation (x-axis) against the potential return on the City’s investment (y-axis). The lines between the management strategies are arbitrary and drawn here to illustrate the general concept. As is summarized later in this memorandum, assignment of management strategy is based not just on relative stream degradation and ROI but also based on institutional knowledge used to assess the components of the axes shown in Figure 3.

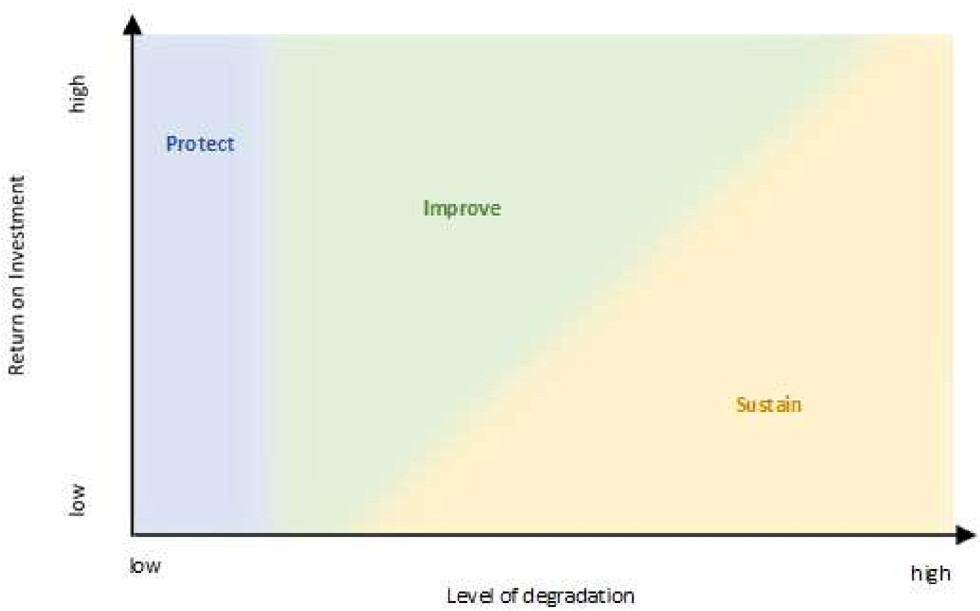

Figure 3. Graphical Representation of Assignment of Management Strategy Based on Level of Stream Degradation and Potential Return on Investment

3.1 Stream Degradation

Based on the results of the ARs, a metric for stream degradation was developed called a Conceptual Model Score (CMS) reflecting the limiting factors shown in Figure 2.

A CMS was developed for 19 out of the 27 subbasins in the City. The 19 are associated with a fish bearing streams. These scores were based on four parameters shown here in Table 1, echoing the limiting factors shown in Figure 2. Table 1 shows the data parameter used as a surrogate for each limiting factor.

Table 1. Data Used in the Calculation of Conceptual Model Scores (CMSs)

Conceptual Model Limiting Factor	Surrogate Used
Upland Hydrologic Alteration	% Impervious surface / Age of Development
Loss of Floodplain and Loss of Riparian Vegetation (Riparian Corridor Alteration)	% Riparian corridor vegetation
Pollutant Loading	Land use: Commercial / Industrial / Roads / Highways
In-stream Physical Barriers	Number of fish passage barriers

Data and information gathered for these subbasins and streams characterize the relative degradation in each subbasin as compared to the other subbasins in the City. Note that the higher the conceptual model score the more degraded a stream is in relation to the other streams in the City. A lower score indicates less degradation. Figure 4 shows the conceptual model scores for each fish bearing subbasin in the City, with the details provided in Attachment B to this Memorandum. Note that the conceptual model scores shown in Figure 4 are unweighted, meaning that each parameter has the same weight towards the total conceptual model score.

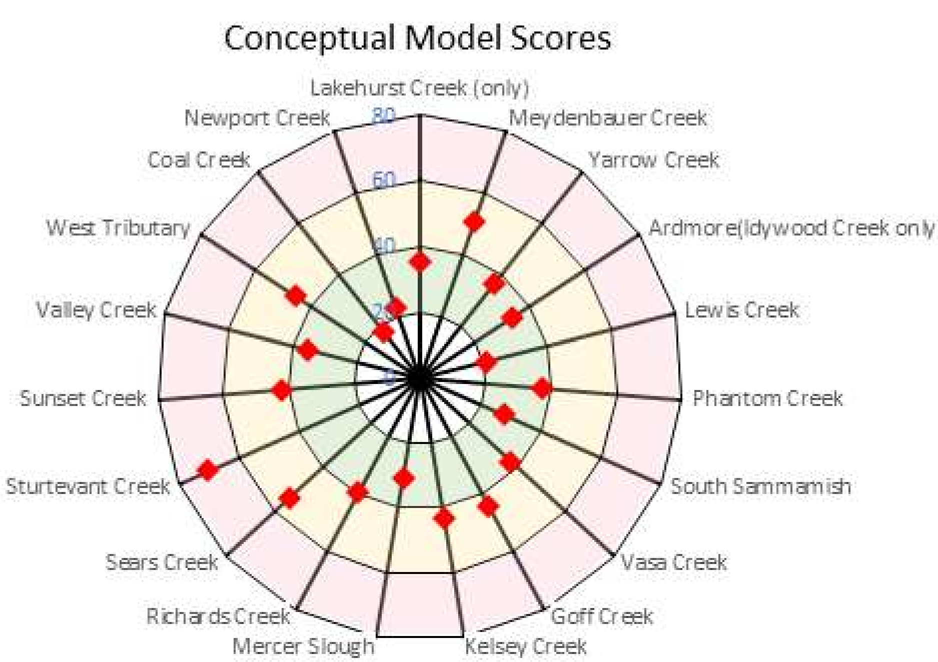

Figure 4. Unweighted Conceptual Model Scores for the 19 subbasins within the City of Bellevue with a Fish Bearing Stream

To aid in assignment of management strategies to each subbasin, City staff combined the conceptual model scores for each of the four unmanaged effects of urbanization into one index, or score, of relative stream degradation. To do this, a relative weighting was assigned to each of these four unmanaged effects. Figure 5 presents a Stream Functions Pyramid model prepared by Harman (2009) which, along with the hierarchical model of stream functions, suggests improved stream health (located at the top of the pyramid) is most effectively attained by first addressing stressors at the lower levels of the pyramid. The intention of the pyramid is to show the dominant cause and effect relationships. In general, biodiversity is dependent on habitat structure and quality, which are dictated by the lower levels of the pyramid beginning with hydrologic conditions. Considering Figure 5, the four conceptual model scores representing the four unmanaged effects were given the relative weightings based on professional judgement as shown here, with upland hydrologic alteration having the largest weighting reflecting its position on the bottom of the pyramid:

- Upland hydrologic alteration – 45%
- Riparian corridor alteration – 15%
- Pollutant loading – 25%
- In-stream physical barriers – 15%

These weightings were used to calculate a relative stream degradation score (see Table 2), with the lower scores indicating the least stream degradation. Attachment C contains the details of these calculations.

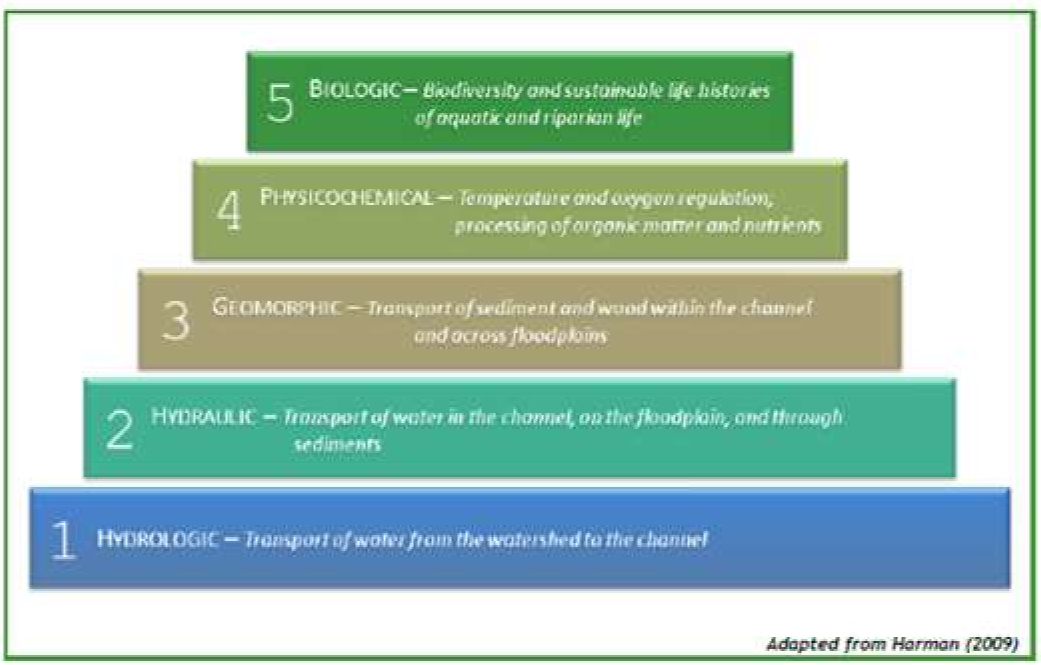

Figure 5. Stream Functions Pyramid

Table 2. Limiting Factors, Conceptual Model Scores, and the Characterization of Relative Stream Degradation for Each of the City's 27 Subbasins

Subbasin	**Watershed**	**Limiting Factors[1]**				**Conceptual Model Scores[2]**				**Stream Degradation Score[3]**
		Stormwater Runoff / Impervious Surface	**Loss of Floodplain and Riparian Vegetation**	**Pollutant Loading**	**Road Culverts and Other Physical Barriers**	**Upland Hydrologic alteration** (weighting = 45%)	**Riparian Corridor Alteration** (weighting = 15%)	**Pollutant Loading** (weighting = 25%)	**In-stream Physical Barriers** (weighting = 15%)	
Coal	Coal	Primary	Secondary	Primary	Secondary	3.1	4.6	1.2	11.8	4.1
Newport	Coal	Primary		Primary		18.8	1.0	1.9	1.0	9.2
Mercer Slough	Kelsey	Secondary		Primary	Primary	6.3	14.8	5.8	5.3	7.3
Kelsey Creek	Kelsey	Primary		Primary	Secondary	13.4	14.7	3.9	12.6	11.1
Sturtevant Creek	Kelsey	Primary	Primary	Primary	Secondary	**20.0**	**20.0**	**20.0**	10.3	18.5
Richards Creek	Kelsey	Primary	Secondary	Primary		12.7	12.3	7.4	8.1	10.6
Sunset Creek	Kelsey	Primary	Secondary	Primary	Secondary	14.0	11.4	4.5	14.0	11.2
West Tributary	Kelsey	Primary	Secondary	Primary		12.9	16.6	10.7	7.1	12.0
Goff Creek	Kelsey	Primary	Secondary	Primary	Secondary	7.0	13.4	5.5	**20.0**	9.5
Valley Creek	Kelsey	Secondary		Primary	Secondary	4.0	12.4	4.2	15.2	7.0
Sears Creek	Kelsey	Primary	Secondary	Primary	Secondary	14.0	13.2	13.9	12.9	13.7
Lewis Creek	Lake Sammamish	Primary		Secondary	Primary	1.0	9.0	1.0	11.8	3.8
Vasa Creek	Lake Sammamish	Primary		Primary	Primary	10.0	10.0	4.4	14.3	9.2
Ardmore / Idylwood Creek	Lake Sammamish	Primary		Secondary		15.8	5.0	1.0	12.0	9.9
Redmond 400	Lake Sammamish	Primary	Secondary			Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Rosemont	Lake Sammamish	Primary		Secondary		Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Wilkins Creek	Lake Sammamish	Primary		Secondary		Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
North Sammamish	Lake Sammamish	Primary				Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Phantom Creek	Lake Sammamish	Primary		Primary		8.7	10.0	7.2	11.5	8.9
Spirit Ridge	Lake Sammamish	Primary				Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
South Sammamish	Lake Sammamish	Primary		Primary	Secondary	6.3	11.1	3.0	10.4	6.8
Lakehurst	Lake Washington	Primary			Secondary	11.3	8.0	1.9	14.5	8.9
Meydenbauer	Lake Washington	Primary	Secondary	Primary	Secondary	15.5	14.4	9.0	12.1	13.2
Beaux Arts	Lake Washington					Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Clyde Beach	Lake Washington	Primary	Secondary	Secondary		Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Yarrow Creek	Lake Washington	Primary	Secondary	Primary	Secondary	8.5	12.7	8.0	10.0	9.2
Point Cities	Lake Washington					Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable

[1] Limiting Factors are either Primary or Secondary, with secondary limiting factors being factors that limit stream health in only a portion of the subbasin.
[2] Details behind determination of conceptual model scores are described in Attachment B. Note that the higher the conceptual model score, the more degraded is the stream, relative to the other streams in Bellevue (not an absolute measure of degradation). The most degraded subbasin for each individual conceptual model score parameter is shown in **bold**. Conceptual Model scores were only calculated for those subbasins with fish bearing streams.
[3] The relative stream degradation score was calculated using the conceptual model scores weighted according to: upload hydrologic alteration of 45%, riparian corridor alteration of 15%, pollutant loading of 25%, and in-stream physical barriers of 15%. The stream degradation score is used, along with the Return on Investment score, to inform assignment of management strategy to each subbasin. The higher the relative stream degradation score the more degraded the stream.

3.2 Potential Return on Investment

The second input used to prioritize subbasins is the potential ROI. Potential ROI is generally defined as the City's relative ability to improve stream health, based on dollars invested. It is made up of two components: the area of land owned by the City in each subbasin and the opportunity to retrofit existing stormwater infrastructure. The parameters used for these components are shown in Table 3.

Table 3. Data Used in the Calculation of Potential Return on Investment

Parameter	Surrogate Used	Weighting Used in Determining Potential Return on Investment
Measure of Potential Investment Cost	Percent of subbasin owned by the City	30%
	Percent of land within 100 feet of streams that's owned by the City	20%
Measure of Potential Benefits that Could be Achieved (water quality and hydrology)	Percent of area within subbasin that was developed prior to 1996 (when the majority of stormwater controls went into effect within the City)	50%

The premise behind the Measure of Potential Investment Cost component (and the surrogate measures of City-owned land) is that investments in stream health will be much less expensive if sited on property already owned by the City, including public right-of-way. This applies to either investment within a stream channel or riparian area as well as investments in the upland area such as stormwater retrofits.

The premise behind the Measure of Potential Benefit component is: 1) Improving hydrologic process and water quality is needed most in areas where little or no stormwater controls currently exist. 2) improving hydrologic process and water quality will provide the most benefit to stream health compared to other investments according to the pyramid shown in Figure 5.

The resultant Potential Return on Investment score considers both potential cost and the potential benefits that could be achieved. Table 4 shows the values for the components of the potential ROI for the 27 subbasins within the City. Similar to the relative stream degradation score, a composite score was calculated by weighting each of the above measures based on professional judgement. The relative weightings of each of these three elements were decided upon in a workshop with City staff are shown in Table 3. Attachment C contains the details of these calculations.

Sensitivity analyses performed on the weighting (last column in Table 3) shows that the ROI score (and relative scoring of subbasins) is not sensitive to change in weighting. Also note that relatively small subbasins are more likely to fall at the extreme ends of the ROI scoring because the presence or absence of a City-owned parcel or a parcel developed without stormwater controls will have a disproportionate impact. This was considered when assigning management strategy (discussed in Section 3.3).

Table 4. Limiting Factors, Measures of Investment Cost and Hydrologic/Water Quality Benefit, and the Characterization Potential Return on the City's Investment for Each of the City's 27 Subbasins

Subbasin	Watershed	Limiting Factors[1]				Measures of Investment Cost and Hydrologic/Water Quality Benefit[2]			Potential Return on the City's Investment in Stream Health[3]
		Stormwater Runoff / Impervious Surface	Loss of Floodplain and Riparian Vegetation	Pollutant Loading	Road Culverts and Other Physical Barriers	Measure of Investment Cost (% Subbasin-wide City Land Ownership) (weighting = 30%)	Measure of Investment Cost (% City Land Ownership of 100-foot stream buffer) (weighting = 20%)	Measure of Hydrologic/Water Quality Benefit (percent of developed area developed prior to 1996 stormwater controls) (weighting = 50%)	
Coal	Coal	Primary	Secondary	Primary	Secondary	41%	51%	45%	-0.12
Newport	Coal	Primary		Primary		30%	91%	72%	1.14
Mercer Slough	Kelsey	Secondary		Primary	Primary	53%	51%	39%	0.05
Kelsey Creek	Kelsey	Primary		Primary	Secondary	36%	53%	57%	0.28
Sturtevant Creek	Kelsey	Primary	Primary	Primary	Secondary	32%	36%	63%	0.29
Richards Creek	Kelsey	Primary	Secondary	Primary		34%	42%	67%	0.66
Sunset Creek	Kelsey	Primary	Secondary	Primary	Secondary	41%	43%	60%	0.55
West Tributary	Kelsey	Primary	Secondary	Primary		31%	45%	61%	0.20
Goff Creek	Kelsey	Primary	Secondary	Primary	Secondary	21%	15%	70%	0.05
Valley Creek	Kelsey	Secondary		Primary	Secondary	23%	39%	65%	0.07
Sears Creek	Kelsey	Primary	Secondary	Primary	Secondary	30%	38%	69%	0.52
Lewis Creek	Lake Sammamish	Primary		Secondary	Primary	38%	52%	39%	-0.60
Vasa Creek	Lake Sammamish	Primary		Primary	Primary	26%	30%	62%	-0.07
Ardmore/Idylwood Creek	Lake Sammamish	Primary		Secondary		32%	89%	68%	1.00
Redmond 400	Lake Sammamish	Primary	Secondary			25%	19%	53%	-0.66
Rosemont	Lake Sammamish	Primary		Secondary		19%	0%	68%	-0.23
Wilkins Creek	Lake Sammamish	Primary		Secondary		26%	26%	68%	0.24
North Sammamish	Lake Sammamish	Primary				32%	0%	53%	-0.53
Phantom Creek	Lake Sammamish	Primary		Primary		28%	40%	66%	0.32
Spirit Ridge	Lake Sammamish	Primary				30%	0%	66%	0.07
South Sammamish	Lake Sammamish	Primary		Primary	Secondary	34%	25%	50%	-0.38
Lakehurst	Lake Washington	Primary			Secondary	39%	41%	44%	-0.35
Meydenbauer	Lake Washington	Primary	Secondary	Primary	Secondary	27%	14%	62%	-0.17
Beaux Arts	Lake Washington					25%	0%	53%	-0.81
Clyde Beach	Lake Washington	Primary	Secondary	Secondary		27%	0%	51%	-0.85
Yarrow Creek	Lake Washington	Primary	Secondary	Primary	Secondary	35%	34%	53%	-0.11
Point Cities	Lake Washington					23%	0%	59%	-0.57

[1] Limiting Factors are either Primary or Secondary, with secondary limiting factors being factors that limit stream health in only a portion of the subbasin.
[2] Details behind determination of these scores are described in Attachment C.
[3] The score of potential return on the City's investment in stream health was calculated by normalizing each of the percentages for the three parameters, then weighting the three measures of Investment cost and hydrologic/water quality benefit according to: % of subbasin owned by the City (30%), % of land within 100-feet of streams that's owned by the City (20%); % of area developed prior to 1996 (50%)

3.3 Management Strategies by Subbasin

Figure 6 shows a scatter graph using the relative stream degradation score on the x-axis (Table 2, Section 3.1) and the potential return on the City's investment (in terms of magnitude and timeliness of benefit) on the y-axis (Table 3, Section 3.2).

Figure 6 does not include the eight non-fish bearing subbasins (Wilkins, North Sammamish, Redmond 400, Rosemont, Beaux Arts, Spirit Ridge Clyde Beach, and Point Cities), as no conceptual model scores were developed for those subbasins.

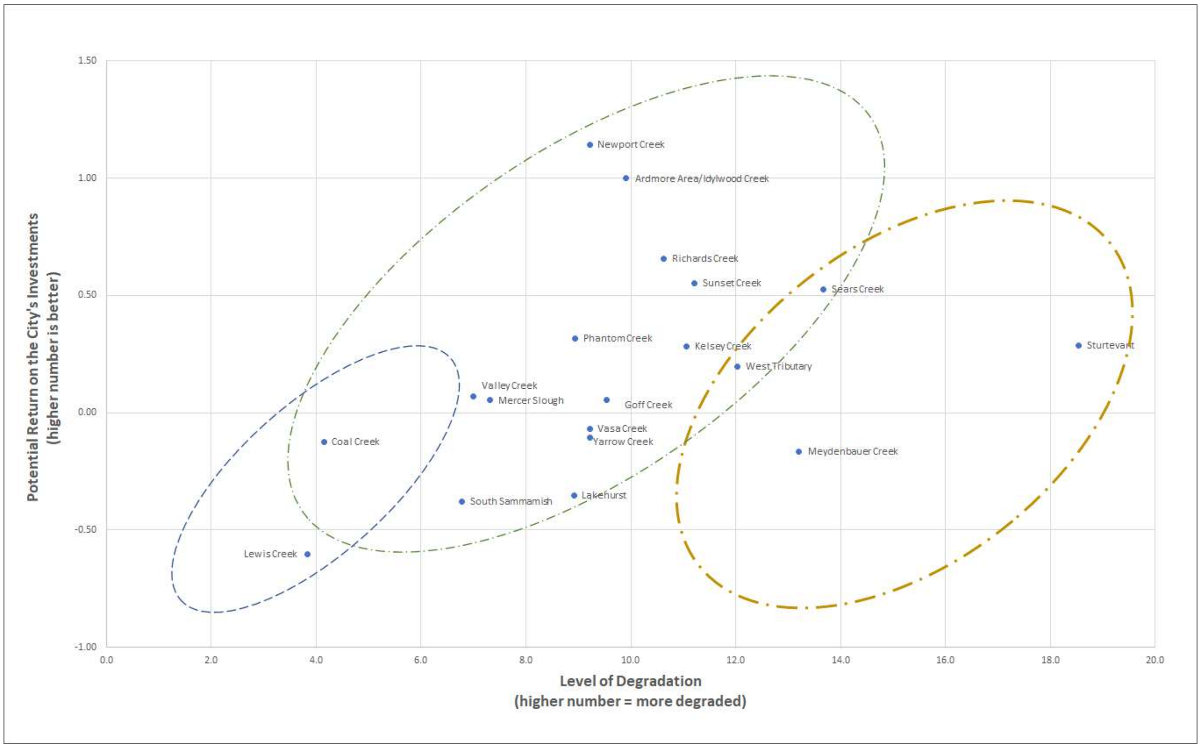

Figure 6. Scatter Graph Showing Relative Stream Degradation and Potential Return (in terms of magnitude and timeliness of benefit) on the City's Investment

The dashed line circles are representations of lines drawn around protect (in blue), improve (in green) and sustain (in brown) management strategies. These dashed lines were added to this graph to commence the process of assigning management strategies, acknowledging that each subbasin's position on the graph shown in Figure 6 was a starting point for that assignment.

Table 5 below shows the management strategy assigned to each subbasin, with an explanation provided if a management strategy is different than what Figure 6 would suggest. These modifications were made based on institutional knowledge of City staff that wouldn't have been reflected in the data on which Figure 6 was based, including consideration of the relative size of the subbasin. Table 5 shows that of the City's 19 fish bearing subbasins, three are Protect or Improve/Protect (Coal Creek, Valley Creek, and Lewis Creek), 13 are Improve or Improve/Sustain, and the remaining three are Sustain. Figure 7 shows these graphically.

The eight subbasins that are not fish bearing will not be the focus of the Watershed Improvement Plan or WMP. The City will continue to enforce all applicable stormwater and environmental regulation in these eight subbasins (Sustain) and may choose to opportunistically invest in those subbasins should funding or outside partnerships be available, but will focus investments in the 'improve' and 'protect' subbasins.

Table 5. Assignment of Management Strategies for Each of the City's 19 fish bearing Subbasins

Subbasin	Watershed	Management Strategy	Explanation if Management Strategy is Different than What Figure 6 would suggest
Coal	Coal	Protect/ Improve	Lower and Middle Coal Creek have dynamic and unstable sediment transport, and more intensive land use/development so IMPROVE while the upper watershed is more intact and warrants PROTECT.
Newport	Coal	Improve	
Mercer Slough	Kelsey	Improve	
Kelsey Creek	Kelsey	Improve	
Sturtevant Creek	Kelsey	Sustain	
Richards Creek	Kelsey	Improve	
Sunset Creek	Kelsey	Improve	
West Tributary	Kelsey	Improve	
Goff Creek	Kelsey	Improve	
Valley Creek	Kelsey	Protect/ Improve	Middle and Upper Valley Creek has large parcels and riparian canopy warranting PROTECT management strategy, IMPROVE management strategy applies to all of the rest of the subbasin
Sears Creek	Kelsey	Sustain	
Lewis Creek	Lake Sammamish	Protect	
Vasa Creek	Lake Sammamish	Improve	
Ardmore / Idylwood Creek	Lake Sammamish	Improve	
North Sammamish	Lake Sammamish	Sustain	
Phantom Creek	Lake Sammamish	Improve	
South Sammamish	Lake Sammamish	Improve/ Sustain	Moving the lower portion of the subbasin to SUSTAIN from IMPROVE. There are limited opportunities for the City both at the mouth (privately owned) and along I-90 corridor, though opportunities exist for non-City investment and City partnerships
Lakehurst Area/Creek	Lake Washington	Sustain	Moving subbasin from IMPROVE to SUSTAIN; piped from its mouth at Lake Washington to a sediment pond east of I-405; limited opportunities for City investment (mostly privately owned, or I-405); often runs low or dry in the summer.
Meydenbauer	Lake Washington	Improve	Moving from SUSTAIN to IMPROVE because of water quality concerns and proximity to aquatic resources (Meydenbauer Beach Park); Downtown is growing, may be opportunities with business community (ex: pet waste) and partnerships with developers
Yarrow Creek	Lake Washington	Improve	

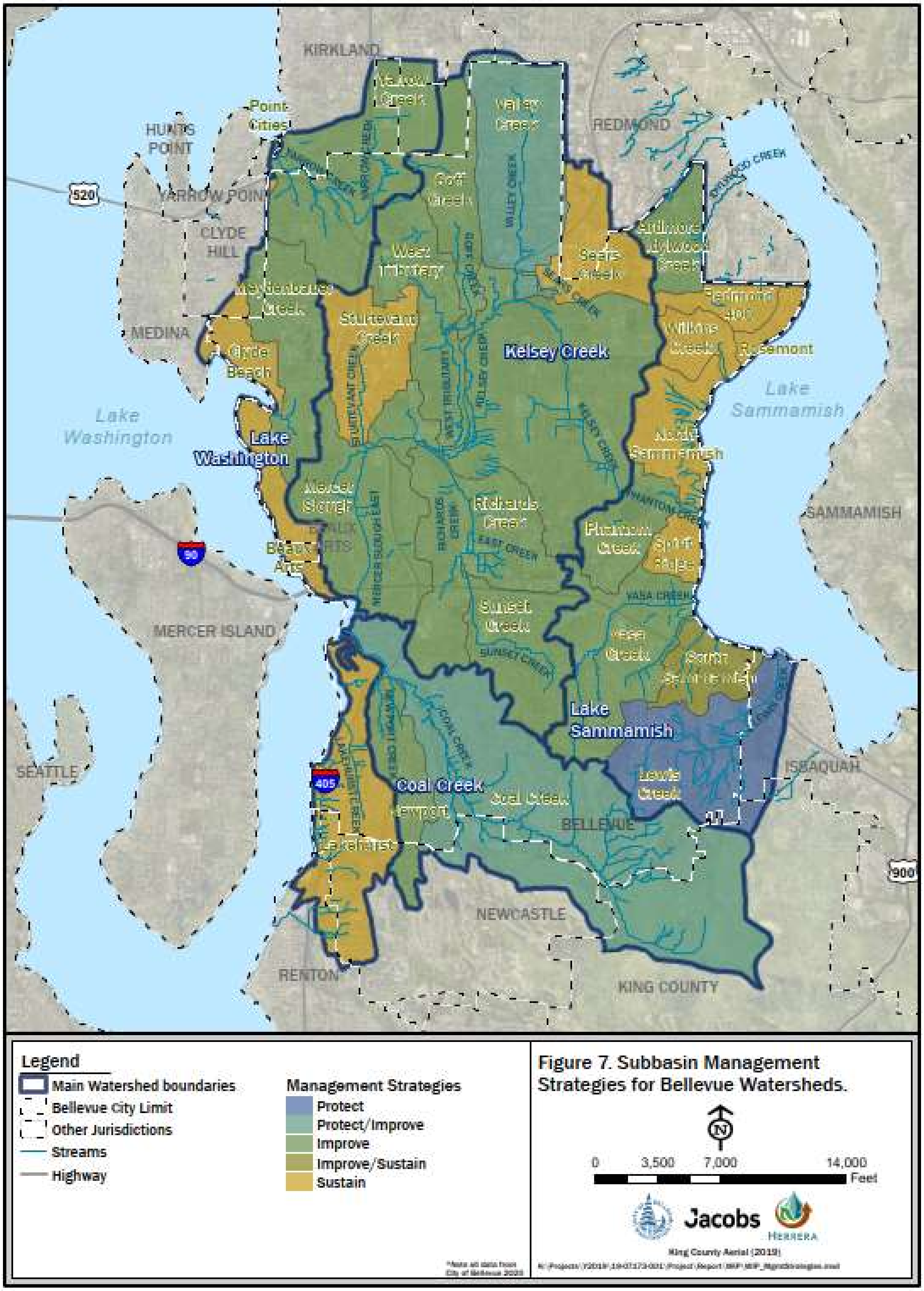

Figure 7. Assigned Management Strategies by Subbasin within the City of Bellevue

4. Prioritizing Which 'Protect' and 'Improve' Subbasins are Addressed First

Based on the theoretical construct in Figure 3, the results shown in Figure 6 suggests that the subbasins in the upper left portion of the 'Improve' category should be addressed first with those in the lower right addressed last. Instead of taking this literal data-driven approach to prioritization, the City instead intends to consider a variety of factors when deciding what order to address the subbasins. These factors, including equity and social justice, human health and well-being, regional and/or cultural importance, sensitivity to climate change or to growth/development, proximity of investments planned by other City Departments (affecting affordability), and outside funding availability would be considered as 'lenses' overlaid on the subbasins in the improve and protect categories to inform the timing and phasing of investments in those subbasins.

5. Utilizing this Prioritization in the Watershed Improvement Plan and in the WMP

As described earlier in this Memorandum, the Watershed Improvement Plan will focus on identifying the investments that are needed to improve stream health. The WMP, however, will overlay community values and other City objectives, including investment amounts, on those stream health needs.

In the Watershed Improvement Plan, more attention will be given to developing investments in the 'Protect' and 'Improve' subbasins because those are priorities as compared to the 'Sustain' subbasins. While investments in the 'Protect' and 'Improve' subbasins will be both programmatic and capital investments, most capital investments will be proposed in the 'Protect' subbasins. The magnitude of investment will be highest in the 'Improve' subbasins, as minimal investment will be required in the 'Protect' subbasins to maintain the current level of (minimal) stream degradation. These 'Protect' subbasins will more than likely be addressed with programmatic or policy/regulatory recommendations rather than capital projects.

While the 'Improve' and 'Protect' subbasins will receive the most focus, the 'Sustain' subbasins will still be addressed with Citywide watershed management activities in all sub basins, including those required by the City's NPDES Phase II MS4 Permit and other citywide programs including street sweeping and education as well as citywide policy/code efforts. Investments will be opportunistic and may include partnerships with non-City entities (such as WSDOT, other Cities, or non-profits) and/or on regional investments (such as kokanee restoration).

Consideration of sensitivity to climate change and/or to growth and urban development might accelerate investments in certain subbasins. This will be further evaluated within the Watershed Improvement Plan.

Within the Watershed Improvement Plan, the 'Improve' and 'Protect' subbasins will be evaluated by watershed and not just individually. Each of the City's four watersheds will be evaluated based on its most pressing needs (documented by limiting factors) first by looking at it at the subbasin level. This will be determined by reviewing limiting factors and the stream health pyramid (Figure 5), according to the following in priority order:

- Hydrology (first priority)
- Pollutant Loading (second priority, along with riparian vegetation / floodplain connection)
- Riparian Vegetation / Floodplain Connection (second priority, along with pollutant loading)
- Fish passage barriers (third priority)

During Watershed Improvement Plan development, the specific Watershed Management Tools applicable to each of the limiting factors will be identified and applied as needed in each subbasin. The Watershed

Improvement Plan will identify investments needed to adapt to climate change and to population growth. The Watershed Management Plan will include performance goals specific to each subbasin in the 'Improve' and 'Protect' categories as compared to the stream health metrics developed earlier as Foundational Element Memorandum #2 (Jacobs 2021a).

The WMP will include consideration of community benefits and other City goals and objective in the prioritization of specific investments in stream health. When programming out the investments, partnerships and outside funding (ex: grants) will be considered. A verification will be conducted that looks at the amount of investment (in terms of dollars) by subbasin and by management strategy to confirm that the 'Improve' subbasins are receiving the most investment. The WMP will include performance goals and numeric performance targets (as well as outline the monitoring requirements to obtain data in order to be able to measure performance).

One of the last phases of the WMP effort is development of an adaptive management plan. That adaptive management plan will identify actions to be taken if goals are not met, or if the rate of change in population growth / development, climate change, or regulatory requirements is faster or different than what was anticipated in the future conditions characterization (Jacobs 2022b). This adaptive management plan will also call for the review (and/or confirmation) of assignment of management strategies as things may change in the future.

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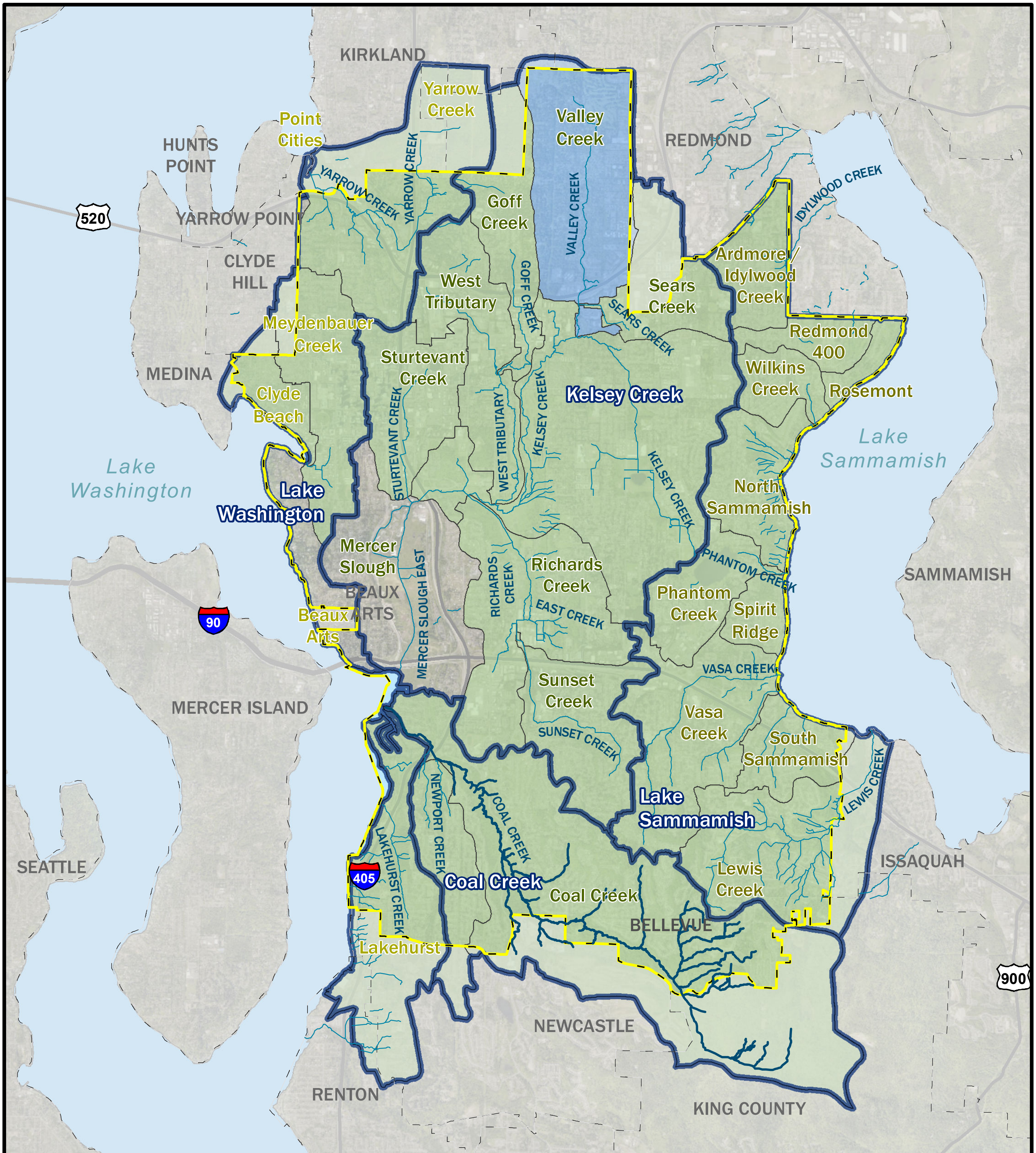
Attachment A – Limiting Factors by Subbasin from the Watershed Assessment Reports



Legend

- Watershed Boundary
- Bellevue City Limit
- Other Jurisdictions

Stormwater Runoff/ Impervious Surfaces

- Primary Limiting Factor
- Secondary limiting Factor
- Streams
- Highway

*Note all data from City of Bellevue 2020

Limiting Factors by Subbasin: Stormwater runoff and impervious surfaces.

N

0 3,500 7,000 14,000 Feet

Jacobs

HERRERA

King County Aerial (2019)

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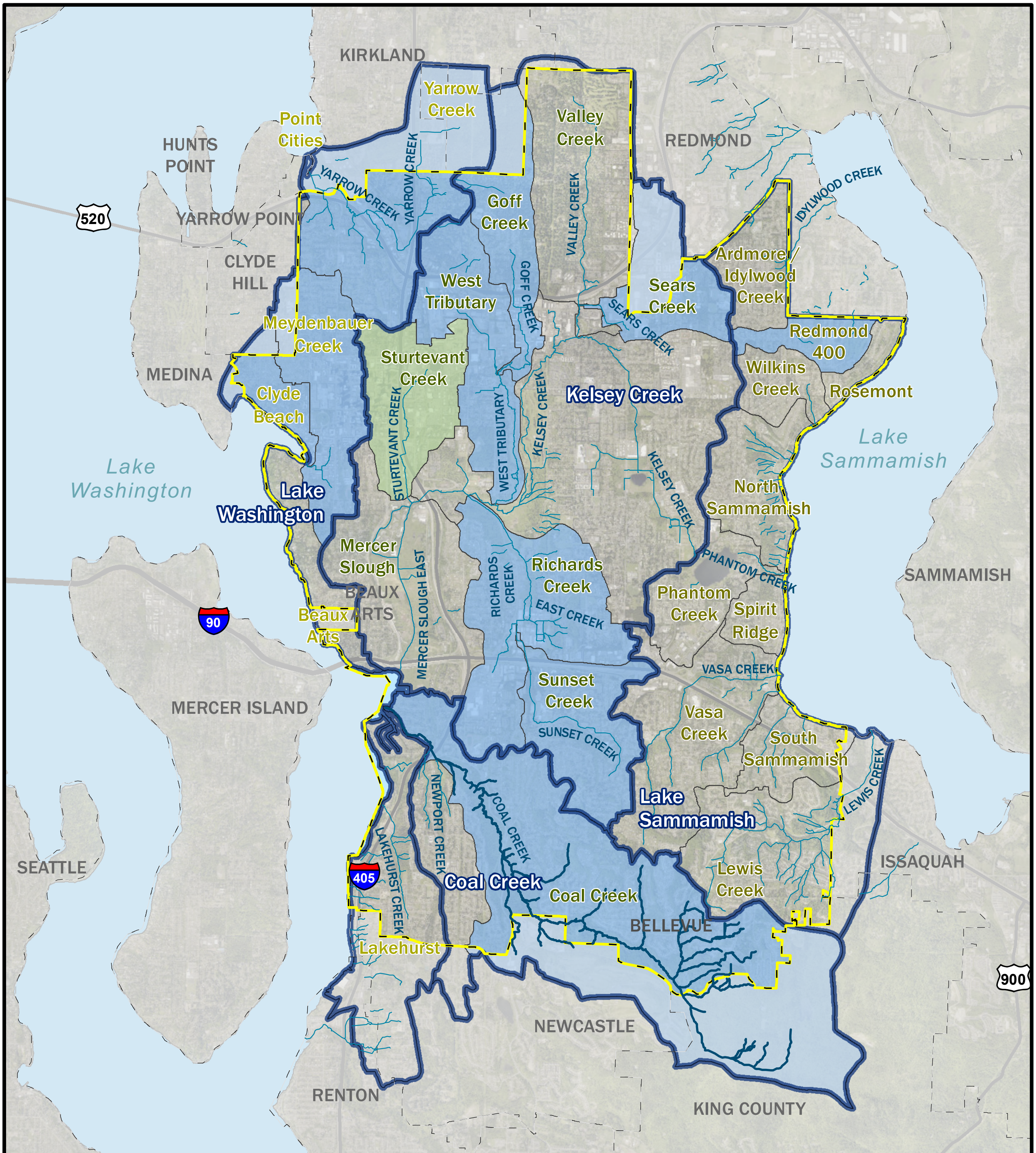

Legend

- Watershed Boundary
- Bellevue City Limit
- Other Jurisdictions

Loss of Floodplain and Riparian Vegetation

- Primary Limiting Factor
- Secondary Limiting Factor
- Streams
- Highway

*Note all data from City of Bellevue 2020

Limiting Factors by Subbasin: Loss of floodplain and riparian vegetation

N

0 3,500 7,000 14,000 Feet

City of Bellevue Washington

Jacobs

Herrera

King County Aerial (2019)

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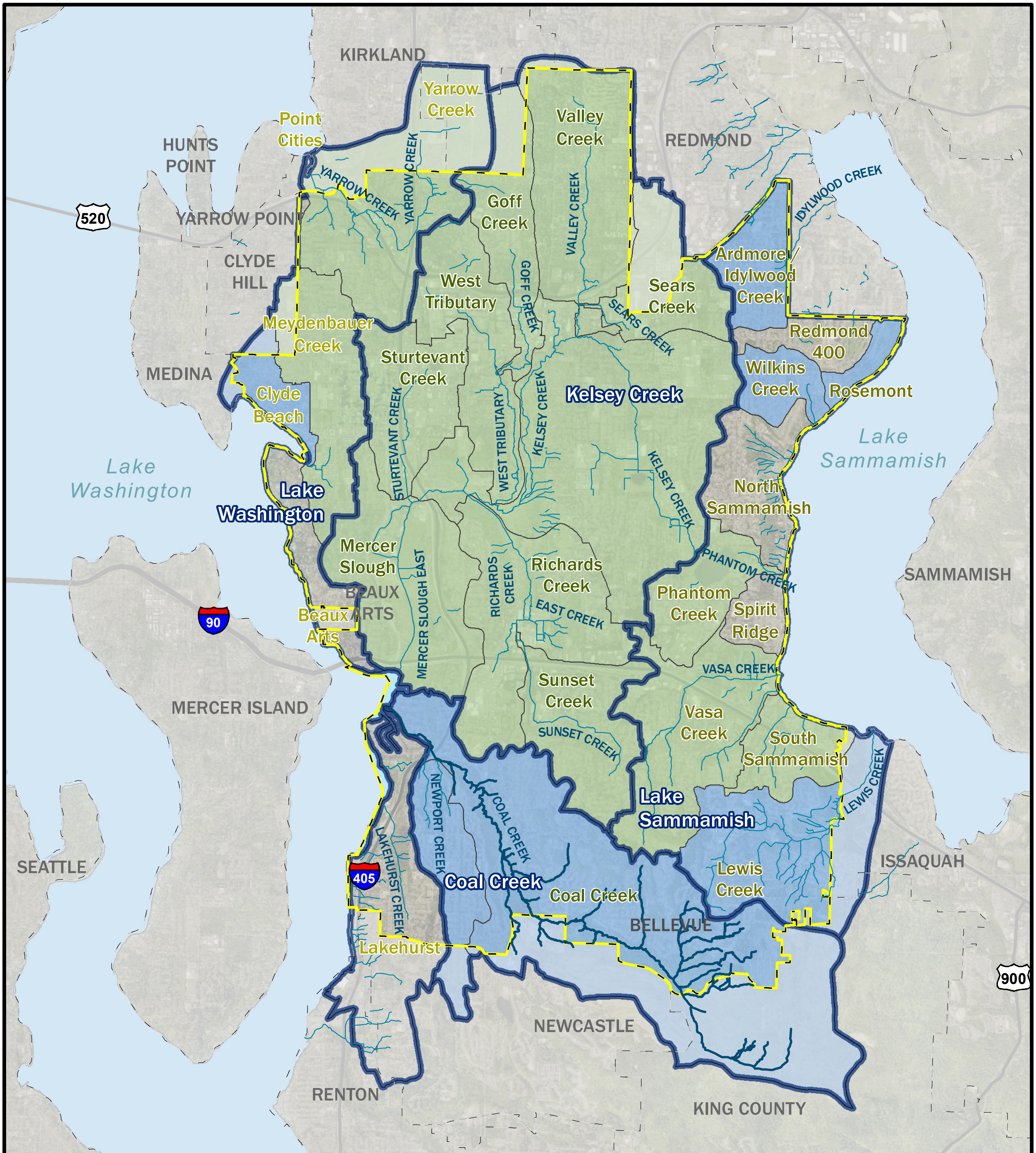

Legend

- Watershed Boundary
- Bellevue City Limit
- Other Jurisdictions

Pollutant Loading as Limiting Factor

- Primary
- Secondary
- Streams
- Highway

*Note all data from City of Bellevue 2020

Limiting Factors by Subbasin: Pollutant loading.

N

0 3,500 7,000 14,000 Feet

City of Bellevue Washington · Jacobs · Herrera

King County Aerial (2019)

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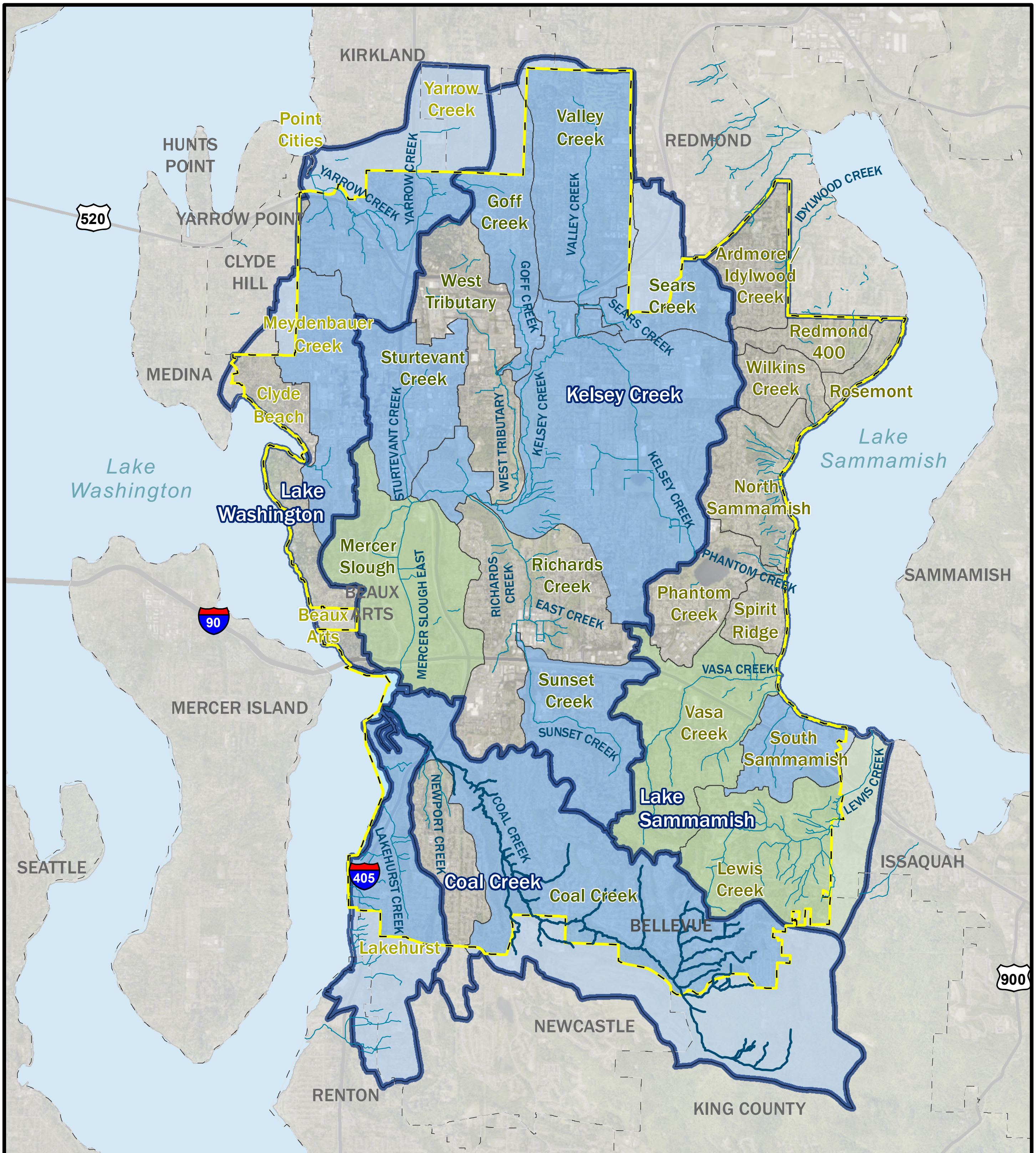

Limiting Factors by Subbasin: Fish passage.

N

0 3,500 7,000 14,000 Feet

Jacobs

HERRERA

King County Aerial (2019)

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Attachment B – Conceptual Model Scores and Background

Conceptual Model Score Computation Methodologies and Data for Bellevue's Watershed Management Plan

Jerry Shuster, P.E.
Senior Stormwater Engineer
City of Bellevue Utilities Department

1.0 Introduction

The purpose of computing Conceptual Model Scores (CMS) is to provide a planning level ranking of watersheds and of subbasins[1] based on selected attributes that can inform prioritization for assignment of management actions. These scores use existing data as a proxy for the major stressors (or limiting factors) to streams shown in the conceptual model (Brown boxes to the left on Figure 1). Table 1 provides a cross-walk between the conceptual model stressor and the parameter used as a proxy in the CMS:

Table 1 - Cross-walk between the conceptual model stressor and the parameter used as a proxy in the CMS

No.	Conceptual Model Stressor	Proxy CMS Parameter	Applied to Areas:
1	Stormwater runoff from effective impervious surfaces	Impervious area and age of development (combined into the Impervious Area Factor)	Within Bellevue City limits
2	Loss of Floodplain/Riparian Vegetation	Percent tree canopy in riparian corridor	Main stem & tributaries for the "stream of interest" (described in Table 2 below)[2]
3	Pollutant Loading	Percent land use for: highway, commercial, industrial, and mixed use	Within Bellevue City limits
4	Substandard road culverts & other physical barriers	Number and location of fish passage barriers	Main stem of streams in all subbasins including outside of Bellevue City limits

Two of the proxy parameters, Impervious Area factor and pollutant loading/land use, are subbasin-wide measures. The other two parameters, riparian corridor vegetation and fish passage barrier are stream corridor-specific measures.

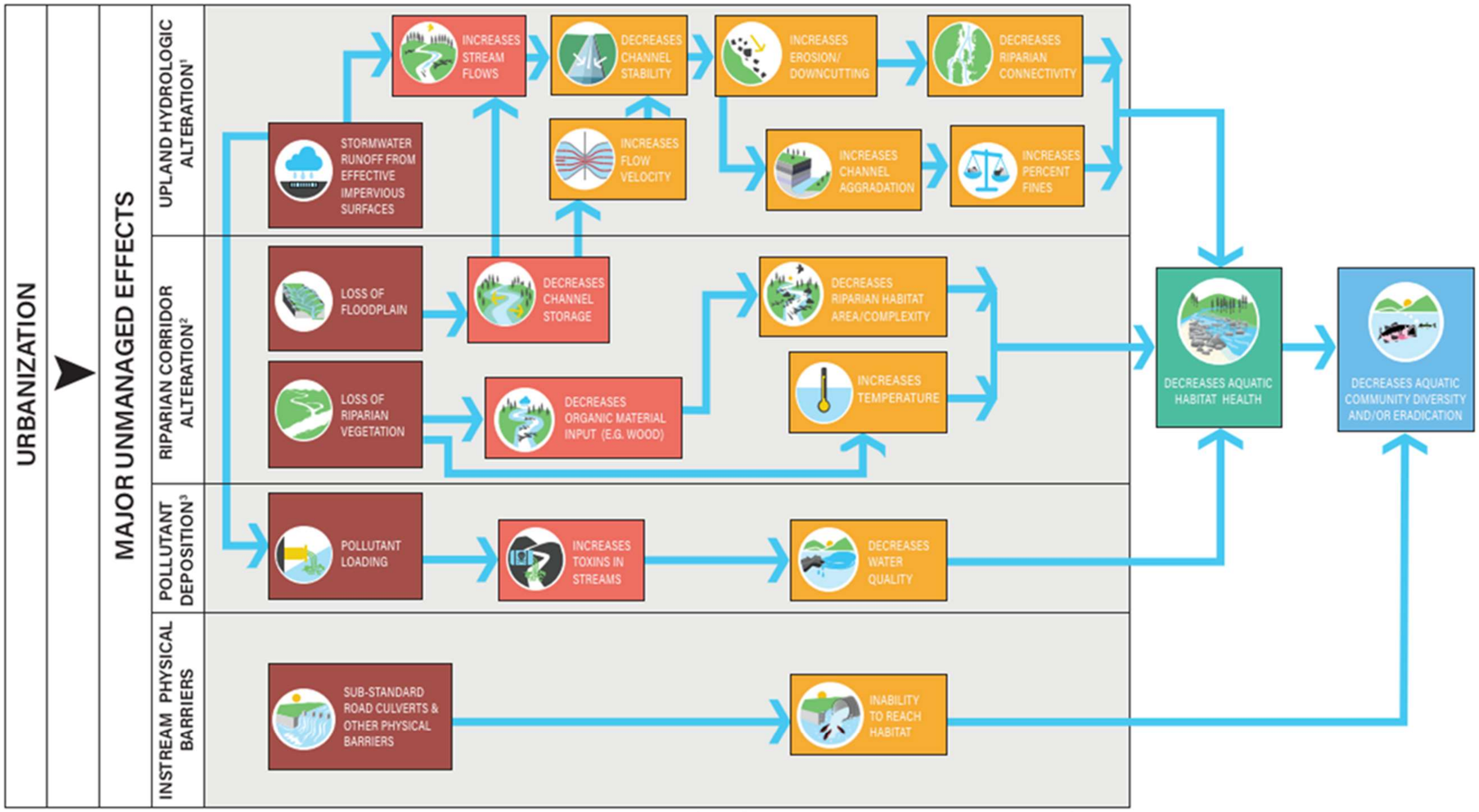
1.1 Use

CMSs will be used to assist in classifying the watersheds and subbasins for the management actions of:

[1] A subbasin is a portion of a larger watershed.

[2] See Section 2.2 for more details.

CONCEPTUAL MODEL OF THE IMPACTS OF URBANIZATION ON STREAM HEALTH



1 = Conversion of upland forest/ other vegetated areas to: Impervious areas (roads, roofs, sidewalks, driveways, parking lots, sport courts) that drain to streams

2 = Removal of vegetation, paving, and armoring of riparian corridor

3 = Vehicle deposits on roads and other impervious surfaces (petroleum products, antifreeze, brake and tire residue, etc.)
- Releases from septic tanks/drain fields regulated by King County Public Health
- Releases categorized as "Illicit Discharges" (illegal dumping, misuse of herbicides/ pesticides/ other chemicals, accidental spills, etc.) regulated by COB Phase II NPDES program

- **Protect** – Watersheds in this management strategy category are the most pristine, and least degraded. Therefore, they require substantially less rehabilitation compared to more degraded watersheds and warrant management strategies that provide a high level of protection to maintain existing conditions.
- **Improve** – Watersheds in this category have moderately impaired water bodies but have the most potential to support all beneficial uses. Therefore, the near-term focus for these watersheds will be management strategies that emphasize rehabilitation measures such as stormwater facility retrofits and stream corridor improvements that have the potential to provide measurable benefits relatively quickly.
- **Sustain** – Watersheds in this category have water bodies with more substantial impairment and therefore are expected to require a greater rehabilitation effort with a longer response time. Therefore, the near-term focus for these watersheds will be the implementation of management strategies that prevent further impairment.

The CMS will not be the only information used to classify the watersheds and subbasins. Other information will include institutional knowledge of watershed health from City staff and others, Watershed Assessment Reports, Open Streams Condition Assessment data, redevelopment potential, and Community input.

1.2 Approach

CMSs were computed for 19 out of the 27 subbasins. These 19 subbasins contain streams that are classified Type F or Type S waters per Bellevue code. These are the streams are the largest in Bellevue and contain the most fish and aquatic habitat. The subbasins within the larger watersheds that do not have Type F or Type S waters and, therefore, CMSs were not computed, are:

- Small Lake Washington
  - Point Cities (no stream)
  - Beaux Arts (no stream)
  - Clyde Beach
- Lake Sammamish
  - North Sammamish
  - Redmond 400
  - Rosemont (no stream)
  - Spirit Ridge (no stream)
  - Wilkins Creek

These smaller drainages are mostly on private property, either have no mapped streams or have very short stream segments. They may also have steams that are steep to harbor abundant aquatic life, compared to the Type F streams. These subbasins will be prioritized with the others using other information to inform their condition other degradation criteria. For example, the Wilkins Creek and North Sammamish have small streams that may be important for Kokanee spawning.

A score between 1 and 20 was calculated for each CMS proxy parameter by subbasin/stream; **1 being the best** (least degraded) **and 20 being the worst (most degraded)**. The formula below was used to calculate the scores - t_{max} = 20, t_{min}=1):

$$m \mapsto \frac{m - r_{\min}}{r_{\max} - r_{\min}} \times (t_{\max} - t_{\min}) + t_{\min}$$

will scale m linearly into $[t_{\min}, t_{\max}]$ as desired.

- $r_{\min}$ denote the minimum of the range of your measurement
- $r_{\max}$ denote the maximum of the range of your measurement
- $t_{\min}$ denote the minimum of the range of your desired target scaling
- $t_{\max}$ denote the maximum of the range of your desired target scaling
- $m \in [r_{\min}, r_{\max}]$ denote your measurement to be scaled

The total CMS score for each subbasin/stream was calculated by adding up each CMS proxy scores. These total scores were then ranked for final CMS ranking. Note that all CMSs are a relative measure of degradation. The scores place the subbasin in relation to the other subbasins in Bellevue, not necessarily where they are compared to other creeks in the region.

The next section discusses how these scores were calculated and summed up to get a total CMS score and rankings for each subbasin. CMSs were aggregated into the four large watershed in Bellevue as shown in Table 2.

Table 2 - Subbasins within each Larger Watershed and Steam Scored CMSs

Watershed	Subbasin	Stream of Interest
Small Lake Washington	Lakehurst[3]	Lakehurst Creek only
	Meydenbauer Creek	Meydenbauer Creek
	Yarrow Creek	Yarrow Creek
Lake Sammamish	Ardmore[4]	Idylwood Creek only
	Lewis Creek	Lewis Creek
	Phantom Creek	Phantom Creek
	South Sammamish	Stream 0161 only[5]
	Vasa Creek	Vasa Creek plus stream 0160
Greater Kelsey	Goff Creek	Goff Creek
	Kelsey Creek	Kelsey Creek Main Stem
	Mercer Slough	Mercer Slough
	Richards Creek	Richards Creek
	Sears Creek	Sears Creek
	Sturtevant Creek	Sturtevant Creek
	Sunset Creek	Sunset Creek

[3] Only area that drains to Lakehurst Creek
[4] Only area that drains to Idylwood Creek
[5] Assumed to be representative of the small streams in this subbasin

Watershed	Subbasin	Stream of Interest
	Valley Creek	Valley Creek
	West Tributary	West Tributary Creek
Coal Creek	Coal Creek	Coal Creek
	Newport	Newport Creek

2.0 Computing CMS Parameters

This section discusses how each of four CMS parameters were computed.

2.1 Impervious Area and Age of Development

Two sets of existing data were used to calculate this CMS parameter.

- Percent impervious area
- Age of Development rating

The percent impervious area was computed based on the total impervious area divided by the area of the total subbasin. Impervious surface area was identified using the City of Bellevue 2013 Impervious Surface layer from the City's Geographic Information System (GIS) files.

The percent impervious area was modified by the area-weighted average age of development (AWAAD). This rating accounts for the assumed level of stormwater controls attached to the parcel age (Table 3). A rating of 1 means the parcel was developed prior to any stormwater control requirements. A rating of 6 means the parcel was developed with the current level of required stormwater controls.

The rating for each subbasin was calculated by first assigning a rating from 1 to 6 to every parcel in the subbasin based on the associated age of development. The age of development was determined using the existing attributes in the Parcel Time of Development (*YearBuiltRes*) for the City of Bellevue. Park and Vacant/Undeveloped parcels were not assigned any score. The data layer was limited to the City; hence, development in subbasins / watersheds outside of the City's jurisdictional boundaries is not captured in this analysis. The total area within each subbasin for rating 1 through 6 were used to calculate the AWAADs.

The parameter for scoring was the Impervious Area Factor (IAF):

IAF = Impervious Area Fraction/ AWAAD

The Impervious Area Factor for each subbasin was then assigned a score between 1 (best - lowest value) and 20 (worst – highest value)

Data Sources

- City of Bellevue Age of Development
- City of Bellevue 2013 Impervious surface layer

Table 3 – Age of Development Sub Score Information

Age of Development	Age of Development Rating	Stormwater Management Requirements
2017-Current	6	The 2017 Surface Water Engineering Standards updated the On-site Stormwater Management requirements (List #1, List #2, or LID Performance Standard) and adopted the 2012/14 Department of Ecology Stormwater Management Manual for Western Washington.
2010-2016	5	The 2010 Surface Water Engineering Standards added water quality requirements, flow control requirements, and continuous modeling per the 2005 Department of Ecology Stormwater Management Manual for Western Washington . On-site Stormwater Management was also included either applying default LID credits or deriving LID credits with demonstrative modeling.
1996-2009	4	Bellevue adopts the Department of Ecology's1992 Stormwater Management Manual for the Puget Sound Basin (Technical Manual) - 2-year peak develop flow matches 50% of 2-year pre-developed flow - 10-year peak developed flow matches 10-year pre-developed flow - 100-year peak developed flow matches 100-year pre-developed flow - Unit-hydrograph method required for detention sizing - 1.18 to 1.5 safety factor required for pond sizing dependent on percent impervious area
1988-1995	3	Bellevue introduces Large Site stormwater controls for sites serving more than 5 acres and within ¼-mile of a stream (large subdivisions developed in the Coal Creek Watershed during this time). - 10-year peak developed flow matches the 2-year peak pre-developed flow (using computer modeling), 24-hour event - 100-year peak developed flow matches the10-year peak pre-developed flow (using computer modeling), 24 hour event A 30% increase in detention volumes for the Cookbook Method was adopted for all other sites.
1975-1987	2	The first set of Storm and Surface Water Utility Engineering Standards (published in 1975) focused on detention that could store the difference in runoff volume between the post-development 100 year, 4 hour storm and the pre-development 10 year, 4-hour event. To meet this requirement, a maximum allowable release rate of 0.2 cfs per acre and a storage requirement of 1.0 inch per impervious acre and 0.5 inch per pervious acre were required (Also known as the "Cookbook Method").
Pre-1975	1	No stormwater management required.

2.2 Riparian Corridor Vegetation

The Riparian Corridor Vegetation Score was computed for each stream of interest in the subbasins based on the percentage of vegetated area in the associated stream riparian corridor. For all streams of interest, except for Idylwood Creek (Ardmore subbasin), Lewis Creek, and Yarrow Creek, the calculations included mainstem and connected tributary corridors inside and outside of the Bellevue city limits. This was done to include the effects of riparian and floodplain alteration upstream and outside of the city in the conceptual model scores for stream within Bellevue.

For Idylwood Creek, the calculations were done for the tributaries and mainstem only within the city limits. Once leaving the city of Bellevue, the mainstem travels through Redmond and then discharges to Lake Sammamish. The calculations for Lewis Creek did not include the downstream reaches outside of the city limits. Yarrow Creek has tributaries that begin in Kirkland, flow though Bellevue (including mainstem) then leaves Bellevue and discharges into Lake Washington in Kirkland. For this stream the tributaries and mainstem originating in Kirkland were included in the calculations but not the main stem once it leaves the Bellevue city limits (focus is on stream health in Bellevue).

For this analysis, the merged City of Bellevue 2017 and 2013 Landcover rasters were used to quantify riparian corridor vegetation. After discussions with City staff, riparian corridor vegetation was mapped within a 100 ft buffer on either side of the stream to maintain consistency with previous City tree canopy analyses (Plan-it Geo 2018). Stream length in each subbasin / watershed was determined based on data obtained from the City's Open Streams Condition Assessment (OSCA). A polygon corresponding to the 100 ft buffer from the stream centerline as well as the start and end of each reach was created and then intersected with the tree canopy data from the rasters identified above.

The percentage total tree canopy cover within each 100 ft buffer reach polygon was then calculated. The computed percentages of total canopy cover for each subbasin were subsequently ranked to obtain a score ranging from 1 (highest) to 5 (lowest).

Several streams within subbasin boundaries did not have a SegmentID from the OSCA data. These were included as a conglomerate in calculations under "NULL" for Segment ID and were included in the total riparian corridor calculations.

The 100 ft buffer areas for several streams also extended outside the associated subbasin / watershed boundaries. In these situations, only the 100 ft buffer area located within the subbasin boundary was included in the analysis.

Data Source:

- City of Bellevue 2013 Landcover raster
- City of Bellevue 2017 Landcover raster
- OSCA Stream layer

The parameter for scoring was the Riparian Corridor Vegetation percentage. This was calculated as the fraction of the area within 100 ft of a stream for each subbasin. The subbasin percentages were then scored from 1 (best -highest value) to 20 (worst - lowest value) [6].

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[6] Note that the higher the percentage of riparian vegetation the better. the scoring was inverted so that highest cover is a "1" and the lowest cover is a "20."

2.3 Pollutant Loading/Land Use

Studies have shown that pollutant loading in runoff from highways, commercial, industrial, and mixed use areas are higher than for areas used as residential, Parks and undeveloped land (Ecology, 2011 and 2015). For each subbasin the total percent land area within the Bellevue city limits was summed for the following land use types: highways, commercial, industrial and mixed use. This total was used to score each subbasin on a scale from 1 (Best - lowest percentage) and 20 (worst- highest percentage).

Data Sources

- City of Bellevue Land use layer
- City of Bellevue Highways layer

2.4 Fish Passage Barriers

The Fish Passage Barrier parameter is based on three subscores (SS):

- First Barrier from Mouth: This is the percent of the stream length available from the mouth to the first barrier. The score is modified, as described below based on whether the first barrier is Full, Partial, or there are no barriers at all on the stream (SS1).
- Subsequent Barriers: Once past the first barrier, a barrier density subscore was calculated based on the number of barriers (after the first) per unit length of stream as described below based on whether the subsequent barriers are Full, Partial, or there are no barriers at all on the stream (SS2).
- For second and third order streams only: The number of barriers from the mouth of a second or a third order stream to the lake (Washington or Sammamish) was calculated as described below based on whether they are Full, Partial, or there are no barriers at all on the stream (SS3). This modification was removed for the subbasins of Kelsey and Coal when the results were rolled up by watershed.

All barrier data are based the Washington Department of Fish & Wildlife Barrier map as of April 15, 2021 and supplemented by OSCA data. The following information was incorporated into the CSM for barriers based on OSCA data and other staff knowledge:

- Lakehurst Creek – Complete barrier at mouth.
- Phantom Creek - At W. Lake Sammamish Parkway, head cutting has created a approximately 3 foot hydraulic drop on the downstream end. There is also a end has a catch basin on the upstream end of the culvert with >1ft drop This culvert is a complete barrier that is 470 ft upstream of Lake Sammamish.
- Mercer Slough – Accessible only the distance from mouth to confluence with west channel (1,700 ft - the GIS length of all segments of Mercer Slough East). At channel split, staff indicates there is a sediment wedge that is a barrier (Assumed full)
- Valley Creek - At NE 20th there is a partial barrier. At NE 21st St, the culvert is a complete barrier. OSCA documented a 4 ft hydraulic drop on upstream side. NE 20th (partial barrier) is 1,445 ft upstream from confluence with Kelsey. NE 21st St (presumed full barrier) is 1,917 ft US from the confluence.
- Sears Creek - the downstream-most regional facility on is a complete barrier. It is 1,178 ft from the confluence with Valley Creek.

The analysis was done for the entire length of the mainstem including those with stream mouths in other jurisdictions:

- Yarrow Creek – Kirkland
- Idylwood Creek (Ardmore) - Redmond

These sub-scores were calculated for one stream per subbasin, usually the mainstem stream or the longest stream in the subbasin. Exceptions were:

- Coal Creek Watershed – Sub-scores were also calculated for Newport Creek, a second order stream.
- Kelsey Creek Watershed – Sub-scores were calculated for all major tributaries including the second order tributaries: Sturtevant, Richards, West Tributary, and Valley and the third order tributaries: Sunset, Goff and Sears.

2.4.1 First Barrier

The location of the first barrier from the stream's mouth (from the lake or from a lower order stream) is important to know as it shows how much habitat may be initially accessible to migratory fish (or resident fish, especially on second and third order streams). Necessary data are the percent of stream length from the mouth to the first barrier

Sub-score 1 (SS1) = fraction of total stream length to the first barrier (full, partial or other).

The sub-scores were then scored from 1 (highest value - best) to 20 (lowest value - worst)

2.4.2 Subsequent Barriers

The number of barriers on the rest of the stream (after the first) is an important to know for overall habitat accessibility and the desire for the City to initiate barrier removal. A stream with many barriers will be more costly to open up compared to one with fewer barriers. Additionally, we assume that multiple barriers on a stream limits the habitat gain per barrier correction (i.e. the additional stream length of new unimpeded habitat available with a barrier correction project).

This sub-score is the number of barriers (full or partial) per unit stream length once past the first barrier. The unit stream length chosen was for the mainstem shortest creek (without tributaries)[7], Newport Creek. This sub-score was calculated as follows:

Sub- score 2 (SS2): Barrier Density (BD) after first Barrier: = NB_{af}/ SL_{af}

NB_{af} (Number of Barriers) = number of full barriers (after first) + 0.5 X Number of Partial Barriers (after first)

SL_{af} (Stream length-ft) = Stream length after first barrier (mainstem only)

The sub-scores were scored 1 (Lowest value -best) through 20 (Highest value - worst).

[7] Any unit stream length could be used to normalize the data, as long as it is the same for all subbasin calculations.

2.4.3 Modification for Second and Third Order Streams

Modifications to the scoring are needed for second and third order streams since the presence of barriers on the lower order stream impacts fish pass ability to tributary streams higher in the watershed. This factor was considered by looking at the number of barriers (full and partial) between the mouth of the second or third order stream and the number of barriers present in first order streams that connect directly with either Lake Sammamish or Lake Washington. Full barriers are counted as 1 and Partial barrier are counted as 0.5. This Barriers to Lake Modification (BTLM) was calculated as follows for 2nd & 3rd order streams:

Sub-Score 3 (SS3): BTLM = “Full” X 1 + “Partial” x 0.5

SS3 is zero for all first order streams. The sub-scores were scored 1 (Lowest value- best), through **10** - (Highest value - worst). This was done since there are nine 2nd & 3rd order streams total. First order streams were all ranked 1.

2.4.4 Total Fish Barrier Score

The total fish barrier score (FBS) for each subbasin was computed as follows:

Total FBS = ($SS1_{scaled\ score}$) + ($SS2_{scaled\ score}$)+ ($SS3_{scaled\ score}$); (Lowest is Best)

3.0 Caveats

These CM scores, both individually and in aggregate:

- Are relative measures of stream degradation applicable based on the conceptual model limiting factors to the 19 subbasins in Bellevue; they are not an absolute measure of degradation based on a reference stream.
- Represent an average condition across the entire subbasin or watershed. Many subbasins such as Goff, Valley, and others have very different conditions in the headwaters/upper subbasin than in the more intensely developed middle and/or lower sections.

A few specific caveats to keep in mind regarding the results:

- **Impervious Area factor –** Since 2017, flow control in the Sturtevant Creek subbasin has been different than the rest. The pre-developed condition to be matched is the “historic” land cover condition, not forested, like all other subbasins that discharge to creeks.
- **Riparian Corridor Vegetation –** This parameter does not specifically take int account any losses in the floodplain as part of riparian corridor alteration called out in the conceptual model.
- **Pollutant Loading –** The loading is a subbasin value only. It an estimate of the pollutant loading from subbasin that enters the adjacent stream. It does not include the pollutants that are in the stream from upstream subbasins. For example, the Mercer Slough score does not include pollutant loading in the Slough from Kelsey Creek and all the upstream tributaries.
- **Fish Passage Barriers –** WDFW data is from various surveys over the past 10 years and may not be consistent with present conditions. WDFW is beginning a comprehensive survey of Bellevue’s streams for fish passage barrier in August 2021. It also does not include the slope of

the stream that can greatly affect the ability of fish to travel upstream, even if no barriers are present.

4.0 Final Conceptual Model Scores

Final CMSs were the sum of the four parameter scores, each weighed the same (weighting may be charged in the future). Figure 2 shows a “radar” chart with the total score for each subbasin. Figure 3 shows the total scores with each total broken down by the four CMS parameters. This figure also ranks the subbasins 1 (best - Coal Creek) to 19 (worst- Sturtevant Creek). Figures 4 -7 shows the individual CMSs by subbasin.

Table 4 and Table 5 below show a comparison of the CMS ranking to ranking done by City staff in a workshop in Spring 2020 based on institutional knowledge. Table 4 is sorted from best to worst as initially ranked by City staff in 2020. Table 5 has the sub-basins together within the larger of the four watersheds. Table 5 also include a ranking of the four Watersheds based on the average score of their induvial subbasins (1 is best 4 is worst).

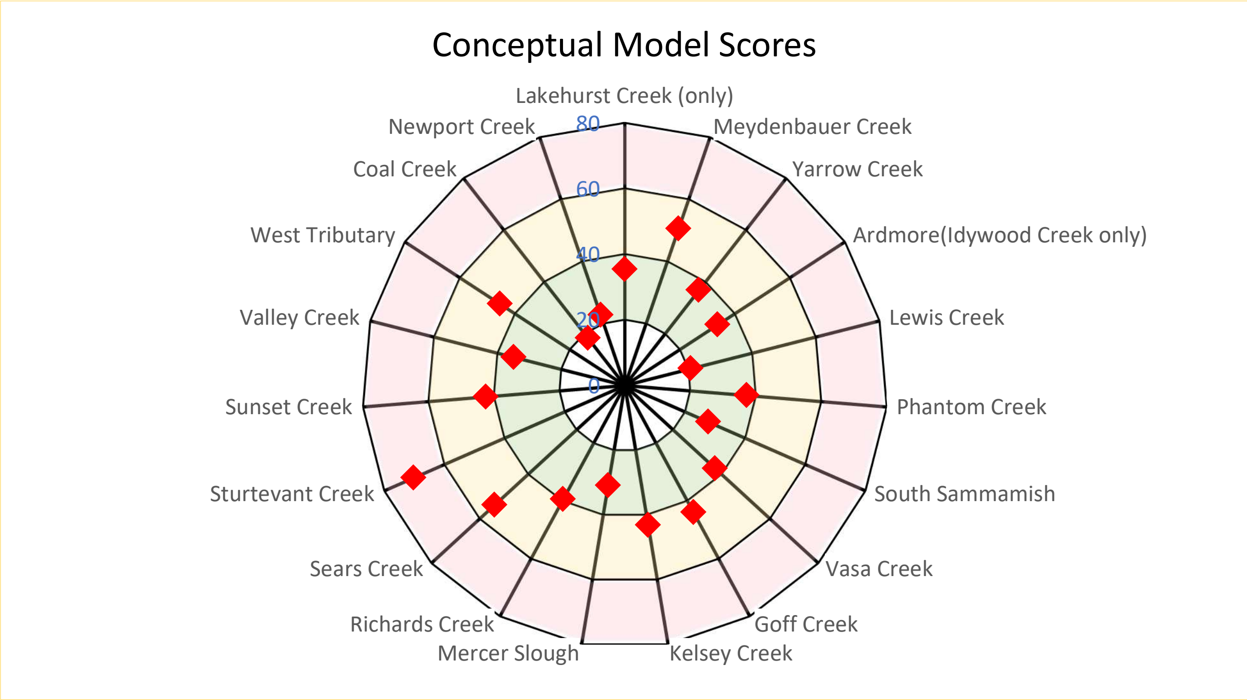

Table 4 – Conceptual Model Scores Compared to Bellevue Staff Ratings from Spring 2020

Subbasin/Stream	Draft Condition Rating by Staff Spring 2020	Conceptual Model Score Ranking 1 (best) – 19 (worst)
Coal Creek	Great	1
Lewis Creek	Good	3
Newport Creek	Good	2
Ardmore (Idylwood Creek)	Fair	6
Goff Creek	Fair	15
Kelsey Mainstem	Fair	14
Mercer Slough	Fair	5
North Sammamish	Fair	Not ranked with CMS[8]
Phantom Creek	Fair	9
Redmond 400	Fair	Not ranked with CMS
Richards Creek	Fair	12
Rosemont	Fair	Not ranked with CMS
South Sammamish/(0161)	Fair	4
Spirit Ridge	Fair	Not ranked with CMS
Sunset Creek	Fair	13
Valley Creek	Fair	8
Vasa Creek	Fair	10
West Tributary Creek	Fair	16
Wilkens Creek	Fair	Not ranked with CMS
Yarrow Creek	Fair	11
Beaux Arts	Poor	Not ranked with CMS
Clyde Beach	Poor	Not ranked with CMS
Lakehurst (Lakehurst Creek)	Poor	7
Meydenbauer Creek	Poor	17
Point Cities	Poor	Not ranked with CMS
Sears Creek	Poor	18
Sturtevant Creek	Poor	19

[8] See section 1.2.

Table 5 – Conceptual Model Scores Compared to Bellevue Staff Ratings from Spring 2020
All Subbasins Grouped by Watershed

Subbasin/Stream	Draft Condition Rating by Staff Spring 2020	Subbasin Conceptual Model Score Ranking 1 (best) – 19 (worst)	Watershed Conceptual Model Score (1-4)
Coal Creek			**1**
Coal Creek	Great	1	
Newport Creek	Good	2	
Lake Sammamish			**2**
Ardmore (Idylwood Creek)	Fair	6	
Lewis Creek	Good	3	
Phantom Creek	Fair	9	
South Sammamish (stream 0161)	Fair	4	
Vasa Creek	Fair	10	
North Sammamish	Fair	Not ranked with CMS	
Redmond 400	Fair	Not ranked with CMS	
Rosemont	Fair	Not ranked with CMS	
Spirit Ridge	Fair	Not ranked with CMS	
Wilkins Creek	Fair	Not ranked with CMS	
Small Lake Washington			**3**
Lakehurst (Lakehurst Creek)	Poor	7	
Meydenbauer Creek	Poor	17	
Yarrow Creek	Fair	11	
Beaux Arts	Poor	Not ranked with CMS	
Clyde Beach	Poor	Not ranked with CMS	
Greater Kelsey Creek			**4**
Goff Creek	Fair	15	
Kelsey Creek Main stem	Fair	14	
Mercer Slough	Fair	5	
Richards Creek	Fair	12	
Sears Creek	Poor	18	
Sturtevant Creek	Poor	19	
Sunset Creek	Fair	13	
Valley Creek	Fair	8	
West Tributary	Fair	16	

5.0 References

Washington State Department of Ecology. 2011. Toxics in Surface Runoff to Puget Sound. Phase 3 Data and Load Estimates. Publication No. 11-03-010. Herrera Environmental Consultants, Inc. April.

Washington State Department of Ecology. 2015. Western Washington NPDES Phase I Stormwater Permit. Final S8.D Data Characterization 2009-2013. (Publication No. 15- 03-001)

Attachment C – Scoring behind Assignment of Management Strategies

Calculation of X-Axis: Conceptual Model Scores and characterization of relative stream degredation

Name	Limiting Factors				Conceptual Model Scores					
					45	15	25	15		
	Stormwater runoff/Impervious	Loss of Floodplain and Riparian Veg	Pollutant Loading	Fish Passage	upland hydrologic alteration	riparian corridor alteration	pollutant loading	in-stream physical barriers	Conceptual Model Score (WEIGHTED)	Ranked Conceptual Model Scores (1=highest rank)
Coal Creek	primary	secondary	primary	secondary	3.1	4.6	1.2	11.8	4.1	2
Newport Creek	primary		primary		18.8	1.0	1.9	1.0	9.2	8
Mercer Slough	secondary		primary	primary	6.3	14.8	5.8	5.3	7.3	5
Kelsey Creek	primary		primary	secondary	13.4	14.7	3.9	12.6	11.1	14
Sturtevant	primary	primary	primary	secondary	20.0	20.0	20.0	10.3	18.5	19
Richards Creek	primary	secondary	primary		12.7	12.3	7.4	8.1	10.6	13
Sunset Creek	primary	secondary	primary	secondary	14.0	11.4	4.5	14.0	11.2	15
West Tributary	primary	secondary	primary		12.9	16.6	10.7	7.1	12.0	16
Goff Creek	primary	secondary	primary	secondary	7.0	13.4	5.5	20.0	9.5	11
Valley Creek	secondary		primary	secondary	4.0	12.4	4.2	15.2	7.0	4
Sears Creek	primary	secondary	primary	secondary	14.0	13.2	13.9	12.9	13.7	18
Lewis Creek	primary		secondary	primary	1.0	9.0	1.0	11.8	3.8	1
Vasa Creek	primary		primary	primary	10.0	10.0	4.4	14.3	9.2	9
Creek	primary		secondary		15.8	5.0	1.0	12.0	9.9	12
Redmond 400	primary	secondary								
Rosemont	primary		secondary							
Wilkins Creek	primary		secondary							
North Sammamish	primary									
Phantom Creek	primary		primary		8.7	10.0	7.2	11.5	8.9	7
Spirit Ridge	primary									
South Sammamish	primary		primary	Secondary	6.3	11.1	3.0	10.4	6.8	3
Lakehurst	Primary			Secondary	11.3	8.0	1.9	14.5	8.9	6
Meydenbauer Creek	Primary	Secondary	Primary	Secondary	15.5	14.4	9.0	12.1	13.2	17
Beaux Arts										
Clude Beach	Primary	Secondary	Secondary							
Yarrow Creek	Primary	Secondary	Primary	Secondary	8.5	12.7	8.0	10.0	9.2	10
Point Cities										

Calculation of Y-Axis: Potential Return on Investment

	Measures of Potential ROI by City							
	30		**20**		**50**			
Name	Measure of Cost Feasibility: City land ownership - overall	normalized	Measure of Cost Feasibility: City land ownership - proximate to stream channels (within 100 ft buffer)	normalized	Measure of Hydrology/WaterQuality Benefit: Stormwater Retrofit Opportunities	normalized	Potential Return on the City's Investment in Stream Health	Ranked - In order of potential return on the City's investment in stream health (1=highest rank)
Coal Creek	41%	1.41	51%	0.77	45%	-1.40	-0.12	17
Newport Creek	30%	-0.11	91%	2.37	72%	1.40	1.14	1
Mercer Slough	53%	2.97	51%	0.77	39%	-1.98	0.05	14
Kelsey Creek	36%	0.64	53%	0.83	57%	-0.16	0.28	8
Sturtevant	32%	0.11	36%	0.15	63%	0.45	0.29	7
Richards Creek	34%	0.44	42%	0.40	67%	0.89	0.66	3
Sunset Creek	41%	1.31	43%	0.41	60%	0.16	0.55	4
West Tributary	31%	-0.05	45%	0.52	61%	0.22	0.20	10
Goff Creek	21%	-1.36	15%	-0.72	70%	1.21	0.05	13
Valley Creek	23%	-1.08	39%	0.26	65%	0.69	0.07	11
Sears Creek	30%	-0.19	38%	0.23	69%	1.07	0.52	5
Lewis Creek	38%	0.93	52%	0.78	39%	-2.07	-0.60	24
Vasa Creek	26%	-0.75	30%	-0.08	62%	0.34	-0.07	15
Ardmore Area/Idylwood Creek	32%	0.17	89%	2.27	68%	0.99	1.00	2
Redmond 400	25%	-0.81	19%	-0.54	53%	-0.62	-0.66	25
Rosemont	19%	-1.61	0%	-1.31	68%	1.03	-0.23	19
Wilkins Creek	26%	-0.71	26%	-0.24	68%	1.01	0.24	9
North Sammamish	32%	0.13	0%	-1.31	53%	-0.62	-0.53	22
Phantom Creek	28%	-0.39	40%	0.30	66%	0.75	0.32	6
Spirit Ridge	30%	-0.13	0%	-1.31	66%	0.74	0.07	12
South Sammamish	34%	0.45	25%	-0.28	50%	-0.91	-0.38	21
Lakehurst	39%	1.12	41%	0.35	44%	-1.51	-0.35	20
Meydenbauer Creek	27%	-0.56	14%	-0.76	62%	0.31	-0.17	18
Beaux Arts	25%	-0.82	0%	-1.31	53%	-0.60	-0.81	26
Clyde Beach	27%	-0.57	0%	-1.31	51%	-0.83	-0.85	27
Yarrow Creek	35%	0.59	34%	0.06	53%	-0.59	-0.11	16
Point Cities	23%	-1.14	0%	-1.31	59%	0.06	-0.57	23
average	31%		32%		58%			
std dev	7.3%		24.7%		9.6%			