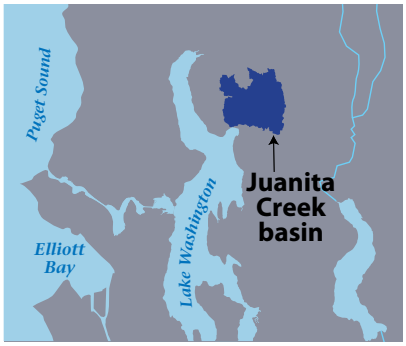
Juanita Creek Basin Stormwater Retrofit Cost Study

by Mark Wilgus, Jeff Burkey, and Hans Berge

Untreated stormwater runoff is an identified threat to water quality and watershed health in the Puget Sound region. In the in the urbanized Juanita Creek basin, runoff patterns and water quality have changed dramatically as a result of development that occurred over many decades with ineffective or no stormwater controls. Consequently, Juanita Creek's water and habitat quality is degraded with issues that include pervasive bank instability, low habitat complexity, excessive sediment deposition that limit salmon spawning areas, and low frequency of large wood and generally poor biological conditions as evidenced by a low BIBI (Benthic Index of Biotic integrity) score of 17 (see **Table 1**, page 4).

This study evaluated the cost and effectiveness of seven potential basin-wide stormwater retrofit strategies at achieving improved water quality and flow conditions that would be supportive of native fish and insects in the stream. There is strong regional interest in understanding the effectiveness of stormwater retrofit strategies because these problems are pervasive in many other parts of the Puget Sound basin.



***Map 2.** Juanita Creek basin.*

Study Area

Located northeast of Juanita Bay in the City of Kirkland, the Juanita Creek basin covers about 6.8 square miles that includes 15.7 miles of stream channel (see **Map 2**). Roofs, streets, and other paved surfaces cover nearly 68 percent of the basin. The primary land use is residential with some commercial development.

The vast majority of development in the basin was constructed with no or highly ineffective stormwater control facilities, a consequence of the mid- and late 20th Century development standards in effect when most development was occurring. As a result, rainwater has less opportunity to infiltrate into the ground, and travels directly to the stream system without being slowed or filtered – causing impacts that reduce the creek's capacity to support salmon and the insects that they feed on.

Project Partners

King County collaborated with the Washington State Department of Ecology (DOE), the City of Kirkland and the Washington State Department of Transportation (WSDOT) to recommend a plan of action to improve water quality and flow conditions in Juanita Creek. Project funding was provided by DOE with matching funds and labor provided by the King County Water and Land Resources Division, the City of Kirkland and WSDOT. The total estimated project cost was $922,389.

Project Approach and Methods

The project included extensive stormwater infrastructure mapping, flow gauging, habitat assessment, and water quality testing, as well as the development of a Hydrological Simulation Program-Fortran model characterizing hydrology and water quality.

Seven potential future stormwater mitigation scenarios were evaluated to assess their effectiveness in improving stream insect community health based on the BIBI score meeting Washington state water quality standards, and reducing the yearly number of gravel disturbances in Juanita Creek. The scenarios included various combinations of low-impact development techniques (e.g., rain gardens) and conventional stormwater ponds. For comparison purposes, fully forested, 1977 land use, existing land

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Findings

- The strategies varied greatly in terms of costs improvements and BIBI scores.
- The best performing stormwater mitigation scenario, **Alternative 4** resulted in a potential BIBI score of 35—just above an identified critical level and at the high end of "Fair" on the narrative BIBI scale and produced significant improvements in stream water quality. This scenario routed 80 percent of impervious surfaces in the basin to both rain gardens and detention ponds.
- The second best performing stormwater mitigation scenario, **Alternative 3** resulted in a potential BIBI score of 28 (low end of "Fair") and had water quality improvements similar to the best scenario by routing 80 percent of impervious surfaces in the basin to rain gardens only.
- The remaining five scenarios produced potential BIBI scores ranging from 17 to 24 ("Poor") and resulted in variable improvements in water quality.
- Benchmark scenarios for fully forested and existing conditions resulted in potential BIBI scores of 38 ("Good") and 17 ("Poor"), respectively.
- All seven scenarios were generally effective in reducing the number of gravel disturbances in the stream.

It should be noted that the best performing mitigation scenario, **Alternative 4** was designed to achieve flow control performance standards proposed in the draft Phase 1 Municipal National Pollutant Discharge Elimination System permit with an effective date of Aug. 1, 2013.

The estimated costs (present value, 2011 dollars) to achieve the seven mitigation scenarios ranged from $200 million to $1.4 billion ($30 million to $200 million per square mile) with increased costs generally equating to increased effectiveness:

- The most effective scenario **Alternative 4** was also the most expensive at $1.4 billion;
- The second most effective scenario **Alternative 3** was estimated at $1.2 billion;
- The other five mitigation scenarios had lower cost estimates and lower overall levels of effectiveness.

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use, and hypothetical build-out land use conditions were also evaluated. (See **Tables 1** and **2** respectively.)

Present value cost estimates for the mitigation scenarios were calculated in 2011 dollars with an assumed 4 percent discount rate over a 40-year design life. Estimates include capital costs (land acquisition, design, and construction) and operation and maintenance costs.

For the full report, go to http://green.kingcounty.gov/WLR/Waterres/StreamsData/reports/JuanitaCreek2012

Key Results and Recommendations

1. Based upon the study results, retrofitting urbanized Puget Sound basins to achieve the highest performance standard will require a significant public and private sector resource investment. Along with the cost, the time factor to achieve the water quality standard is measured in decades.
2. For the Juanita Creek basin, implementing and measuring the best performing mitigation strategy in a pilot study area prior to building capital retrofit projects basin-wide is strongly encouraged to field test the efficacy of the strategy.
3. To achieve the Alternative #4 performance standard, both conventional end-of-pipe facilities (e.g. ponds) and low impact development techniques (e.g. rain gardens) that infiltrate stormwater into the ground were required for most impervious surfaces.
4. To achieve the targets a detailed plan is recommended that includes performance measures and targets; monitoring and adaptive management; and, a cost benefit effectiveness evaluation. The study did not evaluate the cost-benefit of meeting different targets.

***Table 1.** Comparative BIBI Score Scenarios*

SCENARIOS	DESCRIPTION	BIBI
Forested	Basin is assumed fully forested, pristine conditions.	**38**
Land Use / Cover 1977	Land use derived from 1977 aerial imagery.	**19**
65/10	Basin is assumed to have evolved under early watershed planning threshold of stream stability with forest retention and limited impervious surfaces.	**29**
Land Use / Cover 2002	Existing conditions as defined with 2002 satellite imagery.	**17**
FUTURE	Full build-out of potential land use based on current zoning, no mitigation.	**16**

***Table 2.** Stormwater Mitigation Alternatives Total Cost*

ALTERNATIVES	DESCRIPTION	BIBI	TOTAL COSTS
1	King County Future land use with Level 2 stormwater ponds applied basin-wide.	**23**	$210 million
2	Future land use with 40 percent Total Impervious Area (TIA) captured by rain gardens	**20**	$590 million
3	Future land use with 80 percent Total Impervious Area (TIA) captured by rain gardens	**28**	$1.2 billion
4	New Washington State DOE Proposed Standard: Matching durations from 8 percent of the 2-year forested to the 50-year forested, using a combination of Alternative 3 and stormwater detention ponds stacked on basic wetponds applied basin-wide.	**35**	$1.4 billion
5	Combination of alternative 2 throughout the basin with King County Level 2 stormwater detention ponds stacked on basic wetponds in three catchments.	**20**	$591 million
6	Future land use with King County Level 2 stormwater detention ponds stacked on basic wetponds applied basin-wide.	**24**	$215 million
7	Future land use where roof area runoff from a mild wet season of rainfall is captured, then released July-September each calendar year at a constant rate.	**17**	$257 million