



Snohomish County

# North Creek Drainage Needs Report

Executive Summary

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The North Creek Drainage Needs Report (DNR) is one of a series of 11 drainage plans completed for most of Snohomish County's Urban Growth Areas (UGAs). The purpose of these plans is to identify flooding and surface water problems and to recommend solutions.

In order to gain a better understanding of the drainage systems, streams, and wetlands within the unincorporated UGAs of Snohomish County, the Snohomish County Council authorized the accelerated development of drainage plans, known as the DNRs project. The purpose of the DNR project is to plan for existing and future drainage infrastructure needs to reduce road and property flooding, protect and enhance aquatic habitat, and reduce stormwater pollution. This North Creek DNR is one of a series of 11 individual reports that were prepared, in addition to a summary report for the entire DNR project.

## Overview

The North Creek watershed, which covers an area of approximately 18,240 acres (28.5 square miles), is located in southwestern Snohomish County, though a small portion of the basin is also located in King County. Roughly two-thirds of the basin lies within unincorporated Snohomish County. The rest lies in the cities of Everett, Mill Creek, and Bothell, and nearly all is within the UGA.

Most of the study area is extensively developed, with the majority being single-family residential, along with a substantial amount of multifamily residential and commercial, with the latter typically focused along the major roadways (Interstate 5, or I-5, I-405, and numerous other state routes and other arterials). However, the majority of the riparian corridor for the mainstem of North Creek remains undeveloped.

The DNR study identified a total of 382 surface water problems in the North Creek study area. Of these, 255 are flooding problems within the basin, most of which are due to undersized pipes and channels in the developed areas of the basin. Many of these problems are clustered along the same drainage systems and many tend to occur along the older drainage systems. Few flooding problems are currently located along the main stem of the creek, except within the City of Bothell.

To address both flooding and fish passage problems throughout North Creek, alternative solutions were evaluated for many of the higher-priority problems (but not for all the identified problems). Solutions generally consisted of replacing the existing drainage systems, installing new detention ponds, and installing high-flow bypass pipelines. In

**Scope of Analyses:** For the North Creek study area, detailed hydrologic and hydraulic models were created to analyze flooding problems along the entire mainstem of North Creek, most of the major tributaries in the basin, and many local drainage systems that have experienced historical drainage problems. However, not all of the smaller local drainage systems in the study area were analyzed due to budget constraints. Habitat, water quality, and erosion assessments were also conducted for this study area.

many areas of the basin, it was difficult to find suitable undeveloped locations in which to install new detention ponds, but several proposed locations were identified, including a large 25-acre-foot pond near 124th Street SE in the north end of the basin.

In addition, the study found 75 habitat problems, such as fish barrier culverts and inadequate vegetation to provide good habitat. In the unincorporated UGA there are relatively few fish passage problems along the entire main stem of North Creek. More fish passage barriers are found on the tributaries. However, throughout the basin the lack of large woody debris (LWD) and pools and low habitat complexity (i.e., low quality) in streams result in degraded spawning and rearing habitat for fish.

Because of the high level of urbanization in the study area, water quality is generally poor, with streams failing to meet state standards for fecal coliform bacteria and dissolved oxygen (DO).

<b>Table ES-1 Recommended Projects for North Creek Basin</b>		
34	Flooding projects	\$8,821,000
13	Habitat projects	\$4,387,000
7	Water quality projects	\$1,104,000
9	Flooding and habitat projects	\$7,768,000
1	Flooding and water quality project	\$1,699,000
<b>64</b>	<b>Total recommended projects</b>	<b>\$23,779,000</b>

The recommended plan for the North Creek study area addresses the most significant flooding problems as well as some of the more significant habitat, water quality, and erosion problems. In addition, a number of nonproject actions are recommended that are primarily aimed at improving water quality. The recommendations include a total of 64 projects, most of which address multiple problems. The projects that address flooding problems generally consist of

replacing existing drainage pipes, culverts, and ditches with larger ones, along with a few detention facilities where they can cost-effectively reduce creek flows. This includes a regional 25-acre-foot detention pond near 124th Street SE. Typical habitat projects consist of culvert upgrades to remove fish passage barriers and revegetation improvements along some stream channels and/or adjacent riparian corridors. A typical water quality project consists of retrofitting roadside ditches into biofiltration swales so that they effectively treat stormwater runoff.

The estimated implementation cost of these recommended projects is \$23.8 million. In order to implement the recommended projects, a number of issues will need to be resolved, such as available funding, project responsibility, prioritization of projects, detailed design, construction sequence, and permits. These issues are discussed in Section 10.3.

## Study Area

The North Creek DNR basin is located in the Sammamish River basin in the southwest portion of Snohomish County (see Figure 1-1), and it covers an area of approximately 18,240 acres (28.5 square miles). The main drainage corridor through the basin is North Creek, which originates in the heavily developed City of Everett and flows through the unincorporated and generally less developed portions of the UGA as well as the heavily developed Cities of Bothell and Mill Creek (see Figure 1-2). Roughly two-thirds of the basin lies within unincorporated Snohomish County. The main stem of North Creek exits Snohomish County and the North Creek DNR study area to continue south within King

County for approximately 1 mile before discharging into the Sammamish River. The main stem of North Creek is approximately 13 miles long, with the headwaters located in the City of Everett between Evergreen Way and SE Everett Mall Way. The major tributaries include Silver Creek, Penny Creek, Nickel Creek, Tambark Creek, Greening Creek, Filbert Creek, and Sitka Creek.

For the purpose of this study, the North Creek basin was divided into six subbasins (see Figure 1-2). Penny Creek and Silver Creek are tributary subbasins that discharge into the mainstem of North Creek at two discrete locations. The four remaining subbasins contain a portion of the North Creek main stem and its associated tributary area. They are referred to in this report as North North Creek, Middle 2 North Creek, Middle 1 North Creek, and South North Creek subbasins. The approximate drainage areas for the six subbasins are as follows:

- Penny Creek: 3,600 acres (5.6 square miles)
- Silver Creek: 3,400 acres (5.3 square miles)
- North North Creek: 3,300 acres (5.1 square miles)
- Middle 1 North Creek: 3,100 acres (4.8 square miles)
- Middle 2 North Creek: 1,400 acres (2.3 square miles)
- South North Creek: 3,500 acres (5.4 square miles)

### **Penny Creek Subbasin**

Existing land use in the northern portion of the Penny Creek subbasin primarily consists of single-family and multifamily residential and commercial development. The middle portion of the subbasin is significantly less developed. The southern portion of the Penny Creek subbasin makes up roughly 50 percent of the City of Mill Creek. Existing land use in this portion is mostly medium-density residential with some high-density and multifamily development.

### **Silver Creek Subbasin**

Existing land uses in the western portion of the Silver Creek subbasin, along the State Route (SR) 527 corridor, include commercial and high-density single-family and multifamily residential development. The central portion of the subbasin is predominantly single-family residential, and the eastern portion is predominantly rural.

### **North North Creek Subbasin**

The northern portion of the North North Creek subbasin is in the City of Everett. Much of this area is highly urbanized with the top three existing land uses being commercial, medium-density single-family residential, and multifamily residential development. The southern portion of the subbasin is the northwest corner of the City of Mill Creek. This area is mostly single-family residential.

### **Middle 1 North Creek Subbasin**

Existing land uses in the Middle 1 North Creek subbasin are dominated by low- and medium-density single-family residential, with the exception of commercial and multifamily housing in the southernmost portion of the subbasin. The southeast portion of the subbasin lies within the City of Bothell, which is predominately commercial and high-density multifamily residential development.

### **Middle 2 North Creek Subbasin**

Most of the Middle 2 North Creek subbasin lies within the City of Mill Creek. Existing land uses within this subbasin consist of mainly low- and medium-density single-family housing with some commercial and multifamily development.

### **South North Creek Subbasin**

A significant portion of the South North Creek subbasin lies within the City of Bothell, with commercial businesses, single-family and multifamily housing making up the majority of existing land uses.

Anticipated future land use in the North Creek DNR study area includes substantial new commercial and high-density residential development and redevelopment. The modeled future land use scenarios include substantial conversions of pastureland to impervious surfaces and a resulting dramatic increase in peak runoff and drainage system flows.

## **Flooding**

Detailed hydrologic and hydraulic models were developed for the DNR project to quantify existing and future surface water conditions within or related to the DNR study area and to evaluate potential solutions to identified problems. In general, hydrologic models were used to estimate the amount of stormwater runoff that would be generated during a storm or series of storms. These data were then input into the hydraulic models, which were used to assess how stormwater moves through the stormwater conveyance system (including stream channels, wetlands, ditches, culverts, and enclosed storm drain systems) and identify potential flooding problems.

Complete descriptions of the over 200 identified flooding problem areas and their estimated flooding frequency are provided in Section 8.0, while a brief overview is provided below for each subbasin. The number of problems identified exceeded the number of problems that could be analyzed within the scope of this DNR project. For this reason, CIP projects were developed to address the higher-priority flooding problems.

Most CIP projects consist of replacing existing culverts with larger ones to increase conveyance capacity and consequently reduce the potential for upstream flooding. Several detention projects were also identified and conceptually designed that provide temporary storage and reduced discharge rates of runoff. As a result of the analyses and assessments, a total of 64 flood and flood and habitat projects were selected to be included in the North Creek DNR recommended plan.

The combined effects of the CIP projects were evaluated by grouping projects into modeling alternatives for the North Creek basin. In general, the first alternative, identified as CIP Modeling Alternative 1, addresses flooding and fish passage problems primarily by increasing the capacity of the conveyance system with minor detention included at select locations. The second alternative, CIP Modeling Alternative 2, addresses these same problems through a combination of conveyance improvements and adding more detention storage in the basin wherever opportunities exist along with some proposed high flow bypass pipelines. In many areas of the basin, it was difficult to find suitable undeveloped locations in which to install new detention ponds, but several locations were identified, including a large 25-acre-foot pond near 124th Street SE in the north end of the basin.

Both alternatives were evaluated using the hydrologic and hydraulic models that were developed for this basin. Generally, both alternatives were equally effective in eliminating the future flooding and fish passage problems in the North Creek basin.

The combined effect of all of the projects in Alternative 1 would result in about a one percent increase in peak flows in North Creek compared with future condition flows. Conveyance system projects to correct flooding problems often result in much higher downstream flows because of the consequent loss of floodplain storage. However, the relatively minor increase in flows for North Creek is because floodplain storage lost in the upper part of the basin is redistributed to the downstream reaches. In comparison to future land use conditions, this alternative causes a slight decrease in the duration of erosive flows above the confluence with Penny Creek and a slight decrease in erosive flow duration below 164th Street SE. Flow durations are not affected in the most downstream reaches below 228th Street SE.

The Alternative 2 projects (including the regional detention facility) result in a comparable reduction in flow in the downstream reaches of North Creek by about 1 percent under future land use conditions. More importantly, the regional storage facility is very effective in reducing the duration of erosive flows in the downstream reaches to levels experienced under existing land use conditions.

The recommended plan for each subbasin includes a combination of Alternative 1 and 2 projects. This is discussed in the following paragraphs, along with subbasin-specific details about the flooding problems and recommended projects in each subbasin.

### **Penny Creek Subbasin**

The 54 flooding problems identified in the Penny Creek subbasin under future land use conditions are the result of inadequate conveyance capacity at culverts, pipes, and ditches. The most significant flooding in this basin occurs in built-out residential areas in the northern portion of the Penny Creek subbasin that were constructed in the 1960s.

Alternative 1 involves replacing the existing drainage systems with larger facilities. The inclusion of a detention pond in Alternative 2 increases the cost by \$500,000 while not effectively changing the flows in Penny Creek downstream of Thomas Lake, although flows would increase upstream of the lake due to the conveyance improvements in both alternatives. Seven conveyance improvement projects in Alternative 1 are recommended, with the lakes and a downstream wetland providing attenuation of the increased flows from these improvements. These projects address all identified drainage problems in the subbasin.

### **Silver Creek Subbasin**

The 25 flooding problems identified in the Silver Creek subbasin under future land use conditions are mostly the result of undersized culverts and pipes. There are localized drainage problem areas scattered in the subbasin with no one area being significantly more severe than another.

A total of five flooding correction projects are recommended. In addition to the four conveyance capacity improvement projects in Alternative 1 that address the identified flooding problems, Alternative 2 includes expanding the existing Mays Pond into a detention facility. At a cost of \$350,000, peak flows in Silver Creek would be reduced by the proposed detention facility, offsetting the flow increases from the upstream conveyance improvements. The modifications to Mays Pond will also result in

downstream water quality benefits. Alternative 2 is therefore recommended for this subbasin.

### **North North Creek Subbasin**

Most of the 84 problems identified in the North North Creek subbasin under future land use conditions are the result of inadequate conveyance capacity at culverts, pipes, and ditches. A few of the remaining problems are due to water backing up from an existing detention facility or undersized downstream structure. There is significant flooding in an unnamed North Creek tributary, referred to as the 124th Street SE tributary, at 124th Street SE between 8th Avenue W and 4th Avenue W. There is also significant flooding at the main stem of North Creek at 124th Street SE and 128th Street SE.

The study analyzed two alternatives: (1) replacing the undersized portions of the existing drainage systems with larger pipes or culverts, or (2) implementing those improvements plus adding two stormwater bypasses and two new detention and water quality treatment facilities. One of these detention facilities is a large 25-acre-foot detention facility near 124th Street SE. Alternative 2, without the high-flow bypasses, is included in the recommend plan. This includes a total of 14 projects to address the identified priority flooding problems, with the majority consisting of culvert replacements or other conveyance improvements that will reduce local flooding. Four of the proposed projects also solve habitat problems, and two of the proposed projects consist of creating detention and water quality ponds, including the large detention facility near 124th Street SE. Some of the recommended projects address numerous individual problems.

### **Middle 1 North Creek Subbasin**

A majority of the 57 problems identified in the Middle 1 North Creek subbasin under future land use conditions are the result of inadequate conveyance capacity of existing culverts, pipes, and ditches. The remaining problems are due to water backing up from restrictive downstream culverts or channel sections. There is significant flooding on the Greening Creek tributary at 207th Place SE.

Two alternatives were studied for this subbasin: (1) replacing the undersized portions of the existing drainage systems with larger pipes or culverts, or (2) implementing those improvements plus adding a flow bypass channel for Greening Creek. The alternatives result in nearly identical flows in Filbert and Greening Creeks. Since the costs were very similar, Alternative 2 is recommended with some modifications. A total of 11 flooding projects are included, with the majority consisting of culvert replacements and other conveyance improvements or replacements that will reduce local flooding. Two of the proposed projects also solve fish passage problems. Each recommended project addresses numerous identified flooding problems along common drainage systems.

### **Middle 2 North Creek Subbasin**

The 13 problems identified in the Middle 2 North Creek subbasin under future land use conditions are localized drainage problems typically consisting of inadequate culverts or drainage pipe systems.

Because of the steep topography of this subbasin, detention is not a suitable approach to solving drainage problems. Therefore, only one alternative was developed for this subbasin, which involved replacing existing drainage systems to increase their conveyance capacity. Two flooding projects are recommended for this subbasin.

## South North Creek Subbasin

The 22 problems identified in the South North Creek subbasin under future land use conditions are associated with an inadequate drainage system located along 39th Avenue SE near 228th Street SW, resulting in frequent and extensive flooding.

Because of the extensiveness of the problems and their location in series paralleling 39th Avenue SE, a comprehensive single project was developed. Alternative 1 included numerous conveyance improvements and a detention facility in the upper reaches of the detailed study area. Alternative 2 included slightly different conveyance improvements and two detention facilities, one in the upper detailed study area (as contained in Alternative 1) and one in the most downstream reach of the detailed study area.

Although the two detention facilities would reduce peak flows significantly more than with just the upper facility, the cost of the second detention facility is about \$800,000. Since the upper detention facility is sufficient to mitigate the future land use flows associated with the drainage improvements, and since there is a significant increase in project costs if both detention facilities are constructed, the Alternative 1 projects are recommended.

## Habitat

The habitat assessment for the North Creek DNR study area involved selecting sites that represent the variety of habitat conditions found within the North Creek DNR study area. A total of 12.9 miles (20.8 kilometers) of fish-bearing stream within the North Creek DNR study area was surveyed. In addition, riparian areas along fish-bearing streams and wetlands within the unincorporated areas of the North Creek DNR study area were evaluated using recent aerial photographs and limited field verification. Analysis was then performed to examine relationships between habitat components and factors that could affect habitat quality.

In the North Creek DNR area, fish passage is generally good on the main stem but more problematic on the tributaries. Extensive riparian wetlands along the main stem help to attenuate erosive flows; however, the system has limited instream LWD, few pools, and low habitat complexity. As a result of the habitat assessments, 75 specific habitat problems were identified in the North Creek DNR study area. These problems include the following:

- Generally low findings of LWD density, high percent fines in riffles downstream of functional pools, low densities of pools, and limited off-channel habitat indicating poor habitat quality in surveyed reaches
- Low salmon productivity
- Poor habitat quality indicated by low average score of stream biological integrity
- Road culverts that are barriers to fish passage
- Generally moderate to poor condition of near-stream riparian habitat indicated by low stream shade and LWD recruitment potential
- A total of 43 wetlands were either wholly or partially removed for a loss of 43 acres, which generally appears to have been the result of filling related to residential development

These habitat problems were reviewed with County staff to determine the ones that would be developed into CIP projects. Potential CIP projects were developed to address

some of the higher priority problems identified. Solutions for some of the problems were not addressed because they were located outside of the study area or were considered as lower priorities. A total of 13 habitat CIP projects (3 fish passage improvements and 10 others) were developed to address some of the identified habitat problems.

Recommended habitat projects include the replacements or retrofits for culvert fish passage barriers identified as high priority. Other CIP projects include installing LWD along stream corridors, planting various types of native riparian vegetation, removing invasive vegetation, and installing log weirs. A total of 13 habitat CIP projects are included in the recommended plan for the North Creek DNR study area. In addition, eight of the flooding projects also solve fish passage problems.

In addition to the North Creek study area, aquatic habitat assessments were performed in many drainage basins within the County. Data from these assessments were combined into a regional analysis to make it possible to explore relationships among physical and habitat and biological variables over a broader range of conditions than would be found in any one-drainage area. The results of the regional analysis conducted for the DNR project are provided in a separate document, *Aquatic Habitat Summary: Current and Future Conditions of Urban and Urbanizing Streams of Snohomish County* (Snohomish County, 2002).

## Water Quality

Existing water quality conditions and problems within the North Creek DNR study area were also assessed. It included characterizing existing water quality conditions for surface waters, as well as assessing general and specific water quality problems. The water quality analysis is primarily based on reviewing available data and reports, which was supplemented with limited field observations. Although the existing water quality conditions characterization is based on information covering the entire North Creek basin, identifying specific water quality problems and potential improvements focused on the DNR study area (the unincorporated portion of the basin in Snohomish County).

As with many other small receiving water bodies in or downstream of developed areas, the overall water quality of North Creek is poor. North Creek is designated as a Class AA fresh water stream according to the Washington State Surface Water Quality Standards (WAC 173-201A). Sampling data indicates the stream is not meeting Washington State Class AA criteria for fecal coliform bacteria and DO, with segments of the stream on the Washington State Department of Ecology's 1998 Clean Water Act (CWA) Section 303(d) list for both. A Total Mean Daily Level (TMDL) evaluation has been initiated for North Creek to determine the sources of fecal coliform bacteria and to assess the approaches to reducing the bacteria loadings and improve the stream's water quality.

Elevated levels of nutrients (nitrate- and nitrite-nitrogen and total phosphorus) are regularly detected in the surface waters of the basin and are suspected of contributing to the stream's low DO concentrations. Metals such as copper, lead, and zinc have also been detected in water samples taken from the stream, with levels exceeding those of the State's water quality standards. The primary sources of these contaminants are runoff from commercial areas, residential neighborhoods and roadways, excess sediment from eroding stream banks and construction sites, and septic system failures.

A total of 28 specific water quality problems were identified within the North Creek basin. These problems are primarily associated with surface runoff from high-use roadways and from commercial and light industrial areas, most of which is untreated in the North Creek basin. Other nonpoint sources of water quality problems are evident in the basin.

A limited number of water quality CIP projects were developed because flooding and habitat projects will or can include water quality benefits and because the cost-effectiveness of many potential water quality CIPs (such as retrofitting runoff treatment for a small portion of an established residential neighborhood) may be quite low. Seven CIP projects specific to water quality were chosen for the North Creek DNR recommended plan. Additional programmatic recommendations for water quality improvements (i.e., actions that are not specific CIPs) were also developed. These actions reduce pollutant loadings into the streams more effectively than site-specific CIPs, primarily because they cover larger areas and affect more land surfaces. In addition, one proposed flooding CIP project also has water quality components to help improve water quality.

To achieve significant improvements in water quality in North Creek, the quality of stormwater runoff from urban areas within the Cities of Everett, Mill Creek, and Bothell would also need to be improved.

## **Erosion and Sedimentation**

Basinwide erosion and sedimentation were qualitatively assessed for the North Creek DNR, which was based primarily on limited field observations. Streambanks throughout the North Creek mainstem and tributary creeks are subject to erosion and channel widening. The cause of the erosion is a combination of flow, stream gradient, and the geology and soils. Sediment is deposited in flat sections of the creek downstream of the erosion, causing channel aggradation that reduces channel capacity. Streambanks are consistently being eroded in the North Creek tributaries, with the steeper reaches of stream in the lower portions of Penny and Nickel Creeks particularly susceptible to severe erosion.

A total of 22 erosion problems were identified in the North Creek DNR study area. The principle types of identified erosion problems are scouring immediately downstream of culverts and other drains and constricted road and foot bridges. The culverts are either partly filled or blocked by sediment or debris, or they are causing significant erosion along channel banks and streambed adjacent to the culvert outfall. Road crossings are associated with significant bank and/or stream erosion beneath and/or downstream of the crossing structure. Footbridges included as erosion problems appear to have been suspended too close to the channel floor, resulting in increased flow velocities causing deeply eroded scour pools directly beneath and downstream of the bridges.

An erosion problem can have several possible solutions, such as stabilizing an eroding bank, replacing a culvert, or removing failed structures that are causing deflected stream flows. Many of the previously identified flooding CIP projects, which include culvert replacements, will solve several identified erosion and sedimentation problems associated with scour pools downstream of undersized culverts. Conversely, solving certain habitat problems can be in direct conflict with erosion reduction measures.

## **Recommended Plan**

The recommended projects listed in Table ES-1 were grouped into five different categories based on the types of problems that were addressed by each project. The first three categories include projects that primarily address only one type of problem: flooding, habitat, or water quality. The other two categories represent projects that address more than one type of problem; this includes a category for projects that

address both flooding and habitat problems and another category for projects that address flooding and water quality problems. The lists of recommended projects for each of these categories are included in Tables 10-2 through 10-6 in Section 10.0 of this report. Appendix F contains additional details for each project, including a summary, a cost estimate, and a sketch of the proposed improvements.

The recommended list of CIP projects would be needed to solve most of the identified problems in the areas of the basin that were analyzed. None of these projects are required to be implemented by current County code. This list also includes projects that would primarily benefit private property owners, which the County is not responsible to implement.

Constructing CIP projects depends on the availability of funding. Based on the current allocation of County revenues for surface water purposes, the County does not have sufficient funds allocated to implement all recommended County-funded CIP projects. The County will need to consider the relative importance of the recommended projects in the North Creek DNR with the rest of DNR study areas in order to use the limited funds most effectively. Since a funding analysis was beyond the scope of the DNR project, the County will need to determine how much funding would be available to construct them, as well as their relative prioritization.

Successful implementation of all 64 CIP projects within the North Creek basin will result in reduced flooding at identified problem sites, enhanced existing habitat conditions, and modest improvements to water quality.

It is further recommended that the following actions be implemented:

- Continued programmatic maintenance of the drainage infrastructure, including identification and performance of high maintenance frequency locations and areas, and repair of priority failed or partially-failed systems
- Additional studies and analyses to quantify problem areas not evaluated or selected for this study
- Additional analysis and monitoring for the problem areas in Detailed Modeling Areas NO-05 and NO-07
- Continuation of a detention pond retrofit program, which will provide additional water quantity and quality control
- Additional programmatic analysis to evaluate the need and effectiveness for retrofitting existing ditches
- Coordination with the Cities of Everett, Mill Creek, and Bothell to implement water quality improvements
- Implementation of small farm best management practices (BMPs)
- Sweeping of public parking lots