Lyon Creek Basin Plan

October 2015

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List of Acronyms/Terms

CF	Capital Facilities
CIP	Capital Improvement Project
City	City of Shoreline
CCTV	Closed-circuit Television
CIPP	Cured In Place Pipe
CMP	Corrugated Metal Pipe
CPP	Corrugated Plastic Pipe
CWA	Clean Water Act
DO	Dissolved Oxygen
Ecology	Washington State Department of Ecology
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
GMA	Growth Management Act
HEC-RAS	Hydraulic Engineering Center River Analysis System
HSPF	Hydrologic Simulation Program-Fortran
MPR	Maintenance Pipe Rating
MPRI	Maintenance Pipe Rating Index
N/A	Not Applicable
NASSCO	National Association of Sewer Service Companies
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric Turbidity Units
OPR	Overall Pipe Rating
OPRI	Overall Pipe Rating Index
ROW	Right of Way
SEPA	State Environmental Policy Act
SPR	Structural Pipe Rating
SPRI	Structural Pipe Rating Index
USACE	US Army Corps of Engineers
USFWS	US Fish and Wildlife Service
WDFW	Washington Department of Fish and Wildlife
WQC	Water Quality Criteria
WQI	Water Quality Index

Executive Summary

The City of Shoreline (City) contains approximately 0.26 square miles of the four square mile Lyon Creek basin (Figure ES-1) which spans portions of the cities of Mountlake Terrace, Shoreline and Lake Forest Park. Ballinger Creek, a tributary to Lyon Creek, is the drainage feature contained in the portion of the basin within the City of Shoreline.

The purpose of this basin plan is to provide a comprehensive representation of the natural and built infrastructure in the Shoreline portion of the basin so that the City can direct its stormwater management resources toward correcting existing issues and minimizing potential future problems. The City's specific goals and objectives include completion of the following:

1. A condition assessment video of all stormwater pipes 12 inches or greater in diameter to evaluate maintenance, repair, and replacement needs in the basin.
2. A prioritized list of structural and programmatic strategies, including a repair and replacement schedule to solve surface water and infrastructure problems in the basin (e.g., water quality, flooding, and habitat).

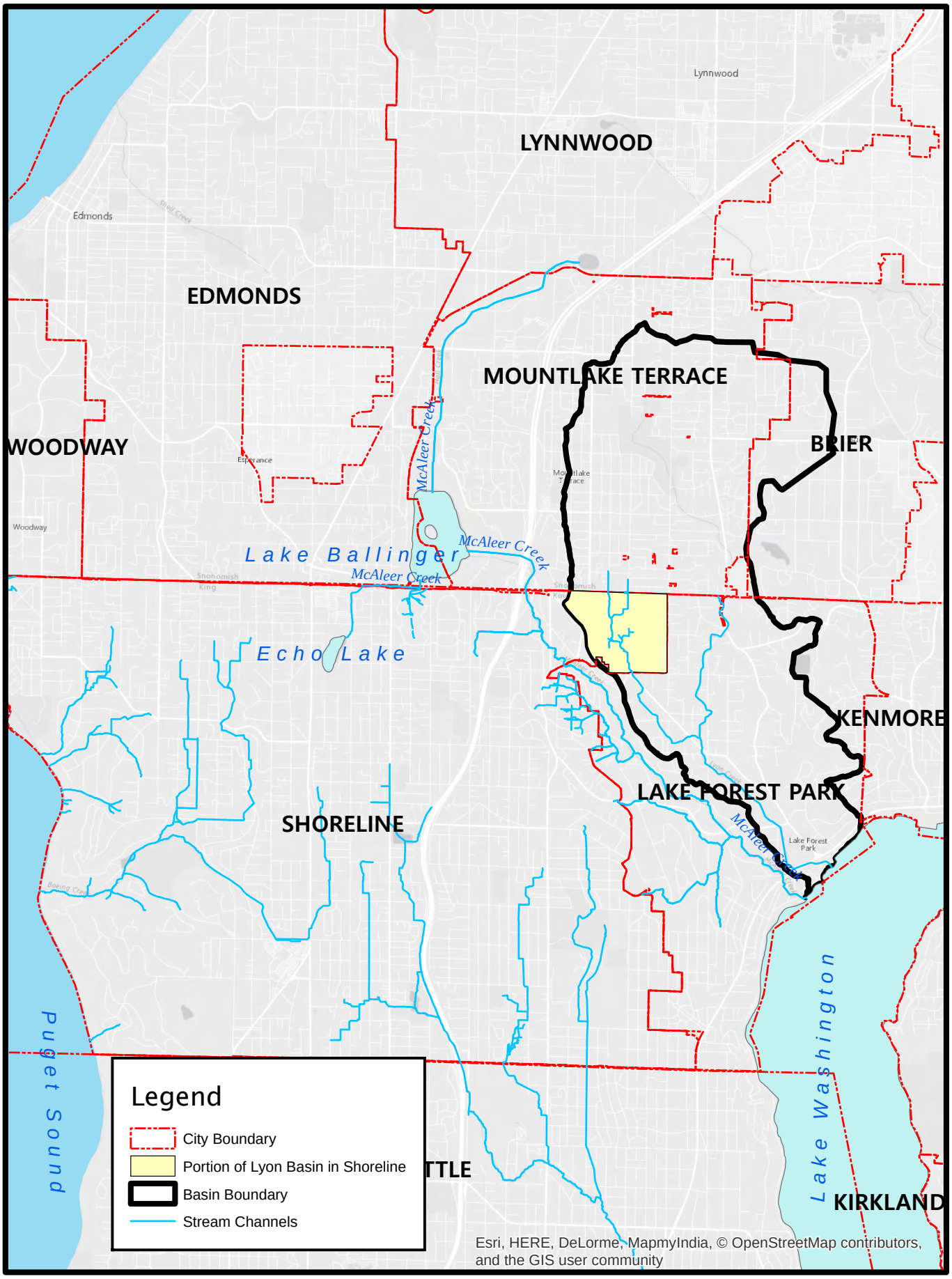

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Figure ES-1. Lyon Creek Basin Vicinity Map

Prepared by E. Nelson 7/13/2015 revised

To develop this basin plan, the Consultant team (including Osborn Consulting Inc., Altaterra Consulting LLC, and The Watershed Company):

- Used existing information and documents for historical context and reference
- Field-verified conditions in both the natural landscape and piped infrastructure
- Evaluated level of service conditions for bridges and culverts at different flow recurrence intervals to predict and/or verify flooding
- Worked with the City and public to develop workable management strategies and feasible projects for managing stormwater in the Lyon Creek basin

The specific natural and built characteristics of the Lyon Creek basin, along with associated issues and potential solutions, are shown in Figure ES-2.

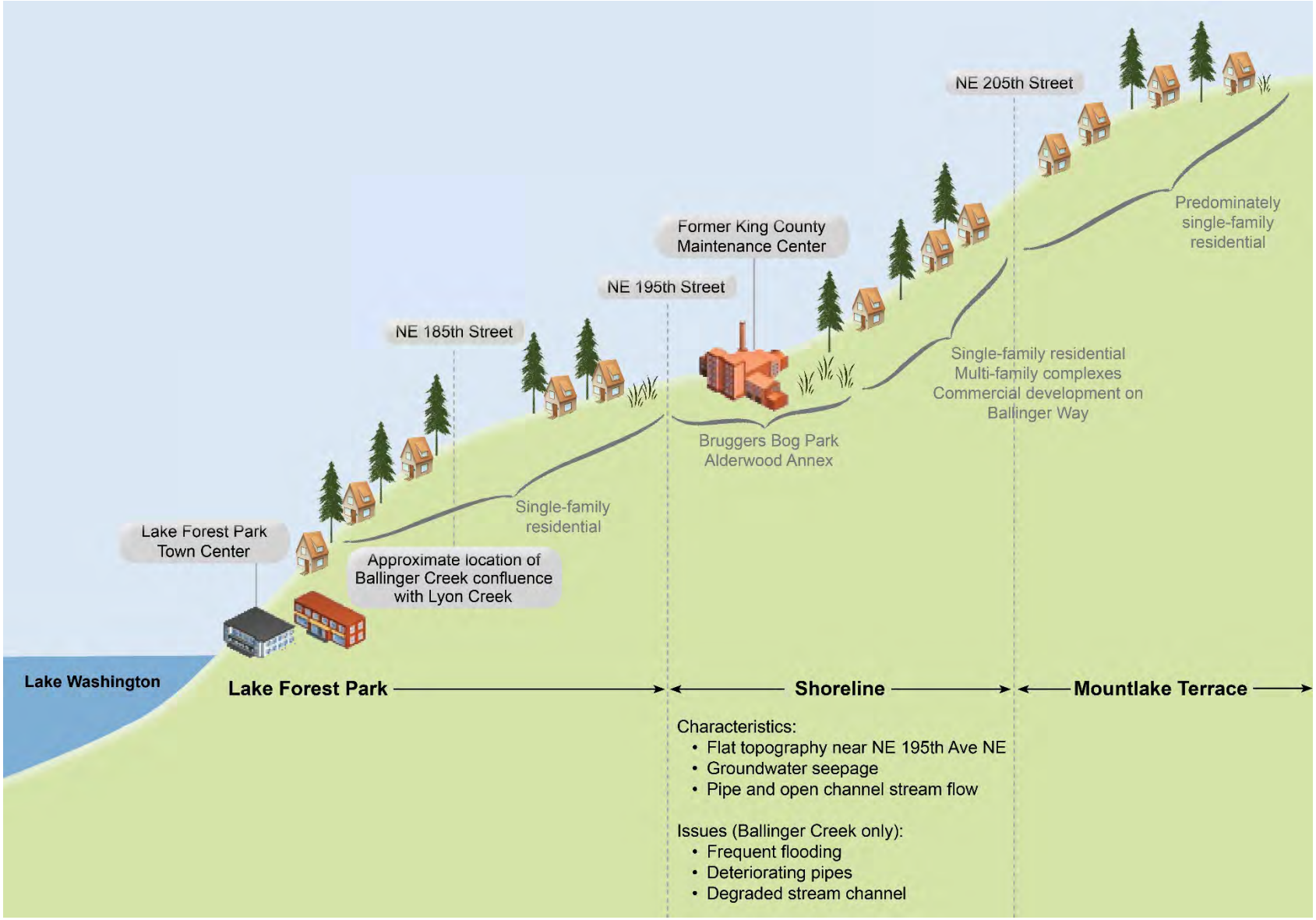
The primary stormwater-related issues in the Lyon Creek Basin include:

- Over 30 percent of stormwater pipes are in poor to failing condition and require immediate attention.
- Several under-sized culverts are not able to convey surface water flows and contribute to frequent flooding along 25th Avenue NE.
- Due to topography, geology and other drainage conditions, some developments built at lower elevations within the basin experience high groundwater conditions and/or localized flooding in basements and other depressions.

The primary issue of concern in the Lyon Creek basin is flooding along 25th Avenue NE. The public is affected when homes, cars, parking areas, roads, driveways, and pedestrian pathways are flooded.

In coming years major changes will likely occur on some of the large properties adjacent to 25th Avenue NE. The City now owns the former King County Brugger's Bog Maintenance Facility and will redevelop it into a new maintenance facility. The Shoreline School District's Alderwood Annex is currently a vacant property that is still owned by the District, but has been rezoned to allow flexibility in how the property is used in the future. Flood reduction will be an important part of the improvements planned for this neighborhood.

Figure ES- 2 Schematic of Lyon Creek Basin Jurisdictions, Characteristics, Issues, and Potential Solutions in Shoreline



Nine capital projects are recommended to be included in the City's capital improvement program for a cost of $6,756,300 (this number includes one project for which a cost was not estimated). Of the nine projects, six were ranked high according to the criteria shown in Table ES-1 for a total cost of $6,270,000, not including the capital projects for which costs were not estimated (Ba-CIP-7). Table ES-2 lists the highest ranked capital projects, scores and estimated costs. Project locations are shown in Figure ES-3.

Table ES- 1 Prioritization Criteria used to Rank Capital Projects

Criteria	Rank Scores		
	High (5 points)	Medium (3 points)	Low (1 point)
Likelihood of success	Proved in other cases	Mixed results	Unproven
Number of issues addressed (water quality, habitat, erosion, flooding)*	Three	Two	One
Protects infrastructure and public safety	Both	One or the other	None
On public property	In ROW or existing easement	Requires easement on other public property	Private property

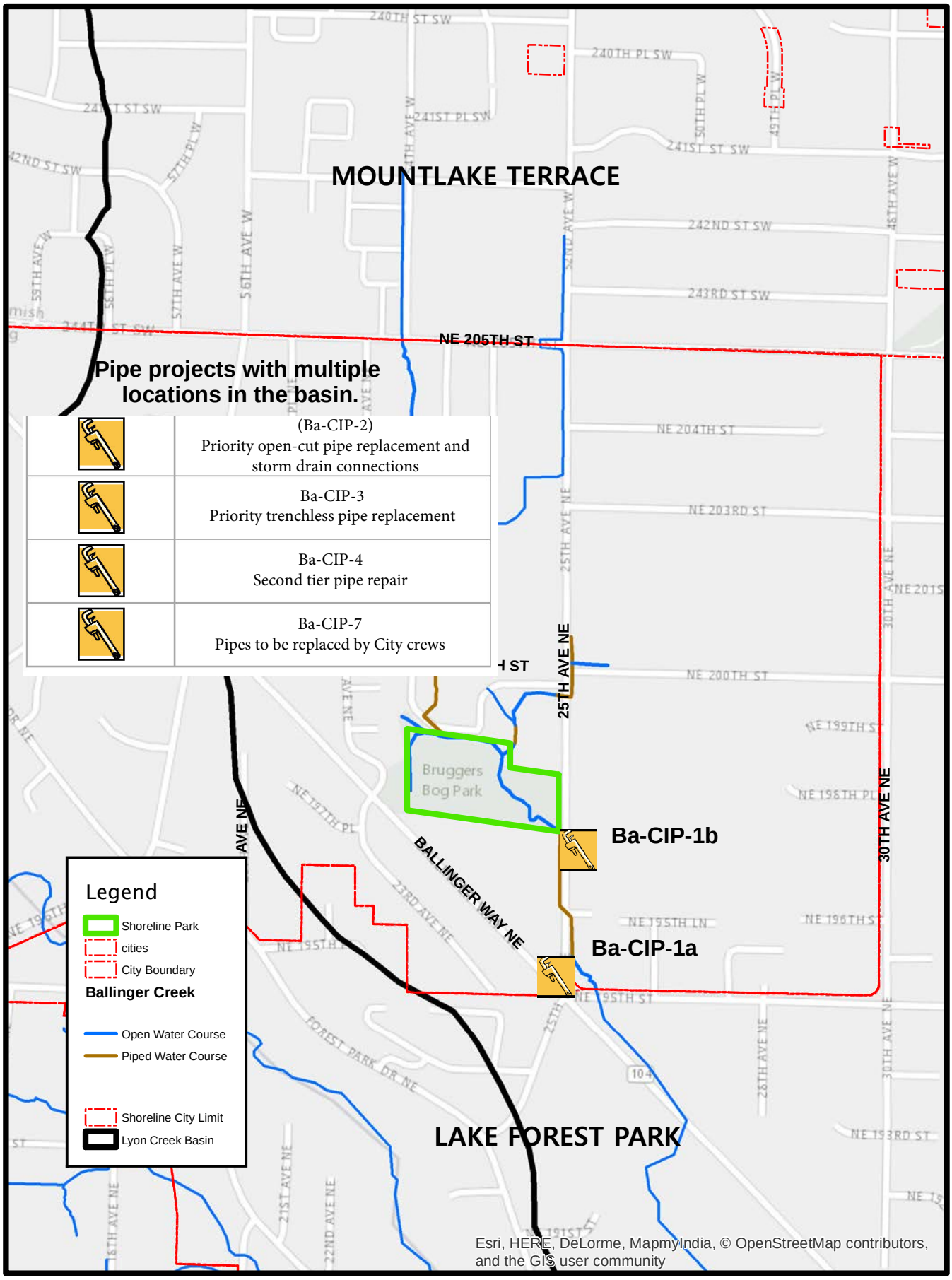
* If project is a flood reduction project, an additional 5 points are applied to overall score for a total possible 10 points for this criteria.

The combined scores of individual criteria were ranked according to the following total points:

- Low priority (10 points or fewer)
- Medium priority (11 to 15 points)
- High priority (16 points or higher)

Table ES- 2 Summary of Highest Ranked Recommended Capital Projects in Lyon Creek Basin

Issue	Project Name	Type	Priority and Score	Cost
Flooding, Drainage and Infrastructure	(Ba-CIP-1a) NE 195th Street Culvert Replacement		HIGH (23)	$2,007,300
	(Ba-CIP-1b) 25th Avenue NE Flood Reduction		HIGH (23)	$3,296,400
	(Ba-CIP-2) Priority Open-Cut Pipe Replacement and Storm Drain Connections		HIGH (18)	$646,700
	(Ba-CIP-3) Priority Trenchless Pipe Replacement		HIGH (18)	$61,600
	(Ba-CIP-4) Second tier pipe repair		HIGH (18)	$258,000
	(Ba-CIP-7) Pipes to be Replaced by City Crews		HIGH (18)	Not estimated.



Prepared by E. Nelson 8/24/2015

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Figure ES-3. Lyon Creek High Priority Capital Project Locations

Several programmatic projects are also recommended to address issues identified in the Lyon Creek basin. These include:

- Coordination efforts internally and externally to ensure that recommended projects are integrated with related transportation improvement or flood reduction projects moving forward within Shoreline and Lake Forest Park (Ba-Coor-1 and Ba-Coor-2)
- A targeted flood education program for affected residents as an interim measure before flood reduction project projects are implemented (Ba-Ed-1)
- Vegetation improvement projects that continue to help improve water quality conditions in Ballinger Creek and rely on volunteer coordination and participation with City support of supplies in Brugger's Bog Park and Ballinger Open Space (Ba-Hab-1 and Ba-Hab-2)
- An evaluation of potential easement acquisitions (Ba-Pol-1)
- An evaluation of existing stream designations and determination as to whether some should be modified (Ba-Pol-2)
- Ballinger Creek Floodplain mapping and FEMA submittal (Ba-Stud-1)

The estimated cost of the programmatic projects is approximately $70,000.

1. Introduction

The City of Shoreline (City) contains a small portion of the Lyon Creek basin in the northeast area of the City (Figure 1-1). Ballinger Creek, which is tributary to Lyon Creek, originates in the City of Mountlake Terrace (located north of Shoreline), flows through Shoreline, and flows into Lake Forest Park (located south and east of Shoreline) where it enters Lyon Creek before discharging to Lake Washington. The purpose of this basin plan is to provide a comprehensive representation of the natural and built infrastructure in the Shoreline portion of the basin so that the City can direct its stormwater management resources toward correcting existing issues and minimizing potential future problems. Stormwater management solutions recommended in this basin plan will then be prioritized among City-wide issues. The City's specific goals and objectives include completion of the following:

1. A condition assessment video of all stormwater pipes greater than or equal to 12 inches in diameter to evaluate maintenance, repair, and replacement needs in the basin.
2. A prioritized list of structural and programmatic strategies, including a repair and replacement schedule to solve surface water and infrastructure problems in the basin (e.g., water quality, flooding, and habitat).

Through the development of this basin plan, the project team (Altaterra Consulting LLC, Osborn Consulting Inc., and The Watershed Company) used existing information and documents for historical context and reference, verified field conditions in both the natural landscape and piped infrastructure, and worked with the City and public to develop workable management strategies and feasible projects for managing stormwater in the Lyon Creek basin.

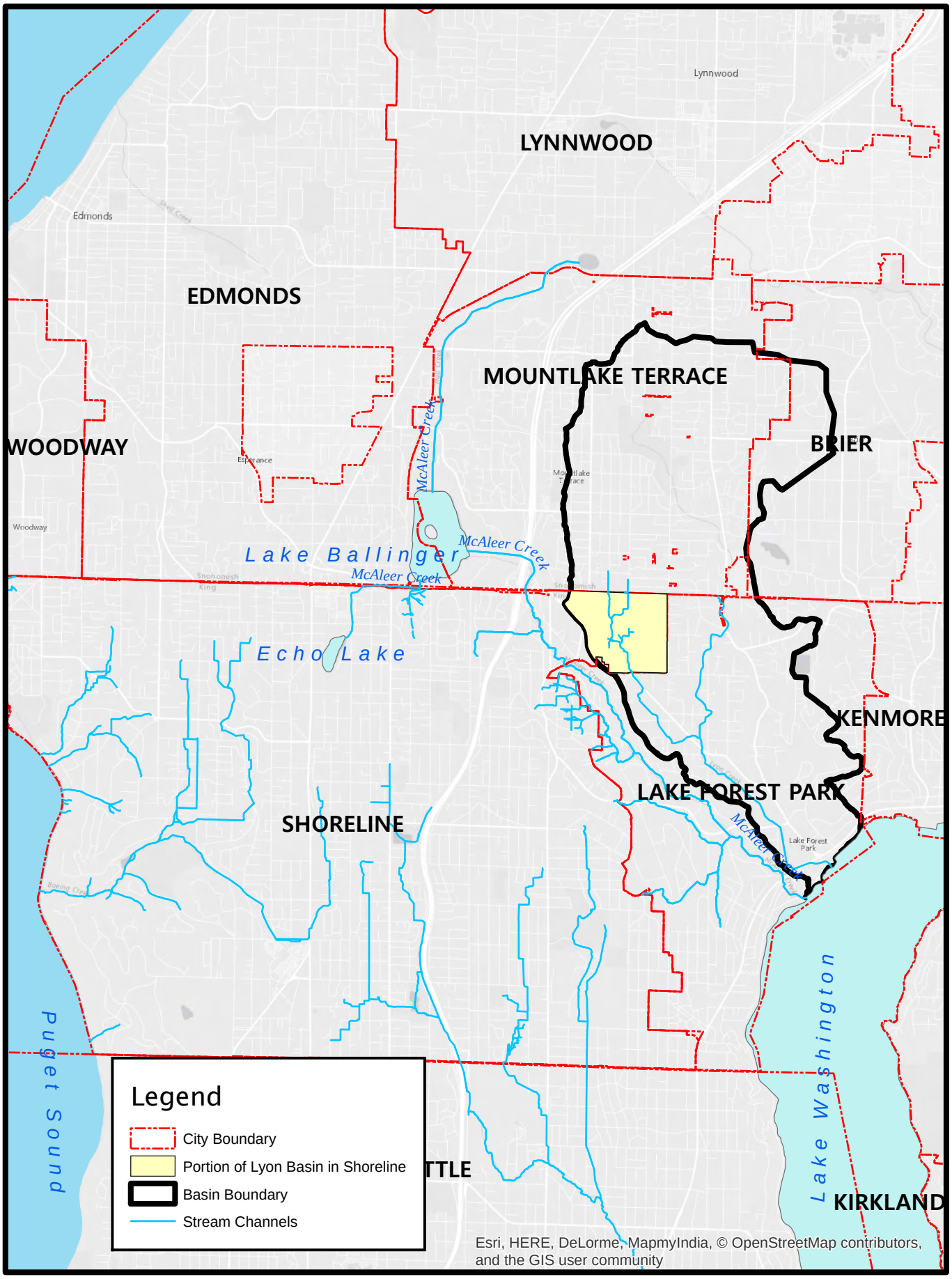

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Figure 1-1. Lyon Creek Basin Vicinity Map

Prepared by E. Nelson 7/13/2015 revised

2. Previous Studies

The City of Shoreline and neighboring jurisdictions have conducted numerous studies and collected a plethora of data in the Lyon Creek basin. These studies and data were evaluated by the project team prior to analysis of issues in and potential solutions for the basin. The reference documents reviewed, including sources, data, and relevance to the Lyon Creek basin, are listed in Table 2-1. Specific findings are discussed in the sections that follow.

Table 2-1. Summary of Data Sources and Relevance to Lyon Creek Basin Plan

Reference	Author(s)	Date	Relevance to Lyon Creek Basin Plan
Geographic Information System (GIS) Coverages	City of Shoreline/King County	Unknown	GIS coverages were used in many of the analyses described in Section 3.
Service Requests	City of Shoreline	2000-2013	Stormwater-related calls; information is summarized in Section 3 and Appendix C.
Washington Interactive Geologic Map Documents	Washington State Department of Natural Resources and various other authors	Various dates	Site-specific geologic information is summarized in Section 3.
City of Shoreline Stream and Wetland Inventory and Assessment: Appendices	Tetra Tech/KCM Inc. (2004)	2004	Relevant information is presented in Section 3.
City of Shoreline Comprehensive Plan	City of Shoreline (2011c)	2004	Relevant information is presented in Section 4.
City of Shoreline Surface Water Master Plan Update	SAIC (2011)	2011	Relevant recommended projects are discussed in Section 5.
City of Shoreline 2011-2017 Parks, Recreation and Open Space (PROS) Plan	City of Shoreline (2011a)	2011	Parks located in Lyon Creek basin are Brugger's Bog Park (4.5 acres) and Ballinger Park Open Space (2.6 acres).
City of Shoreline 2011 Transportation Master Plan	City of Shoreline (2011b)	2011	Recommended improvements include signed bicycle route and pedestrian system on 25th Avenue NE. No specific projects are recommended in this plan.
Lyons [sic] Creek Watershed Comprehensive Drainage Plan for Mountlake Terrace and Lake Forest Park	Entranco (1981)	1981	Description of previously proposed regional detention project in Brugger's Bog Park.

3. Basin Characteristics

The Lyon Creek basin is approximately four square miles in size. However, the City of Shoreline portion, which contains part of Ballinger Creek, is only 0.26 square miles (170 acres) – six percent of the entire basin (as shown in Figure 1-1). The characteristics of the City of Shoreline portion of the Lyon Creek basin are described in this section, with context of the larger basin characteristics

Shoreline has jurisdiction over 6% of the Lyon Creek Basin. Upstream and downstream jurisdictions are Mountlake Terrace and Lake Forest Park, respectively.

provided where necessary and relevant to the existing conditions and issues within Shoreline.

3.1 Built Landscape

The type and location of the built environment influence how surface and stormwater runoff is conveyed across the landscape. This starts with how land is zoned by the City and what is allowed to be built according to that zoning. Table 3-1 summarizes the zoning statistics within the Lyon Creek basin in Shoreline.

Table 3-1. Zoning Statistics within Lyon Creek Basin in Shoreline

Zoning Classification	Area of Basin within Zoning Class (Acres)	Percentage of Basin within Zoning Class	Percentage of Parcels within Zoning Class Currently Underdeveloped*	Area of Underdeveloped Parcels (Acres)
R6	72.3	43%	35%	25.1
R24	25.6	15%	3%	0.7
City Right of Way (ROW)	24.0	14%	41%	9.8
PA 3 (Aldercrest Planned Area 3)	16.1	10%	100%	16.1
CB (Community Business)	15.0	9%	0%	0
R24 (Brugger's Bog)	4.5	2.6%	n/a	n/a
R48	2.8	1.6%	0%	0
R12 (Ballinger Open Space)	2.6	1.5%	n/a	n/a
R12	2.2	1.3%	14%	0.3
R18	2.2	1.3%	100%	2.2
MB (Mixed Business)	1.0	<1%	0%	0
NB (Neighborhood Business)	0.9	<1%	0%	0
Total	***169.1***	***100%***	***N/A***	***54.2***

*"Underdeveloped" parcels were estimated based on a GIS analysis of parcel area relative to zoning area and current occupancy (single home, duplex, apartment, etc.). For instance, a parcel was assumed to be "underdeveloped" if the zoning class was R6, but the property size was 4 times as large as the minimum R6 property size (7,200 SF) with only one home on the parcel. Underdeveloped right-of-way was assumed to be pervious areas within the City right-of-way.

Land use is predominantly residential (76%), with commercial and neighborhood business congregated along the Ballinger Way NE corridor. The former Aldercrest Annex School property (referred to as the Aldercrest Annex) was rezoned to "Planned Area 3" in 2011. The new designation would allow for other potential uses of that property (Figure 3-1).

The underlying zoning for the two park properties is residential; however, the land use will remain as parks. Any future development would be “light” development consistent with typical park uses. Accordingly, these park parcels are listed separately in Table 3-1 and not included in underdevelopment calculations.

Most of the basin within Shoreline can be considered as built out according to current zoning. However, many parcels could be further developed under current zoning with corresponding increases in impervious area. Other potential sources of increased impervious area within the basin due to future development within current zoning could occur with the construction of accessory dwelling units (ADUs), remodeling to increase an existing building’s footprint, entirely redeveloping a property, or other miscellaneous increases in impervious areas such as driveways, parking areas, decks, patios, walkways, or outbuildings.

Stormwater impacts from any significant increase in impervious area would generally be mitigated by development regulations. The City of Shoreline has adopted Ecology surface water regulations for development (see Table 4-1). Current regulations require engineered flow control facilities for any development with new or replaced impervious area of 5,000 square feet or larger, and non-engineered on-site dispersion techniques for any development with new or replaced impervious area of 2,000 square feet or larger. Thus, for future development stormwater impacts would be limited to small sub-regulatory development, non-compliant development, poorly-functioning private systems, or rare regulatory exceptions.

There are no current plans to rezone any areas within this basin.

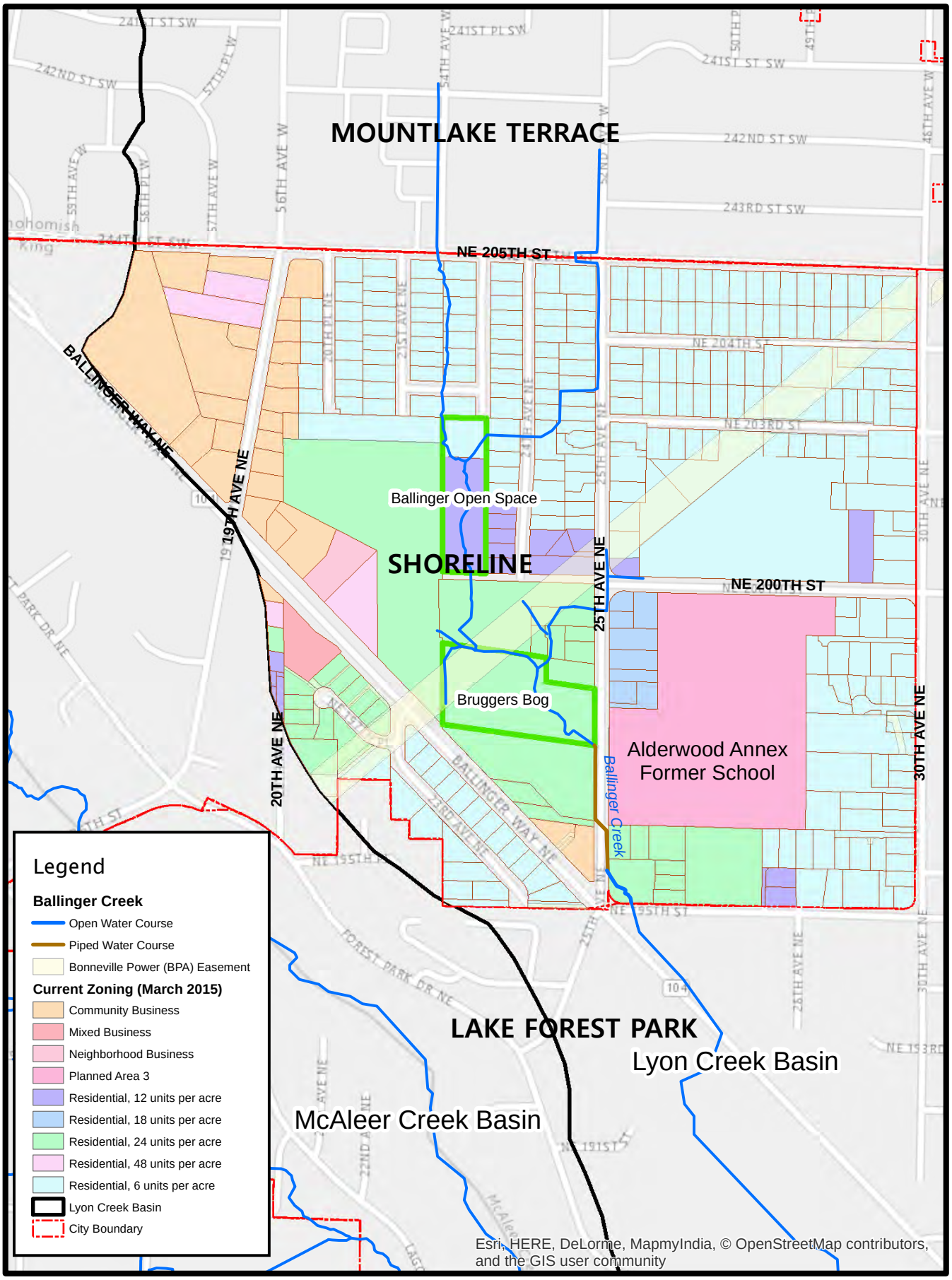

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Figure 3-1. Zoning in the Lyon Creek Basin

Prepared by E. Nelson 11/29/2014, revised 8/14/2015

3.1.1 Age of Development

The Lyon Creek basin within the City of Shoreline was largely built out by 1980, and most of the homes were constructed much earlier in the 1950s and 1960s (Figure 3-2). Mountlake Terrace, to the north of Shoreline, was also constructed in the same era. Existing stormwater systems in both areas typically date to original construction.

Accordingly, there are few stormwater management facilities to control flow or provide water quality treatment within the City or areas upstream of the City. A few stormwater management vaults and ponds have been installed more recently on multi-family and commercial properties, but these provide little large-scale benefit in terms of flow control.

The portion of Lyon Creek basin that is within Shoreline currently has approximately 42 percent impervious surface (King County GIS. 2012). Buildings, driveways, parking lots, and sidewalks make up 80 percent of the impervious surface coverage; the remaining 20 percent is road surfaces.

There are around 23 acres of undeveloped or lightly developed property in the Shoreline portion of Lyon Creek Basin with a fair amount of vegetated green space, almost exclusively limited to these three sites:

- Ballinger Open Space (owned by the City) – roughly 2.6 acres
- Brugger's Bog Park (owned by the City) – roughly 4.5 acres
- Aldercrest Annex (owned by Shoreline School District) – roughly 16 acres

Additionally, the Bonneville Power Easement that occupies approximately 11 acres and cuts across the center of the basin is relatively undeveloped and currently provides open green space (Figures 3-1 and 3-2). Structures cannot be built within this easement, although surface treatments can be changed from pervious to impervious.

Why does the age of development matter?

Current stormwater practices were not in place when a large part of the Lyon Creek basin was constructed (including upstream in Mountlake Terrace) resulting in few stormwater treatment facilities in the basin.

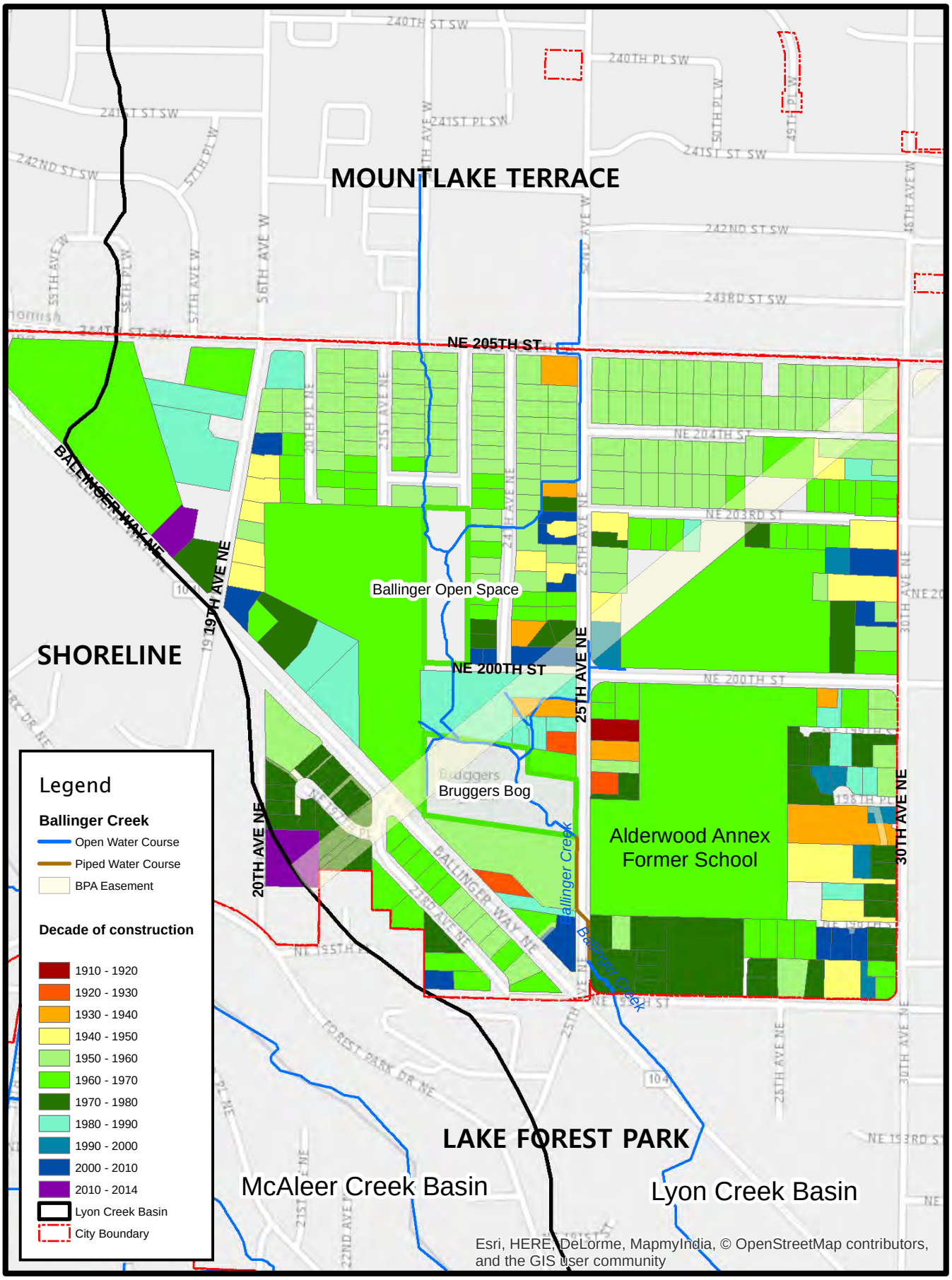

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Figure 3-2. General Housing Age in Lyon Creek Basin

Prepared by E. Nelson 11/29/2014, revised 8/14/2015.

3.1.2 Park Properties

The City has two parks within the Lyon Creek Basin: Brugger's Bog Park and Ballinger Open Space. Brugger's Bog Park is 4.5 acres; amenities include a playground and swings, picnic area, trails, and concrete pedestrian bridge over Ballinger Creek built in 2011. Ballinger Open Space is 2.6 acres, is undeveloped, lightly used and accessible only by informal foot paths.

The City's 2011 Parks, Recreation and Open Space (PROS) Plan identified future improvements for master planning these parks and providing better pedestrian access to the parks. These identified future improvements have been included in the City's 2015-2020 Capital Improvement Plan (CIP).

The Ballinger Neighborhood Parks Master Planning project, with a budget of $150,000 is scheduled for 2018. The purpose of this project is to plan for future park improvements in the Ballinger neighborhood including the existing park sites at Brugger's Bog and Ballinger Open Space. Other sites would also be considered in the master plan process.

Additionally, the 25th Avenue NE Sidewalks project to construct sidewalks along the west side of 25th Ave NE from NE 195th Place to NE 200th Street is scheduled for construction by 2017. A portion of the new sidewalk will be adjacent to Brugger's Bog Park.

3.2 Topography

Lyon Creek basin ranges in elevation from 460 feet at its high point within the City of Mountlake Terrace to around 30 feet at the mouth of the creek at the northern end of Lake Washington within the City of Lake Forest Park, near the intersection of NE Bothell Way and Ballinger Way NE.

Within the City of Shoreline, the Lyon Creek basin ranges in elevation from approximately 356 to 210 feet above mean sea level. The high point is near the northeast corner of the basin at NE 205th St and 30th Ave NE, while the low point is at the south end within the Ballinger Creek channel at the NE 195th St culvert just east of 25th Ave NE. These high and low points are separated by approximately one half mile, with a fairly constant moderate grade between the two, averaging approximately 5%.

LiDAR imagery and topographic contours of the area provides a view of the ground surface characteristics, confirming the typical presence of moderate slopes within this area, generally absent of steep slopes or deeply incised ravines (Figure 3-3).

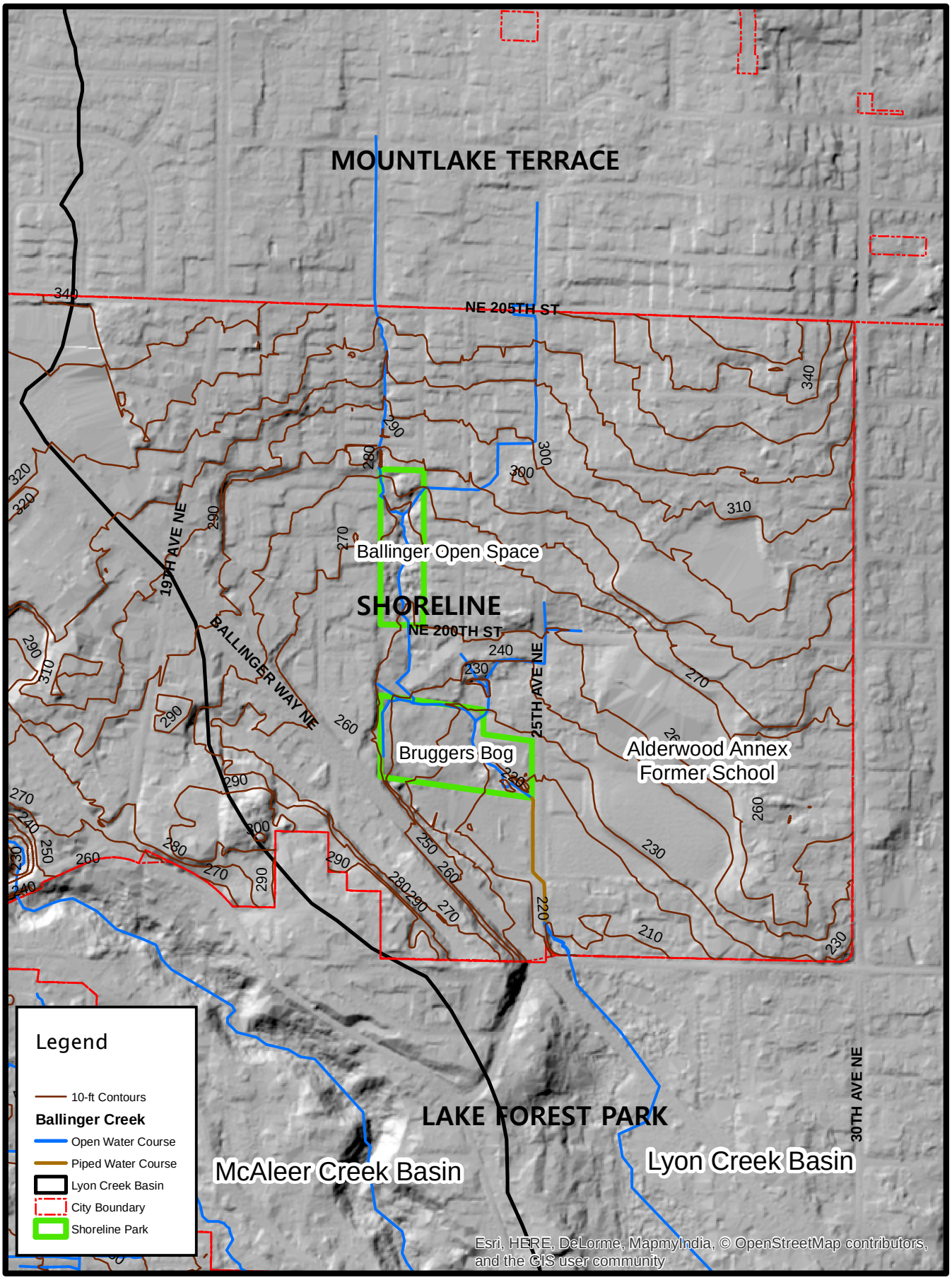

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Figure 3-3. LiDAR Imagery and Topographic Contours Lyon Creek Basin

Prepared by E. Nelson 11/29/2014, revised 8/14/2015

3.3 Geology and Geomorphology

Surface and subsurface geologic conditions influence topography, erosional processes, and surface and ground water flow both regionally and locally at the basin scale. The modern-day Puget Sound landscape is the result of continental glaciation of the Cordilleran Ice Sheet, with the maximum extent of the last glacial episode (known as the Vashon Stade of the Fraser Glaciation) occurring nearly 14,000 years ago (Thorson, 1980). Most of the surficial geologic deposits in the Puget Sound region are associated with the Vashon Stade. The glacial deposits mapped in the Lyon Creek basin are described below.

What is the impact of geology on surface water runoff?

Geologic conditions affect how much water runs off the landscape naturally, how much is infiltrated, and how easily streams and hillslopes are eroded. The geologic conditions in Shoreline's portion of the Lyon Creek basin are generally good for surface water infiltration. However, the infiltrative geologic unit is not very thick where it crops out in the basin and sits on top of geologic material that does not infiltrate well. This can cause seepage when the ground becomes saturated.

3.3.1 Geology

The predominant surficial geologic conditions in the City of Shoreline portion of the Lyon Creek basin consists of Quaternary-age Advance Outwash deposits, underlain by Quaternary-age Transitional Beds (Figure 3-4) as mapped by J. P. Minard (United States Geological Survey 1983).

According to the USGS map, the surficial geologic deposits in the topographically higher areas of the Lyon Creek Basin within the City and to the north include glacial till and recessional outwash deposits on top of the till.

Available boring logs were reviewed on the Washington Interactive Geologic Map (https://fortress.wa.gov/dnr/geology/ accessed on January 3, 2015) in the vicinity of Ballinger Creek to obtain a better understanding of subsurface geologic conditions and how the geologic conditions influence surface and groundwater flow in the basin.

One deep boring was drilled at the former King County Brugger's Bog Maintenance Facility as part of King County's Brightwater sewage conveyance system design project. Geologic materials encountered in this boring during drilling consisted of fine and coarse sand to a depth of approximately 30 feet below ground surface that was characterized as alluvium underlain by advance outwash. Beneath the outwash, glaciolacustrine silt was encountered to a depth of about 75 feet below ground surface. Groundwater was measured in this well on two occasions in February and March of 2008, the year it was drilled. On both occasions, groundwater was within 1 foot of the ground surface. The geology reported is fairly consistent with the surficial geologic map, although Minard had mapped the glaciolacustrine (also known as transitional beds) deposits at the surface in the vicinity of Brugger's Bog Park, suggesting perhaps the USGS mapping is slightly inaccurate as to the surface elevation where the transitional beds outcrop.

Additional subsurface data was reviewed for the following locations, generally corroborating the 1983 USGS Map by Minard:

- Shallow borings (up to 10 feet deep) at 19th Avenue NE and NE 200th Street;

- Shallow exploration pits (up to 8 feet deep) at 244th Street SW and 56th Avenue W in Mountlake Terrace just north of the City boundary (equivalent intersection to NE 205th St and 19th Ave NE in Shoreline);
- Shallow test pit data for commercial properties in the northwestern part of the basin.

Geologic material encountered in the test pits and shallow borings generally consisted of fill, glacial till, or recessional outwash underlain by glacial till.

A single 38.5-feet deep boring log drilled near the southwestern corner of the intersection of Ballinger Way NE and 25th Avenue NE was also reviewed. This boring consisted of approximately five feet of fine sand, underlain by silt with organics to a depth of 38.5 feet, the final depth of the boring. The fine silt with organics is likely indicative of the transitional beds geologic unit.

3.3.2 Geomorphology

During field reconnaissance in July 2014 most of the open channel sections of Ballinger Creek were walked and qualitatively evaluated, with the exception of the channel between NE 203rd and NE 205th Streets. Right of entry was not granted for all of the private properties along this reach, making it impractical to conduct a field investigation. In general, the current conditions of Ballinger Creek were observed to be fairly degraded, similar to observations made during the City's 2004 Stream Inventory and Assessment (Tetra Tech/KCM 2004). Ballinger Creek stream reaches identified in the 2004 assessment are shown in Figure 3-5 and current conditions observed during the July 2014 field reconnaissance are described below.

3.3.2.1 NE 195th Street to Southeast Corner of Brugger's Bog Park (Reach BA1 downstream to upstream)

Reach BA1 has only a small portion of open channel immediately upstream of NE 195th Street, to the east of 25th Avenue NE and west of an apartment complex. This open channel section has been rehabilitated and has benefited from revegetation efforts, however, it appears that approximately 1 foot of downcutting has occurred in this reach in the years (~10 years) since channel-spanning logs were installed during the rehabilitation effort. Substrate consists of small gravel and sand. Upstream of NE 196th Place, the stream is piped under 25th Avenue NE up to the southern edge of Brugger's Bog Park. According to the 2004 stream inventory, the piped section does not appear to be a fish passage barrier, but might hinder access at extremely low flows.

3.3.2.2 Brugger's Bog Park Reach (Reach BA2 downstream to upstream)

Reach BA2 is the reach in Brugger's Bog Park. The channel in the southern end of the park is characterized by small sand and gravel, meanders, and debris build-up in some locations. In this location, the stream channel has a wider area to migrate across its floodplain as sediment and debris deposits build up and force the stream to move to a new location. This reach has been revegetated and improved since the 2004 Stream Inventory and Assessment (Tetra Tech/KCM 2004), which describes the riparian area consisting of primarily grass that is regularly mowed and no large wood pieces present. Large wood is still missing, but native riparian vegetation is present albeit in a narrow corridor.

Upstream of the pedestrian bridge in Brugger's Bog Park, Ballinger Creek is much more confined and ditch-like, spanning only 4 to 5 feet in width and inaccessible in places due to dense vegetation. Channel incision (down-cutting) is occurring in some places, up to 3 or 4 feet in depth.

The main stem of Ballinger Creek is routed on the north side of the park along the property line between Brugger's Bog Park and the Ballinger Creek Condominiums to the north. The channel's left bank is immediately adjacent to an elevated parking lot in this location that is supported by creosote timbers

and concrete ecology blocks. The upstream end of this reach is at the northwest corner of Brugger's Bog Park, where this open channel section of Ballinger Creek is fed by three concrete culverts. In the City's previous 2004 Stream Inventory and Assessment (Tetra Tech/KCM 2004), it was reported that these culverts would constitute a fish passage barrier because the bottom edge of the culverts is a minimum of 30 inches above the channel bottom, presenting a constraint for jumping height and because of the very low flows and shallow water depths in this location.

The east tributary of Ballinger Creek (also labeled reach BA2) enters the main stem of Ballinger Creek east of the Ballinger Creek Condominiums. This section of stream channel winds through manicured lawns and multiple driveway culverts. The upstream end of this reach is in a wetland (see Section 3.8.1).

3.3.2.3 West Tributary in Brugger's Bog Park (Reach BA3)

Reach BA3 was previously shown as skirting the west side of Brugger's Bog Park. During the wetland reconnaissance, it was determined that the reach is actually much shorter and confined to the north end of the park. Reach BA3 was not evaluated during this assessment, but previous documentation indicates that it carries drainage from the adjacent hillside and park to the main channel of Ballinger Creek.

3.3.2.4 Upstream of Brugger's Bog Park to City limits (Reach BA4 downstream to upstream)

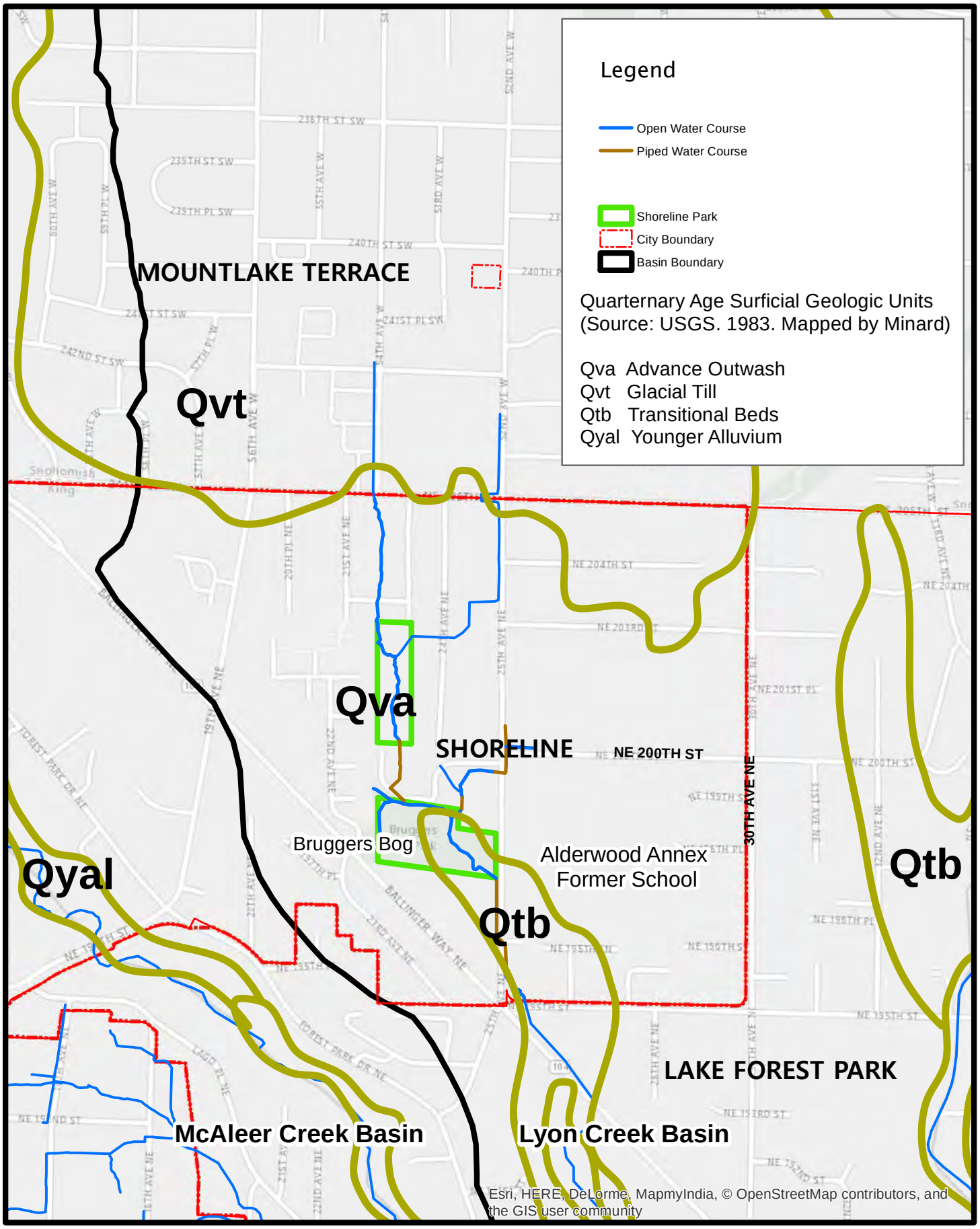
Upstream of Brugger's Bog Park, Ballinger Creek flows through the Ballinger Creek Condominiums in a series of pipes and short open channel sections in manicured landscaping. Upstream of the condominiums, Ballinger Creek flows through the Ballinger Open Space, a Shoreline City Park. The stream channel in this reach is highly degraded, incised several feet in some places. Riparian vegetation in the park is abundant, but mostly invasive.

Between NE 203rd St and NE 205th St (to the City boundary), Ballinger Creek is an open channel that crosses multiple private property backyards and is generally hidden from public view. Aerial photographs and observations from public right-of-way intermittently reveal an apparently narrow channel cross-section, overgrown with dense invasive vegetation in some places, and integrated into backyard landscaping in other places.

3.3.2.5 Other Reaches (Reach BA5 and un-named reaches)

Immediately upstream of the City of Shoreline boundary, within Mountlake Terrace, Ballinger Creek appears to flow along the west side of 54th Ave W within a typical roadside ditch and culvert system.

Ballinger Creek within the City of Shoreline has two small eastern tributaries. One such tributary originates north of the City within the 25th Ave NE piped storm drain then flows westward through private property channels in the vicinity of NE 203rd St before joining the main channel within Ballinger Creek Open Space. The other tributary originates within the 25th Ave NE piped storm drain south of NE 203rd St, turns west at 19843 25th Ave NE, flows through a dry pond on private property, then joins the main channel in Brugger's Bog Park (Reach BA5). Backyard channel characteristics for these tributaries are typically narrow and confined, and like the main channel from NE 203rd to NE 205th, overgrown with dense invasive vegetation in some places and integrated into backyard landscaping in other places.



Prepared by E. Nelson 1/4/2015 revised 8/15/2015

AltaTerra Consulting LLC

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0 312.5 625 1,250 Feet

Figure 3-4. Surficial Geology
Lyon Creek Basin

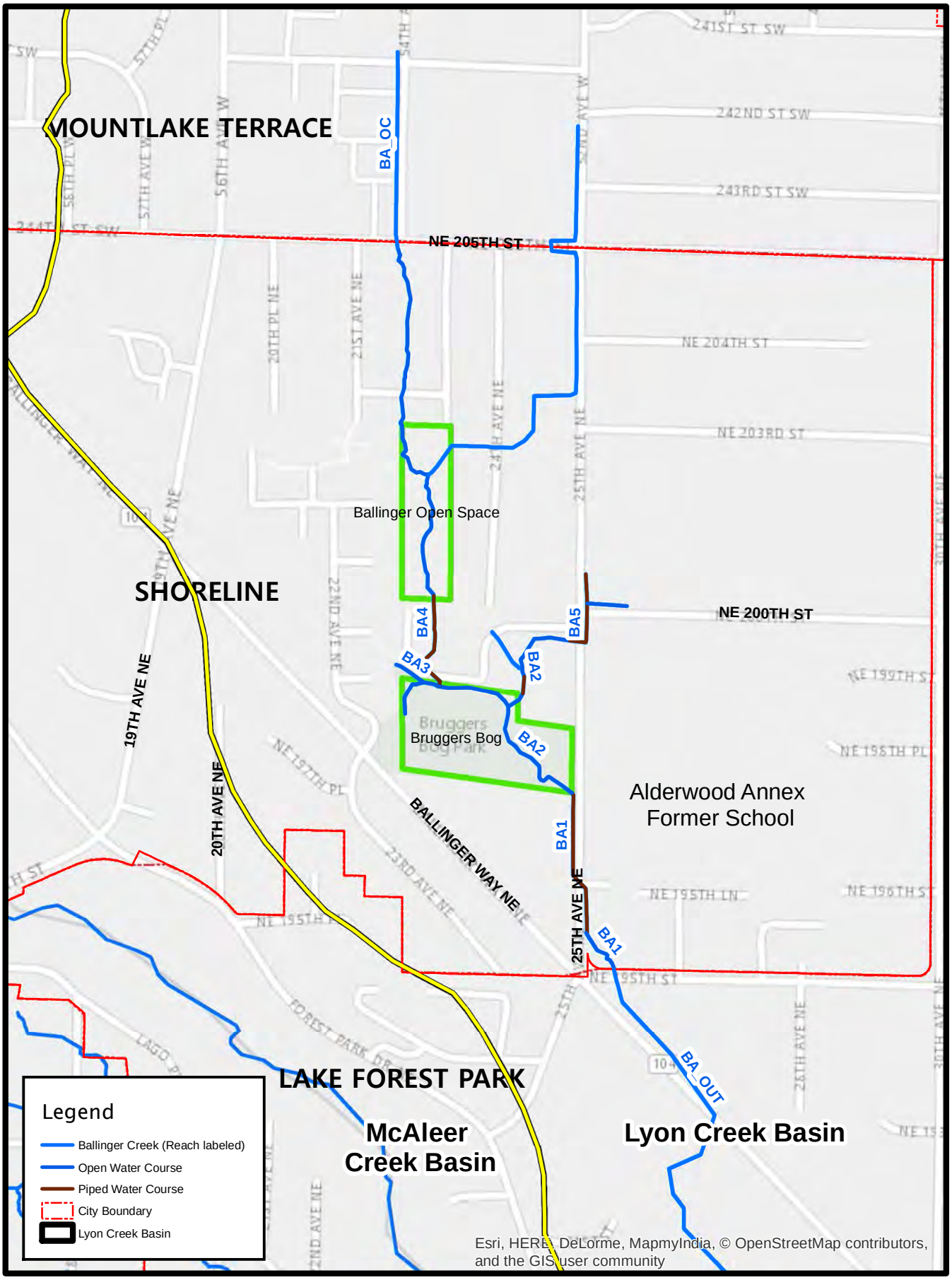

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Figure 3-5.Ballinger Creek Stream Reaches Lyon Creek Basin

Prepared by E. Nelson 12/31/2014, revised 8/15/2015

3.4 Surface Water

Ballinger Creek, a tributary to Lyon Creek, is the primary surface water feature in the basin. Approximately 0.6 miles of open stream channel is present in the portion of the basin within Shoreline, and approximately 0.25 miles of stream channel is piped. The piped portion is along 25th Avenue NE and through the Ballinger Creek Condominiums, which are located just north of Brugger's Bog Park around NE 200th Street (Figure 3-6).

A Hydrologic Simulation Program-Fortran (HSPF) model was developed for the Lyon Creek Basin by the City of Lake Forest Park in 2009 (Otak 2009). The HSPF was used to determine 25-year and 100-year flow frequencies for Ballinger Creek and import them into a hydraulic model developed for Ballinger Creek to identify existing flooded areas and prepare a preliminary 100-year floodplain map for Ballinger Creek. The hydraulic model used for the flooding analysis was the United States Army Corps of Engineers Hydraulic Engineering Center River Analysis System (HEC-RAS) Version 4.1.0. The hydrologic and hydraulic modeling memorandum is included in Appendix A.

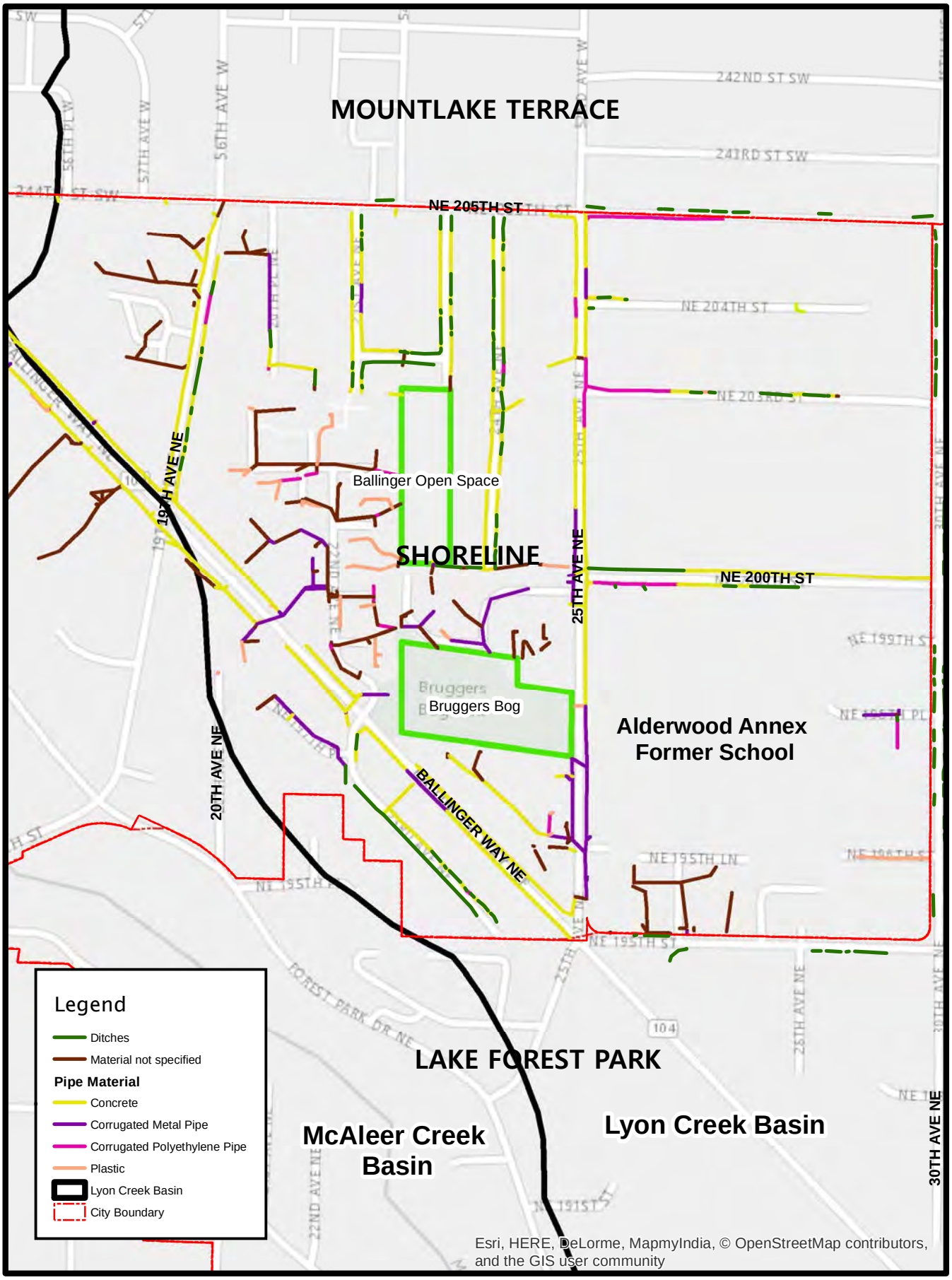
Flow frequency data from the 2009 HSPF hydrologic model ranged from around 55 cubic feet per second (cfs) for the 2-year flow up to around 240 cfs for the 100-year flow in the vicinity of 25th Avenue NE and Brugger's Bog Park (Table 3-2). Because the basin is largely built out and new development and significantly redeveloped properties are required to control stormwater flows according to current stormwater regulations (Section 4), it was assumed that future conditions would not vary much from the 2009 model or existing conditions, and therefore a future conditions scenario was not modeled.

The stormwater collection and conveyance systems outside of the Ballinger Creek main channel (including the tributary channels) were not included in the present surface water modeling effort.

Table 3-2. Ballinger Creek Estimated Flow Data

Location	Flow (cfs)*		
	2-year	25-year	100-year
Upstream of 25th Avenue NE	61.16	165.32	243.53
25th Avenue NE	59.51	162.70	240.43
NE 195th Street	56.18	152.92	224.68

* Explanation of calculated flow is provided in the hydrologic and hydraulic modeling memorandum (Appendix A).



AltaTerra Consulting LLC

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Figure 3-6. Lyon Basin Drainage Network

Prepared by E. Nelson 11/29/2014, revised 8/15/2014

3.4.1 Flooding

The hydraulic analysis conducted for this basin plan indicates that the main channel Ballinger Creek culverts within the basin typically overtop at the 25-year flow and above (Table 3-3). The Ballinger Creek flow frequency results seem high in that flows are higher in the Ballinger Creek tributary than they are downstream in Lyon Creek, flows are much higher than previously published flow frequency results, and flows indicate roads flood at the 2-year event. Yet, the results cannot be easily dismissed because flows are derived from the best available data and frequent flooding is, in fact, observed and reported at certain basin locations. The Modeling Memorandum (Appendix A) further describes how historical modeling results have varied and how this uncertainty is accounted for in the recommended strategies presented (Section 5.1).

Additionally, information obtained from the public during community meetings (Section 4), from the City, and through a review of drainage complaints and service requests (Section 3.7) indicates that flooding in the vicinity of 25th Avenue NE and Brugger's Bog Park can occur at flows much lower than the 25-year return frequency. Examples of such flooding were included in service requests tied to four events between November 2003 and November 2004, and were observed by City staff and/or residents in April and July 2014. The hydrologic and hydraulic modeling found three of the five culverts overtop during the 2-year event.

Previous studies have also shown the 25th Avenue NE and Brugger's Bog Park area to be prone to flooding and to have under-sized culverts (Entranco 1981; Hammond Collier & Wade Livingstone Associates 1999).

Table 3-3. Locations of Flooding in Lyon Creek Basin within Shoreline

Location	Type of flooding		
	2-year flow	25-year Flow	100-year Flow
NE 203rd Street	0.7-ft freeboard	Surcharge	Overtop
NE 200th Street	0.3-ft freeboard	Overtop	Overtop
Ballinger Creek Condominiums	Overtop	Overtop	Overtop
25th Avenue NE	Overtop	Overtop	Overtop
NE 195th Street	Overtop	Overtop	Overtop
Note: A surcharged culvert cannot adequately convey flows and creates a backwater condition upstream of the pipe. An overtopped culvert has surcharged to the point of backwatered flows overtopping the banks and exiting the channel into adjacent areas. Freeboard is the distance between the water surface elevation and the culvert crown at the culvert inlet.			

Figure 3-7 presents a map estimating the extent of potential flooding during both a 25-year and 100-year event based on the modeling information. This map is for planning purposes only and provides the City a general idea of what area(s) surrounding Ballinger Creek might flood during a 100-year event. The approximate locations and extents of flooding shown on Figure 3-7 have been verified by City staff field observations during flooding events (although recurrence intervals of observed flooding are unknown).

Two locations within the basin are on the City's stormwater operations and maintenance "hot-spot" list to check before or during heavy rain events because they are prone to debris build-up or flooding. The two locations are:

- Ballinger Open Space Park (NE 200th Street west of 24th Avenue NE) — check pipe inlet for debris, prone to blockage.
- Ballinger Creek open channel transition to piped conveyance along 25th Ave NE at southeast corner of Brugger's Bog Park and northeast corner of former King County Maintenance Facility (19547 25th Avenue NE) — prone to localized flooding.

OSBORN CONSULTING INCORPORATED

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0 200 400 Feet

0 200 Meters

Figure 3-7: Preliminary 100-year Floodplain Map of Ballinger Creek in Shoreline

Shoreline, WA

Prepared by MLP, 12/17/2014

3.4.2 Rainfall

The National Oceanic and Atmospheric Administration (NOAA) publishes weather extremes and has data for the Seattle area between 1948 and 2014. Table 3-4 lists the 10 greatest precipitation events within a 24-hour period in Seattle. The gage for these data is located at Seattle-Tacoma International Airport, approximately 25 miles south of the basin plan area. Weather patterns vary greatly even between short distances, so while these precipitation statistics may not be directly applicable to the Lyon Creek Basin area within the City of Shoreline they do give an idea of regional precipitation history. Of the 10 greatest precipitation events, 7 have occurred since 1990, and five have occurred since the City's incorporation in 1995.

It should also be noted that occurrences and magnitudes of flooding are not necessarily correlated with the size of the 24-hour precipitation event. Flooding may occur during events that would not appear as a large 24-hour precipitation event, such as short-duration high-intensity rainfalls, multiple-day lower-intensity storms, snowmelt-related events, or due to debris blockages or other capacity restrictions.

Table 3-4. Ten Greatest Precipitation Events in Seattle between 1948 and 2014

Date	Inches of Precipitation in 24 hours
October 2003	5.02
December 2007	3.77
November 1959	3.41
November 2006	3.29
February 1996	3.06
November 1998	3.04
January 1986 (tie)	2.98
February 1951 (tie)	2.98
November 1990	2.95
November 1990	2.93

3.5 Groundwater

Geologic conditions in the Lyon Creek basin within Shoreline result in typically high groundwater levels because water does not readily infiltrate into clay and silty soils that are present near Brugger's Bog Park and the former King County Maintenance Facility (see Figure 3-4). The Ballinger Creek Condominiums located along the Ballinger Creek channel between Ballinger Open Space and Brugger's Bog Park have reported groundwater intrusion problems in crawl spaces and lower levels and use sump pumps to keep these areas dry. Additionally, the City has received complaints of high groundwater and drainage problems in the Lyon Creek basin (Section 3.7 and Appendix C).

3.6 Stormwater Infrastructure

The City and private property owners maintain a series of pipes, ditches, and connecting structures (i.e., catch basins and manholes) that convey and route stormwater through the basin away from houses, road surfaces, and parking lots (Figure 3-6), as well as stormwater treatment facilities designed to provide water quality improvement and reduce high flows. This stormwater infrastructure is

connected to the natural channel network, including Ballinger Creek. This system typically flows by gravity and follows general topography with slopes running from north to south.

The condition of City-owned pipes in the Lyon Creek basin was assessed through video inspection using closed-circuit television (CCTV) technology. Table 3-5 summarizes the conveyances that are present in the basin and Figure 3-6 shows the locations of the conveyance features.

Table 3-5. Summary of Conveyance Types, Materials, and Lengths

Conveyance Type	Material	Owner		Total Approximate Linear Feet
		Private	City of Shoreline or Unknown	
Open Channel	N/A	Not specified		***3,300***
Ditch	N/A	Not specified		***3,900***
Pipe	Corrugated metal pipe (CMP)	1,333	3,322	***4,455***
	Concrete	167	17,082	***17,249***
	Corrugated plastic pipe (CPP)	360	1,824	***2,184***
	Ductile Iron (DI) or high density polyethylene (HDPE)	473	17	***490***
	Plastic	1,743	490	***2,233***
	Not specified	7,943	903	***8,846***
	Total Conveyance Length	***12,019***	***23,638***	***42,657***

3.6.1 Stormwater Treatment Facilities

The Lyon Creek basin within Shoreline has a few small stormwater treatment facilities catalogued in the City's GIS information. Most of these facilities were probably installed by private entities as part of required stormwater regulations; however, detailed plans or ages of installation were not reviewed. Table 3-6 and Figure 3-8 present facility types and areal sizes.

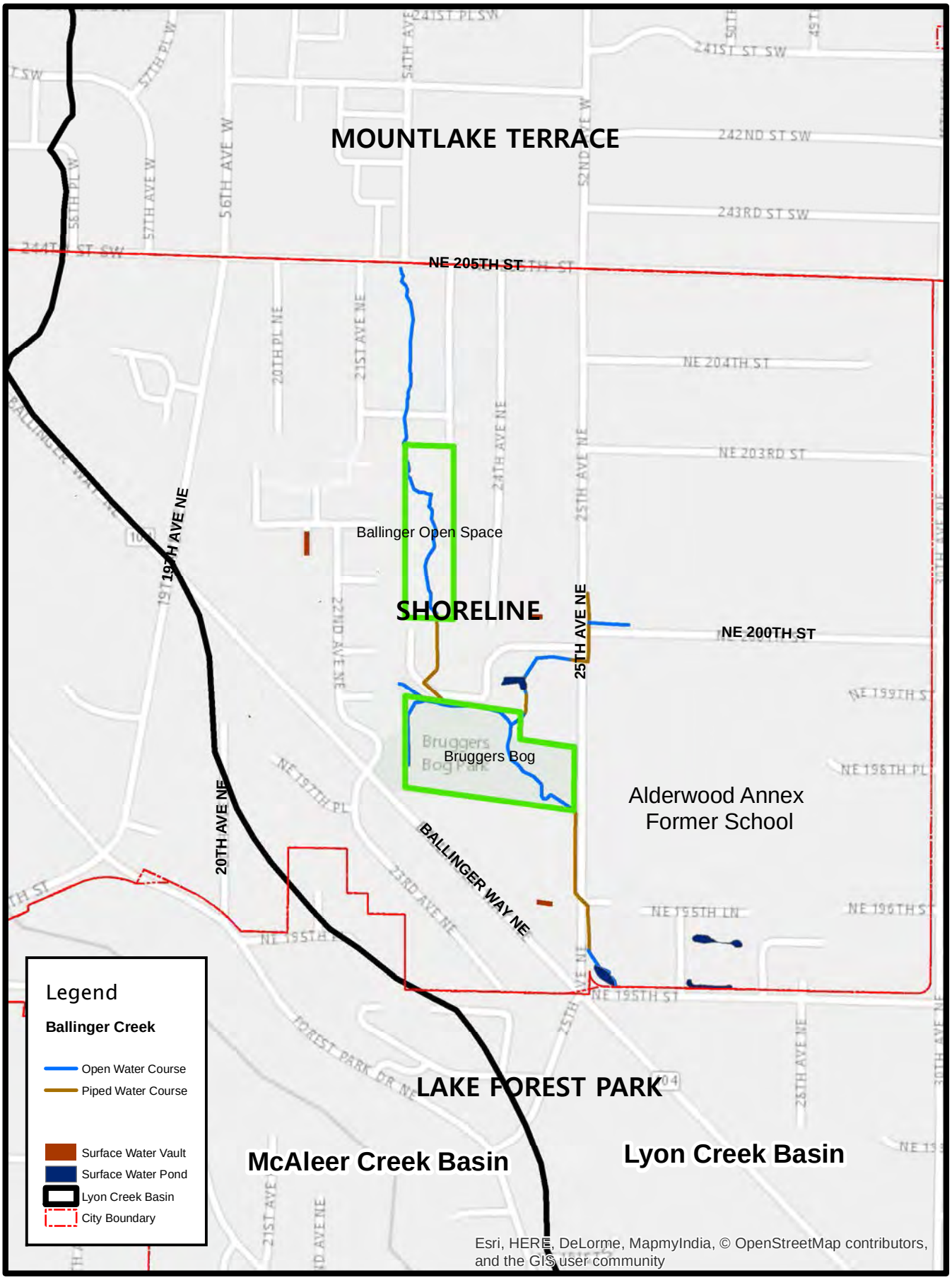
Table 3-6. Stormwater Treatment Facilities

Facility Type	Owner	Location	Approximate Size (square feet)
Wet Vault	Ballinger Commons (King County Housing Authority)	2200 NE 201st Place	1,828
Wet Vault	25th Place Condominiums	19500 Ballinger Way NE	1,100
Dry Vault	Islamic Community Center of Shoreline	20001 25th Avenue NE	835
Dry Pond	Private 4-plex Residences	19831 25th Avenue NE	2,806
Dry Pond	Canterbury Court Apartments	2620 NE 195th Street	3,022
Dry Pond	Canterbury Court Apartments	2620 NE 195th Street	2,149
Dry Pond*	Private Apartments	2518 NE 195th Street	2,619

* Dry pond is on Ballinger Creek upstream of NE 195th culvert in area that is frequently flooded.

Additionally, there are approximately thirteen private properties within the City of Shoreline portion of the Lyon Creek basin featuring large diameter pipe-style detention tank facilities:

- Ballinger Creek Condominiums on 25th Ave NE: 154 LF x 48-inch, 62 LF x 36-inch diameter pipes
- Shoreline Village Condominiums on 19th Ave NE: 176 LF x 40-inch diameter pipe
- Compton West Condominiums on 19th Ave NE: 85 LF x 42-inch diameter pipe
- Arco Gas Station/Mini-Mart at 1901 NE 205th St: 143 LF x 18-inch diameter pipe
- O'Reilly Auto Parts at 20319 Ballinger Way NE: 195 LF x 24-inch diameter pipe
- Retail plaza at 19939 Ballinger Way NE: 89 LF x unknown diameter pipe
- Ballinger Office Complex at 19921 Ballinger Way NE: 71 LF x 72-inch diameter pipe
- Northwest Hand Specialists at 19930 Ballinger Way NE: 86 LF x 36-inch diameter pipe
- Pepper Tree Apartments at 19926 Ballinger Way NE: 107 LF x 48-inch diameter pipe
- Alston Apartments at 19831 25th Ave NE: 92 LF x 30-inch diameter pipe
- Brinton Apartments at 19833 25th Ave NE: 52 LF x 30-inch diameter pipe
- Residential development at 2936 NE 198th Pl: 124 LF x 30-inch diameter pipe
- 4-plex housing at 2526 NE 195th St: 181 LF x 42-inch diameter pipe



AltaTerra Consulting LLC

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Figure 3-8. Lyon Basin Stormwater Facilities

Prepared by E. Nelson 12/31/2014, revised 8/15/2015

3.6.2 Condition Assessment

The condition assessment included inspection of all pipes with a diameter of 12 inches or more in the Lyon Creek basin within the City boundaries. Everson Econo-Vac (Everson) was the vendor selected to inspect the pipes using CCTV and rate the pipes. Everson began the CCTV inspections in May 2014 and completed the final inspections in November 2014. The CCTV inspection videos and reports were processed and organized and the City's GIS database was updated with the inspection results. Pipes between 25 and 50-feet in length were not inspected using CCTV and the NASSCO rating system, rather through a visual inspection called "candling." Everson shone a flashlight down the length of the culvert and noted any deficiencies which were visible. These pipes were assigned ratings based on the notes provided. A memorandum documenting the condition assessment procedures and results is provided in Appendix B.

The CCTV inspection included a qualitative inspection rating following the industry standard National Association of Sewer Service Companies (NASSCO) system of rating. The rating system includes three categories: structural, maintenance, and overall pipe conditions. The Structural Pipe Rating (SPR), Maintenance Pipe Rating (MPR), and Overall Pipe Rating (OPR) are based on the sum of the defects (ranging from a score of 0 to 5 per defect) found in each pipe segment in each category, resulting in scores of 0 and above. The rating criteria are shown in Table 3-7.

How is the condition assessment data used?

The City uses the condition assessment results in its asset management program for which it schedules repair, replacement, and maintenance of City assets including stormwater pipes. Pipes that are identified as needing repair or replacement are prioritized and scheduled for that work. Recommended projects to repair pipes are included in Section 5.

The pipes were also compared using rating indices. The Structural Pipe Rating Index (SPRI), Maintenance Pipe Rating Index (MPRI), and Overall Pipe Rating Index (OPRI) represent the average of the individual defect scores for all of the defects found in a particular pipe segment, resulting in scores on a 0 to 5 scale.

Pipe Rating and Pipe Rating Index scores can be used in tandem to best evaluate pipe condition. For instance, a pipe with a large number of minor structural defects (not necessarily needing repair) could have a high SPR score, but would have a low SPRI score. Conversely, a pipe with a single but very serious defect (definitely needing repair) would have a relatively low SPR score but a high SPRI. A pipe with a mix of minor and serious defects could have a fairly low SPRI score. Thus, neither SPRI nor SPR alone should be used to represent pipe condition.

Table 3-7. NASSCO Rating Criteria

NASSCO Score	Description	Estimated Time to Failure
0	EXCELLENT: no defects	Unlikely in the foreseeable future
1	EXCELLENT: minor defects	Unlikely in the foreseeable future
2	GOOD: defects that have not begun to deteriorate	20 years or more
3	FAIR: moderate defects that will continue to deteriorate	10 to 20 years
4	POOR: severe defects that will become grade 5 defects within the foreseeable future	5 to 10 years
5	IMMEDIATE ATTENTION: defects requiring immediate attention	Has failed or will likely fail within the next 5 years

Table 3-8 summarizes the number of pipes and structures inspected by Everson, and Table 3-9 lists the number of pipes within each rating category. The pipes in the Lyon Creek basin are in fairly poor condition, with approximately 30 percent having an SPR rating of five or greater. Specific pipes and recommendations for the type of immediate actions needed are summarized in Section 5. Figure 3-9 shows all the pipes in the Shoreline portion of Lyon Creek basin with pipes scoring a 5 or higher in SPR, SPRI, MPR and MPRI highlighted.

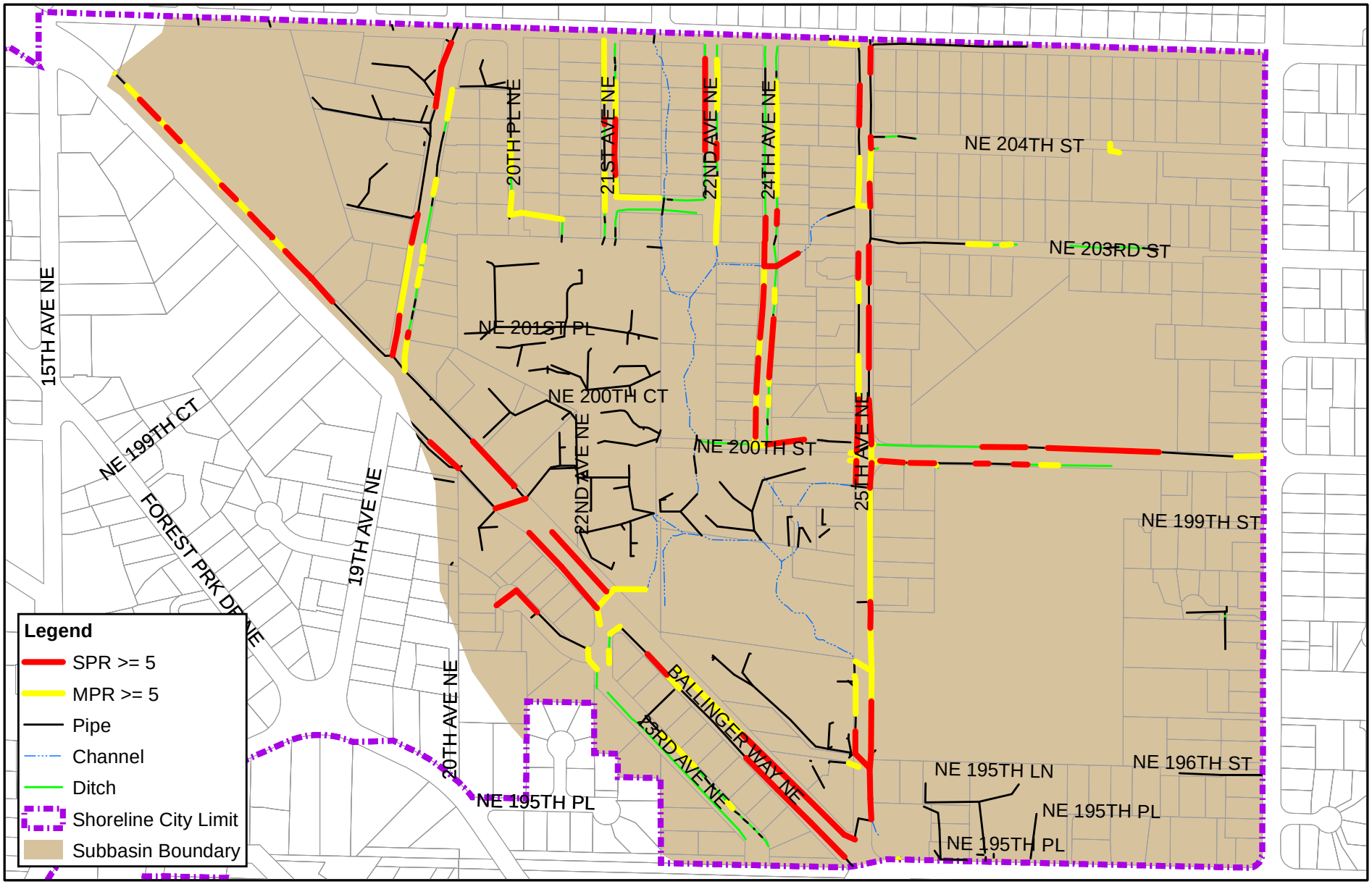
To develop CIPs based on the condition assessment, the CCTV videos and NASSCO reports for each pipe were reviewed for deficiencies and placed into two categories: potential CIPs and pipes not requiring immediate repair or replacement. Then, prioritization criteria were applied to each pipe placed in the potential CIP category. The criteria included considerations for risk of failure, consequence of failure, importance of pipe, and condition. Risks of failure taken into account consisted of slope of pipe and surrounding area, presence of a void, and whether or not the pipe was located in a flood, slide, or erosion hazard zone. Consequences of failure were comprised of proximity to an arterial and presence of a utility crossing. The importance of the pipe was determined through its location within the basin and the size of the pipe. The combination of the above criteria and the condition reported by Everson allows for a complete review of each pipe and the immediacy of repair. For a list of prioritized pipes and additional information regarding the prioritization process, refer to Appendix B.

Table 3-8. Summary of Pipes and Structures Inspected by CCTV in Lyon Creek Basin

Number of Pipes	Number of Structures	Length of Inspected Pipes (linear feet)	% of Total Pipes Inspected in Basin
234	389	18,842	80

Table 3-9. Pipe Condition Summary

Rating Type	Number of Pipes within Each Category Rating					
	Rating =0	Rating = 1	Rating =2	Rating =3	Rating =4	Rating =5
SPR	130	6	12	10	8	75
MPR	73	8	19	13	17	111
OPR	35	4	16	10	11	165
SPRI	130	13	27	52	10	9
MPRI	73	12	79	23	8	46
OPRI	35	14	89	41	11	51



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0 450 900 Feet

0 225 Meters

Figure 3-9: Condition Assessment Ratings Greater than 5 in Lyon Creek Basin

Shoreline, WA

3.7 Infrastructure Service Requests

City service requests received between 2002 and 2014 were reviewed to identify problematic areas in the basin and potential causes. Three sources of City GIS data were reviewed: flood calls, drainage requests, and other related requests.

How are infrastructure service requests used in the basin plan?

Evaluation of the type, location, and frequency of service requests in conjunction with other data (e.g., condition assessment information, hydraulic modeling, and field assessment) is valuable to provide validation of issues (in the case of flooding events and timing) and identify whether the issues are isolated or broader in nature (for instance, is an entire neighborhood affected by the same thing, such as high groundwater, or is it just one home?).

Appendix C includes the listing of all available infrastructure service requests received from the Lyon Creek basin. Total number of unique service requests was 39. There were eleven flooding-related service requests; the remaining 28 service requests included drainage complaints, maintenance requests, and water quality issues. Some of the non-flooding service requests were identified as private property issues outside of City responsibility.

Nine of the eleven flooding service requests were received for four events occurring between November 2003 and November 2004, and seven of those nine reported flooding calls were at properties just upstream of the NE 195th Street culvert. Figure 3-10 shows the types of service calls received and the years in which they were received, and Figure 3-11 shows the distribution of service calls by month. The majority of the flood-related service calls were related to August 2004 precipitation events. Three calls were associated with drainage and flooding problems related to a precipitation event apparently occurring late in the day on Friday, August 6, 2004 that resulted in localized flooding in these neighborhoods and resulting service requests on Monday, August 9, 2004 (also occurring within the City's neighboring McAleer Creek Basin as well) from overtopped conveyance systems. Additionally, another August 2004 event (resulting in calls on August 23) was responsible for two more flood-related service requests. Precipitation across the region on August 6 and 7, 2004 and later in the month on between August 21 and 23, 2004 was variable. However, data accessed from regional rain gauges available in the National Climatic Data Center's (now National Oceanic and Atmospheric Administration [NOAA] National Center for Environmental Information) indicated around 1 inch of rain fell between August 6 and August 7 in Everett (0.86"), Magnuson Park Sand Point in Seattle (0.7"), SeaTac International Airport (0.87") and Boeing Field in Seattle (1.07"). This same data showed nearly 1 to 2 inches of rain fell between August 21 and 23 in Monroe (2.09"), Everett (1.2"), Boeing Field in Seattle (0.98"), SeaTac International Airport (0.74") and Magnuson Park Sand Point in Seattle (1.76").

There were no service requests listed for one very large precipitation event on December 3, 2007. On this day between 2 and 4 inches of rain fell across the greater Seattle region. Data accessed from regional rain gauges available from NOAA's National Center for Environmental Information indicated that Seattle Tacoma International Airport received 3.7 inches of rain on December 3, 2007, Everett received 2.2 inches, and Magnuson Park Sand Point in Seattle received 4 inches. The entire region was experiencing extreme weather conditions and the City reports that calls came in through emergency services (911) directly to field dispatch and may not have been logged into the Utility's system.

The service request data confirms flooding in the residential area immediately upstream of the NE 195th Street culvert (north of NE 195th St and east of 25th Ave NE), as well as prior individual instances of

flooding at the more upstream developments at Ballinger Creek Condominiums and Ballinger Commons, as suggested by previous studies and system hydraulic modeling. Figure 3-12 presents a plan view map of the type and location of calls.

There were five unique service requests from different properties along NE 205th Street between 25th Avenue NE and 30th Avenue NE between 2003 and 2008 that involved issues associated with roadway runoff due to lack of or poorly functioning drainage infrastructure on the Shoreline side (south) of NE 205th Street. The drainage system in this area has not been improved in the years since.

Figure 3- 10 Service Call Received from Lyon Creek Basin by Year

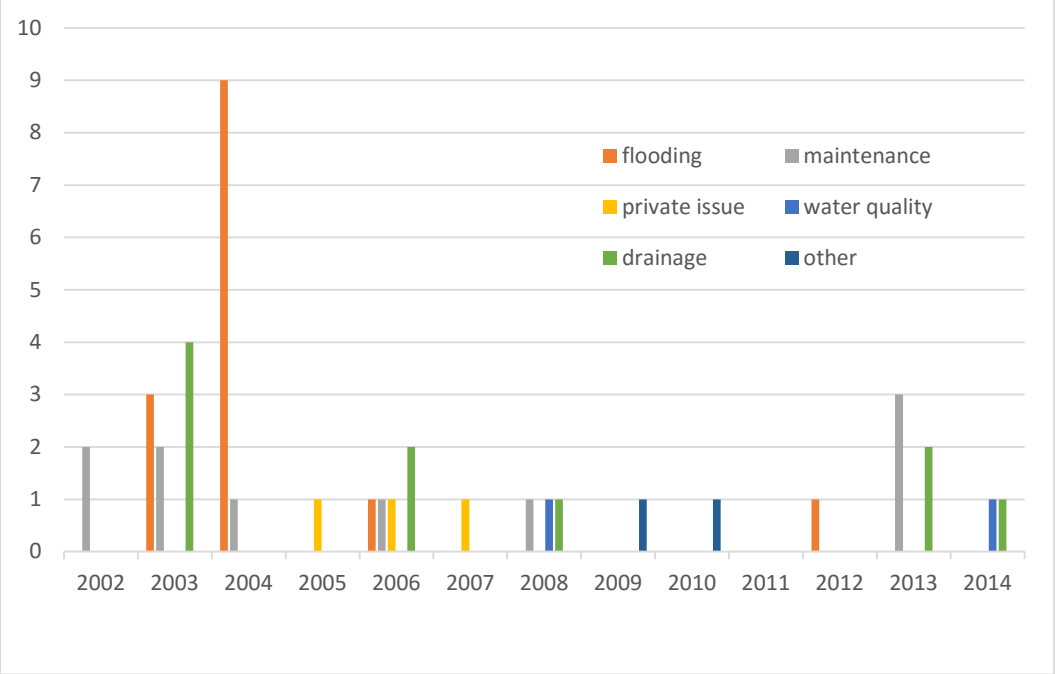
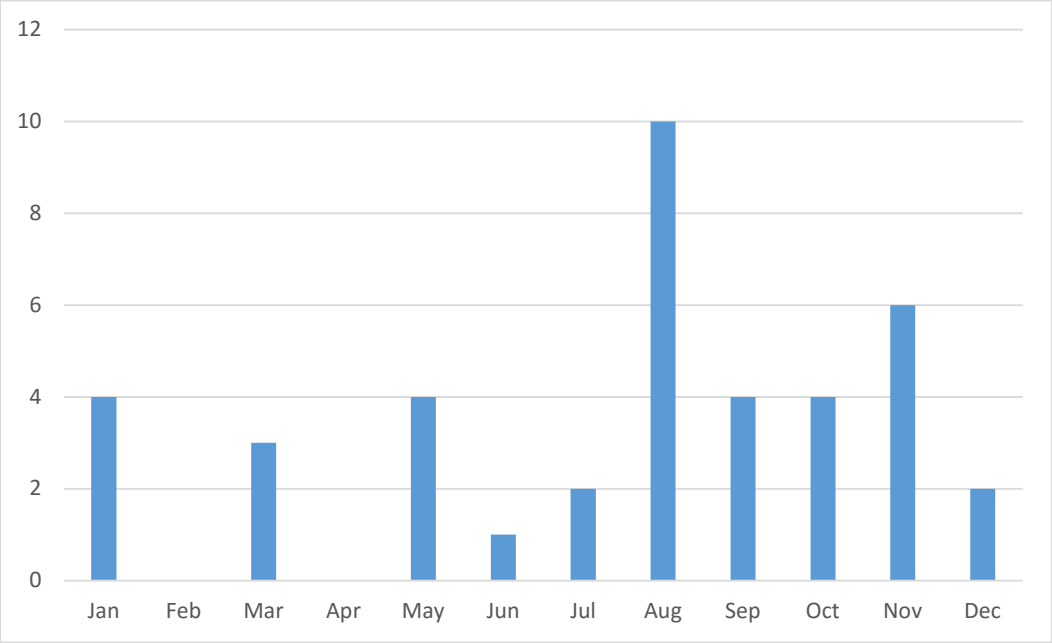
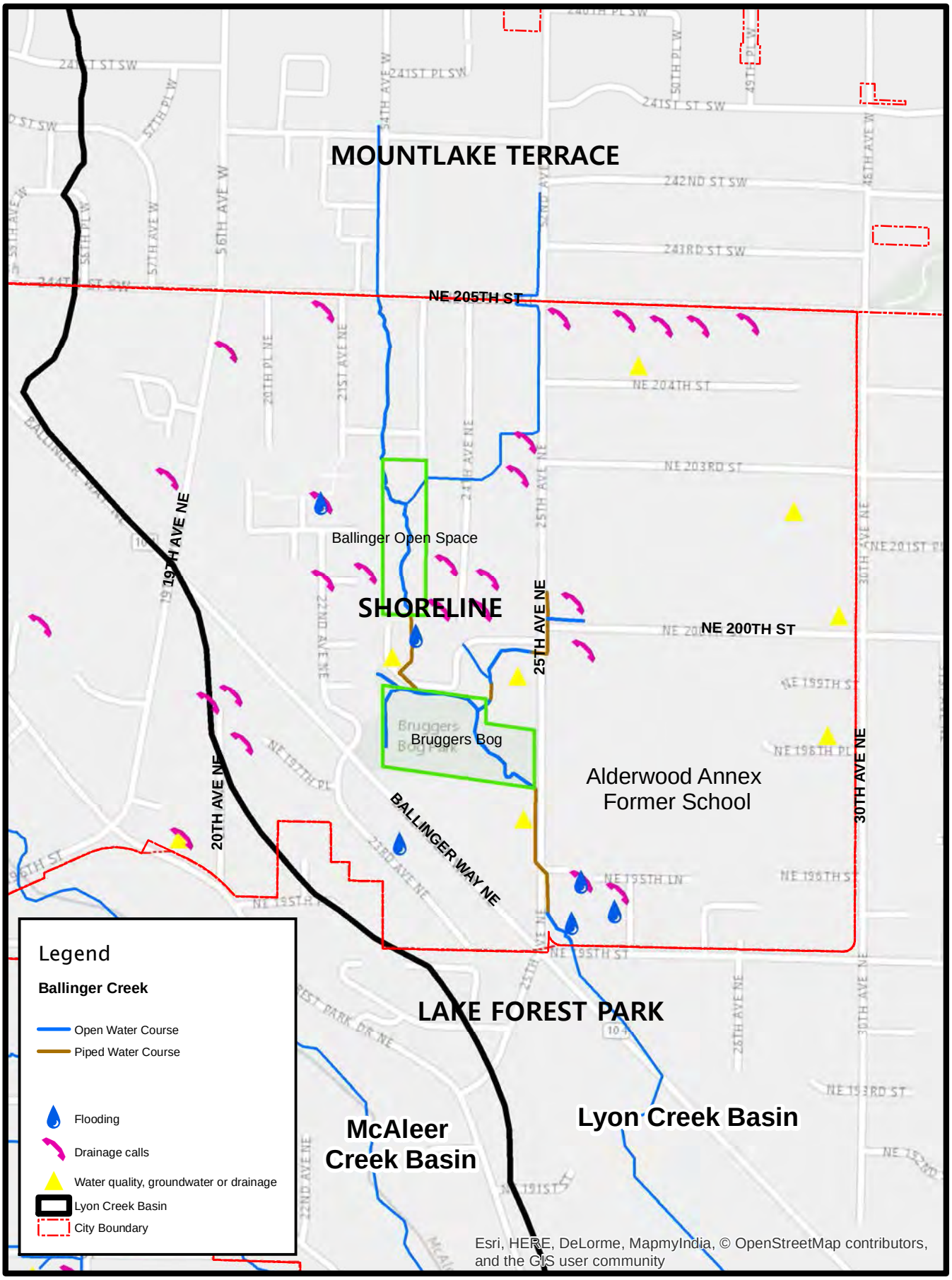


Figure 3- 11 Number of Service Calls Received from Lyon Creek Basin by Month (between 2002 and 2014)





AltaTerra Consulting LLC

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0 255 510 1,020 Feet

Figure 3-12. Lyon Creek Basin Service Request Locations

Prepared by E. Nelson 12/31/2014, revised 8/15/2015

3.8 Biological Conditions

Biological conditions, including a qualitative assessment of wetlands and stream conditions in the Lyon Creek basin, were evaluated during stream walks in July 2014.

3.8.1 Wetlands

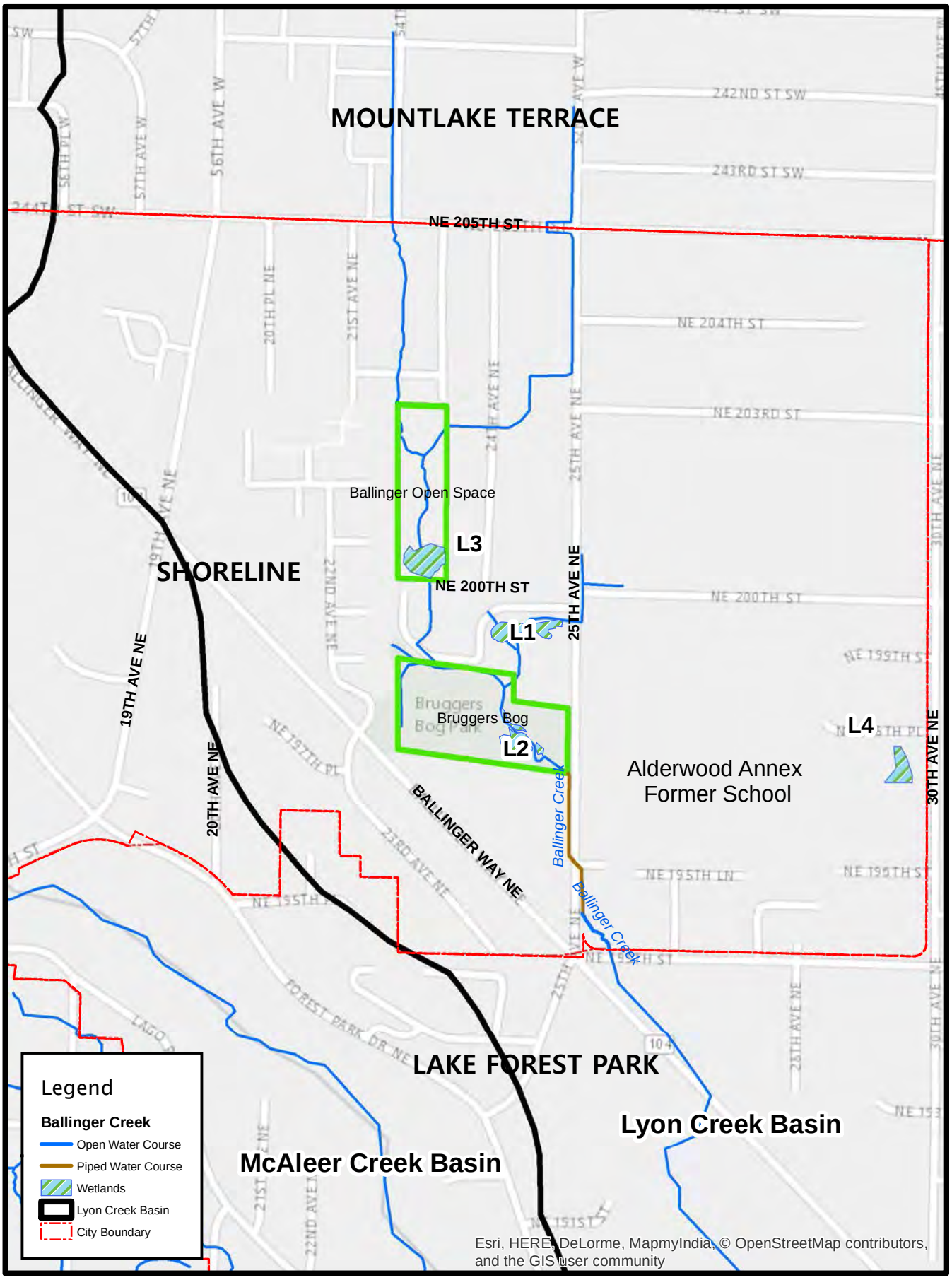
An inventory-level analysis of wetlands basin-wide within the City of Shoreline was conducted for this basin plan. During fieldwork, wetland areas were sketched onto aerial maps and later transferred to a GIS layer. Wetland presence and approximate boundaries were based on observable field conditions from private properties where entry permission was granted or from public roads and rights of way. Preliminary ratings were given for each wetland based on the current Shoreline wetland classification system outlined in Chapter 20.80 of the Shoreline Municipal Code. No formal delineations were conducted; all information generated regarding wetlands is suitable for landscape- or region-level planning, but is not a substitute for formal wetland delineations. Specific development proposals should rely on this information only as a guide. On projects where wetlands are present, formal delineations of wetland boundaries and determinations of wetland classifications are necessary to support individual clearing, grading, and building applications.

Only three wetlands in Lyon Creek basin were noted during the fieldwork, although the potential exists for additional wetlands present in areas that are not viewable from public roads. All three wetlands (referred to as L1, L2, and L3) are preliminarily classified as Type III wetlands. Of these wetlands, only L2 was previously identified (as WL-T) in the basin characterization report (Tetra Tech/KCM 2004). Shoreline Municipal Code (SMC 20.80.320) describes Type III wetlands as “those wetlands that are equal to or less than one acre in size and that have one or two wetland classes and are not rated as Type IV wetlands, or wetlands less than one-half acre in size having either three wetlands classes or a forested wetland class or subclass.” Wetland locations are shown in Figure 3-13. One additional wetland, L4, is shown on the City GIS map on the eastern boundary of the City. This wetland is located on private property and was not visited during the field reconnaissance. Table 3-10 lists the wetlands, approximate sizes, preliminary classifications, and descriptions.

Table 3-10. Lyon Creek Basin Wetlands

Wetland	Location	Preliminary Rating*	Size (acres)	Description
L1	East of 25th Avenue NE	3	<0.5	This wetland is dominated by emergent species with a fringe of trees and shrubs. The east tributary to Ballinger Creek flows through the wetland.
L2	South end of Brugger's Bog Park	3	<0.5	This riparian wetland was recently delineated by The Watershed Company in 2013. The results of the delineation concluded the Shoreline GIS data wetland boundary is incorrectly shown along the southern edge of the park. Figure 3-13 shows a more accurate representation of the wetland boundary as it was delineated, flagged, and surveyed.
L3	South end of Ballinger Open Space Park	3	0.32	This wetland appears accurately marked for an inventory-level analysis. Vegetation in this wetland is dominated by a weedy assemblage of shrubs with a forested fringe.
L4	Private property on east boundary of City near 30th Avenue NE	3	0.12 (appx.)	According to a 2013 wetland delineation submitted to the Shoreline planning department, this wetland is dominated by deciduous trees with an understory of emergent species.

* The City Planning Department is reviewing a code revision that will likely modify the classification system to reference the Washington State Wetland Rating System for Western Washington: 2014 Update (Ecology 2014); (Personal communication between Hugh Mortensen, the Watershed Company, and Juniper Nammi, City of Shoreline, 2014).



AltaTerra Consulting LLC

N

0 230 460 920 Feet

Figure 3-13. Wetlands
Lyon Creek Basin

Prepared by E. Nelson 12/31/2014, revised 8/15/2015

3.8.2 Stream and Aquatic Habitat Conditions

Stream and aquatic habitat conditions were qualitatively assessed during stream walks conducted in July 2014. In addition to evaluating conditions, the City requested that stream conditions be evaluated relative to their current City designation to determine whether any current designations should be modified to reflect actual conditions. The reach locations are shown in Figure 3-5. Table 3-11 summarizes stream reaches and conditions observed. Stream conditions were similar to conditions reported in the City of Shoreline Stream and Wetland Inventory and Assessment conducted by Tetra Tech/KCM in 2004 (Tetra Tech/KCM 2004).

Table 3- 11 Summary of Ballinger Creek Conditions by Reach

Reach	Location	City Designation*	Description
BA1	North of NE 195th Street to SE corner of Brugger's Bog Park	"Type II" open channel, "piped stream segment" on 25th Ave NE	There is a short, open-channel segment in the lower portion of reach BA1, extending north from NE 195th Street, which was the subject of a prior restoration project and has demonstrated salmonid habitat value. The channel includes alternating pools and riffles and is well shaded with native vegetation (Photo 1). The upper part of this reach is piped and has no habitat value.
BA2	Within Brugger's Bog Park	"Type II"	The stream channel through Brugger's Bog Park is well shaded, though the stream buffer is somewhat narrow. Fairly good gravel for fish spawning is present, with both pool and riffle habitat and some wood. The channel downstream of the maintenance and pedestrian bridge is wider (roughly 12 feet) and is allowed to migrate across the floodplain (Photo 2). Upstream of the bridge, the channel becomes more confined and narrows substantially (about 4 to 6 feet). On the north edge of the park, the channel is confined against the edge of a timber retaining wall next to the Ballinger Creek Condominium parking lot, is very degraded, and is surrounded by blackberries (Photo 3).
BA3	West side of Brugger's Bog Park	"Type III"	This is a very small ditch-line channel that was likely dug to intercept flow from the adjacent hillslope and drain the wetland.
BA4a	Ballinger Condos from Brugger's Bog to NE 200th Street	"piped stream segment" on GIS	The stream segment through the Ballinger Creek Condominiums is a combination of pipes and open stream segments through the central common area, where the channel is approximately 6 to 8 feet wide and is primarily riffle and glide habitat without pools or wood. There is some shading provided by landscaping (see Photo 4)
BA4	NE 200th St to NE 205th St, including Ballinger Open Space	"Type III"	Ballinger Creek is fairly degraded in this stream reach at Ballinger Open Space Park. The channel is incised and trash was present (Photos 5 and 6). Non-native vegetation dominates the park.
BA5 (Trib.)	NE 200th Street/25th Avenue NE to Brugger's Bog	"Type III"	This small, east tributary originates northeast of Brugger's Bog Park in the vicinity of the intersection of NE 200th Street and 25th Avenue NE. The stream channel is 4 to 6 feet wide and generally flows through alternating dense, shrubby vegetation, landscaped and manicured yards, and wetland-type environments choked with nightshade. There were several springs and seeps observed adjacent to the creek. Flow to this tributary originates from an 18-inch culvert on 25th Avenue NE (Photos 7 and 8).

Reach	Location	City Designation*	Description
Storm runoff from east (Trib.)	25th Ave NE/NE 203rd St to Ballinger Open Space east	Not classified as a stream	Drainage from street runoff enters Ballinger Creek in the Ballinger Open Space Park. It is considered to be an open, un-piped storm drainage channel section within a constructed storm drainage system which is piped both upstream and downstream. Therefore, it is not used to convey a naturally-occurring stream as is required for non-fish-bearing, artificial channels to be considered streams by code definition. It is, rather, an example of the "surface runoff devices or other entirely artificial watercourses" which are excluded under the City's stream definition.

*Stream reach designations are based on Shoreline Municipal Code 20.80.460. Type III streams are subject to confirmation of lack of fish use or habitat and a channel width of two feet or more.

Stream reaches were classified as City of Shoreline designation Type II or Type III. Type II streams according to Shoreline Municipal Code (SMC 20.80.470) are those streams that are not Type I streams and are either perennial or intermittent and have one of the following characteristics:

1. Salmonid fish use; or
2. Demonstrated salmonid habitat value as determined by a qualified professional.

Type III streams are those streams which are not Type I or Type II streams with perennial (year-round) or intermittent flow with channel width of two feet or more taken at the ordinary high water mark and are not used by salmonid fish.

A Water Type Conversion Table (Table 3-12) is provided below for cross-referencing with the stream classification system(s) used by the Washington Department of Natural Resources (DNR). To complicate matters, DNR defines a "permanent" water typing system under WAC 222-16-30 and an interim water typing system under WAC 222-16-31. Type 1 streams or "waters" are Shorelines of the state in each case. However, as can be seen, there is not a direct or 1:1 correspondence between the three systems in all cases. The state distinguishes between Type 4 (or Np) and 5 (or Ns) waters based on whether they are seasonal or perennial, while the City of Shoreline distinguishes between Type III and IV streams based on their channel width.

Table 3- 12 Water type conversion table

DNR Permanent Water Typing (WAC 22-16-030)	DNR Interim Water Typing (WAC 222-16-031)	City of Shoreline Rating
Type "S"	Type 1 Water	Type I Stream
Type "F"	Type 2 and 3 Water	Type II Stream
Type "Np"	Type 4 Water	Type III or IV Stream
Type "Ns"	Type 5 Water	Type III or IV Stream

Photo 1. Reach BA1 Upstream of NE 195th Street

Photo 2. Reach BA2 in Brugger's Bog Park (downstream of pedestrian bridge)

Photo 3. Reach BA2 Adjacent to Timber Retaining Wall (parking lot is approximately 15 feet above stream channel on right side of photo)

Photo 4. Ballinger Creek within Ballinger Creek Condominiums (looking upstream)

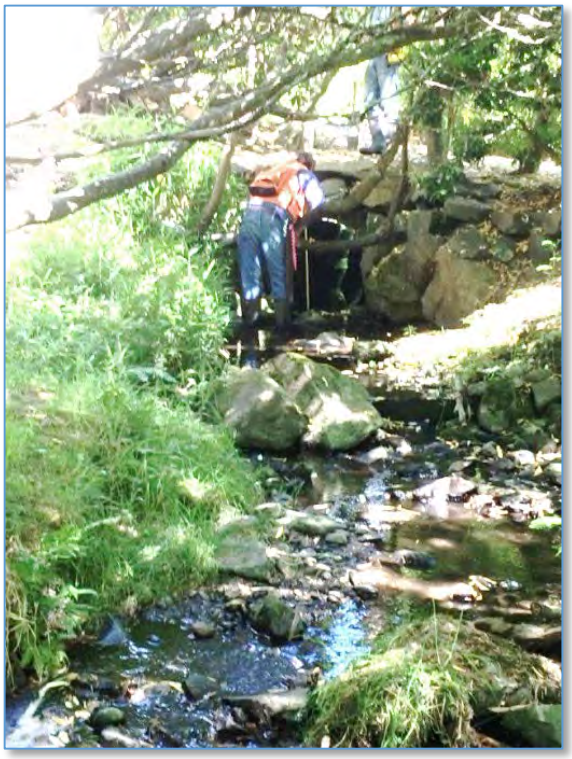


Photo 5. Trash and Debris in Reach BA4 at Ballinger Open Space Park

Photo 6. Channel Incision in Reach BA4 at Ballinger Open Space Park

Photo 7. Outfall to Reach BA5 from 25th Avenue NE

Photo 8. Reach BA5 Meandering through Private Yards

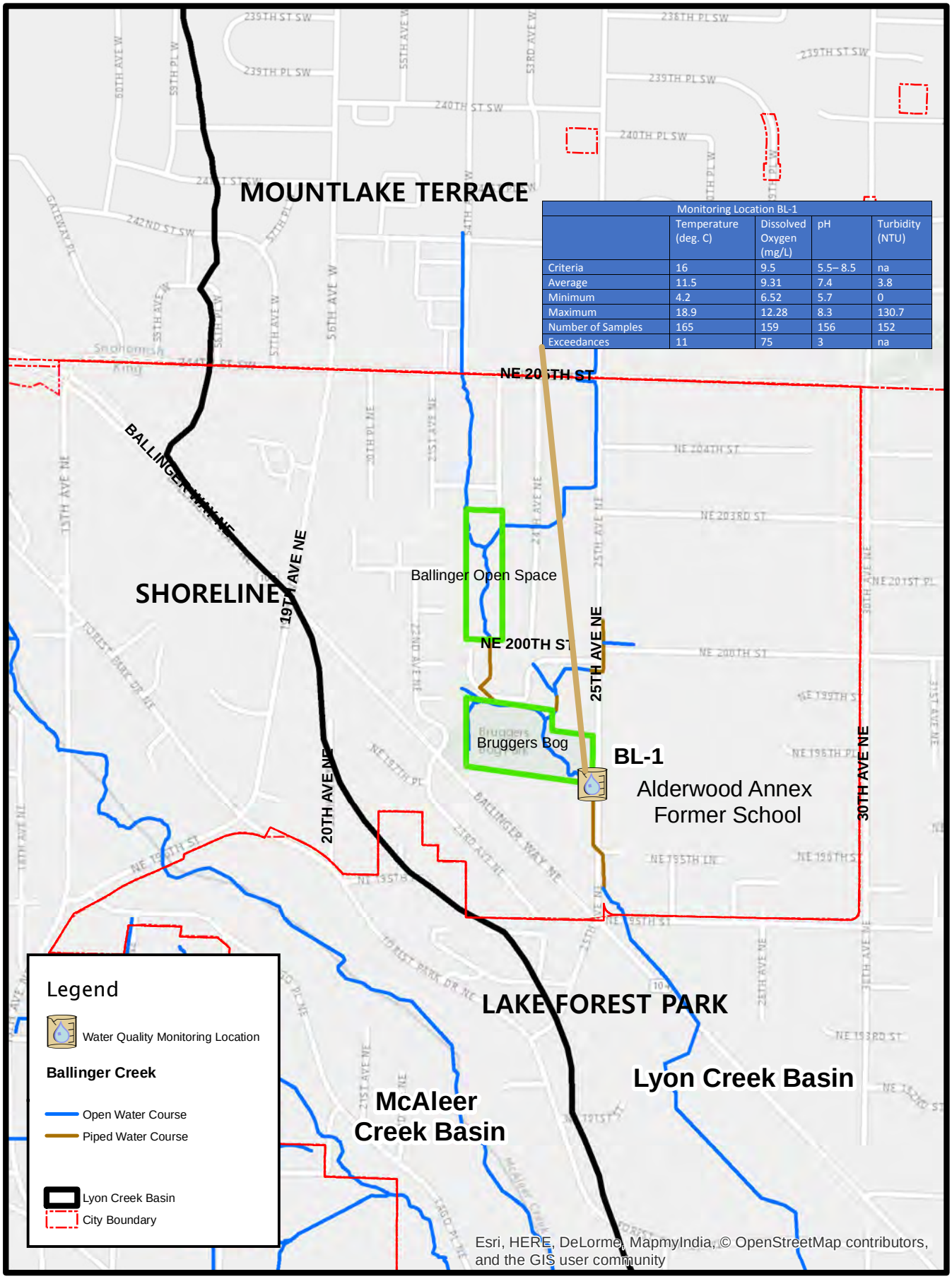
3.8.3 Fish Use and Barriers

Resident cutthroat trout, considered salmonid fish, are presumed to be present along portions of Ballinger Creek upstream at least through Brugger's Bog Park. Downstream portions outside the City limits are also documented to contain Coho salmon. No federally listed fish are documented within any portion of Ballinger Creek.

Additionally, the Washington Department of Fish and Wildlife (WDFW) SalmonScape website (http://apps.wdfw.wa.gov/salmonscape; accessed on January 9, 2015) documents a number of full or partial fish-passage barriers along Ballinger Creek within the City of Shoreline, including several culverts between Ballinger Open Space and Brugger's Bog Park. The 25th Avenue NE piped stream section downstream of Brugger's Bog Park is identified by SalmonScape as a culvert-type total barrier to fish passage (site #931630). SalmonScape also shows multiple partial fish passage barriers along Ballinger Creek downstream of the City of Shoreline, including the NE 195th Street culvert at the City boundary and nine additional sites. Eight of these are concentrated along the lowermost section of the creek between Forest Park Drive NE and the confluence of Ballinger Creek and Lyon Creek.

3.8.4 Water Quality

The City has been monitoring water quality parameters in Ballinger Creek at the downstream end of Brugger's Bog Park (water quality sampling location BL-1) since 2001 in an attempt to establish baseline water quality conditions and evaluate trends. Figure 3-14 shows the Ballinger Creek water quality monitoring location and a summary of data collected. Figures 3-15 through 3-18 show graphs of the data collected by the City. Additional water quality data is provided in Appendix D.



Monitoring Location BL-1				
	Temperature (deg. C)	Dissolved Oxygen (mg/L)	pH	Turbidity (NTU)
Criteria	16	9.5	5.5– 8.5	na
Average	11.5	9.31	7.4	3.8
Minimum	4.2	6.52	5.7	0
Maximum	18.9	12.28	8.3	130.7
Number of Samples	165	159	156	152
Exceedances	11	75	3	na

AltaTerra Consulting LLC

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0 310 620 1,240 Feet

Figure 3-14. Ballinger Creek Monitoring Location and Data

Prepared by E. Nelson 12/31/2014, revised 8/15/2015

Figure 3- 15 Dissolved Oxygen (DO) concentrations in Ballinger Creek (mg/L)

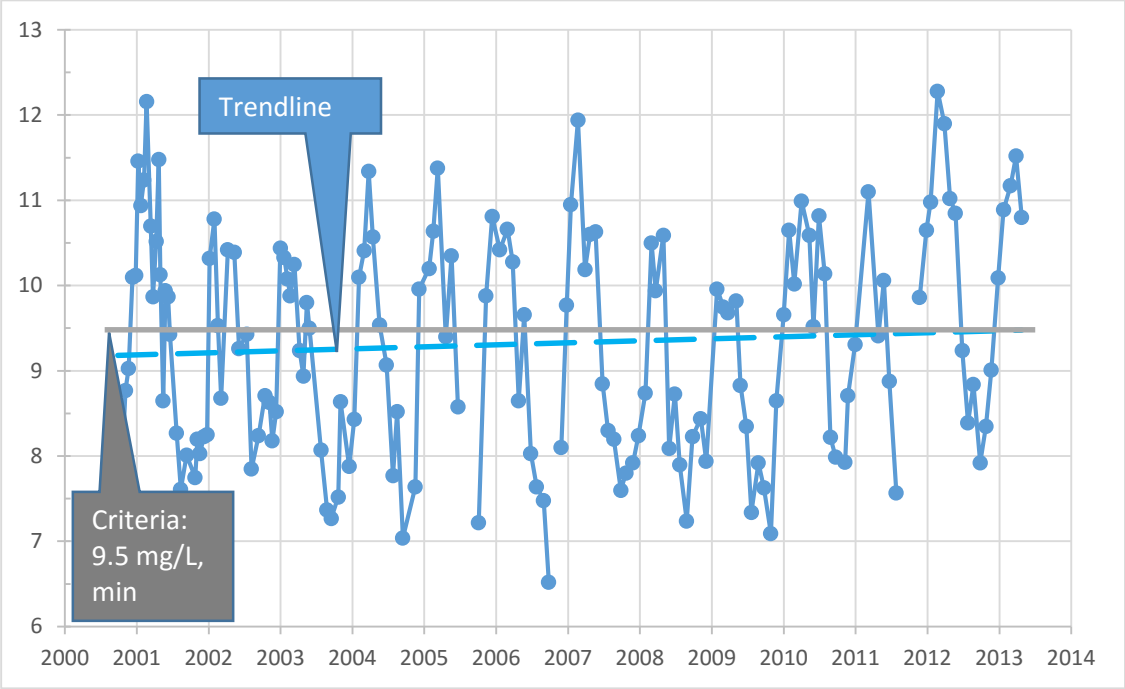


Figure 3- 16 Temperature Data Collected in Ballinger Creek (degrees Celsius)

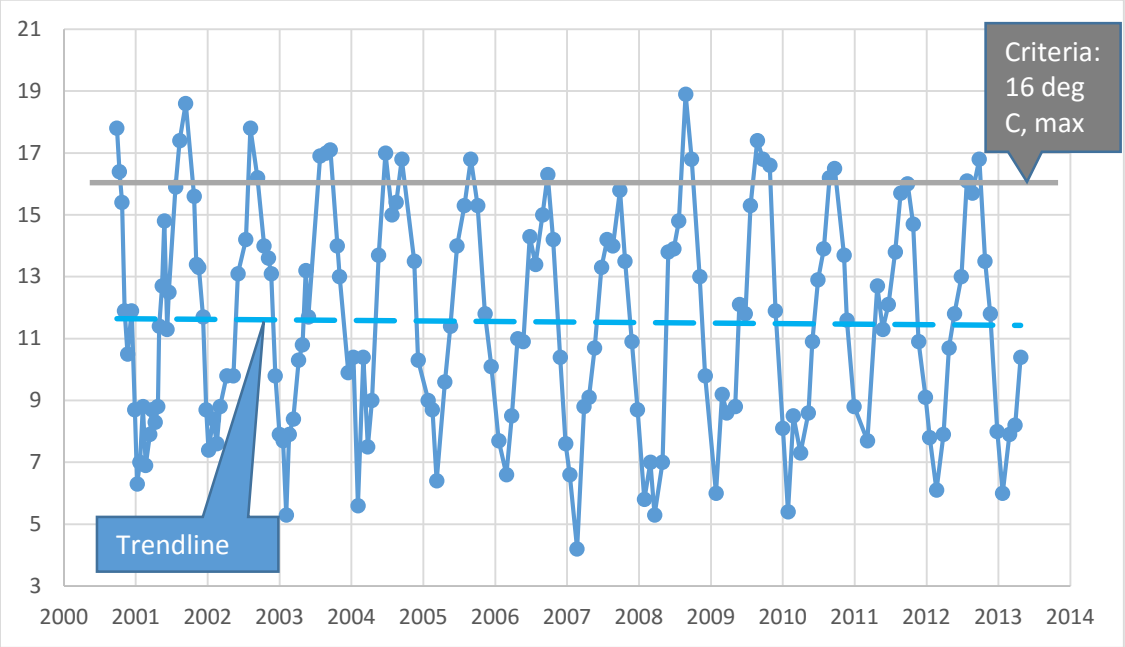


Figure 3- 17 Turbidity Measured in Ballinger Creek (nephelometric turbidity units or NTUs)

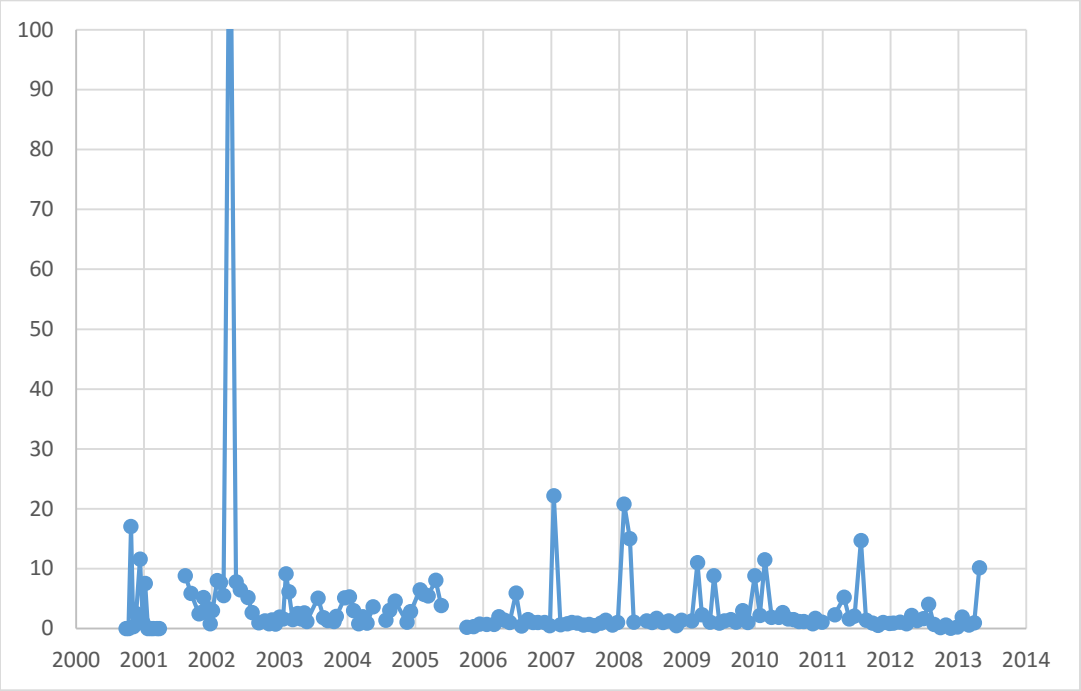
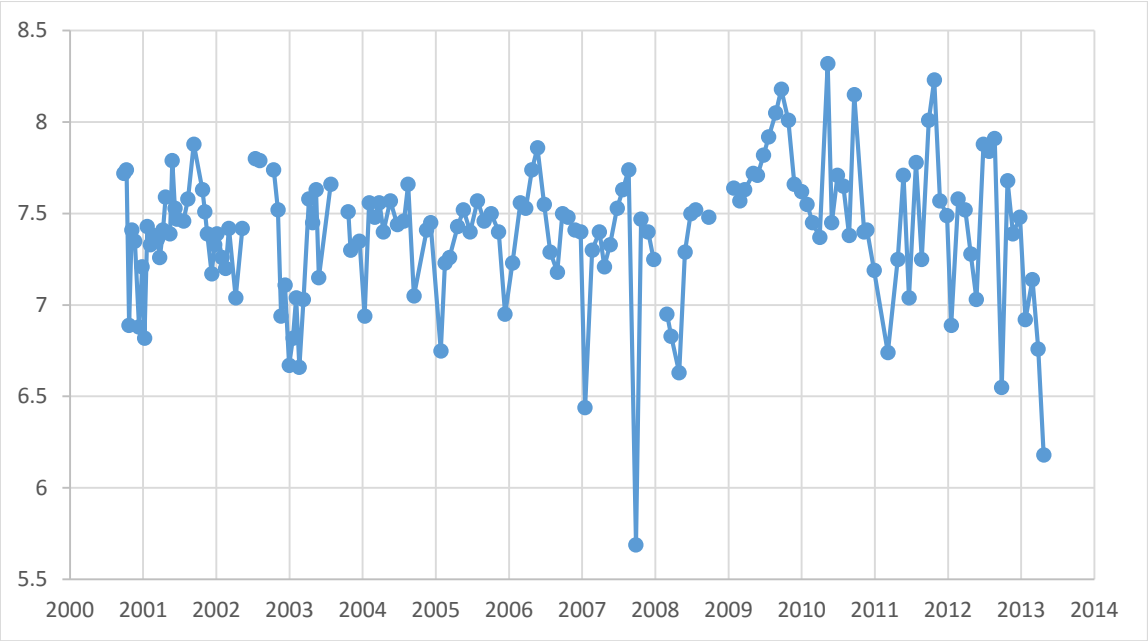


Figure 3- 18 pH Measured in Ballinger Creek



The 12-year time span represented by the data collected (2001 through 2013) is the minimum required for a trend analysis. The information should be viewed with the caveat that it is only the beginning of the trend. No predictions about future trends can be made. However, the trend analysis does give the City a way to assess data with the longest history of collection for DO, temperature, pH, and turbidity.

Water quality data was analyzed using a Seasonal Kendall test covering late 2001 through 2013 for DO, temperature, pH, and turbidity. Daily stream discharge was used as a co-variable in the analysis to reduce co-variable trends that might affect pollutant concentrations.

WAC 173-201A-200 establishes water quality criteria for fresh surface waters of the state. Table 3-13 shows summary of these criteria and a qualitative comparison of measured water quality parameters for Ballinger Creek within the City of Shoreline, and the general trend observed for the water quality parameter analyzed.

Table 3-13. Summary of Water Quality Criteria in Ballinger Creek

Site	Parameter	Criteria	Qualitative Observation	Trend
BL-1	DO	Lowest 1-Day Minimum = 9.5 mg/L	DO typically falls below this criterion in the second half of each year.	Improving trend – slight increase
	Temperature	7-day average of daily maximum temperatures (7-DADMax) = 16 degrees C	Temperature typically exceeds this criterion 1-3 months/year (in summer). Actual 7-DADMax not taken.	Improving trend – slight decrease
	Turbidity	Shall not exceed 5 NTU over background	Since 2006, background is <2 NTU, criteria has been exceeded in eight instances. Prior to 2006, turbidity was more variable and often higher.	Improving trend –decrease
	pH	Within range of 6.5 to 8.5	Criteria not met in only three instances, each time pH below 6.5.	No significant finding – relatively stable

Data for nutrients, bacteria, and total suspended solids were not analyzed for the Ballinger Creek location. Therefore, Washington State Department of Ecology's (Ecology's) Water Quality Index (WQI) for small Puget Sound lowland streams could not be calculated. The City uses Ecology's WQI to evaluate other monitoring locations.

Ballinger Creek is not listed on Ecology's 303(d) 2012 list for impairment; however downstream of Ballinger Creek, Lyon Creek in Lake Forest Park is listed on the 2012 303(d) list for impairment for the following parameters:

- DO,
- Temperature,
- Bacteria,
- pH,
- Mercury, and
- Ammonia-nitrogen.

An additional potential water quality concern was noted during the stream walks conducted for this plan. On the upstream side of Brugger's Bog Park, Ballinger Creek is immediately adjacent to the Ballinger Creek Condominiums parking lot, which is elevated above the stream channel and stabilized by a privately owned timber crib wall treated with creosote and an ecology-block concrete wall on the parking lot side of the timber wall. Presumably, the concrete wall was installed to shore up the failing timber wall without replacing the timbers. The stream is in direct contact with the creosote-treated

timbers. It is widely acknowledged that creosote and copper treated wood products leach contaminants into the aquatic environment (NOAA 2009). The main contaminants of concern are polyaromatic hydrocarbons (PAHs), which are carcinogens and tend to accumulate in sediment. Installation of creosote-treated wood is no longer allowed for use in fresh water environments because of potential impacts.

4. Community and Regulatory Framework

4.1 Community Stakeholders

The Lyon Creek basin is within the City of Shoreline's Ballinger neighborhood, which encompasses both sides of Ballinger Creek and is more or less contiguous with the neighboring cities of Mountlake Terrace (to the north) and Lake Forest Park (to the south and east). The Ballinger Neighborhood Association is an active organization that includes Brugger's Bog Park planting and restoration as one of its primary activities, and this is one of the reasons that the Brugger's Bog reach of Ballinger Creek is in good condition.

Additionally, a subcommittee of the Ballinger Neighborhood Association, Friends of Aldercrest, was formed to promote community stewardship of the Shoreline School District's Aldercrest Annex property, located on the east side of 25th Avenue NE. The Friends of Aldercrest is working to shape the future of the property such that open space, recreational opportunities, ecological functions and character of the neighborhood are preserved, protected or improved (http://ballingerneighborhood.org, accessed on January 3, 2015).

4.2 Public meetings and outreach

Two joint public open houses were held to provide information about the Lyon Creek and McAleer Basin Plans to the public and solicit input on specific issues or concerns in these two basins. The first open house was held at Shoreline City Hall on May 13, 2014. A brief PowerPoint presentation was given to provide an overview of the basin planning projects, and project boards were posted for attendees to note problem areas or other concerns. Additionally, a brief electronic survey was conducted of attendees. The results of the meeting are provided in Appendix E. The Lyon Creek basin concerns and desires noted at the May 13, 2014 meeting included:

- Bad pipes and fish passage issues on 25th Avenue NE, and
- Flood reduction projects in the vicinity of Brugger's Bog Park and Ballinger Open Space Park.

The second open house was held in Brugger's Bog Park on September 17, 2014. Display boards showing basin problems and proposed projects were shown to attendees to provide comments. Additionally, a brief electronic survey was conducted. Some of the specific concerns noted at the open house included:

- Concern about pollution originating in Shoreline (or Mountlake Terrace), entering Lake Forest Park,
- Concern about pollutants entering stormwater from the former King County Brugger's Bog Maintenance Facility,
- Concern about the volume of flows entering Lake Forest Park, and
- Suggestion to mitigate flows in Ballinger Creek by encouraging homeowner installation of rain gardens.

4.3 Regulatory Framework

The City governs land use, stormwater, and the use of natural resources through codes and ordinances that are specific to the City or dictated by overarching state and federal regulations. These regulations, along with the goals outlined in the City's Comprehensive Plan (City of Shoreline 2012), were considered in the development of solutions to address stormwater management issues in the Lyon Creek basin. Table 4-1 summarizes existing federal, state, and local regulations related to stormwater runoff and natural resources and the relevance of these regulations to the Lyon Creek basin.

Table 4-1. Regulatory Framework of Surface Water Management in the Lyon Creek Basin

Law	Implementing Entity	Regulatory Programs	Intent and Specifics	Relevance to Lyon Creek Basin
Clean Water Act (CWA)	Ecology	National Pollutant Discharge Elimination System (NPDES) Phase II Municipal Separate Storm Sewer System Permit	Eliminate discharge of pollutants into the nation's water and achieve water quality levels that are protective of beneficial uses.	The City is a NPDES Phase II permittee and must comply with conditions of the permit. The permit is in its second cycle and many new conditions are being implemented according to the schedule outlined in the permit.
	Ecology	Surface Water Quality Standards	Protect and regulate the quality of surface water in Washington State by: 1) sustaining designated uses, 2) meeting numeric WQC, and 3) implementing anti-degradation policies.	Ballinger Creek is not listed on the state's 303(d) list for non-compliance with water quality standards.
	Ecology and US Army Corps of Engineers (USACE)	Sections 401 and 404	Requires a permit of activities classified by the USACE for dredging or discharge of fill material to Waters of the United States.	Ballinger Creek and associated wetlands and Puget Sound are considered Waters of the United States. In-water activities that meet minimum dredge and fill limits require a permit.
Tribal Agreements and Related Case Law	Muckleshoot Tribe	N/A	Protect fish populations in traditional fishing grounds of Native American tribes.	The Muckleshoot Tribe is party to SEPA review of development proposals within the Lyon Creek basin.
Endangered Species Act (ESA)	US Fish and Wildlife Service (USFWS) and National Oceanic and Atmospheric Administration (NOAA) Fisheries in consultation with lead federal agencies	N/A	Prevent further decline of listed terrestrial and aquatic species.	There are no documented endangered species within the Lyon Creek basin; however, Lyon Creek discharges to Lake Washington, which does have endangered aquatic species, including Chinook salmon.

Law	Implementing Entity	Regulatory Programs	Intent and Specifics	Relevance to Lyon Creek Basin
State Environmental Policy Act (SEPA)	City conducts review and issues SEPA determinations on proposed projects within its jurisdiction	N/A	Identify and require mitigation of the environmental impacts of proposals and programs.	SEPA is used to address impacts from projects in the Lyon Creek basin that are not covered in other City code requirements.
Shoreline Management Act	City (Shoreline Master Program)	N/A	Protect use and functions (e.g., economic, ecological, aesthetic) of shoreline areas.	Ballinger Creek joins Lyon Creek, which discharges to Lake Washington, and is subject to the Shoreline Management Act in Lake Forest Park.
Washington State Hydraulic Code	WDFW	N/A	Set requirements for placement of culverts and other hydraulic devices that may affect fish use.	Projects within the ordinary high water mark of streams must obtain a Hydraulic Project Approval permit from WDFW. Culverts must be fish passable where fish are present.
Growth Management Act (GMA)	City	City Comprehensive Plan	Regulate land use to meet growth targets while providing necessary services and protecting sensitive environmental resources.	N/A
Water Quality Protection Act	Ecology	Puget Sound Partnership	Provide an integrated stormwater management program to protect and restore Puget Sound.	N/A
Chapter 13.10 Surface Water Utility	City	Drainage standards for new development and redevelopment	Promote public health, safety, and welfare by providing design, construction, and maintenance criteria for permanent and temporary surface water drainage facilities for development and redevelopment activities.	The City has adopted the most recent version of the Stormwater Management Manual for Western Washington (Ecology 2012). Shoreline's 2012 Engineering Design Manual provides stormwater engineering design standards.
Chapter 13.12 Floodplain Management	City	Development Code.	Regulate activities, uses and development in regulatory floodplains.	Portions of Ballinger Creek are within the 100-year FEMA floodplain.

Law	Implementing Entity	Regulatory Programs	Intent and Specifics	Relevance to Lyon Creek Basin
Chapter 20.80 Critical Areas	City	Development Code	Establish supplemental standards for the protection of critical areas in compliance with GMA and the City's Comprehensive Plan, including the protection of surface and ground water quality.	Projects proposed within critical areas must adhere to requirements in Chapter 20.80.

A thorough review and description of relevant codes and their relationship to the City can be found in the City's Surface Water Master Plan Update (SAIC 2011).

4.4 City of Shoreline Comprehensive Plan and the Lyon Creek Basin

The following statement is an excerpt from the City's Vision 2029 Statement included in its Comprehensive Plan:

> *Shoreline is a regional and national leader for living sustainably. Everywhere you look there are examples of sustainable, low-impact, climate-friendly practices come to life – cutting edge energy-efficient homes and businesses, vegetated roofs, rain gardens, bioswales along neighborhood streets, green buildings, solar-powered utilities, rainwater harvesting systems, and local food production to name only a few. Shoreline is deeply committed to caring for its seashore, protecting and restoring its streams to bring back the salmon, and to making sure its children can enjoy the wonder of nature in their own neighborhoods.*

Several elements of this vision statement relate directly to stormwater management and Shoreline's strong connection to environmental values. Projects and strategies presented in the Lyon Creek Basin Plan are recommended in the context of the City's overall vision as well as the following Comprehensive Plan goals:

Goal NE VI: Manage the stormwater system through the preservation of natural systems and structural solutions in order to:

- Protect water quality;
- Provide public safety and services;
- Preserve and enhance fish and wildlife habitat and critical areas;
- Maintain a hydrologic balance; and
- Prevent property damage from flooding and erosion.

Goal NE IX: Use education and outreach to increase understanding, stewardship, and protection of the natural environment.

Goal CF V: Facilitate, support, and/or provide citywide utility services that are:

- Consistent, reliable, and equitable;
- Technologically innovative, environmentally sensitive, and energy efficient;
- Sited with consideration for location and aesthetic; and
- Financially sustainable.

5. Summary of Basin Issues and Recommended Strategies

The City only occupies a small portion of the Lyon Basin (6 percent) and approximately 40 percent of the Ballinger sub-basin. Not having jurisdiction over the entire watershed and the ability to direct projects that specifically benefit issues in Shoreline limits the range of solutions to existing problems. However, there are still many strategies that can be employed by Shoreline to improve conditions in Ballinger Creek and the Ballinger neighborhood. A schematic depicting basin characteristics, jurisdictions, and issues is shown in Figure 5-1. With respect to stormwater management, the following beneficial characteristics and deficiencies are noted:

Beneficial characteristics:

- Open space adjacent to Ballinger Creek in Ballinger Open Space Park and Brugger's Bog Park provides opportunities for vegetation enhancement (as is currently being done by the Ballinger

Neighborhood Association in Brugger's Bog Park), which benefits water quality (temperature and DO at a minimum).

- Water quality monitoring indicates apparently improving trends for temperature, turbidity, and DO parameters.
- Strong neighborhood support for open space, pollution control, improved water quality, and flood reduction.

Deficiencies:

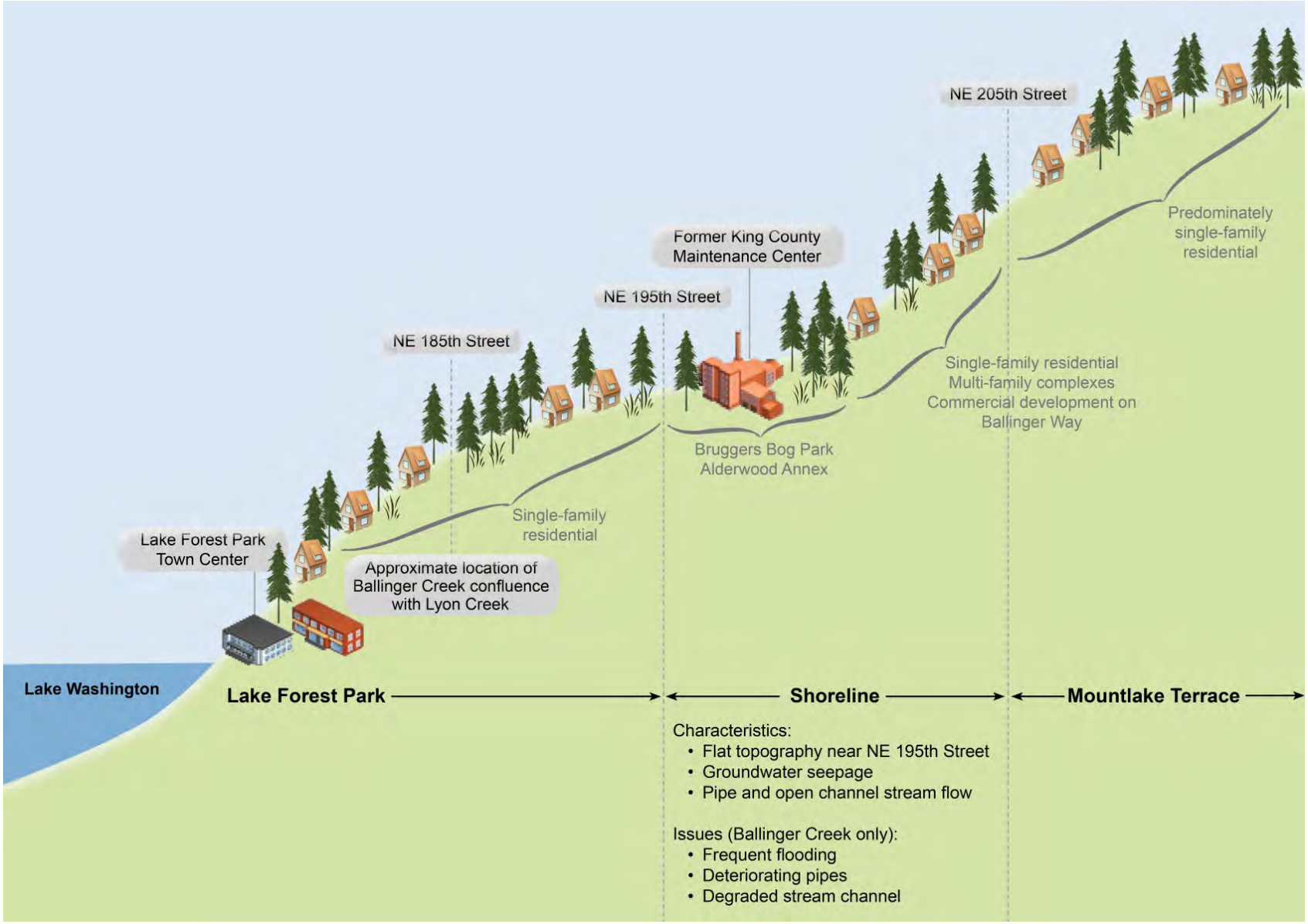
- Few stormwater management facilities are present in Shoreline or upstream in Mountlake Terrace to mitigate runoff from developed areas.
- Over 30 percent of stormwater pipes are in poor to failing condition and require replacement.
- Several under-sized culverts are not able to convey surface water flows and contribute to frequent flooding along 25th Avenue NE.
- Due to topography, geology and other drainage conditions, some developments built at lower elevations within the basin experience high groundwater conditions and/or localized flooding in basements and other depressions.

The primary issue of concern in the Lyon Creek basin is flooding along 25th Avenue NE. The public is affected when homes, cars, parking areas, roads, driveways, and pedestrian pathways are flooded. Additionally, there are other stormwater, public safety, transportation, and ecological issues in this area, including deficient pipes, lack of sidewalks, lost or degraded stream habitat, and potential fish passage barriers.

In coming years major changes will likely occur on some of the large properties adjacent to 25th Avenue NE. The City now owns the former King County Brugger's Bog Maintenance Facility and will redevelop it into a new maintenance facility. The Shoreline School District's Alderwood Annex is currently a vacant property that is still owned by the District, but has been rezoned to allow flexibility in how the property is used in the future. In the development of solutions to the primary flooding issue, a brainstorming session was held with the consultant team and City staff to discuss different alternatives for this area.

The flooding problems within the Lyon Creek Basin are not new and many previous studies and models have been conducted and developed to specifically address them, particularly for downstream flooding in Lake Forest Park. Previous studies have suggested that huge stormwater detention facilities would need to be built to adequately detain runoff volumes to minimize downstream flooding. One such facility was previously planned for Brugger's Bog Park prior to the City of Shoreline's incorporation (Entranco 1981) and, even though it would occupy most of the park space, it was not big enough to detain what was then the 25-year flow. Other solutions have since been developed; the City of Lake Forest Park is currently constructing a number flood reduction projects on Lyon Creek, including a large project at Lake Forest Park Town Center near the mouth of Lyon Creek scheduled for 2015. Evaluation of flood reduction projects considered in this basin plan factored in potential downstream impacts, such that any recommended Shoreline projects would not inadvertently negate flood-reduction work being completed in Lake Forest Park.

Figure 5-1. Schematic of Lyon Creek Basin Jurisdictions, Characteristics, Issues, and Potential Solutions in Shoreline



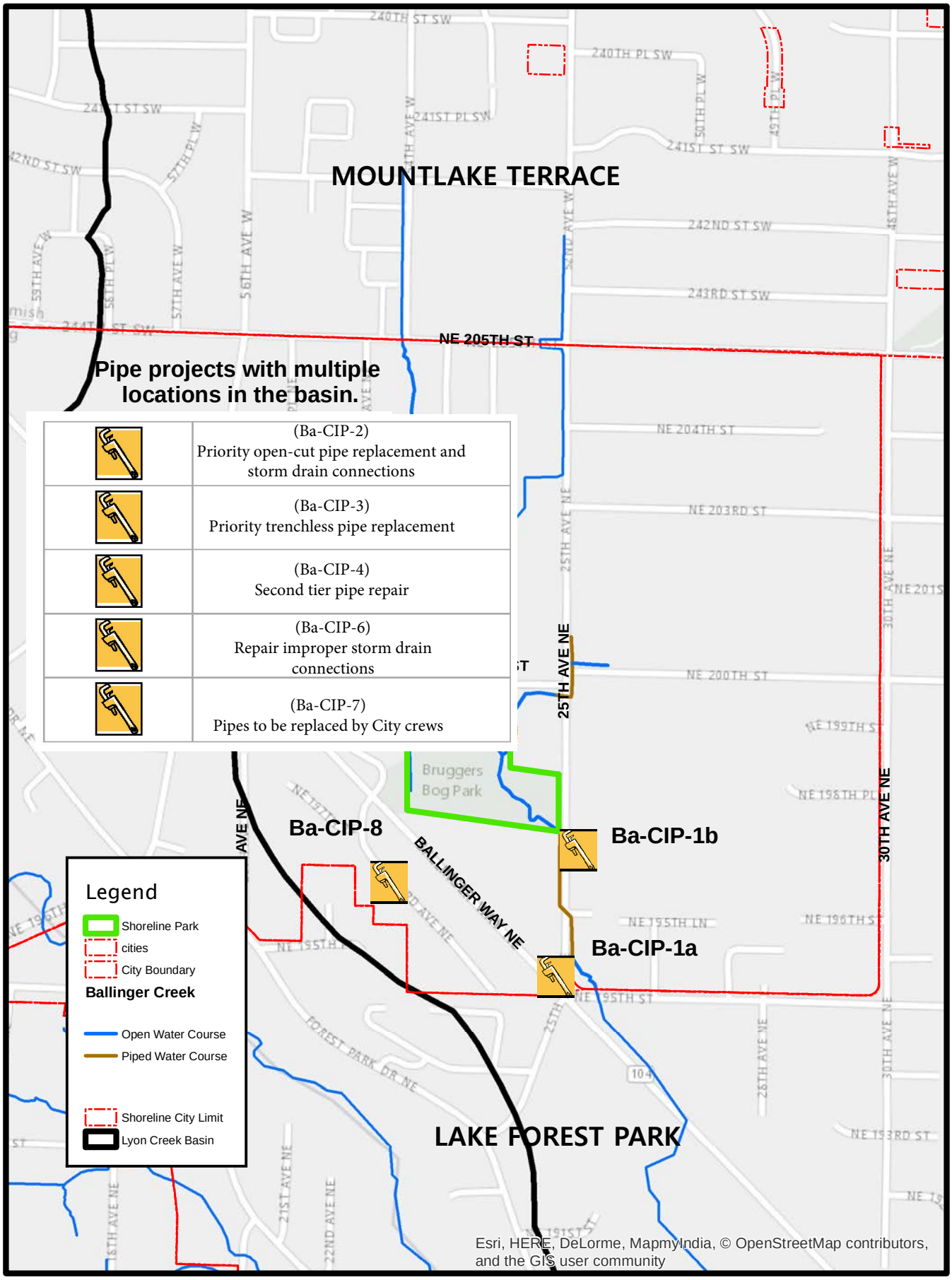
5.1 Recommended Strategies

The recommended strategies discussed in this section include capital projects, programmatic and policy-oriented changes, and educational programs to affect social change for improved stormwater management functions. The projects are discussed according to the general type of solution recommended for the identified issues in the basin. Figure 5-2 and Table 5-1 list the recommended stormwater management strategies. Individual recommendations are also discussed below, including projects that were previously recommended in the 2011 Surface Water Master Plan Update (SAIC 2011) or other City documents.

5.1.1 Previous Recommendations Carried Forward

The 2011 Surface Water Master Plan Update (SAIC 2011) identified Lyon Creek basin projects and City-wide projects to solve flooding and water quality issues, as well as general stormwater management issues. These include:

- NE 195th Street Culvert Replacement (Project L-F2).
- Erosion and channel incision in Brugger's Park Open Space (Project L-WQ2) – This problem, noted in the 2011 Surface Water Master Plan Update (SAIC 2011), was most likely referring to the Ballinger Open Space Park, rather than Brugger's Bog Park, as extensive incision and erosion was noted in Ballinger Open Space Park but not Brugger's Bog Park.
- Advance ROW Acquisition (H-4) – A City-wide surface water program to acquire surface water systems on private property originally proposed in the 2005 SWMP and identified in the 2011 SWMP update as a potential aquatic enhancement project yet to be started. The project has a long-range goal of habitat improvement, erosion reduction, and water quality improvement.



AltaTerra Consulting LLC

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Figure 5-2. Lyon Creek Basin Proposed Capital Project Locations

Prepared by E. Nelson 12/31/2014, revised 8/24/2015

Table 5-1. Summary of Recommended Projects

Issue	How was it Identified?	Specifics	Projects				
			Capital Projects		Planning Projects		Operations Projects
			Capital	Habitat	Education	Policies, Studies, and Coordination	Maintenance
25th Avenue NE flooding	Service requests, public comments, previous documentation, modeling, City input	Residences located at the intersection of NE 195th Street and 25th Avenue NE have experienced flooding on numerous occasions over the past 10 years; 25th Avenue NE has flooded, cars parked along the road.	(Ba-CIP-1a) NE 195th Street culvert replacement to improve capacity and reduce flooding	N/A	(Ba-Ed-1) Targeted Flood education program	(Ba-Stud-1) Ballinger Creek floodplain mapping and FEMA submittal	N/A
			(Ba-CIP-1b) 25th Avenue NE Flood Reduction Project	N/A	N/A	N/A	N/A
Conveyance pipe maintenance and structural deficiencies	CCTV inspection	Up to 50 percent of the pipes in the Lyon Creek basin were determined to have significant structural or maintenance deficiencies during the condition assessment.	(Ba-CIP-2) Priority Open-cut pipe replacement and storm drain connection	N/A	N/A	N/A	(Ba-Main-1) pipe maintenance modifications
			(Ba-CIP-3) Priority Trenchless pipe repair	N/A	N/A	N/A	(Ba-CIP-7) Pipe replacement by City Crews
			(Ba-CIP-4) Second tier pipe repair	N/A	N/A	N/A	N/A
			(Ba-CIP-5) Remove utility crossings	N/A	N/A	N/A	N/A

Issue	How was it Identified?	Specifics	Projects				
			Capital Projects		Planning Projects		Operations Projects
			Capital	Habitat	Education	Policies, Studies, and Coordination	Maintenance
			(Ba-CIP-6) Repair improper storm drain connections	N/A	N/A	N/A	N/A
Habitat and water quality improvements	Field evidence	Degraded vegetation and stream channels	N/A	(Ba-Hab-1) Vegetation management in Ballinger Open Space Park and Brugger's Bog Park	N/A	(Ba-Pol-2) Evaluation of Stream Designations	N/A
			N/A	(Ba-Hab-2) Stream channel restoration in Ballinger Open Space Park	N/A	N/A	N/A
City pipes crossing private property	GIS mapping, City staff	Pipes crossing private property with no easement makes maintenance difficult for the City	(Ba-CIP-8) Abandon pipes on private property and relocate to City ROW	N/A	N/A	(Ba-Pol-1) ROW acquisition	N/A

Issue	How was it Identified?	Specifics	Projects				
			Capital Projects		Planning Projects		Operations Projects
			Capital	Habitat	Education	Policies, Studies, and Coordination	Maintenance
Other projects in Shoreline and other jurisdictions	City Transportation Master Plan, Brugger's Bog Master Plan, Ballinger Neighborhood Association	Several potential land use changes will occur in Shoreline's portion of the Lyon Creek basin over the next decade, including re-development of the Former King County Maintenance Facility, potential re-development of the Shoreline School District's Alderwood Annex, and the construction of transportation improvements on 25th Avenue NE.	N/A	N/A	N/A	(Ba-Coor-1) Utility staff to coordinate with City staff involved in former King County Maintenance Facility re-development and 25th Avenue NE improvements	N/A
			N/A	N/A	N/A	(Ba-Coor-2) Utility staff to coordinate with Mountlake Terrace, Lake Forest Park, and Shoreline School District to keep abreast of developments that affect the Lyon Creek basin	N/A

5.1.2 Capital Projects

Capital projects are those that involve construction or replacement of a stormwater asset. Typically these projects require engineered drawings and bid documents, however, some are fairly simple and can be constructed by City crews.

The recommended capital projects in this Plan address:

- **Flood reduction;**

  Chronic flooding continues to occur along 25th Avenue NE, and the area between NE 195th Street and NE 200th Street has received numerous flood-related complaints between 2002 and 2014. Hydraulic modeling indicates that culverts are not adequately sized to convey the 25-year storm event. The projects are recommended to address flooding on 25th Avenue NE. The culvert crossing at NE 195th Street should be replaced first, prior to pursuing flood reduction on 25th Avenue NE. This culvert is not sized properly to convey flows and, without its replacement first, improvements will go unnoticed.

- **Stormwater pipes with structural deficiencies or improper connections;**

  Several hundred linear feet of pipe were identified as having poor structural or maintenance rating scores during the condition assessment. Additionally, other types of problems were identified during the condition assessment, including utility crossings that cut through stormwater pipe and improper storm drain connections. For the purpose of recommending projects to improve stormwater conveyance infrastructure, similar projects have been grouped together as one. The benefit of this approach is that several small repairs or replacement projects could be completed under one contract with the same equipment. The pipe repair and replacement projects, including the priority open-cut pipe replacement and storm drain connections (Ba-CIP-2), trenchless pipe repair (Ba-CIP-3), second tier pipe repair (Ba-CIP-4) and repair improper storm drain connection (Ba-CIP-6) projects will be implemented through the City's Stormwater Pipe Repair and Replacement Program.

The 2011 Surface Water Master Plan Update (SAIC 2011) recommended a city-wide initiative to advance easement acquisition for stormwater pipes that are currently crossing private properties. A review of pipes that cross private properties was made for this basin plan and one specific project was identified where the pipes could be relocated between 23rd Avenue NE and Ballinger Way NE. That project is specifically called out as a capital project (Ba-CIP-8), and another programmatic project is recommended to pursue additional easements for pipes located on private properties with no easements in place.

These projects were identified through pipe condition assessment, field work, previous studies and City staff input. Project summary sheets and planning-level costs are provided in Appendix F.

A description of the recommended capital projects is provided below.

5.1.2.1 NE 195th Street Culvert Replacement (Ba-CIP-1a)

This project was previously recommended in the 2011 Surface Water Master Plan (SAIC 2011). The culvert is owned by the City of Lake Forest Park, as the City of Shoreline boundary is on the north side of NE 195th Street. However, it is in the City of Shoreline's interest to replace the culvert to help alleviate and reduce flood impacts (with improved fish passage as a side

benefit). A cursory look at potential downstream impacts to Lyon Creek was completed to ensure that there were no fatal flaws. This included coordinating with Lake Forest Park consultant staff working on the lower reaches of the creek system, where it was confirmed that they are using the same HSPF model and not assuming any storage behind the existing culvert. The City of Lake Forest Park will need to be a partner in the project to ensure success, even if financial support is not provided. This project should occur before project Ba-CIP-1b.

5.1.2.2 25th Avenue NE Flood Reduction (Ba-CIP-1b)

This project addresses important and on-going issues occurring along 25th Avenue NE, including flooding and deteriorating pipes. The project involves replacing and upsizing existing pipes to convey the 100 year flow event. This project will need to be closely coordinated with other projects in the vicinity including transportation improvements on 25th Avenue NE and master planning efforts for the Brugger's Bog maintenance facility. Additionally, this project should be completed after project Ba-CIP-1a, which replaces the culvert at NE 195th Street. Open channel and fish passable options were considered for this project, however City policy limits the use of the right-of-way and does not allow for the stream (currently in a pipe under the roadway) to be day-lighted within the right-of-way. The feasibility of purchasing right-of-way to daylight the stream, relative to the very limited habitat value of the system resulted in the City deciding to develop this project for conveyance and flooding only and mitigate offsite, if needed, where the habitat value is greater.

5.1.2.3 Priority Open-cut Pipe Replacement and Storm Drain Connection (Ba-CIP-2)

Over 400 linear feet of pipe is recommended for priority replacement by open-cut trenching methods due to poor structural pipe ratings and significant defects. Most of these pipe segments were rated very poorly and require immediate attention within the next few years, either because of their location or the type of failure. Types of pipe failures requiring open-cut replacement include pipes with major displaced breaks, holes with voids, partial or total collapses, and misalignments which cannot be typically repaired using trenchless techniques.

Lateral or side storm connections improperly connected to the storm mainline is a common issue throughout the basin. For some pipes, connections were made with different pipe material and/or have not been grouted in, resulting in a severe structural deficiency of the storm mainline. Generally, the preferred solution for pipes in this category is to rehabilitate the connection by installing a prefabricated tee, although in some cases it may be necessary or advantageous to install a new catch basin to connect and provide access for all incoming and outgoing pipes. Eight improper storm drain connections associated with these pipes were identified and are recommended for repair at the time that the pipes are replaced. Several other improper connections are in need of repair, but are independent of pipe repair projects. These are included in a separated capital project (Ba-CIP-6). Appendix F lists the specific problems, proposed solutions, and locations of the pipes and drainage connections recommended for repair in the project summary sheets along with a planning level cost estimate

5.1.2.4 Priority Trenchless Pipe Repair (Ba-CIP-3)

Trenchless pipe repair is the City's preferred method to repair and rehabilitate damaged pipes. However, this repair technique is suitable for only certain kinds of damage, such as cracks, fractures, and some non-displaced types of breaks and joint issues. Accordingly, there are only 2 pipes totaling 150 feet recommended for trenchless pipe repair. Trenchless solutions can include slip-

lining, cured-in-place pipe (CIPP), pipe bursting, pipe reaming, and others. A project summary sheet in Appendix F lists the specific pipes, locations, pipe ratings, and cost of this recommended capital project.

5.1.2.5 Second Tier Pipe Repair (Ba-CIP-4)

Pipes that did not fall into one of the priority repair categories, yet have received a poor SPR were included in this category. Structural deficiencies in this category include pipes that have fractures, holes, or minor deformities. It is recommended that the City place these pipes on a "to be repaired" list to ensure the pipe does not fail before the next assessment period. Nearly 700 linear feet of pipe fall into this category.

5.1.2.6 Remove Utility Crossings (Ba-CIP-5)

Structural deficiencies sometimes result from other utilities crossing or coming close to storm drain pipes and damaging them. Two pipes in the Lyon Creek basin were identified as having other utility lines crossing them; one with a gas line and the other with a cable utility. The City was notified of the gas line crossing immediately so that they could notify the gas company. It is recommended that the City identify the likely cable utility owners and coordinate relocation of the utility crossing and repair of stormwater pipes that have been affected. It is assumed that the utility companies that have crossed the storm drain pipes will pay for the repairs and that the City will not be financially responsible for the work; however, there is a cost associated with staff coordination time that is assumed in the project summary sheet in Appendix F.

5.1.2.7 Repair Improper Storm Drain Connections (Ba-CIP-6)

This project includes improper storm drain connections that are not associated with a pipe repair or replacement (as in Ba-CIP-2). There are two pipes that require installation of a catch basin or tee to correct an improper storm drain connection, as shown in the project summary sheet in Appendix F.

5.1.2.8 Abandon Pipes and Relocate to ROW (Ba-CIP-8)

This project involves abandoning an existing stormwater pipe in place and installing two new pipes within the City's right-of-way and connecting to existing catch basins. The project summary sheet, pipe location, and planning level cost estimate are provided in Appendix F.

5.1.3 Planning Projects

Planning projects recommended in this plan are primarily focused on those that support the recommended flood reduction capital projects and acknowledge the ongoing work of the Ballinger Neighborhood Association in their efforts in Brugger's Bog Park. The value of high quality open space areas that contain native vegetation is important for many surface water functions, including water quality. The water quality data collected by the City suggests trends for improving temperature and dissolved oxygen conditions in Ballinger Creek. This could be partly the result of revegetation efforts in Brugger's Bog Park. Therefore, two projects are recommended for (1) continuation of the vegetation management in Brugger's Bog Park, and (2) a new vegetation management project in the Ballinger Open Space Park.

The next decade or two will bring many changes to Shoreline's Lyon Creek basin, including land use changes, property development and redevelopment, and City projects (e.g., the development of Brugger's Bog Maintenance Facility and transportation improvements). The stormwater improvements recommended in this plan will need to be coordinated with these planned projects or at least consider

the types of improvements that are planned for the future, especially the improvements on 25th Avenue NE. To the extent possible, conceptual designs and proposed projects outlined in this plan have considered other projects, but it is imperative that City staff continue conversations with the project managers and proponents that are leading these efforts to ensure that they are compatible and resources are used efficiently. Additionally, the work done in Shoreline should be consistent with that being done in Lake Forest Park and Mountlake Terrace, such that the vision for Lyon Creek basin is the same. The programmatic recommendations below are for staff time to coordinate effectively on issues related to surface and stormwater management in the Lyon Creek basin.

5.1.3.1 Vegetation Management in Brugger's Bog (Ba-Hab-1)

Brugger's Bog Park, like many urban and suburban parks in the Northwest, is overgrown in places with Himalayan blackberry and other non-native plants. The Ballinger Neighborhood Association has been conducting work parties at the park to remove non-native plants. This project recognizes volunteer efforts to manage non-native vegetation and encourages native vegetation growth in the park to continue.

5.1.3.2 Stream Restoration in Ballinger Open Space Park (Ba-Hab-2)

The Ballinger Open Space Park is a fairly large park with great potential. This project is not developed into a capital project with an associated cost, but is rather a placeholder for a project that should be completed at a point when funding and community or City momentum is there to improve the park's natural resources for aquatic and ecological health and community and recreational benefits.

5.1.3.3 Targeted Flood Education (Ba-Ed-1)

Flooding along 25th Avenue NE is the most significant surface water concern in the Lyon Creek basin in Shoreline. The residents that are most impacted live in multi-family units near NE 195th Street and 25th Avenue NE. Renter populations typically have higher rates of turnover so it is possible that some residents of these apartment units are unaware of potential flooding issues until an actual flooding event occurs. Although the City has useful information about flooding on its website, specific outreach to areas known to commonly flood would be helpful to those that are potentially affected. This could be as simple as a visit to the building and leaving behind informational documents about how to prepare for flooding.

5.1.3.4 Ballinger Creek Floodplain Mapping and FEMA Submittal (Ba-Stud-1)

Hydraulic modeling was conducted for this basin plan to depict the 100-year preliminary floodplain of Ballinger Creek (Figure 3-7). This project is currently scoped and planning to submit documentation to the Federal Emergency Management Agency (FEMA) to formalize a map revision in this area with the new floodplain boundary based on the current modeling. Development in the identified floodplain would then be subject to the City's Floodplain Management regulations. However, the City may elect to hold on this effort if there is funding and a commitment to fix the flooding.

5.1.3.5 Evaluate Easement Acquisition (Ba-Pol-1)

This programmatic project involves staff time to review and research options for acquiring drainage easements for storm drainage pipes currently located on private property. A project summary sheet is provided in Appendix F.

5.1.3.6 Evaluation of Stream Designations (Ba-Pol-2)

There are channels in the Lyon Creek basin that may be inaccurately designated or inaccurately depicted in the City's GIS system. Some of these are may be stormwater runoff and do not qualify as streams according to the City's designation. This project involves reviewing the list of streams field verified during reconnaissance for this basin plan and evaluate potential revisions to designations that more accurately reflect actual conditions and might be appropriate for reclassification following discussions with City staff and the Planning department. A project summary sheet is provided in Appendix F.

5.1.3.7 Coordination with City Projects in Lyon Basin (Ba-Coor-1)

This programmatic project is for internal City coordination on City projects in Lyon Creek basin as described in the project summary sheet in Appendix F.

5.1.3.8 Coordination with Outside Stakeholders in Lyon Creek Basin (Ba-Coor-2)

This programmatic project is to continue coordination with neighboring jurisdictions (Lake Forest Park and Mountlake Terrace) to keep abreast of overall issues in the Lyon Creek basin and coordinate on how each jurisdiction can support one another in improving basin conditions.

5.1.4 Operations Projects

Projects in the operational category are maintenance-oriented, but non-routine. Only one project is identified in this basin and it includes extra maintenance for several pipes that were found to be in need of extra cleaning.

5.1.4.1 Maintenance Modifications (Ba-Main-1)

The pipes identified as having a poor maintenance rating or that were not accessible by CCTV because of excessive sedimentation or root buildup were determined to need additional maintenance. Approximately 1,000 linear feet of pipe is on the maintenance modification list, requiring additional cleaning. Appendix F includes the project summary sheet with specific pipes, locations, ratings, and estimated cost.

5.1.4.2 Pipe Replacements and Repairs by City Crews (Ba-CIP-7)

Some of the pipe repairs identified during the infrastructure condition assessment are relatively minor and can be completed by City operations and maintenance crews. Two such pipes were identified; however, a cost estimate was not prepared for the work.

6. Project Prioritization and Costs

The projects recommended in Section 5 represent a variety of strategies to address on-going issues in the Lyon Creek basin. Most of the projects are specific to flooding or infrastructure repair or replacement based on the results of the condition assessment or known problems. Several criteria were used to prioritize the projects within the context of just the Lyon Creek basin. These projects will be prioritized with regard to the City's entire stormwater management program and may rank lower with respect to other City-wide issues. Only the capital projects were prioritized for this effort.

6.1 Criteria

Table 6-1 lists the criteria for project prioritization and shows the conditions under which each criterion's score will rank as high, medium, or low.

Table 6- 1 Criteria and Scoring for Project Prioritization

Criteria	Rank Scores		
	High (5 points)	Medium (3 points)	Low (1 point)
Likelihood of success	Proved in other cases	Mixed results	Unproven
Number of issues addressed (water quality, habitat, erosion, flooding)*	Three	Two	One
Protects infrastructure and public safety	Both	One or the other	None
On public property	In ROW or existing easement	Requires easement on other public property	Private property

* If project is a flood reduction project, an additional 5 points are applied to overall score for a total possible 10 points for this criteria.

The combined scores of individual criteria were ranked according to the following total points:

- Low priority (10 points or fewer)
- Medium priority (11 to 15 points)
- High priority (16 points or higher)

6.2 Matrix of Projects

Table 6-2 lists the recommended capital projects according to issue addressed and prioritization criteria. Preliminary project cost is shown, but was not factored into the prioritization. Using the criteria described above, all of the projects ranked within a few points of one another in the high and medium category.

Table 6- 2 Matrix of Prioritized Projects

Issue	Project Name	Type	Cost	Prioritization Criteria				Total Score and Priority
				Likelihood of Success	Number of Issues Addressed	Protects Infrastructure and Public Safety	On Public Property	
Flooding	(Ba-CIP-1a) NE 195th Street Culvert Replacement		$2,007,300	High (5)	High (10)	High (5)	Medium (3)	***HIGH (23)***
	(Ba-CIP-1b) 25th Avenue NE Flood Reduction		$3,296,400	High (5)	High (10)	High (5)	Medium (3)	***HIGH (23)***
Infrastructure	(Ba-CIP-2) Priority open-cut pipe replacement and storm drain connections		$646,700	High (5)	Medium (3)	High (5)	High (5)	***HIGH (18)***
	(Ba-CIP-3) Priority trenchless pipe replacement		$61,600	High (5)	Medium (3)	High (5)	High (5)	***HIGH (18)***
	(Ba-CIP-4) Second tier pipe repair		$258,000	High (5)	Medium (3)	High (5)	High (5)	***HIGH (18)***
	(Ba-CIP-6) Repair improper storm drain connections		$162,600	High (5)	Low (1)	Medium (3)	High (5)	***MEDIUM (14)***
	(Ba-CIP-7) Pipes to be replaced by City crews		Not estimated	High (5)	Medium (3)	High (5)	High 95)	***HIGH (18)***
Pipes on private property	(Ba-CIP-8) Abandon pipes on private property and relocate to City ROW		$323,700	High (5)	Low (1)	Low (1)	High (5)	***MEDIUM (12)***

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6.3 Project Cost Summary

The total cost of the recommended capital projects for the Lyon Creek basin is estimated to be $6,756,300. The estimated cost of programmatic recommendations is an additional $70,000. The flood reduction projects on 25th Avenue NE (Ba-CIP-1b) and the NE 195th Street culvert replacement project (Ba-CIP-1a) account for 78% of the cost of the recommended projects, but they are also the highest priority for solving the on-going flooding problems that continue at this location. As discussed earlier, Ba-CIP-1a should be completed first.

7. Partnerships/Grant Opportunities

Funding stormwater management programs in addition to other City functions has been a challenge in recent years. Increasingly, many communities are looking to partnerships and grant funding to relieve some of the financial strain. For some of the projects recommended in this plan, there are opportunities to partner with other community and educational organizations for implementation, as well as to pursue grant opportunities from a myriad of organizations.

The projects recommended in this basin plan are primarily centered around the flooding issue on 25th Avenue NE. Combined with planned transportation improvements along this roadway, there may be opportunities for grants from the Washington State Transportation Improvement Board. Stormwater grants have recently been awarded to municipalities for projects that implement low impact development for stormwater retrofit. None of the projects recommended in this basin would necessarily fit well with typical criteria for these type of grants, but as projects are designed, low impact development stormwater management options should be considered. Opportunities for potential grants are much greater for projects that support this type of stormwater management approach.

8. References

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Lyon Creek Basin Plan

Appendix A:

Ballinger Creek Surface Water Basin Plan (Shoreline, WA)
Modeling Memorandum

BALLINGER CREEK SURFACE WATER BASIN PLAN

[SHORELINE, WA]

MODELING MEMORANDUM

City of Shoreline

17500 Midvale Avenue North

Shoreline, Washington 98133

Prepared by

OSBORN CONSULTING INCORPORATED

1800 112th Avenue Northeast, Suite 220E

Bellevue, Washington 98004

425.451.4009

April 2015

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SECTION I
INTRODUCTION AND BACKGROUND

This memorandum presents the methods and results of the Hydrologic and Hydraulic Modeling completed as part of the development of the Ballinger Creek Basin Plan for the City of Shoreline. The Hydrologic and Hydraulic Modeling was conducted by Osborn Consulting Inc. (OCI) under contract to the City of Shoreline (City). The specific project objectives for the Ballinger Creek Basin Plan are:

- Update floodplain mapping,
- Identification and evaluation of management actions to surface water and infrastructure problems (flooding, erosion, water quality),
- Evaluation of stormwater treatment strategies for future development and redevelopment (regional facilities, alternative standards, etc.), and
- Develop a prioritized list of proposed Capital Improvement Projects (CIPs).

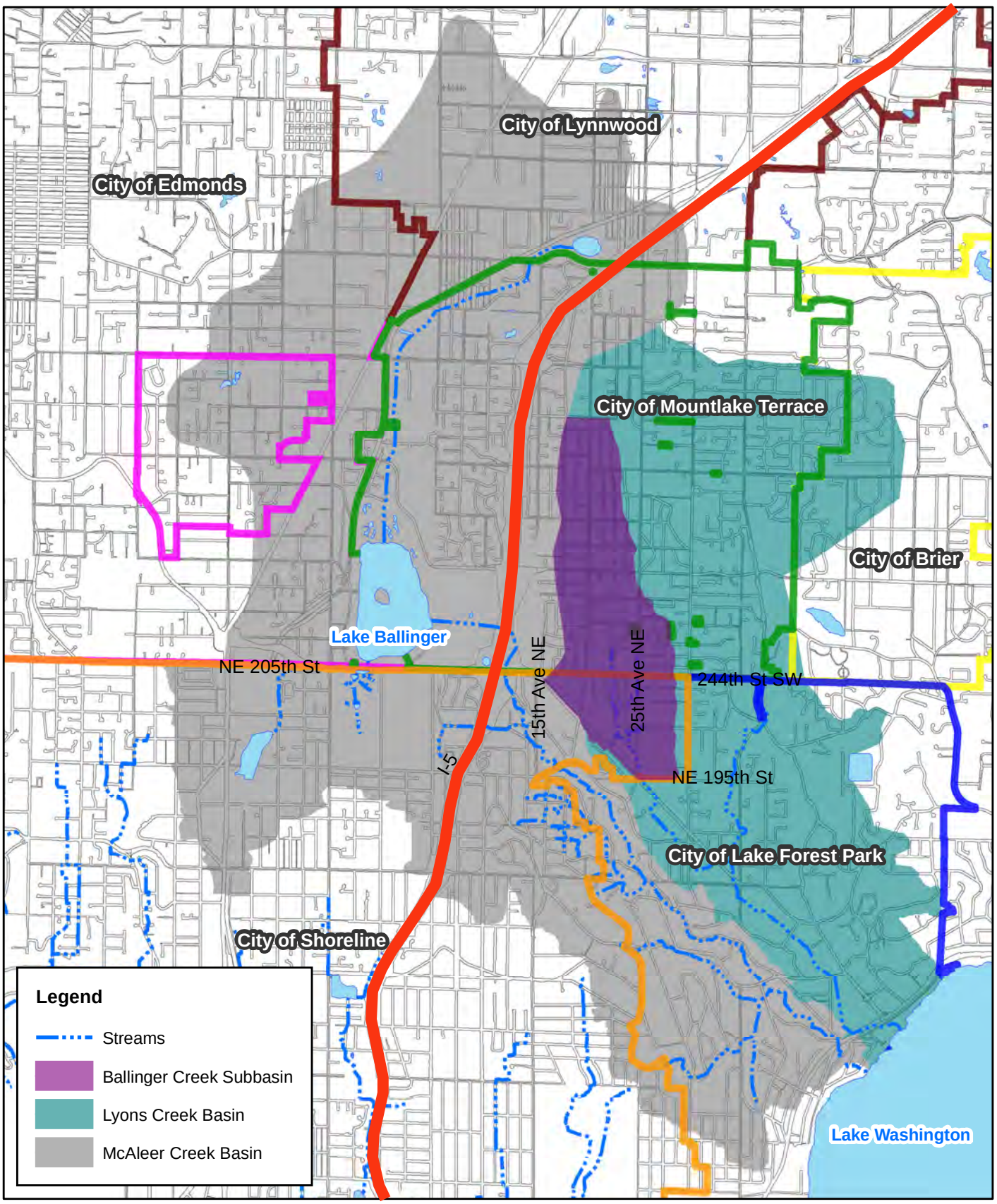
Background

The Ballinger Creek Basin is a subbasin within the Lyon Creek watershed. Multiple jurisdictions share responsibility and interest in addressing long-term watershed planning and conservation efforts in the Lyon Creek watershed.

The Ballinger Creek Basin is 445 acres. The Ballinger Creek headwaters are in the City of Mountlake Terrace. Ballinger Creek flows from north to south through Shoreline from NE 205th Street, between 21st Avenue NE and 22nd Avenue NE, until it crosses into Lake Forest Park at Ballinger Way NE and NE 195th Street and enters Lyon Creek. Lyon Creek flows through Lake Forest Park to Lake Washington. See **Figure 1** for vicinity map.

Photo 1: Ballinger Creek at Brugger's Bridge

Reports of flooding along 25th Ave NE near the intersection with NE 195th St are called into the City several times each year. The roadway floods, as well as properties on either side of the street. Residents have also reported flooding at other locations along Ballinger Creek.



OSBORN CONSULTING INCORPORATED

N

0 1,750 3,500 7,000 Feet

0 875 1,750 Meters

Figure 1: Vicinity Map

Shoreline, WA

Prepared by MLP, 1/6/2015

SECTION II
HYDROLOGIC MODEL (HSPF)

This section documents the Hydrologic Simulation Program Fortran (HSPF) hydrologic modeling methods and results.

Model Selection

An existing Lyon Creek HSPF model, developed by others, was used for the Ballinger Creek hydrology. The Ballinger Creek watershed is a subbasin within the Lyon Creek HSPF model. The 445 acre Ballinger Creek subbasin is labeled as "UPBRUG" and is tributary to RCHRES 390. The Lyon Creek HSPF model was developed and calibrated by Hammond Collier Wade Livingstone in 1999 to simulate a future "built-out" condition. Otak updated the model in 2009 by extending the precipitation through 2007 and updating the Cedar Pond Ftable (located downstream of the Ballinger Creek subbasin in Lake Forest Park). HSPF is a Federal Emergency Management Agency (FEMA) nationally accepted continuous simulation hydrologic model.

Modeling Methods

No changes were made to the Lyon Creek HSPF model developed by others. OCI reran the model and performed a flow frequency analysis (FFA) at two locations along Lyon Creek to verify consistent results with those published in *Flood Reduction Planning Study, Lyon Creek and McAleer Creek Drainage Basins*, Otak, 2009. OCI's FFA results matched the 2009 published results at NE 178th Street and at Ballinger Way. The 2009 published results were focused on Lyon Creek in Lake Forest Park so did not publish Ballinger Creek results. OCI extracted flow data for Ballinger Creek. The HSPF model runs precipitation from the Everett gage. The simulation period is October 2, 1948 through August 25, 2007.

Existing Condition

The Lyon Creek HSPF model developed and calibrated in 1999 to simulate the future "built-out" condition, and updated in 2009, was used to simulate the existing condition flow for Ballinger Creek.

Land Use

No changes were made to the land use in the HSPF model. The HSPF model assumes the 445 acre Ballinger Creek Subbasin is 33.3% impervious. OCI reviewed Shoreline GIS and found the Lyon Creek is 42% impervious. Hydrologic modeling is based on Effective Impervious Area (EIA). EIA is the total impervious area reduced by a "percent connected" factor that accounts for fact that the entire basin is not 100% connected (i.e. roof downspouts may discharge to splash pads and/or open ditches are much less connected than curb and gutter). The hydrologic modeling protocols developed for the Snohomish County Drainage Needs Reports 2002, were referenced, and the percent connected factors for EIA#2 were used (assumes recent development that is fairly well connected). The resulting composite percent connected and calculated effective impervious area are listed below:

- The composite percent connected for the subbasin is 76% based on the following calculation: 76% residential @ 70% connected & 24% roads/commercial @ 95% connected
- 42% total impervious area x 76% connected = 32% effective impervious area

Since the calculated EIA is less than the percent impervious in the HSPF model, no changes were made the land use in the HSPF model.

Calibration

The Lyon Creek HSPF model was previously calibrated by others. No additional calibration was performed as part of this study.

Future Condition

A future condition model was not developed as part of this study. City of Shoreline zoning allows for impervious surface coverages greater than the 33.3% simulated in the HSPF model; however; current development standards include stormwater requirements that will limit the amount of increased runoff associated with new development.

The results of the existing condition HEC-RAS modeling also contributed to the decision to not develop a future condition model. The existing condition HEC-RAS modeling shows flooding at all of the Ballinger Creek Culverts. Culvert replacements will be sized according to Washington Department of Fish and Wildlife (WDFW) fish passage guidelines which rely on channel size, not flow. A detailed discussion of the HEC-RAS modeling is provided in Section III.

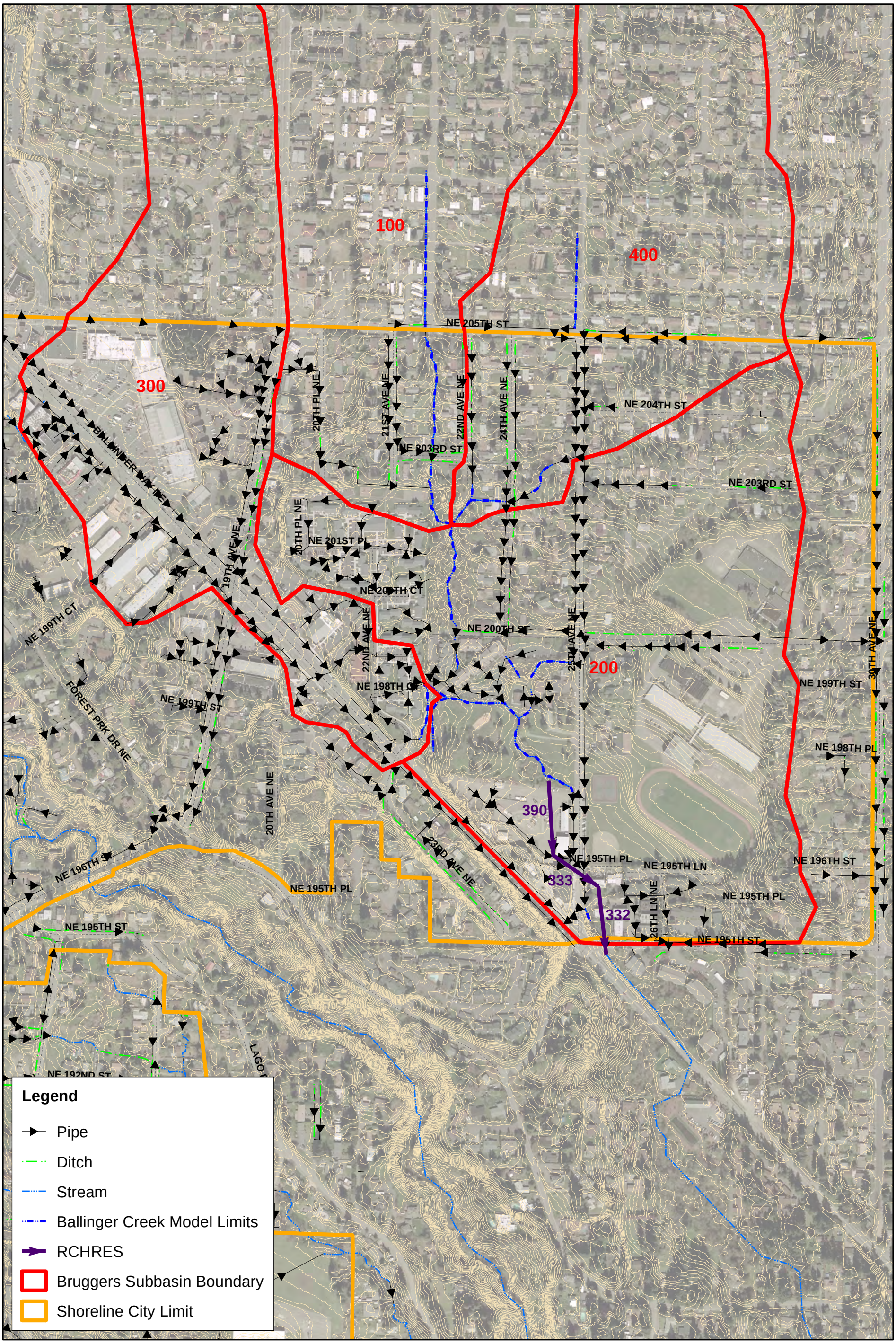
Results – Flow Frequency Analysis

HSPF flow data was available at three RCHRES locations in the Ballinger Creek subbasin (see **Table 1)**. A RCHRES is a location where HSPF uses a stage-storage-discharge relationship to simulate how flow is routed through the basin. All 445 acres of the Ballinger Creek subbasin are routed into 390, then 333, and then 332. The three Ballinger Creek RCHRES demonstrate how the existing culverts in the subbasin restrict peak flows through the system as demonstrated by the reduction in peak flows as you move from upstream to downstream (see **Table 1**). Flow frequency analyses are included as Appendix A-1.

Table 1: Ballinger Creek Flow Frequency Results (1-hr Peaks)

Flow	RCHRES	Location	2-yr (cfs)	25-yr (cfs)	100-yr (cfs)
↓	390	Upstream of 25th Ave. NE	61.16	165.32	243.53
	333	25th Ave. NE	59.51	162.70	240.43
	332	NE 195th St.	56.18	152.92	224.68

The RCHRES 390 flow frequency results were used for the Ballinger Creek HEC-RAS model because they are not influenced by downstream routing and the most conservative flow. Since the RCHRES 390 flows simulate the total runoff from all 445 acres, the Ballinger Creek Subbasin was further delineated into smaller subcatchments so flows could be apportioned, by area, such that flow increases as you move from upstream to downstream along Ballinger Creek. See **Figure 2** for subcatchment delineation and RCHRES locations. The resulting HEC-RAS flow data is presented in **Table 2**.



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0 400 800 Feet

0 200 400 Meters

Figure 2: Ballinger Creek Subbasins

Shoreline, WA

Prepared by MLP, 1/6/2015

Table 2: HEC-RAS Flow Data – Ballinger Creek						
Flow	**River Station**	**Location**	**2-yr (cfs)**	**25-yr (cfs)**	**100-yr (cfs)**	**Source**
↓	4032.7	NE 205th St. (City limits)	24.30	65.68	96.75	Area apportioned
	3474.74	NE 203rd St.	32.04	86.61	127.59	Area apportioned
	2500	NE 200th St.	61.16	165.32	243.53	RCHRES 390

The results of the HEC-RAS modeling are presented in Section III.

Historical Flow Frequency Results

The Ballinger Creek flow frequency results seem high for the following reasons: flows are higher in the Ballinger Creek tributary than they are downstream in Lyon Creek, flows are much higher than previously published flow frequency results, and flows indicate roads flood at the 2-year event (see Table 4: HEC-RAS Results – Ballinger Creek Flooding). Yet, the flow cannot be discounted because: flows are derived from the best available data (the calibrated Lyon Creek HSPF model) and frequent flooding is reported at various locations throughout the Ballinger Creek subbasin. This section describes how the historical flow frequency results have varied, how this uncertainty is accounted for in our conceptual designs, and how the uncertainty can be reduced in the future.

Variation throughout Lyon Creek Basin

The Ballinger Creek flow frequency results are high relative to the flows in the rest of the Lyon Creek Watershed and the size of the existing drainage infrastructure. Flows in upper Lyon Creek are lower than those in Ballinger Creek despite being downstream of the Ballinger Creek confluence. We presume this is a result of a greater level of detail applied to the routing and calibration of Lyon Creek through Lake Forest Park; which is reasonable considering Lake Forest Park funded the studies and the Ballinger Creek subbasin is not located within their jurisdiction.

Demonstrated by the peak flow reductions at each Ballinger Creek RCHRES shown above in **Table 1**, routing flow through stage-storage-discharge tables simulating the actual stormwater infrastructure is an effective way of reducing peak flows to a more realistic flow rate. Additional RCHRES have not been added to the HSPF model as part of this study.

Historical Variation

Several Lyon Creek Basin studies have been performed over the years. The Ballinger Creek flow frequency results at 25th Ave NE from three separate studies are compared in **Table 3**. Each study shows the flow frequency results increasing dramatically compared to the previously published results.

Table 3: Ballinger Creek at 25th Ave NE Historical Flow Frequency Results				
Year	**Study**	**Condition**	**25-yr (cfs)**	**100-yr (cfs)**
1981	Entranco	Current	55.0	61.0
1999	Hammond, Collier & Wade-Livingstone	Current	88.0	117.9
1999	Hammond, Collier & Wade-Livingstone	Future	120.6	151.7
2014	Osborn Consulting	Future	165.3	243.5

Conceptual Design Considerations

For the purpose of this project, we sized conceptual capital improvement projects using the 2014 estimated 25-year and 100-year flows. The 2014, 25-year flow is approximately the same as the 1999, 100-year future flow, therefore designing to both flows brackets the proposed solution within the best available information. As mentioned above in **Future Condition**, the existing condition HEC-RAS modeling shows flooding at all of the Ballinger Creek Culverts within the City. Culvert replacements would be sized according to WDFW fish passage guidelines which are based on the existing channel bankfull width.

Recommendations to reduce uncertainty

Reduced uncertainty in the flow frequency results will improve the City's confidence in the design and construction of flood reduction projects. While improved flows are not needed to design fish passage culverts, improved flows will benefit the proposed channel sizing (i.e. provide adequate conveyance capacity without occupying more right of way than necessary). Two methods to reduce the uncertainty in the hydrology are: stream gaging and adding detail to the hydrology model.

1. Stream gage data can be used to compare the actual response between rainfall and stream flow. Several months of stream data can be used to calibrate a hydrologic model. Several years of stream data can be used for a flow frequency analysis. Selecting a location for the stream gage can be challenging. Since the gages measure the flow depth, the gage must be located where a reliable stage-discharge relationship can be established. Flooding and backwater conditions can adversely affect the reliability of stage-discharge relationships because a range of flows may be occurring at a given water surface elevation. With so much existing flooding in the Ballinger Creek subbasin, selecting a gaging station may be challenging.
2. Detail can be added to the HSPF hydrologic model by breaking the Ballinger Creek portion of the model into more subbasins and incorporating more of the existing hydraulics into the model's routing. Adding this kind of detail allows the model to account for piped constrictions and storage areas throughout the subbasin and can improve the accuracy of the flow rates predicted in the channel.

Adding detail to the HSPF model is recommended as a component of proposed stream improvement projects.

SECTION III
HYDRAULIC MODEL (HEC-RAS)

This section documents the HEC-RAS hydraulic modeling methods and results. The HEC-RAS model was used to run 25-year and 100-year design flows from the Lyon Creek HSPF model for the purpose of identifying flooding problems and mapping the 100-year floodplain.

Model Selection

Ballinger Creek was modeled using US Army Corps of Engineers Hydrologic Engineering Centers River Analysis System (HEC-RAS) Version 4.1.0. HEC-RAS performs one-dimensional steady and unsteady flow river hydraulics calculations (steady flow was used for this project). HEC-RAS is a Federal Emergency Management Agency (FEMA) nationally accepted hydraulic model. Use of a FEMA approved model is important because it allows the City to pursue a Zone A 100-year Flood Hazard designation. HEC-RAS is a publically available model that could easily be updated and used by City staff as infrastructure is replaced or upgraded throughout the basin.

When this project was scoped, it was assumed that an existing Lyon Creek XPSWMM model developed by others for the City of Lake Forest Park would be used. However, review of that model found it does not extend upstream to Ballinger Creek. There was a large enough gap between Ballinger Creek and the upstream limits of the Lyon Creek XPSWMM model that we decided it was more cost effective to build a new HEC-RAS model for Ballinger Creek than to extend the Lyon Creek XPSWMM model upstream (which would involve extending the model through sections of Lyon Creek that are outside of our study area).

Modeling Methods

This section documents the data and the assumptions that were used to develop the Ballinger Creek HEC-RAS model.

Existing Condition

The Ballinger Creek HEC-RAS geometry was developed using City of Shoreline GIS data for the stream alignment and cutting channel cross sections in CAD using contours generated from 2001 LiDAR data. The LiDAR sections were updated with low flow channels based on field observations. Culvert information (size, type, and approximate invert elevation) was obtained from field observations as well. The road surfaces defining the over topping elevation of the culverts were cut from LiDAR. The 2012 LiDAR data became available after the model development was underway so sections were not re-cut using the more recent data. Contour lines from both data sets (2001 and 2012) were compared in GIS and no significant differences between the two were identified.

Field observations, site photos, and engineering judgment were used to estimate various characteristics defining Ballinger Creek as summarized below:

- Cross section locations were determined based on observed bends in the stream alignment and at changes in cross section shape.

- Manning's n values range from 0.035 to 0.055 for the channel, and 0.05 to 0.12 for the overbanks based on observed vegetation.
- Ineffective areas model the active flow area due to contraction and expansion of the channel at each culvert in accordance with HEC-RAS guidelines.
- The downstream boundary condition is normal depth at the NE 195th St. NE culvert. According to the model, the culvert at 195th Street NE is the hydraulic control for the Ballinger Creek reach.
- The culvert(s) / piped network flowing through the Ballinger Creek Condos is an estimate based on site visit observations. For modeling purposes, it was assumed that one culvert (the observed inlet) extends through the entire complex.

The resulting HEC-RAS model simulates 3,290 linear feet of Ballinger Creek, including five culvert crossings, in the City of Shoreline. See **Figure 3**: Plan view showing HEC-RAS river stations and culvert crossings. The HEC-RAS flow data is presented in **Table 2** located in the previous section. See **Appendix A-2** for field notes and site photos.

Results

The HEC-RAS model indicates the Ballinger Creek culverts are all undersized. Three culverts flood at the 2-year flow frequency, four culverts flood at the 25-year flow frequency and all five culverts floods during the 100-year flow frequency. The culvert flooding locations are presented in **Table 4**.

Table 4: HEC-RAS Results – Ballinger Creek Flooding

Flow	River Station	Location	2-yr Flooding	25-yr Flooding	100-yr Flooding
↓	3527	NE 203rd St.	0.7-ft freeboard	Surcharge	Overtop
	2646	NE 200th St.	0.3-ft freeboard	Overtop	Overtop
	2300	Ballinger Creek Condos	Overtop	Overtop	Overtop
	1448	25th Ave. NE	Overtop	Overtop	Overtop
	787	NE 195th St.	Overtop	Overtop	Overtop

Note: A surcharged culvert cannot adequately convey flows and creates a backwater condition upstream of the pipe. An overtopped culvert has surcharged to the point of backwatered flows overtopping the banks and exiting the channel into adjacent areas. Freeboard is the distance between the water surface elevation and the culvert crown at the culvert inlet.

The Ballinger Creek 25-year and 100-year water surface profile, provided as **Figure 4**, shows every culvert being overtopped. As mentioned in Section II, there is some uncertainty with the design flows. A public meeting was held September 17, 2014 to solicit feedback from residents adjacent to Ballinger Creek. The public concurred with the model results which indicate that flooding may be more frequent than the 25-year storm event.

In addition to roadway flooding at culvert crossings, the floodplain mapping overlaid with the 2012 aerial photo shows several parcels (including some buildings) affected by the 100-year floodplain, as shown in **Figure 5**. The floodplain map shows the footprint of the HEC-RAS predicted water surface elevations on the 2012 contour data. Flooding typically occurs upstream of every undersized culvert as described below:

- The floodplain upstream of NE 203rd St. is located in the back yards of several private properties. The 2012 contour data indicates the 100-year water surface elevation may extend to the houses adjacent to the culvert. However, the 2001 contour data indicates the flooding does not extend towards the houses. The HEC-RAS model indicates the 100-year flow stays within the channel banks through this reach and no complaints are known of at this location.
- Predicted flooding upstream of NE 200th St. is located within the Ballinger Open Space and is not predicted to cause adverse effects to private property.
- The Ballinger Creek Condos experience flooding based on predicted floodplain mapping.
- Known flooding upstream of 25th Ave NE affects Brugger's Bog Park and the City's proposed maintenance facility. Flooding in the park does not have adverse effects to private property. Flooding at the maintenance facility property should be addressed before site improvements are made.
- Known flooding upstream of the NE 195th St. culvert has significant impacts to private property and homes.

FEMA Floodplain Mapping

Current Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) mapping does not include Ballinger Creek. FIRM panel 43 of 1725 (map number 53033C0043 F, last revised 5/16/1995 as shown in **Appendix A-3**) shows Lyon Creek and McAleer Creek as contained within their channels during the 100-year flood. Ballinger Creek is not shown on this map. The HEC-RAS analysis performed as part of this study identified existing flooding so updating the FIRM with a Ballinger Creek Zone A boundary is recommended as a way to limit future development within flooded areas. If the flooding culverts identified in this report will be addressed soon, then the City may prefer to wait until those improvements are constructed before updating the FIRM. Waiting to update the FIRM until after the flood reduction projects are complete will reduce the number of properties required to purchase flood insurance.

Zone A identifies an approximately studied special flood hazard area for which no base flood elevations (BFEs) have been provided. The following restrictions are places on Zone A properties:

- Flood insurance is required as a condition of obtaining a loan from a Federally insured or regulated lender.
- New development shall be constructed using methods that will minimize flood damages. This often requires obtaining or calculating BFEs at a development site.

The Ballinger Creek HEC-RAS model was developed with FEMA flood mapping standards in mind so that it may be used by the City to pursue the Zone A boundary.

Figure 5: Ballinger Creek Preliminary 100-year Floodplain Map depicts the approximate 100-year Ballinger Creek Floodplain as simulated by HEC-RAS. The approximate 100-year floodplain is based on a simulation of 100-year flow frequency results of HSPF RCHRES 390; see **Table 2**, above.

A letter of map amendment (LOMA) or letter of map revision (LOMR) request will need to be made to establish a Zone A boundary. The City should contact the FEMA Regional Project Officer (RPO) for guidance on which method is most appropriate for Ballinger Creek. Reference guidance documents outlining the map revision process include the following:

- *Guidelines and Specifications for Flood Hazard Mapping Partners - Appendix A-3: Guidance for Riverine Flooding Analysis and Mapping.* FEMA, April 2003.
- *Managing Floodplain Development in Approximate Zone A Areas: A guide for obtaining and developing base (100-year) flood elevations.* FEMA, July 1995.

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Legend

- Bank Station
- Cross Section
- Ballinger Creek
- Culvert
- City Limit

Figure 3: Ballinger Creek HEC-RAS Plan View

Shoreline, WA

Prepared by MLP, 1/6/2015

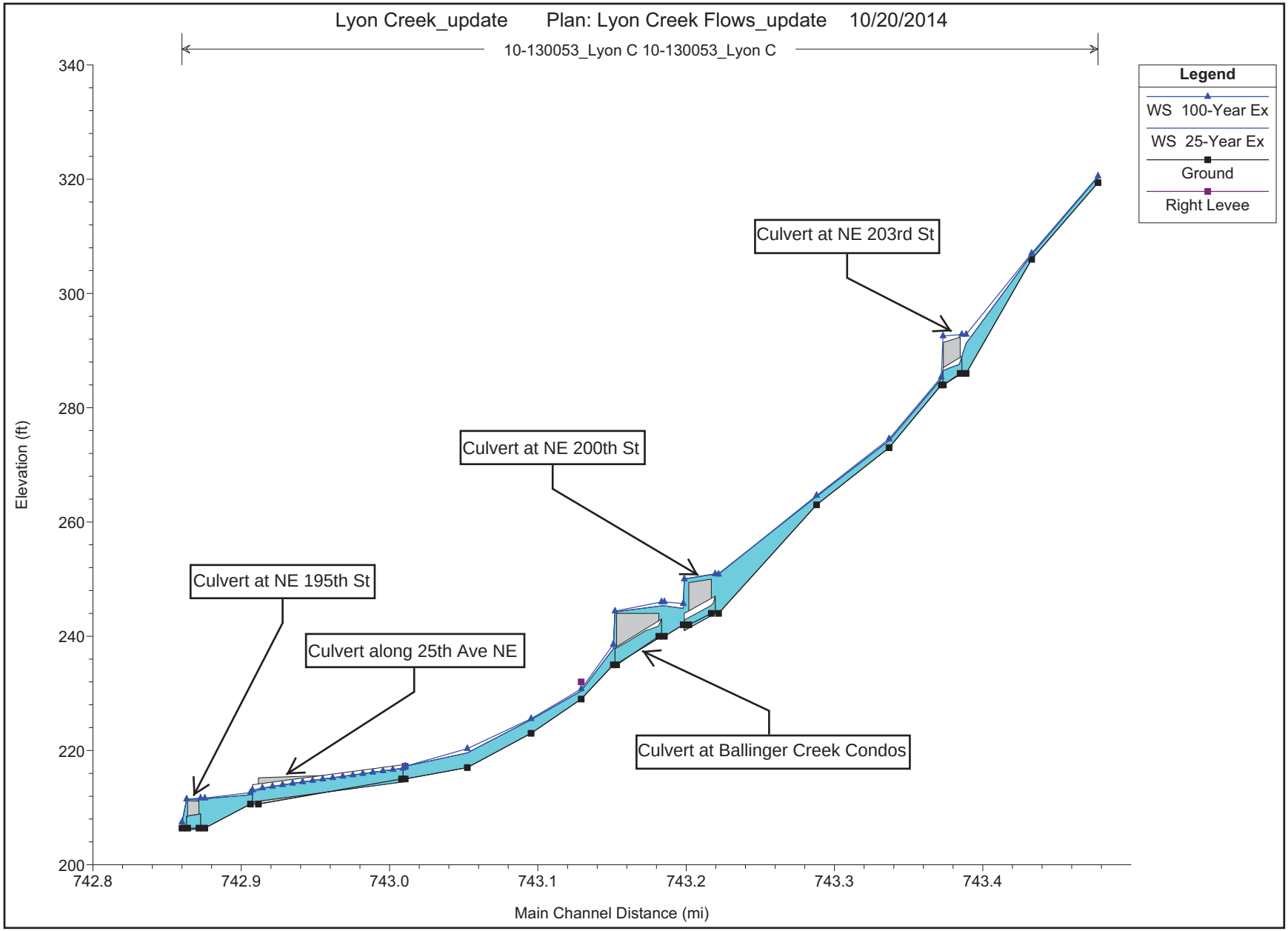

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Figure 4: 25 and 100-Yr Profile
Ballinger Creek Subbasin
Shoreline, WA

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0 200 400 Feet

0 200 Meters

Figure 5: Ballinger Creek Preliminary 100-Year Floodplain Map

Shoreline, WA

Prepared by MLP, 1/6/2015

SECTION IV
ALTERNATIVES ANALYSIS

This section documents the alternatives analysis performed in support of the CIP project identification and conceptual design for Ballinger Creek flood reduction and habitat improvement projects.

Ballinger Creek Flood Reduction and Fish Passage Improvements

As discussed in Section II, the 100-year design flow has increased with each study published over the past 30-years. The peak 100-year flow was estimated to be 61 cfs in 1981, 138 cfs in 1999, and 243 cfs in 2009 and 2014. Due to the wide range of flows computed, two flows were examined to size the Ballinger Creek culverts. The calculated 25-year (165 cfs) and 100-year (243 cfs) flow frequency results from this study were used to represent the lower and upper bounds of the 100-year flow.

All of the Ballinger Creek culverts in the City experience flooding at the 25-year flow frequency and probably much lower flows based on information from the public. Alternatives to reduce flooding in the vicinity of 25th Avenue NE were evaluated with the following assumptions:

- Four new culverts are installed; one at each of the following creek crossings: 25th Ave NE, NE 195th Pl, Private driveway south of NE 195th Pl., and NE195th St.
- New open channel conveyance is constructed along the east side of 25th Ave NE from the 25th Ave NE culvert to the new culvert at the private driveway south of NE 195th Pl. The following assumptions were used for the proposed daylighted channel:
    - The minimum channel slope for the daylighted and re-graded creek sections is 1-percent.
    - The typical channel cross section is 4-feet deep with an 8-foot bottom width and 3H:1V side slopes where adequate ROW is available.
    - Side slopes are steeper along 25th Ave NE where ROW is limited.
- Road elevations are low where Ballinger Creek crosses, but this solution assumes roads would not be raised. Instead, the culvert inverts would be placed at an elevation that allows the culverts to be constructed with 2-feet of cover. Road elevations were estimated from the City's 2001 LiDAR data.
- Stormwater pipe will be repaired/maintained as needed for collection and conveyance of roadway and offsite stormwater but will no longer be used as a high flow bypass for Ballinger Creek.

The four proposed culverts were sized according the minimum size required to pass the design flows and do not specifically take into consideration fish-passage requirements. Because of the low road elevations, an emphasis was placed on shorter and wider culverts.

The resulting HEC-RAS culvert sizing as well as culverts sized according the WDFW *2013 Water Crossing Design Guidelines* are provided in **Table 5**. The WDFW guidelines assume a channel bankfull width as 8-feet (based on approximate field observations made during this Basin Plan). HEC-RAS modeling files are included as **Appendix A-4**.

Table 5: Ballinger Creek Culvert Sizing			
Method	**Flow**	**Rise**	**Span**
HEC-RAS, 25-year flow	165.3 CFS	4-ft	8-ft
HEC-RAS, 100-year flow	243.5 CFS	4-ft	10-ft
WDFW – No-Slope: Bankfull width & 20% countersink	NA	4.8-ft	8-ft
WDFW – Stream Simulation: 1.2*Bankfull width + 2-ft & 30% countersink	NA	5.2-ft	11.6-ft

Proposed culvert sizes for the undersized culverts in the upper reaches of Ballinger Creek will likely be smaller than those presented in **Table 5**. Replacement of those culverts is not recommended until the flooding in the 25th Ave NE and NE 195th Street vicinity has been addressed.

Brugger's Bog Storage Alternative

Flood reduction alternatives considered included stormwater detention. This alternative has been evaluated in previous studies, where the current Brugger's Bog Park was recommended for regional detention when this area was part of unincorporated King County (Entranco 1981). An updated evaluation of flow storage solutions at Brugger's Bog was considered as an alternative for contributing to flood reduction in the 25th Ave NE and NE 195th Street vicinity without upsizing the existing culverts. The Western Washington Hydrology Model (WWHM) was used for this analysis.

To test extreme storage solution, the entire Brugger's Bog Park was assumed to be converted to a regional stormwater facility. This solution provides flood protection through the 5-year event; however, existing culverts will continue to flood at the 10-year event and above. In a meeting with the City, it was decided that the missed opportunity for stream habitat improvement and the total loss of the park space were not worth the flood reduction benefit of this alternative. A stormwater detention facility is not recommended at this location.

APPENDIX A-1

HSPF FLOW FREQUENCY ANALYSIS

Lyon Creek Long Simulation Build-Out Condition (May 2009)
City of Shoreline, Ballinger Creek Basin Plan
HSPF Flood Frequency Results
Engineer: lcr Run Date: 6/1/2014 Source: LyonOtak_TS.uci

Flow Direction

Upstream

1390	**225-ft W of 25th**
Return Period	Flow (cfs)
2	61.16
5	95.21
10	123.11
25	165.32
50	202.11
100	243.53

The 445 ac UPBRUG subcatchment is tributary to RCHRES 390. This includes all area tributary to Ballinger Creek at Ballinger Way (vic. 25th Ave NE and NE 195th St.) .

1333	**25th Ave NE**
Return Period	Flow (cfs)
2	59.51
5	93.17
10	120.81
25	162.70
50	199.25
100	240.43

RCHRES 333 and 332 provide additional routing for this subcatchment at 25th and 195th. No additional tributary area is added at either of these locations.

Downstream

1332	**NE 195th St.**
Return Period	Flow (cfs)
2	56.18
5	87.97
10	113.90
25	152.92
50	186.76
100	224.68

FREQUENCY ANALYSIS: Lyon Creek

6/20/2014 existing 1-hour

1332 NE 195th St.

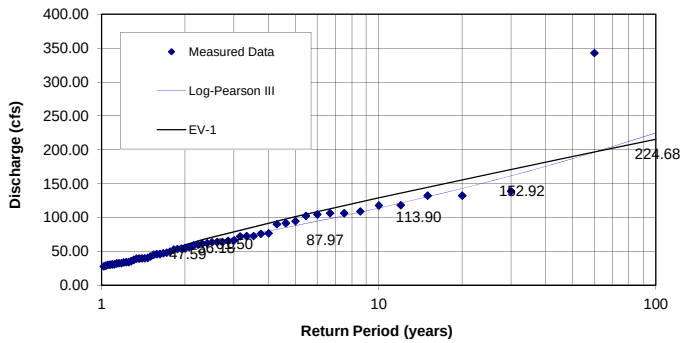
return(yr)	*p*	*zp*	*K*	*log(Q)*	***Q***	***EV I*** *K*	*Q*
1.25	0.200	-0.839	-0.852	1.58	**37.75**	-0.82	28.74
1.58	0.367	-0.337	-0.397	1.68	**47.59**	-0.45	46.18
2	0.500	0.000	-0.071	1.75	**56.18**	-0.16	59.75
2.33	0.571	0.177	0.107	1.79	**61.50**	0.00	67.55
5	0.800	0.839	0.810	1.94	**87.97**	0.72	101.46
10	0.900	1.281	1.317	2.06	**113.90**	1.30	129.09
25	0.960	1.757	1.896	2.18	**152.92**	2.04	163.98
50	0.980	2.064	2.289	2.27	**186.76**	2.59	189.87
100	0.990	2.337	2.652	2.35	**224.68**	3.14	215.57

average	67.5	1.77
std.dev.	47.2	0.22
skew	3.67	0.84
		0.43 regional skew or calculated

*Bulletin 17B recommends averaging calculated skew with regional skew estimate

Regional skew coefficient (of logarithms) = 0.02 from Bulletin 17B Map

year	*flow, cfs*	*log(flow)*	*rank*	*P=m/(N+1)*	*T=1/P*
1949	37.78	1.58	46	0.767	1.30
1950	117.96	2.07	6	0.100	10.00
1951	49.95	1.70	34	0.567	1.76
1952	46.08	1.66	38	0.633	1.58
1953	72.91	1.86	17	0.283	3.53
1954	102.63	2.01	11	0.183	5.45
1955	91.88	1.96	13	0.217	4.62
1956	32.50	1.51	53	0.883	1.13
1957	76.18	1.88	16	0.267	3.75
1958	104.73	2.02	10	0.167	6.00
1959	46.30	1.67	37	0.617	1.62
1960	40.53	1.61	41	0.683	1.46
1961	132.47	2.12	3	0.050	20.00
1962	72.83	1.86	18	0.300	3.33
1963	132.46	2.12	4	0.067	15.00
1964	40.06	1.60	42	0.700	1.43
1965	30.37	1.48	57	0.950	1.05
1966	30.83	1.49	56	0.933	1.07
1967	139.03	2.14	2	0.033	30.00
1968	63.97	1.81	23	0.383	2.61
1969	109.22	2.04	7	0.117	8.57
1970	35.87	1.55	47	0.783	1.28
1971	64.00	1.81	22	0.367	2.73
1972	106.59	2.03	9	0.150	6.67
1973	56.39	1.75	29	0.483	2.07
1974	62.39	1.80	25	0.417	2.40
1975	59.08	1.77	28	0.467	2.14
1976	39.75	1.60	44	0.733	1.36
1977	32.72	1.51	52	0.867	1.15
1978	31.12	1.49	54	0.900	1.11
1979	118.40	2.07	5	0.083	12.00
1980	34.12	1.53	50	0.833	1.20
1981	39.51	1.60	45	0.750	1.33
1982	39.98	1.60	43	0.717	1.40
1983	48.37	1.68	35	0.583	1.71
1984	45.33	1.66	39	0.650	1.54
1985	72.44	1.86	19	0.317	3.16
1986	106.60	2.03	8	0.133	7.50
1987	61.53	1.79	26	0.433	2.31
1988	47.44	1.68	36	0.600	1.67
1989	76.91	1.89	15	0.250	4.00
1990	32.94	1.52	51	0.850	1.18
1991	34.48	1.54	49	0.817	1.22
1992	53.66	1.73	32	0.533	1.88
1993	90.35	1.96	14	0.233	4.29
1994	29.29	1.47	58	0.967	1.03
1995	54.43	1.74	31	0.517	1.94
1996	66.65	1.82	20	0.333	3.00
1997	342.93	2.54	1	0.017	60.00
1998	31.03	1.49	55	0.917	1.09
1999	52.85	1.72	33	0.550	1.82
2000	28.10	1.45	59	0.983	1.02
2001	60.28	1.78	27	0.450	2.22
2002	34.52	1.54	48	0.800	1.25
2003	42.76	1.63	40	0.667	1.50
2004	94.87	1.98	12	0.200	5.00
2005	54.70	1.74	30	0.500	2.00
2006	65.80	1.82	21	0.350	2.86
2007	63.59	1.80	24	0.400	2.50



FREQUENCY ANALYSIS: Lyon Creek

6/20/2014 existing 1-hour

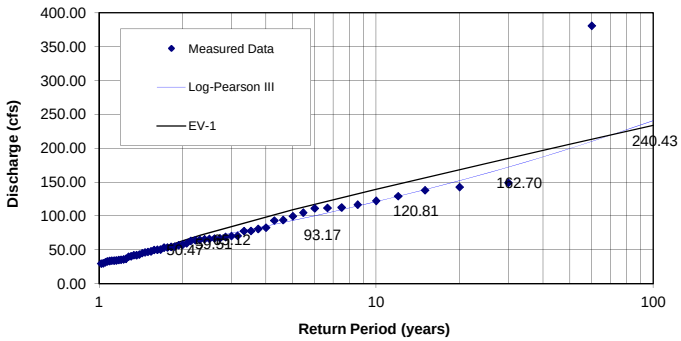
1333 25th Ave NE

return(yr)	*p*	*zp*	*K*	*log(Q)*	***Q***	***EV I*** *K*	*Q*
1.25	0.200	-0.839	-0.853	1.60	**40.14**	-0.82	29
1.58	0.367	-0.337	-0.401	1.70	**50.47**	-0.45	48
2	0.500	0.000	-0.076	1.77	**59.51**	-0.16	63
2.33	0.571	0.177	0.101	1.81	**65.12**	0.00	72
5	0.800	0.839	0.807	1.97	**93.17**	0.72	109
10	0.900	1.281	1.319	2.08	**120.81**	1.30	139
25	0.960	1.757	1.906	2.21	**162.70**	2.04	177
50	0.980	2.064	2.306	2.30	**199.25**	2.59	206
100	0.990	2.337	2.676	2.38	**240.43**	3.14	234
average	71.8	1.79					
std.dev.	51.7	0.22					
skew	3.93	0.90					
		0.46	regional skew or calculated				

*Bulletin 17B recommends averaging calculated skew with regional skew estimate

Regional skew coefficient (of logarithms) = 0.02 from Bulletin 17B Map

year	*flow, cfs*	*log(flow)*	*rank*	*P=m/(N+1)*	*T=1/P*
1949	42.27	1.63	44	0.733	1.36
1950	122.42	2.09	6	0.100	10.00
1951	54.82	1.74	32	0.533	1.88
1952	50.51	1.70	36	0.600	1.67
1953	77.79	1.89	18	0.300	3.33
1954	105.03	2.02	11	0.183	5.45
1955	94.11	1.97	13	0.217	4.62
1956	31.71	1.50	57	0.950	1.05
1957	81.01	1.91	16	0.267	3.75
1958	111.84	2.05	9	0.150	6.67
1959	47.09	1.67	40	0.667	1.50
1960	45.15	1.65	42	0.700	1.43
1961	142.75	2.15	3	0.050	20.00
1962	77.81	1.89	17	0.283	3.53
1963	138.10	2.14	4	0.067	15.00
1964	40.50	1.61	46	0.767	1.30
1965	33.61	1.53	55	0.917	1.09
1966	34.13	1.53	54	0.900	1.11
1967	149.13	2.17	2	0.033	30.00
1968	66.92	1.83	23	0.383	2.61
1969	116.81	2.07	7	0.117	8.57
1970	39.95	1.60	47	0.783	1.28
1971	69.13	1.84	21	0.350	2.86
1972	112.63	2.05	8	0.133	7.50
1973	59.66	1.78	29	0.483	2.07
1974	67.19	1.83	22	0.367	2.73
1975	64.19	1.81	27	0.450	2.22
1976	43.10	1.63	43	0.717	1.40
1977	36.84	1.57	48	0.800	1.25
1978	34.38	1.54	52	0.867	1.15
1979	129.25	2.11	5	0.083	12.00
1980	35.35	1.55	50	0.833	1.20
1981	46.17	1.66	41	0.683	1.46
1982	42.25	1.63	45	0.750	1.33
1983	53.31	1.73	35	0.583	1.71
1984	49.93	1.70	38	0.633	1.58
1985	70.51	1.85	20	0.333	3.00
1986	111.31	2.05	10	0.167	6.00
1987	66.18	1.82	24	0.400	2.50
1988	50.23	1.70	37	0.617	1.62
1989	82.85	1.92	15	0.250	4.00
1990	33.00	1.52	56	0.933	1.07
1991	35.18	1.55	51	0.850	1.18
1992	57.49	1.76	30	0.500	2.00
1993	93.32	1.97	14	0.233	4.29
1994	29.70	1.47	59	0.983	1.02
1995	54.46	1.74	33	0.550	1.82
1996	65.81	1.82	25	0.417	2.40
1997	380.90	2.58	1	0.017	60.00
1998	34.20	1.53	53	0.883	1.13
1999	56.82	1.75	31	0.517	1.94
2000	30.19	1.48	58	0.967	1.03
2001	64.93	1.81	26	0.433	2.31
2002	35.94	1.56	49	0.817	1.22
2003	47.81	1.68	39	0.650	1.54
2004	99.73	2.00	12	0.200	5.00
2005	53.56	1.73	34	0.567	1.76
2006	70.73	1.85	19	0.317	3.16
2007	63.22	1.80	28	0.467	2.14



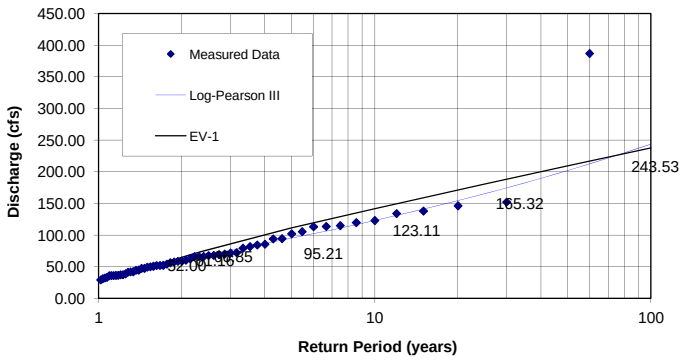
FREQUENCY ANALYSIS: Lyon Creek
6/20/2014 existing 1-hour
1390 225-ft W of 25th

return(yr)	*p*	*zp*	*K*	*log(Q)*	***Q***	***EV I*** *K*	*Q*
1.25	0.200	-0.839	-0.853	1.62	**41.51**	-0.82	31
1.58	0.367	-0.337	-0.403	1.72	**52.00**	-0.45	50
2	0.500	0.000	-0.078	1.79	**61.16**	-0.16	65
2.33	0.571	0.177	0.099	1.83	**66.85**	0.00	74
5	0.800	0.839	0.806	1.98	**95.21**	0.72	111
10	0.900	1.281	1.320	2.09	**123.11**	1.30	142
25	0.960	1.757	1.909	2.22	**165.32**	2.04	181
50	0.980	2.064	2.311	2.31	**202.11**	2.59	209
100	0.990	2.337	2.683	2.39	**243.53**	3.14	238

average	73.5	1.80	
std.dev.	52.4	0.22	
skew	3.95	0.92	
		0.47	regional skew or calculated

*Bulletin 17B recommends averaging calculated skew with regional skew estimate
Regional skew coefficient (of logarithms) = 0.02 from Bulletin 17B Map

year	*flow, cfs*	*log(flow)*	*rank*	*P=m/(N+1)*	*T=1/P*
1949	44.76	1.65	43	0.717	1.40
1950	123.21	2.09	6	0.100	10.00
1951	57.53	1.76	32	0.533	1.88
1952	52.38	1.72	35	0.583	1.71
1953	79.39	1.90	18	0.300	3.33
1954	105.57	2.02	11	0.183	5.45
1955	94.14	1.97	14	0.233	4.29
1956	33.22	1.52	56	0.933	1.07
1957	84.39	1.93	16	0.267	3.75
1958	115.04	2.06	8	0.133	7.50
1959	47.59	1.68	42	0.700	1.43
1960	47.68	1.68	41	0.683	1.46
1961	146.47	2.17	3	0.050	20.00
1962	82.03	1.91	17	0.283	3.53
1963	138.12	2.14	4	0.067	15.00
1964	42.14	1.62	46	0.767	1.30
1965	35.90	1.56	55	0.917	1.09
1966	36.44	1.56	52	0.867	1.15
1967	152.34	2.18	2	0.033	30.00
1968	68.01	1.83	23	0.383	2.61
1969	119.89	2.08	7	0.117	8.57
1970	41.49	1.62	47	0.783	1.28
1971	71.87	1.86	20	0.333	3.00
1972	113.77	2.06	9	0.150	6.67
1973	60.46	1.78	29	0.483	2.07
1974	69.19	1.84	22	0.367	2.73
1975	66.16	1.82	27	0.450	2.22
1976	44.44	1.65	44	0.733	1.36
1977	38.86	1.59	48	0.800	1.25
1978	37.63	1.58	49	0.817	1.22
1979	134.24	2.13	5	0.083	12.00
1980	37.54	1.57	50	0.833	1.20
1981	49.40	1.69	40	0.667	1.50
1982	42.22	1.63	45	0.750	1.33
1983	56.42	1.75	33	0.550	1.82
1984	52.24	1.72	36	0.600	1.67
1985	70.09	1.85	21	0.350	2.86
1986	113.16	2.05	10	0.167	6.00
1987	67.75	1.83	24	0.400	2.50
1988	50.81	1.71	38	0.633	1.58
1989	85.80	1.93	15	0.250	4.00
1990	32.42	1.51	57	0.950	1.05
1991	36.23	1.56	53	0.883	1.13
1992	59.12	1.77	30	0.500	2.00
1993	94.48	1.98	13	0.217	4.62
1994	29.39	1.47	59	0.983	1.02
1995	54.34	1.74	34	0.567	1.76
1996	66.38	1.82	25	0.417	2.40
1997	387.10	2.59	1	0.017	60.00
1998	36.15	1.56	54	0.900	1.11
1999	58.63	1.77	31	0.517	1.94
2000	31.19	1.49	58	0.967	1.03
2001	66.37	1.82	26	0.433	2.31
2002	36.64	1.56	51	0.850	1.18
2003	50.18	1.70	39	0.650	1.54
2004	102.08	2.01	12	0.200	5.00
2005	51.94	1.72	37	0.617	1.62
2006	72.42	1.86	19	0.317	3.16
2007	63.01	1.80	28	0.467	2.14



FREQUENCY ANALYSIS: Lyon Creek
6/20/2014 existing 1-hour
1060 NE 178th

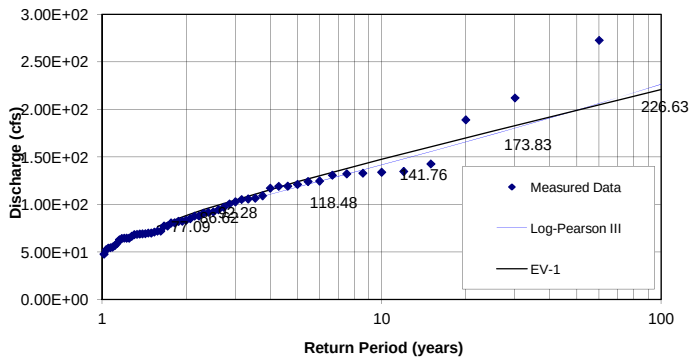
return(yr)	*p*	*zp*	*K*	*log(Q)*	***Q***	Otak 2009* *Q*	***EV I*** *K*	*Q*
1.25	0.200	-0.839	-0.852	1.82	**65.46**		-0.82	62
1.58	0.367	-0.337	-0.393	1.89	**77.09**	77.1	-0.45	77
2	0.500	0.000	-0.066	1.94	**86.62**	86.6	-0.16	88
2.33	0.571	0.177	0.111	1.97	**92.28**	92.3	0.00	95
5	0.800	0.839	0.812	2.07	**118.48**	118.5	0.72	124
10	0.900	1.281	1.316	2.15	**141.76**	141.8	1.30	147
25	0.960	1.757	1.888	2.24	**173.83**	173.8	2.04	177
50	0.980	2.064	2.275	2.30	**199.55**	199.5	2.59	199
100	0.990	2.337	2.632	2.36	**226.63**	226.6	3.14	221

*Bulletin 17B recommends averaging calculated skew with regional skew estimate
Regional skew coefficient (of logarithms) = 0.02 from Bulletin 17B Map

average	95.0	1.95
std.dev.	40.2	0.15
skew	2.14	0.78
		0.40 regional skew or calculated

*2009 Otak reported results included to verify consistent results from each study

year	*flow, cfs*	*log(flow)*	*rank*	*P=m/(N+1)*	*T=1/P*
1949	5.53E+01	1.74	55	0.917	1.09
1950	1.21E+02	2.08	12	0.200	5.00
1951	7.22E+01	1.86	37	0.617	1.62
1952	7.76E+01	1.89	35	0.583	1.71
1953	8.24E+01	1.92	32	0.533	1.88
1954	1.09E+02	2.04	16	0.267	3.75
1955	1.34E+02	2.13	6	0.100	10.00
1956	9.72E+01	1.99	22	0.367	2.73
1957	1.43E+02	2.16	4	0.067	15.00
1958	1.33E+02	2.12	7	0.117	8.57
1959	8.79E+01	1.94	28	0.467	2.14
1960	8.07E+01	1.91	34	0.567	1.76
1961	1.17E+02	2.07	15	0.250	4.00
1962	9.21E+01	1.96	25	0.417	2.40
1963	1.32E+02	2.12	8	0.133	7.50
1964	9.09E+01	1.96	26	0.433	2.31
1965	6.85E+01	1.84	46	0.767	1.30
1966	5.42E+01	1.73	57	0.950	1.05
1967	9.23E+01	1.97	24	0.400	2.50
1968	1.19E+02	2.08	14	0.233	4.29
1969	8.53E+01	1.93	29	0.483	2.07
1970	6.48E+01	1.81	48	0.800	1.25
1971	1.05E+02	2.02	19	0.317	3.16
1972	1.01E+02	2.00	21	0.350	2.86
1973	7.01E+01	1.85	40	0.667	1.50
1974	8.08E+01	1.91	33	0.550	1.82
1975	8.81E+01	1.94	27	0.450	2.22
1976	6.47E+01	1.81	49	0.817	1.22
1977	5.91E+01	1.77	53	0.883	1.13
1978	6.68E+01	1.82	47	0.783	1.28
1979	1.31E+02	2.12	9	0.150	6.67
1980	6.86E+01	1.84	45	0.750	1.33
1981	6.30E+01	1.80	52	0.867	1.15
1982	6.91E+01	1.84	44	0.733	1.36
1983	7.21E+01	1.86	38	0.633	1.58
1984	7.00E+01	1.85	41	0.683	1.46
1985	1.25E+02	2.10	10	0.167	6.00
1986	2.12E+02	2.33	2	0.033	30.00
1987	1.07E+02	2.03	17	0.283	3.53
1988	6.95E+01	1.84	42	0.700	1.43
1989	8.36E+01	1.92	30	0.500	2.00
1990	6.47E+01	1.81	50	0.833	1.20
1991	7.75E+01	1.89	36	0.600	1.67
1992	8.26E+01	1.92	31	0.517	1.94
1993	1.19E+02	2.08	13	0.217	4.62
1994	5.47E+01	1.74	56	0.933	1.07
1995	1.35E+02	2.13	5	0.083	12.00
1996	1.89E+02	2.28	3	0.050	20.00
1997	2.73E+02	2.44	1	0.017	60.00
1998	6.93E+01	1.84	43	0.717	1.40
1999	1.03E+02	2.01	20	0.333	3.00
2000	4.79E+01	1.68	59	0.983	1.02
2001	7.11E+01	1.85	39	0.650	1.54
2002	5.69E+01	1.75	54	0.900	1.11
2003	5.25E+01	1.72	58	0.967	1.03
2004	9.47E+01	1.98	23	0.383	2.61
2005	6.43E+01	1.81	51	0.850	1.18
2006	1.24E+02	2.09	11	0.183	5.45
2007	1.06E+02	2.03	18	0.300	3.33



FREQUENCY ANALYSIS: Lyon Creek

6/20/2014 existing 1-hour

1100 Ballinger Way

return(yr)	*p*	*zp*	*K*	*log(Q)*	***Q***
1.25	0.200	-0.839	-0.852	1.78	**60.91**
1.58	0.367	-0.337	-0.400	1.85	**71.17**
2	0.500	0.000	-0.075	1.90	**79.60**
2.33	0.571	0.177	0.103	1.93	**84.62**
5	0.800	0.839	0.808	2.03	**107.89**
10	0.900	1.281	1.319	2.11	**128.65**
25	0.960	1.757	1.904	2.20	**157.35**
50	0.980	2.064	2.302	2.26	**180.46**
100	0.990	2.337	2.670	2.31	**204.88**

average	87.2	1.91
std.dev.	36.6	0.15
skew	2.46	0.89
		0.45 regional skew or calculated

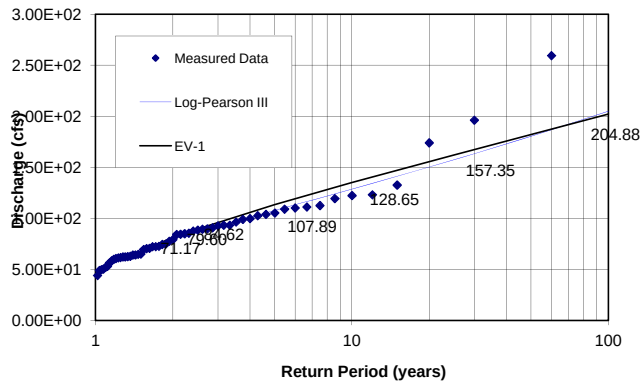
Otak 2009*	***EV I***	
Q	*K*	*Q*
	-0.82	57
71.2	-0.45	71
79.6	-0.16	81
94.6	0.00	87
107.9	0.72	114
128.7	1.30	135
157.4	2.04	162
180.5	2.59	182
204.9	3.14	202

*Bulletin 17B recommends averaging calculated skew with regional skew estimate

Regional skew coefficient (of logarithms) = 0.02 from Bulletin 17B Map

*2009 Otak reported results included to verify consistent results from each study

year	*flow, cfs*	*log(flow)*	*rank*	*P=m/(N+1)*	*T=1/P*
1949	5.03E+01	1.70	56	0.933	1.07
1950	9.98E+01	2.00	15	0.250	4.00
1951	6.43E+01	1.81	42	0.700	1.43
1952	7.48E+01	1.87	32	0.533	1.88
1953	8.43E+01	1.93	29	0.483	2.07
1954	9.08E+01	1.96	21	0.350	2.86
1955	1.19E+02	2.08	7	0.117	8.57
1956	8.97E+01	1.95	22	0.367	2.73
1957	1.33E+02	2.12	4	0.067	15.00
1958	1.22E+02	2.09	6	0.100	10.00
1959	7.76E+01	1.89	31	0.517	1.94
1960	6.96E+01	1.84	39	0.650	1.54
1961	1.05E+02	2.02	12	0.200	5.00
1962	8.77E+01	1.94	25	0.417	2.40
1963	1.09E+02	2.04	11	0.183	5.45
1964	7.92E+01	1.90	30	0.500	2.00
1965	6.26E+01	1.80	45	0.750	1.33
1966	4.90E+01	1.69	58	0.967	1.03
1967	8.94E+01	1.95	23	0.383	2.61
1968	1.11E+02	2.05	9	0.150	6.67
1969	8.55E+01	1.93	26	0.433	2.31
1970	5.99E+01	1.78	51	0.850	1.18
1971	8.85E+01	1.95	24	0.400	2.50
1972	9.91E+01	2.00	16	0.267	3.75
1973	7.04E+01	1.85	38	0.633	1.58
1974	7.24E+01	1.86	35	0.583	1.71
1975	8.50E+01	1.93	27	0.450	2.22
1976	6.18E+01	1.79	48	0.800	1.25
1977	5.64E+01	1.75	53	0.883	1.13
1978	6.07E+01	1.78	50	0.833	1.20
1979	1.10E+02	2.04	10	0.167	6.00
1980	6.13E+01	1.79	49	0.817	1.22
1981	6.41E+01	1.81	43	0.717	1.40
1982	6.23E+01	1.79	47	0.783	1.28
1983	7.27E+01	1.86	34	0.567	1.76
1984	6.51E+01	1.81	40	0.667	1.50
1985	1.04E+02	2.02	13	0.217	4.62
1986	1.96E+02	2.29	2	0.033	30.00
1987	9.64E+01	1.98	17	0.283	3.53
1988	6.23E+01	1.79	46	0.767	1.30
1989	8.44E+01	1.93	28	0.467	2.14
1990	5.86E+01	1.77	52	0.867	1.15
1991	7.07E+01	1.85	37	0.617	1.62
1992	7.45E+01	1.87	33	0.550	1.82
1993	1.03E+02	2.01	14	0.233	4.29
1994	4.97E+01	1.70	57	0.950	1.05
1995	1.23E+02	2.09	5	0.083	12.00
1996	1.74E+02	2.24	3	0.050	20.00
1997	2.59E+02	2.41	1	0.017	60.00
1998	6.28E+01	1.80	44	0.733	1.36
1999	9.33E+01	1.97	18	0.300	3.33
2000	4.41E+01	1.64	59	0.983	1.02
2001	7.24E+01	1.86	36	0.600	1.67
2002	5.30E+01	1.72	54	0.900	1.11
2003	5.21E+01	1.72	55	0.917	1.09
2004	9.33E+01	1.97	19	0.317	3.16
2005	6.48E+01	1.81	41	0.683	1.46
2006	1.13E+02	2.05	8	0.133	7.50
2007	9.27E+01	1.97	20	0.333	3.00



McAleer and Lyon Creeks Drainage Basin Study
for the City of Lake Forest Park
June 1999

Prepared by: Hammond, Collier & Wade-Livingstone Assoc. Inc.
and Aqua Terra Consultants

APPENDIX B

EXISTING CULVERT INVENTORY

McAleer & Lyon Creeks Culvert Inventory

Owner: City of Lake Forest Park
Project: McAleer & Lyon Creeks Drainage Basin Study

Revised: 3/24/98

Apparent Responsibility Code:
L.F.P. = Lake Forest Park
WSDOT = Wash. State Dept. of Transportation
PRIVATE = culverts on private property
BRIER = Brier
KING CO. = King County
M.L.T. = Mountlake Terrace

*** Denotes capacity at road overtopping.**

				EXISTING CULVERT CONFIGURATION						EXISTING CULVERT CONFIGURATION							
Culvert #	Location	Subbasin	Apparent Responsibility	# of Culv's	Culv. Type	Span (ft)	Rise (ft)	Invert Elev.	Outlet Elev.	Length (ft)	Slope (ft/ft)	Slope (ft/ft)	Manning	*Capacity (cfs)	* Total Capacity (cfs)	Inlet Type	Overtop Elev.
L5	BEACH DRIVE NE	TOWNE CENTER	L.F.P.	1	CAA	9	3.88	20	19.1	16.03	0.0561	0.0562	0.035	301	301	CONVENTIONA	29.0
L10	BOTHELL WAY NE (150' W of NE Ballinger Way)	TOWNE CENTER	L.F.P./WSDOT	1	RCB	5	4	24.87	24.56	110	0.0028	0.0028	0.012	307	307	CONVENTIONA	30.2
L20	TOWNE CENTER ENTRANCE FROM BOTHELL WAY	TOWNE CENTER	PRIVATE in L.F.P.	1	CAA	7	3.67	25	24.9	73	0.0014	0.0014	0.035	108		CONVENTIONA	30.0
L20	TOWNE CENTER ENTRANCE FROM BOTHELL WAY	TOWNE CENTER	PRIVATE in L.F.P.	2	CSP	2.5	2.5	26.34	26.33	73	0.0001	26.33	0.031	18	126	CONVENTIONA	30.0
L30	TOWNE CENTER (NEAR SKIPPERS)	TOWNE CENTER	PRIVATE in L.F.P.	1	RCB	6	3	28.2	28	75	0.0027	0.0027	0.012	84		CONVENTIONA	31.5
L30	TOWNE CENTER (NEAR SKIPPERS)	TOWNE CENTER	PRIVATE in L.F.P.	2	CSP	2.5	2.5	27.6	27.5	150	0.0007	1	0.031	16	100	CONVENTIONA	31.5
L40	TOWNE CENTER (NEAR CLEANERS)	TOWNE CENTER	PRIVATE in L.F.P.	1	RCB	6	3	28.2	28	150	0.0013	0.0027	0.012	94		CONVENTIONA	31.5
L40	TOWNE CENTER (NEAR CLEANERS)	TOWNE CENTER	PRIVATE in L.F.P.	2	CSP	2.5	2.5	28.2	28	75	0.0027	1	0.031	17	111	CONVENTIONA	31.5
L60	NE 178TH ST (W of 44th Ave NE)	LYON 2	L.F.P.	1	CMPA	6.08	4.58	60	59.9	60	0.0017	0.0017	0.028	258	258	CONVENTIONA	70.0
L70	40TH AVE NE (W of NE Ballinger Way)	LYON 3	L.F.P.	1	CAA	8	4.17	96	95.1	40.01	0.0225	0.0225	0.035	208	208	CONVENTIONA	103.5
L80	35TH AVE NE (S of NE Ballinger Way)	LYON 3	L.F.P.	1	CMPA	7.25	5.25	120	119.7	46	0.0065	0.0065	0.028	266	266	CONVENTIONA	128.0
L90	NE 185TH ST (W of 35th Ave NE)	LYON 3	L.F.P.	1	RCPA	3.02	1.88	125	124.9	32	0.0031	0.0031	0.012	114	114	CONVENTIONA	131.5
L100	NE BALLINGER WAY (E of 35th Ave NE)	LYON 3	PRIVATE in L.F.P./WSDOT	1	RCB	5	3	130	129	150	0.0067	0.0067	0.012	177	177	CONVENTIONA	138.0
L110	35TH AVE NE (S of NE 190th St)	LYON 4	L.F.P.	1	RCB	7	5	150	149.7	40	0.0075	0.0075	0.012	97	97	CONVENTIONA	154.0
L120	35TH AVE NE (N of NE 190th St)	LYON 4	L.F.P.	1	RCB	5	3	155	154.2	33.01	0.0242	0.0242	0.012	176	176	CONVENTIONA	161.0
L130	165' W of 35TH AVE NE (450' S of NE 195th St)	LYON 4	PRIVATE in L.F.P.	1	CAA	10	3.46	161	160.65	27	0.0130	0.013	0.035	196	196	CONVENTIONA	168.0
L140	150' W of 35TH AVE NE (300' S of NE 195th St)	LYON 4	PRIVATE in L.F.P.	1	RCB	2.5	3.5	175	174.65	25	0.0140	0.014	0.012	90		CONVENTIONA	182.0
L140	150' W of 35TH AVE NE (300' S of NE 195th St)	LYON 4	PRIVATE in L.F.P.	2	RCB	5.8	2.5	175.5	175.15	25	0.0140	1	0.012	154	244	CONVENTIONA	182.0
L150	150' W of 35TH AVE NE (150' S of NE 195th St)	LYON 4	PRIVATE in L.F.P.	1	RCB	4.5	3.2	176	175.6	15.01	0.0266	0.0267	0.012	95	95	CONVENTIONA	180.2
L155	NE 195TH ST (150' W of 35th Ave NE)	LYON 5	L.F.P.	1	CSP	4	4	180	179.7	51	0.0059	0.0059	0.031	201	201	CONVENTIONA	187.0
L160	35TH AVE NE (525' S of 40th Place NE)	LYON 5	L.F.P.	1	RCP	4	4	218	217.9	41	0.0024	0.0024	0.012	146	146	CONVENTIONA	225.0
L161	W of 32ND AVE NE (near NE 198th Place)	32ND TRIB	L.F.P.	1	CSP	2.5	2.5	218	216.5	80.01	0.0187	0.0188	0.031	36	36	CONVENTIONA	224.0
L163	NE 200TH ST (E of 32nd Ave NE)	32ND TRIB	L.F.P.	1	CSP	2.5	2.5	240	239.2	50.01	0.0160	0.016	0.031	41	41	CONVENTIONA	246.5
L164	W of 32ND AVE NE (75' N of NE 200th St)	32ND TRIB	PRIVATE in L.F.P.	1	CSP	1.5	1.5	248	243	250.05	0.0200	0.02	0.031	7	7	CONVENTIONA	251.0
L165	W of 32ND AVE NE (150' N of NE 200th St)	32ND TRIB	PRIVATE in L.F.P.	1	RCP	1.5	1.5	250	248.5	70.02	0.0214	0.0214	0.012	22	22	CONVENTIONA	252.5
L166	W of 32ND AVE NE (250' N of NE 200th St)	32ND TRIB	PRIVATE in L.F.P.	1	CSP	1	1	254	252	105.02	0.0190	0.019	0.031	2	2	CONVENTIONA	256.0
L167	N 204TH ST (W of 33rd Ave NE)	32ND TRIB	L.F.P.	1	CSP	3	3	265	263.8	60.01	0.0200	0.02	0.031	52	52	CONVENTIONA	270.5
L168	W of 243RD PLACE SW	32ND TRIB	M.L.T./PRIVATE in M.L.T.	1	RCP	1.5	1.5	280	275	250.05	0.0200	0.02	0.012	13	13	CONVENTIONA	283.0
L170	E of 35TH AVE NE	LYON 5	PRIVATE in L.F.P.	1	CSP	1	1	219	218.3	18.01	0.0389	0.0389	0.031	7		CONVENTIONA	224.0
L170	E of 35TH AVE NE	LYON 5	PRIVATE in L.F.P.	2	CMPA	4.08	2.75	220	219.3	18.01	0.0389	0.0389	0.024	60	67	CONVENTIONA	224.0
L180	35TH AVE NE (375' S of 40th Place NE)	LYON 5	L.F.P.	1	CSP	4	4	221	219.7	45.02	0.0289	0.0289	0.031	127	127	CONVENTIONA	229.0
L190	35TH AVE NE (150' S of 40th Place NE)	LYON 5	L.F.P.	1	RCP	2.5	2.5	240	238.9	43.01	0.0256	0.0256	0.012	71	71	CONVENTIONA	250.0
L200	40TH PLACE NE (75' W of 35th Ave NE)	LYON 6	L.F.P.	1	RCP	3	3	245	244.3	31.01	0.0226	0.0226	0.012	94		CONVENTIONA	254.0
L200	150' N of 40TH PLACE NE	LYON 6	PRIVATE in L.F.P.	2	RCP	2	2	245	244.3	31.01	0.0226	0.0226	0.012	49	143	CONVENTIONA	254.0
L210	37TH AVE NE (300' N of 40th Place NE)	LYON 6	PRIVATE in L.F.P.	1	CSP	2.5	2.5	250	249.5	18.01	0.0278	0.0278	0.031	73	73	CONVENTIONA	254.5
L220	37TH AVE NE (450' N of 40th Place NE)	LYON 6	L.F.P.	1	CMPA	4.75	3.17	251	250.9	42	0.0024	0.0024	0.024	138	138	CONVENTIONA	260.0
L230	E of 37TH AVE NE	LYON 6	L.F.P.	1	RCP	2	2	255	254.6	50	0.0080	0.008	0.012	68	68	CONVENTIONA	261.0
L240	37TH AVE NE (580' N of 40th Place NE)	LYON 6	PRIVATE in L.F.P.	1	CSP	4	4	258	257.9	21	0.0048	0.0048	0.031	93	93	CONVENTIONA	264.0
L250	SW 244TH ST (W of 37th Ave NE / Cedar Way S)	LYON 6	L.F.P.	1	CSP	4	4	260	258.5	38.03	0.0394	0.0395	0.031	75	75	CONVENTIONA	266.0
L255	150' W of NE BALLINGER WAY (S of NE 184th St)	LYON 6	L.F.P./BRIER	1	RCB	5.5	4	262	261.9	62	0.0016	0.0016	0.012	207	207	CONVENTIONA	269.0
L260	50' W of NE BALLINGER WAY (S of NE 184th St)	SCHOOLHOUSE CREE	PRIVATE in L.F.P.	1	RCP	1	1	95	94.5	30	0.0167	0.0167	0.012	6	6	CONVENTIONA	98.0
L280	150' E of NE 184TH ST	SCHOOLHOUSE CREE	PRIVATE in L.F.P.	1	CMPA	2.92	2	140	138.8	21.03	0.0571	0.0571	0.025	44	44	CONVENTIONA	146.0
L290	NE BALLINGER WAY (450' N of 35th Ave NE)	LOWER BRUGGERS	L.F.P./WSDOT	1	RCPA	3.02	1.88	138	137.2	69	0.0116	0.0116	0.012	62	62	CONVENTIONA	145.5
L300	75' W of NE BALLINGER WAY (N of 35th Ave NE)	LOWER BRUGGERS	PRIVATE in L.F.P.	1	CMPA	3.5	2.42	145	144.9	22	0.0045	0.0045	0.025	54	54	CONVENTIONA	150.0
L310	150' W of NE BALLINGER WAY (N of 35th Ave NE)	LOWER BRUGGERS	PRIVATE in L.F.P.	1	CMPA	3.5	2.42	150	149.6	40	0.0100	0.01	0.025	42	42	CONVENTIONA	154.0
L320	S of 30TH AVE NE	LOWER BRUGGERS	L.F.P.	1	CSP	4	4	181	180.8	21	0.0095	0.0095	0.031	138	138	CONVENTIONA	190.0
L330	FOREST PARK DRIVE NE (75' W of 30th Ave NE)	LOWER BRUGGERS	L.F.P.	1	RCP	3	3	190	189.5	52	0.0096	0.0096	0.012	112	112	CONVENTIONA	200.0
L331	NE BALLINGER WAY (225' S of NE 195th St)	LOWER BRUGGERS	L.F.P./WSDOT	1	CSP	2.5	2.5	200	199	60.01	0.0167	0.0167	0.031	33	33	CONVENTIONA	206.0
L332	NE 195TH ST (100' E of NE Ballinger Way)	UPPER BRUGGERS	L.F.P./KING CO.	1	CSP	2.5	2.5	210	209.7	50	0.0060	0.006	0.031	33	33	CONVENTIONA	216.0
L333	25TH AVE NE (300' N of NE Ballinger Way)	UPPER BRUGGERS	KING CO.	1	CSP	2	2	215	210	500.02	0.0100	0.01	0.031	11		CONVENTIONA	218.5
L333	26th AVE NE (300' N of NE Ballinger Way)	UPPER BRUGGERS	KING CO.	2	CSP	2	2	215.5	210	500.03	0.0110	0.011	0.031	11	22	CONVENTIONA	218.5
L340	100' W of NE BALLINGER WAY (S of NE 184th St)	SCHOOLHOUSE CREE	PRIVATE in L.F.P.	1	CSP	2	2	100	99	15.03	0.0665	0.0667	0.045	15	15	CONVENTIONA	102.5
L350	NE BALLINGER WAY (150' S of NE 184th St)	SCHOOLHOUSE CREE	L.F.P./WSDOT	1	CSP	2.5	2.5	110	108.3	54.03	0.0315	0.0315	0.031	33	33	CONVENTIONA	114.0
L360	NE 184TH ST	SCHOOLHOUSE CREE	L.F.P.	1	CSP	3	3	150	148.35	19.07	0.0865	0.0868	0.031	34	34	CONVENTIONA	153.1
L370	175' W of NE BALLINGER WAY	SCHOOLHOUSE CREE	PRIVATE in L.F.P.	1	RCPA	1.83	1.13	88	87.9	15	0.0067	0.0067	0.012	14	14	CONVENTIONA	91.0

Ballinger Creek RCHRES locations used by OCI for flow frequency analysis. 332, 333, and 390

McAleer & Lyon Creeks Culvert Inventory

Owner: City of Lake Forest Park
Project: McAleer & Lyon Creeks Drainage Basin Study

Revised: 3/24/98

Apparent Responsibility Code:
L.F.P. = Lake Forest Park
WSDOT = Wash. State Dept. of Transportation
PRIVATE = culverts on private property
BRIER = Brier
KING CO. = King County
M.L.T. = Mountlake Terrace

*** Denotes capacity at road overtopping.**

Culvert #	Location	Subbasin	Apparent Responsibility	EXISTING CULVERT CONFIGURATION # of Culv's	Culv. Type	Span (ft)	Rise (ft)	Invert Elev.	Outlet Elev.	EXISTING CULVERT CONFIGURATION Length (ft)	Slope (ft/ft)	Slope (ft/ft)	Manning	*Capacity (cfs)	* Total Capacity (cfs)	Inlet Type	Overtop Elev.
L390	225' W of 25TH AVE NE	UPPER BRUGGERS	PRIVATE in KING CO.	1	CSP	2.5	2.5	225	223.7	20.04	0.0649	0.065	0.031	30	30	CONVENTIONA	228.5
L400	CEDAR WAY S (N of SW 244th St)	LYON 6	M.L.T.	1	RCB	5.5	4	265	264.5	65	0.0077	0.0077	0.012	216	216	CONVENTIONA	272.0
L410	50' W of CEDAR WAY S (175' N of SW 244th St)	LYON 6	PRIVATE in M.L.T.	1	CMPA	11.83	7.58	272	271.9	19	0.0053	0.0053	0.027	518	518	CONVENTIONA	281.0
L415	CEDAR WAY S DETENTION POND OUTLET	CEDAR POND	M.L.T.	1										20	20		
L420	CEDAR WAY S (300' S of 237th St SW)	TERRACE	M.L.T.	1	CSP	4	4	298	297.9	120	0.0008	0.0008	0.031	130	130	CONVENTIONA	310.0
L430	475' E of CEDAR WAY S (150' N of 236th St SW)	BRIER	PRIVATE in M.L.T.	1	CMPA	7.92	5.58	332	331.6	70	0.0057	0.0057	0.028	301	301	CONVENTIONA	340.0
L450	525' E of CEDAR WAY S (300' N of 236th St SW)	BRIER	PRIVATE in M.L.T.	1	CMPA	9.75	6.58	335	334.8	40	0.0050	0.005	0.028	760	760	CONVENTIONA	350.0
L460	600' E of CEDAR WAY S (750' N of 236th St SW)	BRIER	PRIVATE in M.L.T.	1	CMPA	9.75	6.58	338	336.3	42.03	0.0404	0.0405	0.028	576	576	CONVENTIONA	348.0
L470	600' S of intersection of 228TH ST SW & 40th Place W	BRIER	PRIVATE in BRIER	1	CSP	4.4	4.4	340	339.3	125	0.0056	0.0056	0.031	114	114	CONVENTIONA	348.0
L480	475' S of intersection of 228TH ST SW & 40th Place W	BRIER	PRIVATE in BRIER	1	CSP	4.5	4.5	345	344.9	13	0.0077	0.0077	0.024	103	103	CONVENTIONA	352.0
L490	237TH ST SW (W of Cedar Way S)	TERRACE	M.L.T.	1	CSP	3	3	300	299.7	60	0.0050	0.005	0.031	113	113	CONVENTIONA	320.0
L500	S of 236TH ST SW	TERRACE	PRIVATE in M.L.T.	1	CSP	4	4	345	342.5	21.15	0.1182	0.119	0.031	96	96	CONVENTIONA	350.5
L510	236TH ST SW	TERRACE	M.L.T.	1	RCPA	3.65	2.22	349	348.6	42	0.0095	0.0095	0.012	78	78	CONVENTIONA	358.0
L512	N of 236TH ST SW	TERRACE	PRIVATE in M.L.T.	1	CSP	4	4	352	350	120.02	0.0167	0.0167	0.031	110	110	CONVENTIONA	360.0
L515	233RD ST SW	TERRACE	M.L.T.	1	CSP	3	3	356	354	150.01	0.0133	0.0133	0.031	87	87	CONVENTIONA	376.0
L520	300' E of CEDAR WAY S (50' S of 237th St SW)	BRIER	PRIVATE in M.L.T.	1	CMPA	7.25	5.25	290	289.6	88	0.0045	0.0045	0.028	442	442	CONVENTIONA	304.0
L530	350' E of CEDAR WAY S (300' N of 237th St SW)	BRIER	M.L.T.	1	CMPA	7.92	5.58	310	308.5	144.01	0.0104	0.0104	0.028	469	469	CONVENTIONA	325.0
L540	48TH AVE W (300' N of 233rd St SW)	TERRACE	M.L.T.	1	RCP	3.75	3.75	359	358.9	42	0.0024	0.0024	0.012	179	179	CONVENTIONA	370.0
L550	250' W of 48TH AVE W	TERRACE	M.L.T.	1	CSP	3.75	3.75	360	359.9	21	0.0048	0.0048	0.031	85	85	CONVENTIONA	366.0
L560	600' W of 48TH AVE W	TERRACE	M.L.T.	1	CSP	2	2	365	363.8	16.04	0.0748	0.075	0.031	59	59	CONVENTIONA	371.0
M570	SHORE DRIVE NE (S of NE 170th St)	McALEER S.	L.F.P.	1		16	5	13.5	13.2	30	0.0100	0.01	0.012	401	401		20.5
M580	45TH AVE NE (S of Beach Drive NE)	McALEER S.	L.F.P.	1	RCB	15	4	15	14.6	30	0.0133	0.0133	0.012	416	416	CONVENTIONA	20.0
M585	BEACH DRIVE NE (W of 45th Ave NE)	McALEER S.	L.F.P.	1	RCB	15	4	17	16.97	30	0.0010	0.001	0.012	302	302	CONVENTIONA	23.0
M590	BOTHELL WAY NE (S of Bothell Way NE)	McALEER S.	L.F.P.	1	RCB	39	7	20	19.99	8	0.0013	0.0013	0.045	540	540	CONVENTIONA	28.0
M600	BOTHELL WAY NE	McALEER S.	L.F.P./WSDOT	1	RCB	14	6	22	21.1	85	0.0106	0.0106	0.012	874	874	CONVENTIONA	31.0
M610	BOTHELL WAY NE (at Hamlin Rd NE)	McALEER S.	L.F.P./WSDOT	1	RCB	16	4	22.5	22.2	21	0.0143	0.0143	0.012	702	702	CONVENTIONA	31.0
M620	37TH AVE NE (125' S of NE 178th St)	HILLSIDE	L.F.P.	1	RCPA	3.65	2.22	70	69.9	65	0.0015	0.0015	0.012	67	67	CONVENTIONA	76.0
M630	35TH AVE NE (175' S of NE 178th St)	HILLSIDE	L.F.P.	1	CSP	2.5	2.5	75	74.6	50	0.0080	0.008	0.031	32	32	CONVENTIONA	80.0
M640	35TH AVE NE (150' S of NE 178th St)	HILLSIDE	L.F.P./PRIVATE in L.F.P.	1	CSP	2	2	74	73.6	30	0.0133	0.0133	0.031	23	23	CONVENTIONA	79.0
M650	NE 178TH ST (S of 178th & W of 35th Ave NE)	HILLSIDE	PRIVATE in L.F.P.	1	RCP	2	2	95	93.75	14.06	0.0889	0.0893	0.012	26	26	CONVENTIONA	99.0
M660	NE 178TH ST (S of 178th & W of 35th Ave NE)	HILLSIDE	PRIVATE in L.F.P.	1	RCP	1.5	1.5	100	97.5	15.21	0.1644	0.1667	0.012	18	18	CONVENTIONA	105.0
M670	33RD AVE NE (S of NE 178th St)	HILLSIDE	L.F.P.	1	RCP	2	2	125	124.9	50	0.0020	0.002	0.012	46	46	CONVENTIONA	135.0
M680	NE 178TH ST (W of 37th Ave NE)	McALEER 2	L.F.P.	1	CMPA	7.25	5.25	65	63.6	60.02	0.0233	0.0233	0.028	327	327	CONVENTIONA	78.0
M690	33RD AVE NE (S of NE 18th St)	McALEER 3	L.F.P.	1	CMPA	5.92	3.92	82.52	81.64	40.01	0.0220	0.022	0.024	133	133	CONVENTIONA	87.9
M700	NE 165TH ST (N of 36th Ave NE)	BROOKSIDE	PRIVATE in L.F.P.	1	CSP	2	2	106	105.2	42.01	0.0190	0.019	0.031	19	19	CONVENTIONA	110.0
M710	NE 178TH ST (W of 29th Ave NE)	HILLSIDE	PRIVATE in L.F.P.	1	CSP	2	2	180	179	60.01	0.0167	0.0167	0.031	20	20	CONVENTIONA	185.0
M720	NE 178TH ST (W of 29th Ave NE)	HILLSIDE	PRIVATE in L.F.P.	1	CSP	2	2	200	196.3	67.1	0.0551	0.0552	0.031	24	24	CONVENTIONA	204.5
M730	NE 178TH ST (W of 29th Ave NE)	HILLSIDE	PRIVATE in L.F.P.	1	CSP	2	2	210	207.2	21.19	0.1321	0.1333	0.031	25	25	CONVENTIONA	214.5
M740	28TH AVE NE (NE 177th Place)	HILLSIDE	L.F.P.	1	CSP	1.5	1.5	255	251.9	41.12	0.0754	0.0756	0.031	8	8	CONVENTIONA	260.0
M750	28TH AVE NE (150' N of NE Meadows Place)	HILLSIDE	L.F.P.	1	RCP	1	1	260	256.6	41.14	0.0826	0.0829	0.012	7	7	CONVENTIONA	264.0
M760	28TH AVE NE (225' N of NE Meadows Place)	HILLSIDE	L.F.P.	1	RCP	1	1	260	258.3	36.04	0.0472	0.0472	0.012	7	7	CONVENTIONA	264.0
M770	28TH AVE NE (440' N of NE Meadows Place)	HILLSIDE	L.F.P.	1	RCP	1	1	260	258.1	32.06	0.0593	0.0594	0.012	7	7	CONVENTIONA	264.0
M780	NE PERKINS WAY	McALEER 3	L.F.P./KING CO.	1	RCPA	3.65	2.22	170	169.6	53	0.0075	0.0075	0.012	172	172	CONVENTIONA	179.0
M785	NE 196TH ST	McALEER 5	KING CO.	1	RCB	2.33	4	220	219.99	1	0.0100	0.01	0.012	122	122	CONVENTIONA	230.0
M790	15TH AVE NE	McALEER 5	KING CO.	1	RCB	4	4	240.5	240	51	0.0098	0.0098	0.012	265	265	CONVENTIONA	255.0
M800	FOREST PARK DRIVE NE (W of 14th Ave NE)	McALEER 5	KING CO.	1	CSP	6	6	254	253.8	50	0.0040	0.004	0.031	407	407	CONVENTIONA	269.0
M802	Eastbound SW 244TH ST ONRAMP TO Northbound I-	McALEER 5	KING CO.	1	CSP	5.5	5.5	257	254.7	300.01	0.0077	0.0077	0.031	288	288	CONVENTIONA	277.0
M804	SW 244TH ST	McALEER 5	KING CO./M.L.T.	1	RCB	6	4	261	258.6	320.01	0.0075	0.0075	0.012	476	476	CONVENTIONA	281.0
M806	Northbound I-5 OFFRAMP TO Northbound I-5 ONRAM	McALEER 5	WSDOT	1	CSP	5.5	5.5	265	263	270.01	0.0074	0.0074	0.031	287	287	CONVENTIONA	285.0
M808	I-5	McALEER 5	WSDOT	1	CSP	5	5	272.72	269	470.01	0.0079	0.0079	0.024	255	255	CONVENTIONA	295.0
M810	NILE TEMPLE GOLF COURSE (East)	McALEER 5	M.L.T./PRIVATE in M.L.T.	1	CSP	5	5	272.66	272.6	21	0.0029	0.0029	0.031	141	141	CONVENTIONA	279.5
M820	NILE TEMPLE GOLF COURSE	McALEER 5	M.L.T./PRIVATE in M.L.T.	1	CSP	5	5	274.21	274.15	23	0.0026	0.0026	0.031	101	101	CONVENTIONA	281.0
M830	NILE TEMPLE GOLF COURSE (West)	McALEER 5	M.L.T./PRIVATE in M.L.T.	1	CSP	5	5	275.02	274.81	44	0.0048	0.0048	0.031	168	168	CONVENTIONA	284.5
													TOTAL CULVERTS:		101		

McAleer Creek RCHRES locations used by OCI for flow frequency analysis.

APPENDIX C

CURRENT CONDITIONS MODELING RESULTS

McAleer & Lyon Creeks Culvert Inventory

Owner: City of Lake Forest Park
Project: McAleer & Lyon Creeks Drainage Basin Study

Revised: 3/18/98

NOTE: "Def." = deficiency (difference between existing culvert capacity and food frequency flow)

		CURRENT CONDITIONS FLOOD FREQUENCIES																	
Culvert #	Location	2 YR FLOOD	2 Yr Flood Flow Def.	% of Cap.	5 YR FLOOD	5 Yr Flood Flow Def.	% of Cap.	10 YR FLOOD	10 Yr Flood Flow Def.	% of Cap.	25 YR FLOOD	25 Yr Flood Flow Def.	% of Cap.	50 YR FLOOD	50 Yr Flood Flow Def.	% of Cap.	100 YR FLOOD	100 Yr Flood Flow Def.	% of Cap.
L5	BEACH DRIVE NE	104.7	196.3	287%	150.7	150.3	200%	182.0	119.0	165%	222.2	78.8	135%	252.6	48.4	119%	283.3	17.7	106%
L10	BOTHELL WAY NE (150' W of NE Ballinger Way)	104.6	202.4	293%	150.6	156.4	204%	181.9	125.1	169%	222.2	84.8	138%	252.7	54.3	121%	283.5	23.5	108%
L20	TOWNE CENTER ENTRANCE FROM BOTHELL WAY																		
L20	TOWNE CENTER ENTRANCE FROM BOTHELL WAY	104.6	21.4	120%	150.6	(24.6)	84%	181.9	(55.9)	69%	222.2	(96.2)	57%	252.7	(126.7)	50%	283.6	(157.6)	44%
L30	TOWNE CENTER (NEAR SKIPPERS)																		
L30	TOWNE CENTER (NEAR SKIPPERS)	104.6	(4.6)	96%	150.7	(50.7)	66%	182.0	(82.0)	55%	222.3	(122.3)	45%	252.8	(152.8)	40%	283.6	(183.6)	35%
L40	TOWNE CENTER (NEAR CLEANERS)																		
L40	TOWNE CENTER (NEAR CLEANERS)	104.6	6.4	106%	150.7	(39.7)	74%	182.1	(71.1)	61%	222.4	(111.4)	50%	252.9	(141.9)	44%	283.7	(172.7)	39%
L60	NE 178TH ST (W of 44th Ave NE)	102.5	155.5	252%	148.5	109.5	174%	179.7	78.3	144%	219.9	38.1	117%	250.3	7.7	103%	280.9	(22.9)	92%
L70	40TH AVE NE (W of NE Ballinger Way)	99.6	108.4	209%	144.0	64.0	144%	174.5	33.5	119%	213.9	(5.9)	97%	243.9	(35.9)	85%	274.3	(66.3)	76%
L80	35TH AVE NE (S of NE Ballinger Way)	94.1	171.9	283%	137.1	128.9	194%	166.7	99.3	160%	205.2	60.8	130%	234.6	31.4	113%	264.6	1.4	101%
L90	NE 185TH ST (W of 35th Ave NE)	94.2	19.8	121%	137.3	(23.3)	83%	167.0	(53.0)	68%	205.8	(91.8)	55%	235.5	(121.5)	48%	265.7	(151.7)	43%
L100	NE BALLINGER WAY (E of 35th Ave NE)	94.1	82.9	188%	137.2	39.8	129%	166.9	10.1	106%	205.5	(28.5)	86%	235.1	(58.1)	75%	265.2	(88.2)	67%
L110	35TH AVE NE (S of NE 190th St)	66.7	30.3	145%	99.2	(2.2)	98%	120.7	(23.7)	80%	147.7	(50.7)	66%	167.5	(70.5)	58%	187.0	(90.0)	52%
L120	35TH AVE NE (N of NE 190th St)	64.2	111.8	274%	95.9	80.1	184%	116.9	59.1	151%	142.9	33.1	123%	161.8	14.2	109%	180.4	(4.4)	98%
L130	165' W of 35TH AVE NE (450' S of NE 195th St)	64.2	131.8	305%	96.0	100.0	204%	116.9	79.1	168%	143.0	53.0	137%	162.1	33.9	121%	180.8	15.2	108%
L140	150' W of 35TH AVE NE (300' S of NE 195th St)																		
L140	150' W of 35TH AVE NE (300' S of NE 195th St)	64.2	179.8	380%	96.0	148.0	254%	117.0	127.0	209%	143.1	100.9	171%	162.2	81.8	150%	180.9	63.1	135%
L150	150' W of 35TH AVE NE (150' S of NE 195th St)	64.2	30.8	148%	96.0	(1.0)	99%	117.0	(22.0)	81%	143.1	(48.1)	66%	162.2	(67.2)	59%	181.0	(86.0)	52%
L155	NE 195TH ST (150' W of 35th Ave NE)	64.2	136.8	313%	96.0	105.0	209%	117.0	84.0	172%	143.1	57.9	140%	162.2	38.8	124%	180.9	20.1	111%
L160	35TH AVE NE (525' S of 40th Place NE)	53.6	92.4	272%	81.9	64.1	178%	100.2	45.8	146%	122.4	23.6	119%	138.3	7.7	106%	153.5	(7.5)	95%
L161	W of 32ND AVE NE (near NE 198th Place)	14.2	21.8	254%	19.3	16.7	187%	22.7	13.3	159%	27.1	8.9	133%	30.4	5.6	118%	33.7	2.3	107%
L163	NE 200TH ST (E of 32nd Ave NE)	14.8	26.2	277%	21.1	19.9	194%	25.6	15.4	160%	31.8	9.2	129%	36.7	4.3	112%	41.9	(0.9)	98%
L164	W of 32ND AVE NE (75' N of NE 200th St)	14.9	(7.9)	47%	21.3	(14.3)	33%	26.0	(19.0)	27%	32.4	(25.4)	22%	37.5	(30.5)	19%	42.8	(35.8)	16%
L165	W of 32ND AVE NE (150' N of NE 200th St)	15.0	7.0	147%	21.5	0.5	102%	26.2	(4.2)	84%	32.6	(10.6)	67%	37.8	(15.8)	58%	43.4	(21.4)	51%
L166	W of 32ND AVE NE (250' N of NE 200th St)	15.1	(13.1)	13%	21.5	(19.5)	9%	26.2	(24.2)	8%	32.6	(30.6)	6%	37.9	(35.9)	5%	43.4	(41.4)	5%
L167	N 204TH ST (W of 33rd Ave NE)	16.9	35.1	308%	24.2	27.8	215%	29.4	22.6	177%	36.5	15.5	142%	42.2	9.8	123%	48.1	3.9	108%
L168	W of 243RD PLACE SW	18.6	(5.6)	70%	26.9	(13.9)	48%	33.2	(20.2)	39%	41.8	(28.8)	31%	48.9	(35.9)	27%	56.5	(43.5)	23%
L170	E of 35TH AVE NE																		
L170	E of 35TH AVE NE	53.6	13.4	125%	82.0	(15.0)	82%	100.3	(33.3)	67%	122.6	(55.6)	55%	138.6	(71.6)	48%	153.9	(86.9)	44%
L180	35TH AVE NE (375' S of 40th Place NE)	53.6	73.4	237%	82.0	45.0	155%	100.4	26.6	126%	122.7	4.3	104%	138.6	(11.6)	92%	154.0	(27.0)	82%
L190	35TH AVE NE (150' S of 40th Place NE)	53.9	17.1	132%	83.1	(12.1)	85%	102.3	(31.3)	69%	126.1	(55.1)	56%	143.2	(72.2)	50%	159.9	(88.9)	44%
L200	40TH PLACE NE (75' W of 35th Ave NE)																		
L200	150' N of 40TH PLACE NE	57.4	85.6	249%	87.9	55.1	163%	107.5	35.5	133%	131.1	11.9	109%	147.9	(4.9)	97%	163.9	(20.9)	87%
L210	37TH AVE NE (300' N of 40th Place NE)	53.0	20.0	138%	82.3	(9.3)	89%	101.1	(28.1)	72%	123.7	(50.7)	59%	139.6	(66.6)	52%	154.8	(81.8)	47%
L220	37TH AVE NE (450' N of 40th Place NE)	53.2	84.8	259%	82.4	55.6	167%	101.1	36.9	136%	123.5	14.5	112%	139.2	(1.2)	99%	154.1	(16.1)	90%
L230	E of 37TH AVE NE	53.2	14.8	128%	82.7	(14.7)	82%	101.6	(33.6)	67%	124.4	(56.4)	55%	140.4	(72.4)	48%	155.6	(87.6)	44%
L240	37TH AVE NE (580' N of 40th Place NE)	53.3	39.7	174%	82.9	10.1	112%	101.8	(8.8)	91%	124.6	(31.6)	75%	140.6	(47.6)	66%	155.8	(62.8)	60%
L250	SW 244TH ST (W of 37th Ave NE / Cedar Way S)	53.4	21.6	140%	83.0	(8.0)	90%	102.0	(27.0)	74%	124.8	(49.8)	60%	140.9	(65.9)	53%	156.1	(81.1)	48%
L255	150' W of NE BALLINGER WAY (S of NE 184th St)	53.4	153.6	388%	83.3	123.7	248%	102.5	104.5	202%	125.6	81.4	165%	141.9	65.1	146%	157.4	49.6	132%
L260	50' W of NE BALLINGER WAY (S of NE 184th St)	6.5	(0.5)	92%	9.9	(3.9)	61%	12.2	(6.2)	49%	15.3	(9.3)	39%	17.7	(11.7)	34%	20.2	(14.2)	30%
L280	150' E of NE 184TH ST	7.1	36.9	620%	10.8	33.2	407%	13.4	30.6	328%	17.1	26.9	257%	19.9	24.1	221%	22.9	21.1	192%
L290	NE BALLINGER WAY (450' N of 35th Ave NE)	36.6	25.4	169%	47.9	14.1	129%	55.1	6.9	113%	63.9	(1.9)	97%	70.3	(8.3)	88%	76.6	(14.6)	81%
L300	75' W of NE BALLINGER WAY (N of 35th Ave NE)	37.9	16.1	142%	51.0	3.0	106%	59.8	(5.8)	90%	71.0	(17.0)	76%	79.5	(25.5)	68%	88.1	(34.1)	61%
L310	150' W of NE BALLINGER WAY (N of 35th Ave NE)	37.9	4.1	111%	50.9	(8.9)	83%	59.7	(17.7)	70%	70.9	(28.9)	59%	79.3	(37.3)	53%	87.9	(45.9)	48%
L320	S of 30TH AVE NE	38.6	99.4	358%	51.7	86.3	267%	60.3	77.7	229%	71.1	66.9	194%	79.2	58.8	174%	87.2	50.8	158%
L330	FOREST PARK DRIVE NE (75' W of 30th Ave NE)	38.7	73.3	289%	51.9	60.1	216%	60.5	51.5	185%	71.2	40.8	157%	79.1	32.9	142%	87.0	25.0	129%
L331	NE BALLINGER WAY (225' S of NE 195th St)	38.0	(5.0)	87%	54.2	(21.2)	61%	66.1	(33.1)	50%	82.6	(49.6)	40%	95.9	(62.9)	34%	110.1	(77.1)	30%

McAleer & Lyon Creeks Culvert Inventory

Owner: City of Lake Forest Park
Project: McAleer & Lyon Creeks Drainage Basin Study

Revised: 3/18/98

NOTE: "Def." = deficiency (difference between existing culvert capacity and food frequency flow)

		CURRENT CONDITIONS FLOOD FREQUENCIES																	
Culvert #	Location	2 YR FLOOD	2 Yr Flood Flow Def.	% of Cap.	5 YR FLOOD	5 Yr Flood Flow Def.	% of Cap.	10 YR FLOOD	10 Yr Flood Flow Def.	% of Cap.	25 YR FLOOD	25 Yr Flood Flow Def.	% of Cap.	50 YR FLOOD	50 Yr Flood Flow Def.	% of Cap.	100 YR FLOOD	100 Yr Flood Flow Def.	% of Cap.
L332	NE 195TH ST (100' E of NE Ballinger Way)	38.8	(5.8)	85%	55.5	(22.5)	59%	67.9	(34.9)	49%	85.1	(52.1)	39%	99.1	(66.1)	33%	114.2	(81.2)	29%
L333	25TH AVE NE (300' N of NE Ballinger Way)																		
L333	26th AVE NE (300' N of NE Ballinger Way)	40.1	(18.1)	55%	56.9	(34.9)	39%	69.5	(47.5)	32%	87.0	(65.0)	25%	101.3	(79.3)	22%	116.7	(94.7)	19%
L340	100' W of NE BALLINGER WAY (S of NE 184th St)	6.7	8.3	224%	10.1	4.9	149%	12.5	2.5	120%	15.8	(0.8)	95%	18.3	(3.3)	82%	21.0	(6.0)	71%
L350	NE BALLINGER WAY (150' S of NE 184th St)	6.7	26.3	493%	10.2	22.8	324%	12.7	20.3	260%	16.0	17.0	206%	18.7	14.3	176%	21.4	11.6	154%
L360	NE 184TH ST	7.0	27.0	486%	10.7	23.3	318%	13.3	20.7	256%	16.9	17.1	201%	19.8	14.2	172%	22.7	11.3	150%
L370	175' W of NE BALLINGER WAY	6.2	7.8	226%	9.3	4.7	151%	11.5	2.5	122%	14.3	(0.3)	98%	16.5	(2.5)	85%	18.7	(4.7)	75%
L390	225' W of 25TH AVE NE	40.7	(10.7)	74%	57.7	(27.7)	52%	70.4	(40.4)	43%	88.0	(58.0)	34%	102.4	(72.4)	29%	117.9	(87.9)	25%
L400	CEDAR WAY S (N of SW 244th St)	53.4	162.6	404%	83.2	132.8	260%	102.4	113.6	211%	125.6	90.4	172%	141.9	74.1	152%	157.4	58.6	137%
L410	50' W of CEDAR WAY S (175' N of SW 244th St)	53.4	464.6	970%	83.3	434.7	622%	102.5	415.5	505%	125.7	392.3	412%	142.0	376.0	365%	157.5	360.5	329%
L415	CEDAR WAY S DETENTION POND OUTLET	53.8	(33.8)	37%	84.3	(64.3)	24%	104.1	(84.1)	19%	127.9	(107.9)	16%	144.9	(124.9)	14%	161.0	(141.0)	12%
L420	CEDAR WAY S (300' S of 237th St SW)	31.9	98.1	408%	42.5	87.5	306%	49.0	81.0	265%	56.6	73.4	230%	61.9	68.1	210%	66.9	63.1	194%
L430	475' E of CEDAR WAY S (150' N of 236th St SW)	33.9	267.1	888%	48.2	252.8	624%	57.9	243.1	520%	70.4	230.6	428%	80.0	221.0	376%	89.7	211.3	336%
L450	525' E of CEDAR WAY S (300' N of 236th St SW)	34.1	725.9	2229%	48.4	711.6	1570%	58.1	701.9	1308%	70.7	689.3	1075%	80.2	679.8	948%	89.9	670.1	845%
L460	600' E of CEDAR WAY S (750' N of 236th St SW)	34.3	541.7	1679%	48.5	527.5	1188%	58.3	517.7	988%	70.9	505.1	812%	80.5	495.5	716%	90.3	485.7	638%
L470	600' S of intersection of 228TH ST SW & 40th Place W	34.5	79.5	330%	48.9	65.1	233%	58.8	55.2	194%	71.7	42.3	159%	81.6	32.4	140%	91.7	22.3	124%
L480	475' S of intersection of 228TH ST SW & 40th Place W	35.2	67.8	293%	49.8	53.2	207%	60.1	42.9	171%	73.8	29.2	140%	84.4	18.6	122%	95.4	7.6	108%
L490	237TH ST SW (W of Cedar Way S)	32.1	80.9	352%	42.6	70.4	265%	49.1	63.9	230%	56.7	56.3	199%	62.0	51.0	182%	67.0	46.0	169%
L500	S of 236TH ST SW	36.6	59.4	262%	48.8	47.2	197%	56.2	39.8	171%	64.9	31.1	148%	71.0	25.0	135%	76.8	19.2	125%
L510	236TH ST SW	36.6	41.4	213%	48.8	29.2	160%	56.2	21.8	139%	64.9	13.1	120%	70.9	7.1	110%	76.6	1.4	102%
L512	N of 236TH ST SW	38.1	71.9	289%	50.8	59.2	217%	58.5	51.5	188%	67.7	42.3	162%	74.2	35.8	148%	80.3	29.7	137%
L515	233RD ST SW	38.1	48.9	228%	50.7	36.3	172%	58.4	28.6	149%	67.6	19.4	129%	74.0	13.0	118%	80.1	6.9	109%
L520	300' E of CEDAR WAY S (50' S of 237th St SW)	33.7	408.3	1312%	47.7	394.3	927%	57.2	384.8	773%	69.5	372.5	636%	78.9	363.1	560%	88.4	353.6	500%
L530	350' E of CEDAR WAY S (300' N of 237th St SW)	33.8	435.2	1388%	47.9	421.1	979%	57.5	411.5	816%	70.0	399.0	670%	79.4	389.6	591%	89.1	379.9	526%
L540	48TH AVE W (300' N of 233rd St SW)	41.6	137.4	430%	59.1	119.9	303%	71.3	107.7	251%	87.3	91.7	205%	99.6	79.4	180%	112.3	66.7	159%
L550	250' W of 48TH AVE W	43.0	42.0	198%	61.6	23.4	138%	75.3	9.7	113%	94.2	(9.2)	90%	109.5	(24.5)	78%	125.8	(40.8)	68%
L560	600' W of 48TH AVE W	45.9	13.1	129%	66.0	(7.0)	89%	81.2	(22.2)	73%	102.8	(43.8)	57%	120.6	(61.6)	49%	140.1	(81.1)	42%
M570	SHORE DRIVE NE (S of NE 170th St)	113.2	287.8	354%	146.0	255.0	275%	167.5	233.5	239%	194.8	206.2	206%	215.2	185.8	186%	235.6	165.4	170%
M580	45TH AVE NE (S of Beach Drive NE)	111.4	304.6	373%	143.7	272.3	289%	165.0	251.0	252%	191.7	224.3	217%	211.7	204.3	197%	231.7	184.3	180%
M585	BEACH DRIVE NE (W of 45th Ave NE)	111.3	190.7	271%	143.7	158.3	210%	164.9	137.1	183%	191.8	110.2	157%	211.8	90.2	143%	231.9	70.1	130%
M590	BOTHELL WAY NE (S of Bothell Way NE)	111.4	428.6	485%	143.7	396.3	376%	165.0	375.0	327%	191.8	348.2	282%	211.8	328.2	255%	231.8	308.2	233%
M600	BOTHELL WAY NE	111.4	762.6	785%	143.7	730.3	608%	165.0	709.0	530%	191.8	682.2	456%	211.8	662.2	413%	231.8	642.2	377%
M610	BOTHELL WAY NE (at Hamlin Rd NE)	111.3	590.7	631%	143.7	558.3	489%	165.0	537.0	425%	191.8	510.2	366%	211.8	490.2	331%	231.8	470.2	303%
M620	37TH AVE NE (125' S of NE 178th St)	16.0	51.0	419%	21.5	45.5	312%	25.1	41.9	267%	29.6	37.4	226%	33.0	34.0	203%	36.3	30.7	185%
M630	35TH AVE NE (175' S of NE 178th St)	5.5	26.5	582%	7.5	24.5	427%	8.8	23.2	364%	10.6	21.4	302%	11.9	20.1	269%	13.3	18.7	241%
M640	35TH AVE NE (150' S of NE 178th St)	5.5	17.5	418%	7.5	15.5	307%	8.8	14.2	261%	10.6	12.4	217%	11.9	11.1	193%	13.2	9.8	174%
M650	NE 178TH ST (S of 178th & W of 35th Ave NE)	5.6	20.4	464%	7.6	18.4	342%	8.9	17.1	292%	10.6	15.4	245%	11.9	14.1	218%	13.2	12.8	197%
M660	NE 178TH ST (S of 178th & W of 35th Ave NE)	5.7	12.3	316%	7.6	10.4	237%	9.0	9.0	200%	10.7	7.3	168%	11.9	6.1	151%	13.2	4.8	136%
M670	33RD AVE NE (S of NE 178th St)	6.1	39.9	754%	8.4	37.6	548%	9.9	36.1	465%	12.0	34.0	383%	13.5	32.5	341%	15.1	30.9	305%
M680	NE 178TH ST (W of 37th Ave NE)	98.7	228.3	331%	127.5	199.5	256%	146.5	180.5	223%	170.5	156.5	192%	188.3	138.7	174%	206.3	120.7	159%
M690	33RD AVE NE (S of NE 18th St)	98.4	34.6	135%	127.1	5.9	105%	146.1	(13.1)	91%	169.9	(36.9)	78%	187.7	(54.7)	71%	205.5	(72.5)	65%
M700	NE 165TH ST (N of 36th Ave NE)	11.5	7.5	165%	15.2	3.8	125%	17.7	1.3	107%	21.0	(2.0)	90%	23.5	(4.5)	81%	26.0	(7.0)	73%
M710	NE 178TH ST (W of 29th Ave NE)	6.6	13.4	303%	9.1	10.9	220%	10.9	9.1	183%	13.3	6.7	150%	15.2	4.8	132%	17.2	2.8	116%
M720	NE 178TH ST (W of 29th Ave NE)	6.7	17.3	358%	9.2	14.8	261%	11.1	12.9	216%	13.7	10.3	175%	15.7	8.3	153%	18.0	6.0	133%
M730	NE 178TH ST (W of 29th Ave NE)	6.8	18.2	368%	9.3	15.7	269%	11.2	13.8	223%	13.9	11.1	180%	16.0	9.0	156%	18.3	6.7	137%
M740	28TH AVE NE (NE 177th Place)	6.8	1.2	118%	9.3	(1.3)	86%	11.2	(3.2)	71%	13.9	(5.9)	58%	16.0	(8.0)	50%	18.3	(10.3)	44%
M750	28TH AVE NE (150' N of NE Meadows Place)	6.8	0.2	103%	9.3	(2.3)	75%	11.2	(4.2)	63%	13.9	(6.9)	50%	16.0	(9.0)	44%	18.3	(11.3)	38%
M760	28TH AVE NE (225' N of NE Meadows Place)	6.8	0.2	103%	9.3	(2.3)	75%	11.2	(4.2)	63%	13.9	(6.9)	50%	16.0	(9.0)	44%	18.3	(11.3)	38%
M770	28TH AVE NE (440' N of NE Meadows Place)	6.8	0.2	103%	9.3	(2.3)	75%	11.2	(4.2)	63%	13.9	(6.9)	50%	16.0	(9.0)	44%	18.3	(11.3)	38%

McAleer & Lyon Creeks Culvert Inventory

Owner: City of Lake Forest Park
Project: McAleer & Lyon Creeks Drainage Basin Study

Revised: 3/18/98

NOTE: "Def." = deficiency (difference between existing culvert capacity and food frequency flow)

		CURRENT CONDITIONS FLOOD FREQUENCIES																	
Culvert #	Location	2 YR FLOOD	2 Yr Flood Flow Def.	% of Cap.	5 YR FLOOD	5 Yr Flood Flow Def.	% of Cap.	10 YR FLOOD	10 Yr Flood Flow Def.	% of Cap.	25 YR FLOOD	25 Yr Flood Flow Def.	% of Cap.	50 YR FLOOD	50 Yr Flood Flow Def.	% of Cap.	100 YR FLOOD	100 Yr Flood Flow Def.	% of Cap.
M780	NE PERKINS WAY	97.6	74.4	176%	127.0	45.0	135%	145.3	26.7	118%	167.5	4.5	103%	183.3	(11.3)	94%	198.7	(26.7)	87%
M785	NE 196TH ST	94.6	27.4	129%	126.2	(4.2)	97%	146.7	(24.7)	83%	172.1	(50.1)	71%	190.8	(68.8)	64%	209.3	(87.3)	58%
M790	15TH AVE NE	69.0	196.0	384%	90.0	175.0	294%	103.3	161.7	257%	119.5	145.5	222%	131.2	133.8	202%	142.7	122.3	186%
M800	FOREST PARK DRIVE NE (W of 14th Ave NE)	63.9	343.1	637%	85.0	322.0	479%	98.4	308.6	414%	114.8	292.2	355%	126.7	280.3	321%	138.2	268.8	295%
M802	Eastbound SW 244TH ST ONRAMP TO Northbound I-5	64.0	224.0	450%	85.1	202.9	338%	98.5	189.5	292%	114.8	173.2	251%	126.7	161.3	227%	138.3	149.7	208%
M804	SW 244TH ST	64.0	412.0	744%	85.1	390.9	559%	98.5	377.5	483%	114.8	361.2	415%	126.7	349.3	376%	138.3	337.7	344%
M806	Northbound I-5 OFFRAMP TO Northbound I-5 ONRAMP	64.0	223.0	448%	85.1	201.9	337%	98.5	188.5	291%	114.8	172.2	250%	126.7	160.3	227%	138.3	148.7	208%
M808	I-5	63.9	191.1	399%	85.1	169.9	300%	98.5	156.5	259%	114.8	140.2	222%	126.7	128.3	201%	138.3	116.7	184%
M810	NILE TEMPLE GOLF COURSE (East)	63.9	77.1	221%	85.1	55.9	166%	98.5	42.5	143%	114.8	26.2	123%	126.7	14.3	111%	138.3	2.7	102%
M820	NILE TEMPLE GOLF COURSE	63.9	37.1	158%	85.1	15.9	119%	98.5	2.5	103%	114.8	(13.8)	88%	126.7	(25.7)	80%	138.3	(37.3)	73%
M830	NILE TEMPLE GOLF COURSE (West)	63.9	104.1	263%	85.1	82.9	197%	98.5	69.5	171%	114.8	53.2	146%	126.7	41.3	133%	138.3	29.7	121%
		# Culv's < 2 YR FLOOD			# Culv's < 5 YR FLOOD			# Culv's < 10 YR FLOOD			# Culv's < 25 YR FLOOD			# Culv's < 50 YR FLOOD			# Culv's < 100 YR FLOOD		
			10			27			31			39			43			47	

APPENDIX E

FUTURE CONDITIONS WITH HYPOTHETICALLY UPSIZED CULVERTS (MAX. FLOW) MODELING RESULTS

McAleer & Lyon Creeks Culvert Inventory

Owner: City of Lake Forest Park
Project: McAleer & Lyon Creeks Drainage Basin Study

Revised: 3/18/98

NOTE: "Def." = deficiency (difference between existing culvert capacity and food frequency flow)

		FUTURE LAND USE & HYPOTHETICALLY UPSIZED CULVERTS FLOOD FREQUENCIES (MAXIMUM POSSIBLE FLOWS)																	
Culvert #	Location	2 YR FLOOD (cfs)	2 Yr Flood Flow Def.	% of Cap.	5 YR FLOOD (cfs)	5 Yr Flood Flow Def.	% of Cap.	10 YR FLOOD (cfs)	10 Yr Flood Flow Def.	% of Cap.	25 YR FLOOD (cfs)	25 Yr Flood Flow Def.	% of Cap.	50 YR FLOOD (cfs)	50 Yr Flood Flow Def.	% of Cap.	100 YR FLOOD (cfs)	100 Yr Flood Flow Def.	% of Cap.
L5	BEACH DRIVE NE	130.4	170.6	231%	181.9	119.1	165%	216.8	84.2	139%	261.8	39.2	115%	295.8	5.2	102%	330.4	(29.4)	91%
L10	BOTHELL WAY NE (150' W of NE Ballinger Way)	130.3	176.7	236%	181.7	125.3	169%	216.4	90.6	142%	261.2	45.8	118%	295.0	12.0	104%	329.4	(22.4)	93%
L20	TOWNE CENTER ENTRANCE FROM BOTHELL WAY																		
L20	TOWNE CENTER ENTRANCE FROM BOTHELL WAY	130.3	(4.3)	97%	181.6	(55.6)	69%	216.4	(90.4)	58%	261.2	(135.2)	48%	295.1	(169.1)	43%	329.5	(203.5)	38%
L30	TOWNE CENTER (NEAR SKIPPERS)																		
L30	TOWNE CENTER (NEAR SKIPPERS)	130.3	(30.3)	77%	181.6	(81.6)	55%	216.4	(116.4)	46%	261.1	(161.1)	38%	295.0	(195.0)	34%	329.4	(229.4)	30%
L40	TOWNE CENTER (NEAR CLEANERS)																		
L40	TOWNE CENTER (NEAR CLEANERS)	130.3	(19.3)	85%	181.6	(70.6)	61%	216.4	(105.4)	51%	261.1	(150.1)	43%	295.0	(184.0)	38%	329.4	(218.4)	34%
L60	NE 178TH ST (W of 44th Ave NE)	126.0	132.0	205%	177.0	81.0	146%	211.6	46.4	122%	256.3	1.7	101%	290.2	(32.2)	89%	324.6	(66.6)	79%
L70	40TH AVE NE (W of NE Ballinger Way)	122.3	85.7	170%	171.8	36.2	121%	205.5	2.5	101%	248.9	(40.9)	84%	281.9	(73.9)	74%	315.4	(107.4)	66%
L80	35TH AVE NE (S of NE Ballinger Way)	113.5	152.5	234%	160.7	105.3	166%	193.3	72.7	138%	235.9	30.1	113%	268.5	(2.5)	99%	302.0	(36.0)	88%
L90	NE 185TH ST (W of 35th Ave NE)	113.6	0.4	100%	161.0	(47.0)	71%	193.7	(79.7)	59%	236.4	(122.4)	48%	269.2	(155.2)	42%	302.7	(188.7)	38%
L100	NE BALLINGER WAY (E of 35th Ave NE)	113.7	63.3	156%	161.1	15.9	110%	193.9	(16.9)	91%	236.5	(59.5)	75%	269.2	(92.2)	66%	302.7	(125.7)	58%
L110	35TH AVE NE (S of NE 190th St)	73.2	23.8	133%	110.3	(13.3)	88%	134.8	(37.8)	72%	165.5	(68.5)	59%	187.9	(90.9)	52%	209.9	(112.9)	46%
L120	35TH AVE NE (N of NE 190th St)	70.6	105.4	249%	106.4	69.6	165%	129.8	46.2	136%	158.6	17.4	111%	179.4	(3.4)	98%	199.7	(23.7)	88%
L130	165' W of 35TH AVE NE (450' S of NE 195th St)	70.6	125.4	278%	106.5	89.5	184%	130.0	66.0	151%	159.0	37.0	123%	179.9	16.1	109%	200.3	(4.3)	98%
L140	150' W of 35TH AVE NE (300' S of NE 195th St)																		
L140	150' W of 35TH AVE NE (300' S of NE 195th St)	70.5	173.5	346%	106.4	137.6	229%	129.9	114.1	188%	158.8	85.2	154%	179.8	64.2	136%	200.1	43.9	122%
L150	150' W of 35TH AVE NE (150' S of NE 195th St)	70.5	24.5	135%	106.4	(11.4)	89%	129.9	(34.9)	73%	158.8	(63.8)	60%	179.7	(84.7)	53%	200.0	(105.0)	48%
L155	NE 195TH ST (150' W of 35th Ave NE)	70.5	130.5	285%	106.4	94.6	189%	129.9	71.1	155%	158.9	42.1	126%	179.8	21.2	112%	200.1	0.9	100%
L160	35TH AVE NE (525' S of 40th Place NE)	58.6	87.4	249%	89.3	56.7	163%	108.7	37.3	134%	131.8	14.2	111%	147.9	(1.9)	99%	163.1	(17.1)	90%
L161	W of 32ND AVE NE (near NE 198th Place)	15.2	20.8	237%	20.6	15.4	175%	24.1	11.9	149%	28.6	7.4	126%	31.9	4.1	113%	35.1	0.9	103%
L163	NE 200TH ST (E of 32nd Ave NE)	16.1	24.9	255%	23.0	18.0	178%	27.8	13.2	147%	34.4	6.6	119%	39.5	1.5	104%	44.8	(3.8)	92%
L164	W of 32ND AVE NE (75' N of NE 200th St)	16.4	(9.4)	43%	23.3	(16.3)	30%	28.3	(21.3)	25%	35.0	(28.0)	20%	40.2	(33.2)	17%	45.7	(38.7)	15%
L165	W of 32ND AVE NE (150' N of NE 200th St)	16.5	5.5	133%	23.5	(1.5)	94%	28.6	(6.6)	77%	35.3	(13.3)	62%	40.6	(18.6)	54%	46.2	(24.2)	48%
L166	W of 32ND AVE NE (250' N of NE 200th St)	16.6	(14.6)	12%	23.6	(21.6)	8%	28.7	(26.7)	7%	35.5	(33.5)	6%	40.8	(38.8)	5%	46.4	(44.4)	4%
L167	N 204TH ST (W of 33rd Ave NE)	16.8	35.2	310%	24.1	27.9	216%	29.4	22.6	177%	36.5	15.5	142%	42.2	9.8	123%	48.2	3.8	108%
L168	W of 243RD PLACE SW	18.6	(5.6)	70%	26.9	(13.9)	48%	33.1	(20.1)	39%	41.7	(28.7)	31%	48.8	(35.8)	27%	56.5	(43.5)	23%
L170	E of 35TH AVE NE																		
L170	E of 35TH AVE NE	58.5	8.5	115%	89.3	(22.3)	75%	108.7	(41.7)	62%	131.8	(64.8)	51%	147.9	(80.9)	45%	163.1	(96.1)	41%
L180	35TH AVE NE (375' S of 40th Place NE)	58.5	68.5	217%	89.2	37.8	142%	108.7	18.3	117%	131.8	(4.8)	96%	147.9	(20.9)	86%	163.1	(36.1)	78%
L190	35TH AVE NE (150' S of 40th Place NE)	58.5	12.5	121%	89.1	(18.1)	80%	108.4	(37.4)	65%	131.5	(60.5)	54%	147.5	(76.5)	48%	162.7	(91.7)	44%
L200	40TH PLACE NE (75' W of 35th Ave NE)																		
L200	150' N of 40TH PLACE NE	60.6	82.4	236%	92.5	50.5	155%	112.7	30.3	127%	136.9	6.1	104%	153.8	(10.8)	93%	169.9	(26.9)	84%
L210	37TH AVE NE (300' N of 40th Place NE)	55.0	18.0	133%	85.2	(12.2)	86%	104.3	(31.3)	70%	127.0	(54.0)	57%	142.8	(69.8)	51%	157.6	(84.6)	46%
L220	37TH AVE NE (450' N of 40th Place NE)	54.9	83.1	251%	85.1	52.9	162%	104.3	33.7	132%	127.2	10.8	108%	143.1	(5.1)	96%	158.2	(20.2)	87%
L230	E of 37TH AVE NE	54.9	13.1	124%	85.2	(17.2)	80%	104.5	(36.5)	65%	127.5	(59.5)	53%	143 5	(75.5)	47%	158.6	(90.6)	43%
L240	37TH AVE NE (580' N of 40th Place NE)	55.0	38.0	169%	85.3	7.7	109%	104.6	(11.6)	89%	127.6	(34.6)	73%	143.7	(50.7)	65%	158.8	(65.8)	59%
L250	SW 244TH ST (W of 37th Ave NE / Cedar Way S)	55.0	20.0	136%	85.4	(10.4)	88%	104.7	(29.7)	72%	127.7	(52.7)	59%	143.8	(68.8)	52%	158.9	(83.9)	47%
L255	150' W of NE BALLINGER WAY (S of NE 184th St)	55.0	152.0	376%	85.4	121.6	242%	104.8	102.2	198%	127.9	79.1	162%	144.0	63.0	144%	159.2	47.8	130%
L260	50' W of NE BALLINGER WAY (S of NE 184th St)	6.6	(0.6)	91%	10.0	(4.0)	60%	12.4	(6.4)	48%	15.7	(9.7)	38%	18.3	(12.3)	33%	21.0	(15.0)	29%
L280	150' E of NE 184TH ST	7.1	36.9	620%	10.8	33.2	407%	13.4	30.6	328%	17.1	26.9	257%	19.9	24.1	221%	22.9	21.1	192%
L290	NE BALLINGER WAY (450' N of 35th Ave NE)	52.8	9.2	117%	64.7	(2.7)	96%	71.9	(9.9)	86%	80.3	(18.3)	77%	86.3	(24.3)	72%	92.0	(30.0)	67%
L300	75' W of NE BALLINGER WAY (N of 35th Ave NE)	53.7	0.3	101%	66.1	(12.1)	82%	73.8	(19.8)	73%	83.0	(29.0)	65%	89.6	(35.6)	60%	96.0	(42.0)	56%
L310	150' W of NE BALLINGER WAY (N of 35th Ave NE)	53.7	(11.7)	78%	66.1	(24.1)	64%	73.7	(31.7)	57%	82.9	(40.9)	51%	89.5	(47.5)	47%	95.8	(53.8)	44%
L320	S of 30TH AVE NE	53.8	84.2	257%	66.2	71.8	208%	73.8	64.2	187%	82.9	55.1	166%	89.4	48.6	154%	95.7	42.3	144%
L330	FOREST PARK DRIVE NE (75' W of 30th Ave NE)	54.6	57.4	205%	66.3	45.7	169%	73.4	38.6	153%	81.6	30.4	137%	87.4	24.6	128%	93.0	19.0	120%
L331	NE BALLINGER WAY (225' S of NE 195th St)	65.6	(32.6)	50%	84.5	(51.5)	39%	97.7	(64.7)	34%	115.0	(82.0)	29%	128.6	(95.6)	26%	142.6	(109.6)	23%
L332	NE 195TH ST (100' E of NE Ballinger Way)	66.0	(33.0)	50%	85.2	(52.2)	39%	98.7	(65.7)	33%	116.6	(83.6)	28%	130.6	(97.6)	25%	145.2	(112.2)	23%
L333	25TH AVE NE (300' N of NE Ballinger Way)																		

McAleer & Lyon Creeks Culvert Inventory

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		FUTURE LAND USE & HYPOTHETICALLY UPSIZED CULVERTS FLOOD FREQUENCIES (MAXIMUM POSSIBLE FLOWS)																	
Culvert #	Location	2 YR FLOOD (cfs)	2 Yr Flood Flow Def.	% of Cap.	5 YR FLOOD (cfs)	5 Yr Flood Flow Def.	% of Cap.	10 YR FLOOD (cfs)	10 Yr Flood Flow Def.	% of Cap.	25 YR FLOOD (cfs)	25 Yr Flood Flow Def.	% of Cap.	50 YR FLOOD (cfs)	50 Yr Flood Flow Def.	% of Cap.	100 YR FLOOD (cfs)	100 Yr Flood Flow Def.	% of Cap.
L333	26th AVE NE (300' N of NE Ballinger Way)	66.7	(44.7)	33%	86.4	(64.4)	25%	100.3	(78.3)	22%	119.0	(97.0)	18%	133.7	(111.7)	16%	149.2	(127.2)	15%
L340	100' W of NE BALLINGER WAY (S of NE 184th St)	6.7	8.3	224%	10.1	4.9	149%	12.6	2.4	119%	15.9	(0.9)	94%	18.5	(3.5)	81%	21.2	(6.2)	71%
L350	NE BALLINGER WAY (150' S of NE 184th St)	6.7	26.3	493%	10.2	22.8	324%	12.7	20.3	260%	16.0	17.0	206%	18.7	14.3	176%	21.4	11.6	154%
L360	NE 184TH ST	7.0	27.0	486%	10.7	23.3	318%	13.3	20.7	256%	16.9	17.1	201%	19.8	14.2	172%	22.7	11.3	150%
L370	175' W of NE BALLINGER WAY	6.3	7.7	222%	9.5	4.5	147%	11.9	2.1	118%	15.1	(1.1)	93%	17.6	(3.6)	80%	20.2	(6.2)	69%
L390	225' W of 25TH AVE NE	67.3	(37.3)	45%	87.2	(57.2)	34%	101.4	(71.4)	30%	120.6	(90.6)	25%	135.7	(105.7)	22%	151.7	(121.7)	20%
L400	CEDAR WAY S (N of SW 244th St)	54.9	161.1	393%	85.3	130.7	253%	104.7	111.3	206%	127.7	88.3	169%	143.9	72.1	150%	159.1	56.9	136%
L410	50' W of CEDAR WAY S (175' N of SW 244th St)	55.0	463.0	942%	85.4	432.6	607%	104.8	413.2	494%	127.9	390.1	405%	144.0	374.0	360%	159.2	358.8	325%
L415	CEDAR WAY S DETENTION POND OUTLET	55.4	(35.4)	36%	86.2	(66.2)	23%	105.8	(85.8)	19%	129.3	(109.3)	15%	145.7	(125.7)	14%	161.1	(141.1)	12%
L420	CEDAR WAY S (300' S of 237th St SW)	32.9	97.1	395%	43.7	86.3	297%	50.1	79.9	259%	57.6	72.4	226%	62.7	67.3	207%	67.6	62.4	192%
L430	475' E of CEDAR WAY S (150' N of 236th St SW)	33.9	267.1	888%	48.2	252.8	624%	57.9	243.1	520%	70.4	230.6	428%	80.0	221.0	376%	89.7	211.3	336%
L450	525' E of CEDAR WAY S (300' N of 236th St SW)	34.1	725.9	2229%	48.4	711.6	1570%	58.1	701.9	1308%	70.7	689.3	1075%	80.2	679.8	948%	89.9	670.1	845%
L460	600' E of CEDAR WAY S (750' N of 236th St SW)	34.3	541.7	1679%	48.5	527.5	1188%	58.3	517.7	988%	70.9	505.1	812%	80.5	495.5	716%	90.3	485.7	638%
L470	600' S of intersection of 228TH ST SW & 40th Place W	34.5	79.5	330%	48.9	65.1	233%	58.8	55.2	194%	71.7	42.3	159%	81.6	32.4	140%	91.7	22.3	124%
L480	475' S of intersection of 228TH ST SW & 40th Place W	35.2	67.8	293%	49.8	53.2	207%	60.1	42.9	171%	73.8	29.2	140%	84.4	18.6	122%	95.4	7.6	108%
L490	237TH ST SW (W of Cedar Way S)	33.0	80.0	342%	43.7	69.3	259%	50.1	62.9	226%	57.7	55.3	196%	63.0	50.0	179%	68.0	45.0	166%
L500	S of 236TH ST SW	38.4	57.6	250%	50.8	45.2	189%	58.1	37.9	165%	66.6	29.4	144%	72.4	23.6	133%	77.8	18.2	123%
L510	236TH ST SW	38.4	39.6	203%	50.8	27.2	154%	58.2	19.8	134%	66.7	11.3	117%	72.5	5.5	108%	77.9	0.1	100%
L512	N of 236TH ST SW	40.0	70.0	275%	53.1	56.9	207%	61.1	48.9	180%	70.4	39.6	156%	76.9	33.1	143%	83.0	27.0	133%
L515	233RD ST SW	40.0	47.0	218%	53.0	34.0	164%	60.8	26.2	143%	70.0	17.0	124%	76.3	10.7	114%	82.3	4.7	106%
L520	300' E of CEDAR WAY S (50' S of 237th St SW)	33.7	408.3	1312%	47.7	394.3	927%	57.2	384.8	773%	69.5	372.5	636%	78.9	363.1	560%	88.4	353.6	500%
L530	350' E of CEDAR WAY S (300' N of 237th St SW)	33.8	435.2	1388%	47.9	421.1	979%	57.5	411.5	816%	70.0	399.0	670%	79.4	389.6	591%	89.1	379.9	526%
L540	48TH AVE W (300' N of 233rd St SW)	47.3	131.7	378%	66.8	112.2	268%	80.2	98.8	223%	97.7	81.3	183%	111.1	67.9	161%	124.8	54.2	143%
L550	250' W of 48TH AVE W	51.3	33.7	166%	73.4	11.6	116%	89.2	(4.2)	95%	110.5	(25.5)	77%	127.4	(42.4)	67%	145.2	(60.2)	59%
L560	600' W of 48TH AVE W	54.1	4.9	109%	77.8	(18.8)	76%	95.1	(36.1)	62%	119.0	(60.0)	50%	138.2	(79.2)	43%	158.7	(99.7)	37%
M570	SHORE DRIVE NE (S of NE 170th St)	125.6	275.4	319%	163.5	237.5	245%	188.7	212.3	213%	220.9	180.1	182%	245.1	155.9	164%	269.6	131.4	149%
M580	45TH AVE NE (S of Beach Drive NE)	123.5	292.5	337%	161.1	254.9	258%	186.1	229.9	224%	217.8	198.2	191%	241.7	174.3	172%	265.9	150.1	156%
M585	BEACH DRIVE NE (W of 45th Ave NE)	123.4	178.6	245%	160.9	141.1	188%	185.8	116.2	163%	217.5	84.5	139%	241.4	60.6	125%	265.5	36.5	114%
M590	BOTHELL WAY NE (S of Bothell Way NE)	123.5	416.5	437%	160.8	379.2	336%	185.6	354.4	291%	217.1	322.9	249%	240.8	299.2	224%	264.7	275.3	204%
M600	BOTHELL WAY NE	123.5	750.5	708%	160.8	713.2	544%	185.5	688.5	471%	217.1	656.9	403%	240.8	633.2	363%	264.7	609.3	330%
M610	BOTHELL WAY NE (at Hamlin Rd NE)	123.5	578.5	568%	160.8	541.2	437%	185.5	516.5	378%	217.1	484.9	323%	240.8	461.2	292%	264.7	437.3	265%
M620	37TH AVE NE (125' S of NE 178th St)	16.5	50.5	406%	22.3	44.7	300%	26.2	40.8	256%	31.2	35.8	215%	35.1	31.9	191%	38.9	28.1	172%
M630	35TH AVE NE (175' S of NE 178th St)	5.6	26.4	571%	7.7	24.3	416%	9.0	23.0	356%	10.8	21.2	296%	12.2	19.8	262%	13.5	18.5	237%
M640	35TH AVE NE (150' S of NE 178th St)	5.6	17.4	411%	7.6	15.4	303%	9.0	14.0	256%	10.8	12.2	213%	12.1	10.9	190%	13.5	9.5	170%
M650	NE 178TH ST (S of 178th & W of 35th Ave NE)	5.7	20.3	456%	7.8	18.2	333%	9.1	16.9	286%	10.9	15.1	239%	12.2	13.8	213%	13.5	12.5	193%
M660	NE 178TH ST (S of 178th & W of 35th Ave NE)	5.8	12.2	310%	7.8	10.2	231%	9.2	8.8	196%	10.9	7.1	165%	12.2	5.8	148%	13.5	4.5	133%
M670	33RD AVE NE (S of NE 178th St)	6.3	39.7	730%	8.6	37.4	535%	10.2	35.8	451%	12.2	33.8	377%	13.8	32.2	333%	15.4	30.6	299%
M680	NE 178TH ST (W of 37th Ave NE)	110.0	217.0	297%	142.9	184.1	229%	164.7	162.3	199%	192.2	134.8	170%	212.8	114.2	154%	233.6	93.4	140%
M690	33RD AVE NE (S of NE 18th St)	109.6	23.4	121%	142.4	(9.4)	93%	164.1	(31.1)	81%	191.4	(58.4)	69%	211.9	(78.9)	63%	232.5	(99.5)	57%
M700	NE 165TH ST (N of 36th Ave NE)	12.2	6.8	156%	16.7	2.3	114%	19.8	(0.8)	96%	24.1	(5.1)	79%	27.5	(8.5)	69%	31.0	(12.0)	61%
M710	NE 178TH ST (W of 29th Ave NE)	6.8	13.2	294%	9.3	10.7	215%	11.2	8.8	179%	13.6	6.4	147%	15.6	4.4	128%	17.7	2.3	113%
M720	NE 178TH ST (W of 29th Ave NE)	6.9	17.1	348%	9.5	14.5	253%	11.4	12.6	211%	14.0	10.0	171%	16.1	7.9	149%	18.4	5.6	130%
M730	NE 178TH ST (W of 29th Ave NE)	6.9	18.1	362%	9.6	15.4	260%	11.5	13.5	217%	14.2	10.8	176%	16.4	8.6	152%	18.8	6.2	133%
M740	28TH AVE NE (NE 177th Place)	6.9	1.1	116%	9.6	(1.6)	83%	11.5	(3.5)	70%	14.2	(6.2)	56%	16.4	(8.4)	49%	18.8	(10.8)	43%
M750	28TH AVE NE (150' N of NE Meadows Place)	6.9	0.1	101%	9.6	(2.6)	73%	11.5	(4.5)	61%	14.2	(7.2)	49%	16.4	(9.4)	43%	18.8	(11.8)	37%
M760	28TH AVE NE (225' N of NE Meadows Place)	6.9	0.1	101%	9.6	(2.6)	73%	11.5	(4.5)	61%	14.2	(7.2)	49%	16.4	(9.4)	43%	18.8	(11.8)	37%
M770	28TH AVE NE (440' N of NE Meadows Place)	6.9	0.1	101%	9.6	(2.6)	73%	11.5	(4.5)	61%	14.2	(7.2)	49%	16.4	(9.4)	43%	18.8	(11.8)	37%
M780	NE PERKINS WAY	107.9	64.1	159%	142.0	30.0	121%	163.6	8.4	105%	189.8	(17.8)	91%	208.7	(36.7)	82%	227.2	(55.2)	76%
M785	NE 196TH ST	101.1	20.9	121%	133.7	(11.7)	91%	155.5	(33.5)	78%	183.5	(61.5)	66%	204.7	(82.7)	60%	226.1	(104.1)	54%
M790	15TH AVE NE	76.8	188.2	345%	99.2	165.8	267%	113.0	152.0	235%	129.7	135.3	204%	141.6	123.4	187%	153.1	111.9	173%
M800	FOREST PARK DRIVE NE (W of 14th Ave NE)	71.7	335.3	568%	94.2	312.8	432%	108.2	298.8	376%	125.0	282.0	326%	137.0	270.0	297%	148.6	258.4	274%

McAleer & Lyon Creeks Culvert Inventory

Owner: City of Lake Forest Park
Project: McAleer & Lyon Creeks Drainage Basin Study

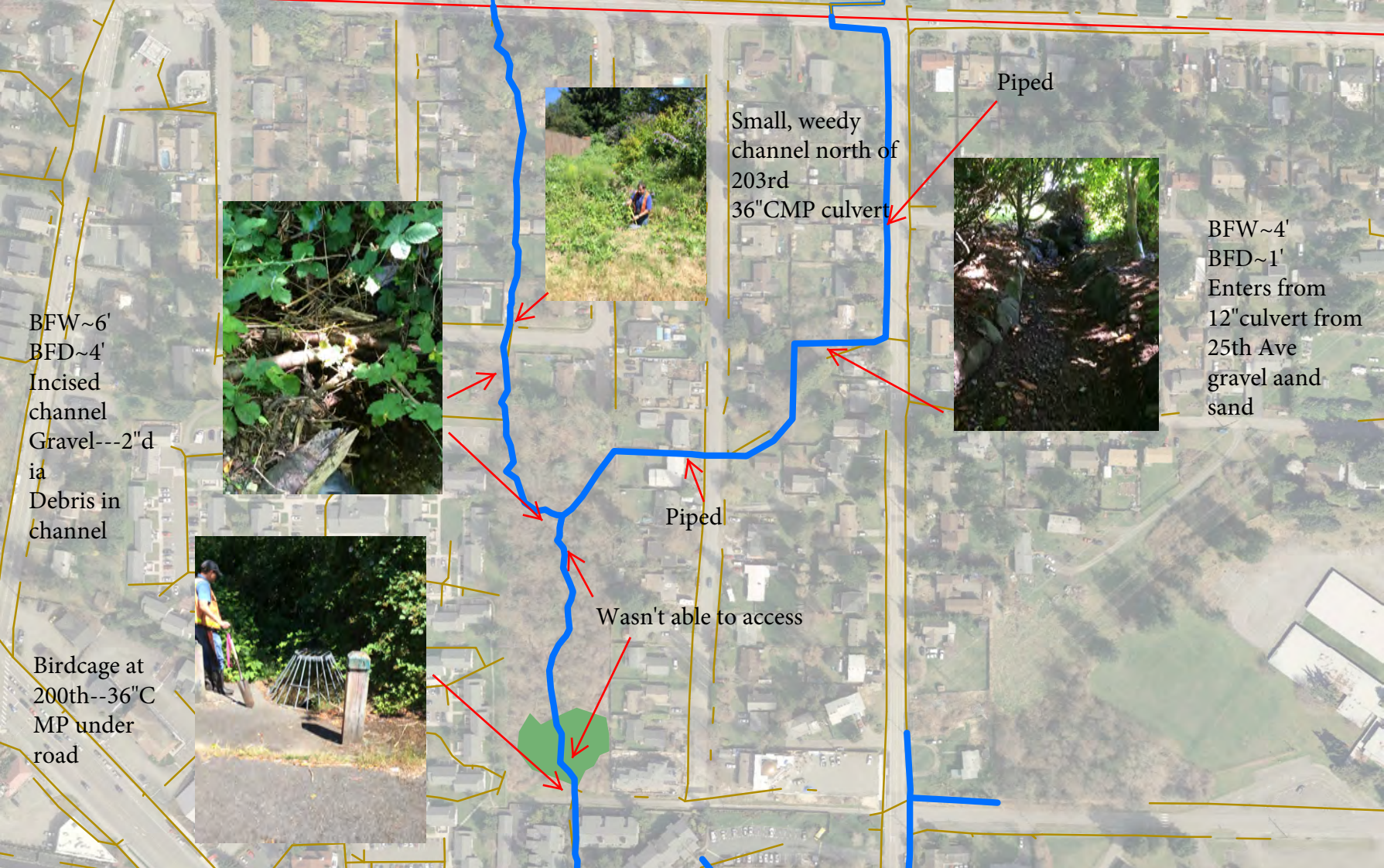
Revised: 3/18/98

NOTE: "Def." = deficiency (difference between existing culvert capacity and food frequency flow)

		FUTURE LAND USE & HYPOTHETICALLY UPSIZED CULVERTS FLOOD FREQUENCIES (MAXIMUM POSSIBLE FLOWS)																	
Culvert #	Location	2 YR FLOOD (cfs)	2 Yr Flood Flow Def.	% of Cap.	5 YR FLOOD (cfs)	5 Yr Flood Flow Def.	% of Cap.	10 YR FLOOD (cfs)	10 Yr Flood Flow Def.	% of Cap.	25 YR FLOOD (cfs)	25 Yr Flood Flow Def.	% of Cap.	50 YR FLOOD (cfs)	50 Yr Flood Flow Def.	% of Cap.	100 YR FLOOD (cfs)	100 Yr Flood Flow Def.	% of Cap.
M802	Eastbound SW 244TH ST ONRAMP TO Northbound I-5	71.7	216.3	402%	94.3	193.7	305%	108.3	179.7	266%	125.1	162.9	230%	137.2	150.8	210%	148.8	139.2	194%
M804	SW 244TH ST	71.7	404.3	664%	94.3	381.7	505%	108.3	367.7	440%	125.1	350.9	380%	137.2	338.8	347%	148.8	327.2	320%
M806	Northbound I-5 OFFRAMP TO Northbound I-5 ONRAM	71.7	215.3	400%	94.2	192.8	305%	108.3	178.7	265%	125.1	161.9	229%	137.2	149.8	209%	148.8	138.2	193%
M808	I-5	71.7	183.3	356%	94.3	160.7	270%	108.3	146.7	235%	125.1	129.9	204%	137.2	117.8	186%	148.8	106.2	171%
M810	NILE TEMPLE GOLF COURSE (East)	71.7	69.3	197%	94.3	46.7	150%	108.3	32.7	130%	125.1	15.9	113%	137.2	3.8	103%	148.8	(7.8)	95%
M820	NILE TEMPLE GOLF COURSE	71.7	29.3	141%	94.3	6.7	107%	108.3	(7.3)	93%	125.1	(24.1)	81%	137.2	(36.2)	74%	148.8	(47.8)	68%
M830	NILE TEMPLE GOLF COURSE (West)	71.7	96.3	234%	94.3	73.7	178%	108.3	59.7	155%	125.1	42.9	134%	137.2	30.8	122%	148.9	19.1	113%
		# Culv's < 2 YR FLOOD (cfs)			# Culv's < 5 YR FLOOD (cfs)			# Culv's < 10 YR FLOOD (cfs)			# Culv's < 25 YR FLOOD (cfs)			# Culv's < 50 YR FLOOD (cfs)			# Culv's < 100 YR FLOOD (cfs)		
			13			31			36			41			47			52	

APPENDIX A-2

FIELD OBSERVATIONS


Small, weedy channel north of 203rd
36"CMP culvert
Piped
BFW~4'
BFD~1'
Enters from 12"culvert from 25th Ave
gravel aand sand
BFW~6'
BFD~4'
Incised channel
Gravel---2"dia
Debris in channel
Piped
Wasn't able to access
Birdcage at 200th--36"CMP under road

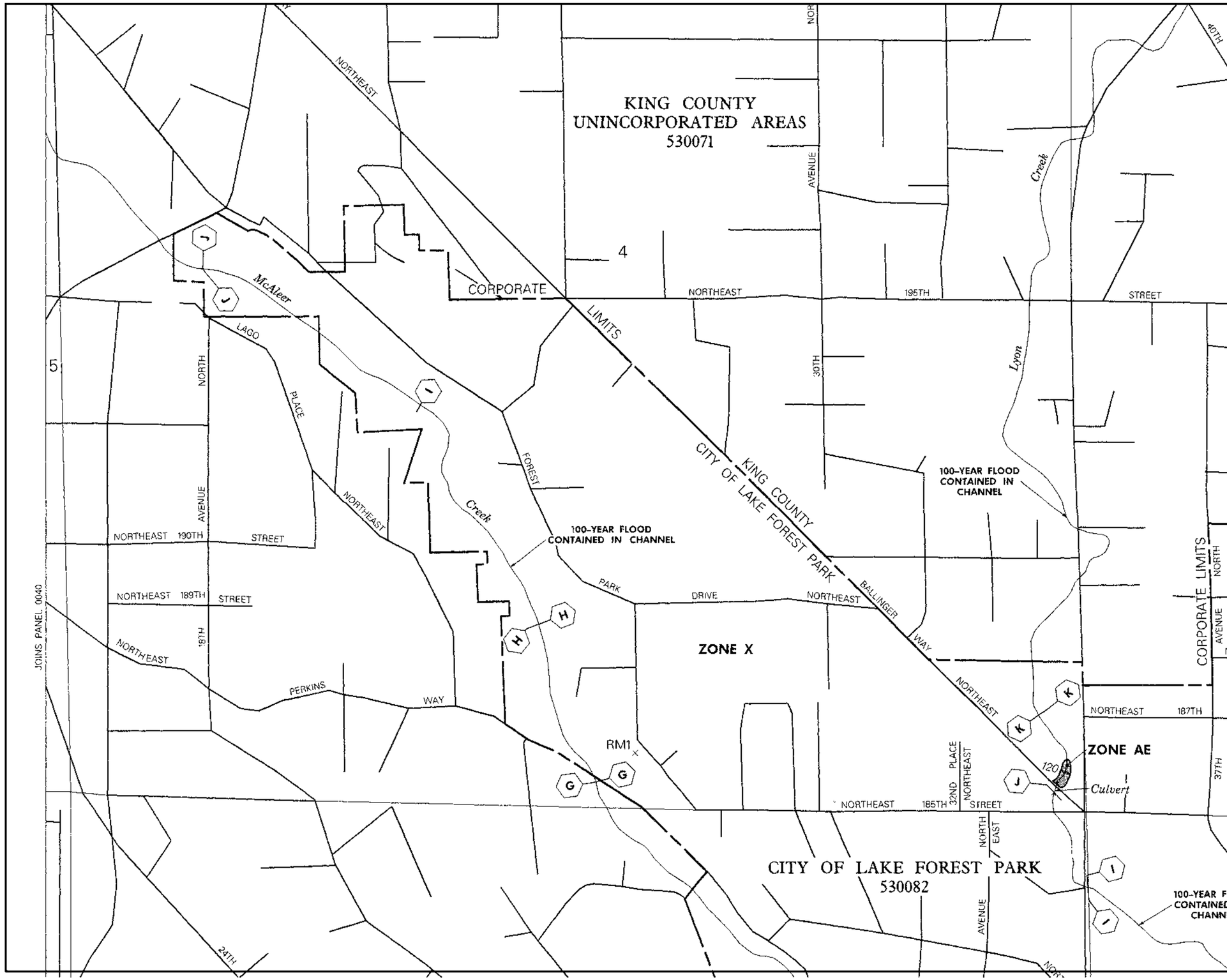
Channel through condo complex
BFW~5'
BFD~3'
Gravel and cobbles
DS culvert is 30"CMP
US culvert is 36"CMP
Pipes entering channel
Riprap
Piped
Timber wall - LB
BFW~3'
BFD~3'
Gravel bed
E. Trib through yards
BFW~3'
BFD~2'
BFW~4"
BFD~3'
Incised, gravel substrate--at confluence

BFW~ 20'
BFD~2"
downstre
am of
bridge
gravel
(1"dia)
Gravel deposition in channel
upstream of debris (~1 inch dia)
Upstream end of culvert
at 25th --24"CMP
BFW~8'
BFD~2'
Sand and
gravel--wetland
area
???stream didn't make
this bend

Piped along 25th Ave
Squashed CMP under driveway
28" Hx 40"W
BFW~8'
BFD~2'
Sand and Gravel substrate,
log grade control--
restoration project--tWC
looking for plans
Culvert under
196th (squashed
CMP--2'Hx 3'W

APPENDIX A-3

BALLINGER CREEK FIRMS



APPROXIMATE SCALE
500 0

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

KING COUNTY, WASHINGTON AND INCORPORATED AREAS

PANEL 43 OF 1725
(SEE MAP INDEX FOR PANELS NOT PRINTED)

COMMUNITY	NUMBER	PANEL	SUFFIX
KING COUNTY, UNINCORPORATED AREAS	530071	0043	F
LAKE FOREST PARK, CITY OF	530082	0043	F

MAP NUMBER
53033C0043 F

MAP REVISED:
MAY 16, 1995

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

E F

122°18'45"
47°48'45"

LEGEND

SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR FLOOD

ZONE A No base flood elevations determined.

ZONE AE Base flood elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.

ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE A99 To be protected from 100-year flood by Federal flood protection system under construction; no base elevations determined.

ZONE V Coastal flood with velocity hazard (wave action); no base flood elevations determined.

ZONE VE Coastal flood with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

ZONE X Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100-year flood.

OTHER AREAS

ZONE X Areas determined to be outside 500-year floodplain.

ZONE D Areas in which flood hazards are undetermined.

UNDEVELOPED COASTAL BARRIERS

Identified 1983 | Identified 1990 | Otherwise Protected Areas

Coastal barrier areas are normally located within or adjacent to Special Flood Hazard Areas.

Flood Boundary

Floodway Boundary

Zone D Boundary

Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones.

~~~513~~~ Base Flood Elevation Line; Elevation in Feet. See Map Index for Elevation Datum.

D——D Cross Section Line

(EL 987) Base Flood Elevation in Feet Where Uniform Within Zone. See Map Index for Elevation Datum.

RM7 × Elevation Reference Mark

● M2 River Mile

97°07'30", 32°22'30" Horizontal Coordinates Based on North American Datum of 1927 (NAD 27) Projection.

NOTES

This map is for use in administering the National Flood Insurance Program; it does not necessarily identify all areas subject to flooding, particularly from

APPROXIMATE SCALE IN FEET

1000 0 1000

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

KING COUNTY, WASHINGTON AND INCORPORATED AREAS

PANEL 40 OF 1725
(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
KING COUNTY, UNINCORPORATED AREAS	530079	0040	F

MAP NUMBER 53033C0040 F

MAP REVISED: MAY 16, 1995

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov
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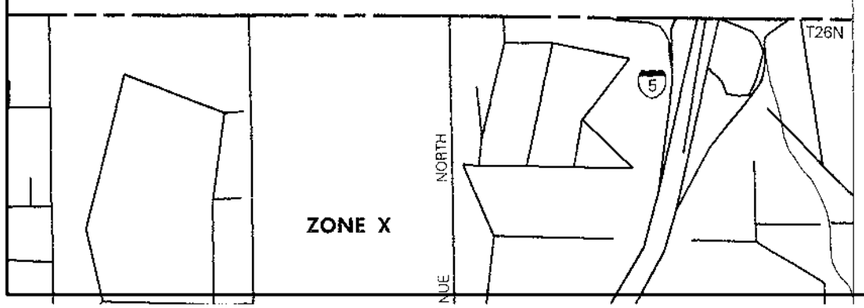

Identified 1983 | Identified 1990 | Otherwise Protected Areas

Coastal barrier areas are normally located within or adjacent to Special Flood Hazard Areas.

Flood Boundary

Floodway Boundary

Zone D Boundary

Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones.

513 — Base Flood Elevation Line; Elevation in Feet. See Map Index for Elevation Datum.

D — D — Cross Section Line

(EL 987) — Base Flood Elevation in Feet Where Uniform Within Zone. See Map Index for Elevation Datum.

RM7 × — Elevation Reference Mark

● M2 — River Mile

97°07'30", 32°22'30" — Horizontal Coordinates Based on North American Datum of 1927 (NAD 27) Projection.

NOTES

This map is for use in administering the National Flood Insurance Program; it does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size, or all planimetric features outside Special Flood Hazard Areas.

Coastal base flood elevations apply only landward of 0.0 NGVD, and include the effects of wave action; these elevations may also differ significantly from those developed by the National Weather Service for hurricane evacuation planning.

Areas of Special Flood Hazard (100-year flood) include Zones A, AE, AH, AO, A99, V, and VE.

Certain areas not in Special Flood Hazard Areas may be protected by flood control structures.

Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the Federal Emergency Management Agency.

Floodway widths in some areas may be too narrow to show to scale. Floodway widths are provided in the Flood Insurance Study Report.

This map may incorporate approximate boundaries of Coastal Barrier Resource System Units and /or Otherwise Protected Areas established under the Coastal Barrier Improvement Act of 1990 (PL 101-591).

Corporate limits shown are current as of the date of this map. The user should contact appropriate community officials to determine if corporate limits have changed subsequent to the issuance of this map.

For community map revision history prior to countywide mapping, see Section 6.0 of the Flood Insurance Study Report.

For adjoining map panels and base map source see separately printed Map Index.

MAP REPOSITORY
Refer to Repository Listing on Map Index

EFFECTIVE DATE OF
COUNTYWIDE FLOOD INSURANCE RATE MAP:

SEPTEMBER 29,1989

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL:
Revised May 16, 1995 to update map format.

To determine if flood insurance is available, contact an insurance agent or call the National Flood Insurance Program at (800) 638-6620.

APPROXIMATE SCALE IN FEET
1000 0 1000

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

KING COUNTY, WASHINGTON AND INCORPORATED AREAS

PANEL 40 OF 1725
(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
KING COUNTY, UNINCORPORATED AREAS	530079	0040	F

MAP NUMBER
53033C0040 F

MAP REVISED:
MAY 16, 1995

Federal Emergency Management Agency

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APPENDIX A-4

MODELING FILES

The following model files are provided to the City via CD.

Title	Description
LyonOtak_TS.uci	HSPF input file
Lyon Creek_Final.prj	HEC-RAS project files. Includes geometry and flow files.

Ballinger Creek, HEC-RAS Files		
Project File:	Lyon Creek_Final.prj	
Plan Files:	LyonCreek_Range of flows	This plan uses the existing conditions geometry but uses a range of flows to determine the capacity of the culvert along 25th.
	Lyon Creek Existing Conditions	This plan represents the existing conditions geometry with flows from the Otak report
	Storage Option 1	This plan represents the exisitng conditions geometry with flows from Storage option 1 in Brugger's Bog Park
	Storage Option 2	This plan represents the exisitng conditions geometry with flows from Storage option 2 in Brugger's Bog Park
	Preferred CIP - 100year Upper Boundary	This plan represens the proposed CIP with updated channel in Brugger's Bog Park, increased culvert capacity in the lower basin, and daylighted creek with 3:1 sideslopes for the upper boundary of the estimated 100-year flood
	Preferred CIP - 100year Lower Bound	This plan represents the proposed CIP with updated channel in Brugger's Bog Park, increased culvert capacity in the lower basin, and daylighted creek with 3:1 side slopes for the lower boundary of the estimated 100-year flood
	CIP Upper 2:1	This plan represents the proposed CIP with updated channel in Brugger's Bog Park, increased culvert capacity in the lower basin, and daylighted creek with 2:1 side slopes for the upper boundary of the estimated 100-year flood
	CIP Lower 2:1	This plan represents the proposed CIP with updated channel in Brugger's Bog Park, increased culvert capacity in the lower basin, and daylighted creek with 2:1 side slopes for the lower boundary of the estimated 100-year flood

Lyon Creek Basin Plan

Appendix B:

City of Shoreline Ballinger Creek Basin Plan
Condition Assessment Summary

OSBORN CONSULTING INCORPORATED

1800 NE 112TH STREET
SUITE 220-E
BELLEVUE, WA 98004
(425) 451-4009

Date: June 12, 2015

Subject: City of Shoreline Ballinger Creek Basin Plan – Condition Assessment Summary

This memorandum presents the results of the Condition Assessment completed as part of the development of the Ballinger Creek Basin Plan for the City of Shoreline. The Condition Assessment work was conducted by Osborn Consulting Inc. (OCI) under contract to the City of Shoreline (City).

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BACKGROUND AND PURPOSE

The Condition Assessment included inspection of all pipes with a diameter of 12-inches or more and a length 25-feet or more within the Ballinger Creek Subbasin within the Lyon Creek Watershed. Everson's Econo-Vac (Everson) was the vendor OCI selected to inspect and rate the pipes through Closed Circuit Television (CCTV) video recording. Everson began the CCTV inspections in May 2014 and completed the final inspections in November 2014. OCI processed and organized the CCTV inspection videos and reports, and updated the City's Geographic Information System (GIS) database with the inspection results.

INSPECTION STANDARD AND PROCESS

The inspection ratings for the pipes inspected through CCTV follow the National Association of Sewer Service Companies (NASSCO) system of rating. The rating system includes three categories; structural, maintenance, and overall pipe conditions. The Structural Pipe Rating (SPR), Maintenance Pipe Rating (MPR) and Overall Pipe Rating (OPR) are based on the sum of the defects (ranging from a score of 0 to 5 per defect) found in each pipe segment in each category, resulting in scores of 0 and above. The rating criteria is shown in **Table 1**.

The pipes were also compared using rating indices. The Structural Pipe Rating Index (SPRI), Maintenance Pipe Rating Index (MPRI), and Overall Pipe Rating Index (OPRI) represent the average of the individual defect scores for all of the defects found in a particular pipe segment, resulting in scores on a 0 to 5 scale.

Table 1: NASSCO Rating Criteria

Grade	Description	Estimated Time to Failure
0	EXCELLENT: No Defects.	Unlikely in the foreseeable future
1	EXCELLENT: Minor Defects.	Unlikely in the foreseeable future
2	GOOD: Defects that have not begun to deteriorate.	20 years or more
3	FAIR: Moderate defects that will continue to deteriorate.	10 to 20 years
4	POOR: Severe defects that will become grade 5 defects within the foreseeable future.	5 to 10 years
5	IMMEDIATE ATTENTION: Defects requiring immediate attention.	Has failed or will likely fail within the next 5 years

Culverts between 25 and 50-feet in length were not inspected using CCTV and the NASSCO rating system, rather through a visual inspection called "candling." Everson shone a flashlight down the length of the culvert and noted any deficiencies which were visible. These pipes were assigned ratings based on the notes provided.

CONDITION ASSESSMENT RESULTS

OCI compiled the information from Everson, including the number of pipes and structures inspected, approximate length in linear feet of inspected pipes, and the number of pipes in each rating category (See **Tables 2, 3,** and **4**). Sixty-one percent of the inventoried pipes have 20 years or more of life left based on the NASSCO rating; however, 31% require immediate attention. **Figure 1** shows all the pipes in the Ballinger Creek Subbasin, with pipes scoring a 5 or higher in SPR, SPRI, MPR, and MPRI highlighted.

Table 2: Ballinger Creek Infrastructure CCTV Inspection Summary

	Number of Pipes	Number of Structures	LF of Inspected Pipes
Total	234	389	18,842

Table 3: Ballinger Creek Infrastructure Candling Inspection Summary

	Number of Pipes	LF of Candled Pipes
Total	7	179

Table 4: Pipe Condition Summary

	Rating=0	Rating=1	Rating=2	Rating=3	Rating=4	Rating=5+
SPR	130	6	12	10	8	75
MPR	73	8	19	13	17	111
OPR	35	4	16	10	11	165
SPRI	130	13	27	52	10	9
MPRI	73	12	79	23	8	46
OPRI	35	14	89	41	11	51
SPR&SPRI	130	6	11	9	3	9
MPR&MPRI	73	8	18	11	6	46
OPR&OPRI	35	4	14	9	4	51

OCI developed lists to succinctly illustrate the results of the inspections and condition of the pipes in Ballinger Basin. **Tables 5** and **6** list the pipes inspected via CCTV and candling, respectively. The lists include the NASSCO ratings, and the pipe diameter, material, and length. Pipes which were identified to be inspected, but which Everson did not inspect are shown in **Table 7**, as well as the reason each pipe was not inspected. With some pipes,

Everson was able to begin inspections, but was unable to complete due to a variety of reasons. **Table 8** lists the pipes and the reasons for the incomplete inspection. Ballinger Creek Basin contains 241 pipes which were inspected either through CCTV or candling; of these, 30 contain no structural or maintenance issues and do not require further inspection. These pipes are summarized on **Table 9**.

RECOMMENDATIONS

Structural Issues

The pipes that were identified to have a poor SPR (≥ 5) were carefully reviewed and several categories were developed to organize the solutions including; 1.) recommended priority open cut pipe replacement, 2.) recommended priority trenchless pipe repair, 3.) illicit utility crossing, 4.) improper storm drain connection, 5.) pipes recommended for second tier repair, and 6.) pipes recommended for operations and maintenance (O&M). These categories are described below.

1.) Recommended Priority Open Cut Pipe Replacement

From the condition assessment, OCI identified pipes that need to be replaced immediately because of their significant deficiencies. These recommended pipe replacements would fix poorly rated pipes that were identified to be high risk of failure and would result in negative consequences associated with failure if that were to occur, based on the prioritization criteria outlined in the "Prioritization Criteria" section below. These pipes are summarized on **Table 10** and shown in **Figure 2**.

2.) Recommended Priority Trenchless Pipe Repair

This category included pipes that received a poor SPR and were identified to be of relatively high risk of failure and/or would result in negative consequences associated with failure if that were to occur. Upon further investigation by OCI, these pipes were identified to be candidates for a trenchless solution. Trenchless solutions include slip-lining, cured in place pipe (CIPP), pipe bursting, and pipe reaming. These pipes are summarized on **Table 11** and shown in **Figure 3**.

3.) Illicit Utility Crossing

There were several structural deficiencies that were a direct result of a utility crossing through the storm drain pipe. Gas lines, water lines, and conduits were identified as the primary crossing issues. It is recommended that the City identify the likely utility owner and coordinate relocation of the utility crossings and repair of the stormwater pipe. OCI has alerted the City to the more serious issues, including gas line crossings, for more immediate action. These pipes are summarized on **Table 12** and shown in **Figure 4**.

4.) Improper Storm Drain Connection

Lateral or side storm drain connections improperly connected to the storm mainline is a common issue throughout the basin. Several of the connections were made with different pipe material and/or have not been grouted in and have resulted in a severe structural deficiency of the storm mainline. Generally the recommended solution for pipes in this category is to install a structure, such as a catch basin or tee and properly connect the

incoming and outgoing pipes to the new structure. These pipes are summarized on **Table 13** and shown in **Figure 4**.

5.) Pipes Recommended for Second Tier Repair

Pipes that did not fall into the categories described above, yet have received a poor SPR were included in this category. Structural deficiencies in this category include pipes that have fractures, holes, or minor deformities. It is recommended that the City place these pipes on a "to be repaired" to ensure the pipe does not fail before the next assessment period. These pipes are summarized on **Table 14** and shown in **Figure 5**.

6.) Pipes Recommended for Operations and Maintenance (O&M)

Several of the pipes require repairs that the City's Operations and Maintenance crews can complete without outside contractor assistance. Pipes that received a poor SPR and were thought to be relatively easy repairs that the City could complete were included in this category. Structural deficiencies in this category include pipes that have fractures, holes, and minor deformities within a relatively short length of pipe. It is recommended that the City monitor the pipes until the Operations and Maintenance crews are able to repair the failures. These pipes are summarized on **Table 15** and shown in **Figure 6**.

Maintenance Issues

The pipes that were identified to have a poor MPR (≥ 5) were carefully reviewed. The majority of the pipes require additional maintenance due to sediment, debris, or root build-up in the pipe. Several pipes are blocked completely by obstacles other than sediment, such as brick structures or basketballs, which need to be removed to ensure pipe functionality.

From the condition assessment several pipes were identified that are likely to need pipe jetting or increased maintenance. These pipes may also need to be potentially replaced in the future if the frequent sedimentation is due to an inadequate design. These pipes are summarized on **Table 16** and shown in **Figure 7**.

Pipe Relocations

A number of City owned pipes in the Ballinger Creek Basin are located on or crossing private property. Many of the pipes were unable to be assessed during the condition assessment because no rights-of-entry (ROEs) were granted and Everson was unable to access the catch basins or manholes. A total of 9 pipes were noted by OCI and the Everson crew as crossing private property. Five of these pipes were able to be accessed and assessed through structures located in the right-of-way. The condition of these pipes are summarized on **Table 17** and shown in **Figure 8**. Additionally, several of the pipes are recommended to be relocated to public right-of-way, or for the City to obtain an easement for better access for future maintenance.

PRIORITIZATION CRITERIA

OCI developed a list of criteria with which to evaluate the possibility of failure, extent of damage, importance of the pipe and impact to the public for each pipe in poor condition.

OCI also considered proximity to other structurally deficient pipes and reviewed other City projects within the basin. Each pipe was scored based on the below criteria.

- Risk of Failure:
  - Slope > 23% (1 point if slope > 23%, 0 points if slope < 23%)
  - Flood Hazard (1 point if in a flood hazard zone, 0 points if not) – no pipes within the Ballinger Basin were located in a flood hazard zone
  - Slide Hazard (1 point if in a slide hazard zone, 0 points if not) – no pipes within the Ballinger Basin were located in a slide hazard zone
  - Erosion Hazard (1 point if in an erosion hazard zone, 0 points if not)
  - Presence of Void (1 point if a void is visible outside the pipe walls, 0 points if no void is visible)
- Consequence of Failure:
  - Arterial Proximity (1 point if crossing or adjacent to an arterial, 0 points if on a collector street)
  - Utility Crossing (1 point if crossed by an outside utility, 0 points if not)
- Importance of Pipe:
  - Location in basin (0 points if upper reach, 1 point if middle reach, or 2 points if lower reach)
  - Size of Storm Drain (0 points if diam. ≤ 12”, 1 point if 12” > diam. < 24”, or 2 points if diam. ≥ 24”)

The SPR and maintenance requirements were also taken into consideration when ranking the pipes. A pipe requiring maintenance due to a poor MPR was given 1 point; no required maintenance received 0 points. Points were then summed to give a total score. The total score dictates the order of priority. For example, a pipe with the following characteristics would receive a total score of 36.

- SPR is 30 (30 points)
- Pipe requires maintenance (1 point)
- Diameter is 18 inches (1 point)
- Is located on an arterial (1 point)
- Is located in the middle of the basin (1 point)
- Has a utility crossing (1 point)
- Does not have a void (0 points)
- Is on a steep slope (1 point)
- Is not in a slide or erosion hazard zone (0 points)

CAPITAL IMPROVEMENT PROJECTS

As a result of the Condition Assessment several Capital Improvement Projects were identified.

2015 Ballinger Creek Basin Stormwater Pipe Replacement

This project would include upgrades and pipe replacement of stormwater pipes and structures throughout the Ballinger Creek Basin. The project would include multiple locations, but be advertised as one construction project. The bid items at each location would be very similar and would achieve economy of scale and ultimately lower bid pricing. The locations would include high priority open cut pipe replacement and installation of storm structures from **Tables 10** and **13**, (excluding the standalone CIP outlined below). Pipes are listed in the tables in order of prioritization for replacement.

Estimated Project Cost = $646,700

2015 Ballinger Creek Basin Trenchless Stormwater Pipe Repair

This project would include replacing approximately 150 linear feet of stormwater pipe in the Ballinger Creek Basin. The project would include multiple locations, but be advertised as one construction project. Locations would include high priority trenchless pipe repairs, excluding the standalone CIP outlined below. Refer to **Table 11** for a prioritized list of pipes recommended for repair.

Estimated Project Cost = $61,600

Pipe Relocations to Right of Way

This project proposes to relocate one pipe from private property to City owned right of way (ROW). An additional two pipes require easement acquisition because it is infeasible to relocate to the ROW. OCI assessed each of the pipes crossing parcel lines for feasibility of relocation. **Table 17** details which pipes can be rerouted, which pipes cannot be rerouted but require the City to purchase an easement, and which pipes are low priority for either relocation or easement acquisition. The table also shows a prioritization of the reroute and easement acquisition projects; projects are listed in order of prioritization. Below is a summary of the top pipe proposed for relocation and its proposed route.

Pipe SP-13079 currently crosses between two property lines from 23rd Ave NE to Ballinger Way NE. The City does not have a drainage easement at the location. OCI proposes to abandon the existing pipe, and install two pipes connecting existing CB-2806 with existing CB-6383. Because of the angle of the intersection and location of CB-6383, two pipes and a new catch basin are required to stay within the ROW.

Two pipes within Ballinger Creek Basin cross private property lines, but rerouting the pipes is infeasible (because of a lack of existing infrastructure, elevation differences, etc.). OCI suggests that the City acquire a drainage easement for pipe SP-13327 and pipe SP-9081.

Estimated Project Cost = $323,700

Table 5: Pipes Inspected Through CCTV										
Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam.	Material	Length	Condition
SP-10466	3.5	2.67	3.14	14	8	22	12	CMP	119.91	Pipe 20% full of water (40 ft), rocks in bottom of pipe (5% full for 1 ft), tap break ins (x2 stormwater), broken pipe (top of pipe, repaired with metal sleeve?), hole in side of pipe, broken side of pipe, broken/hole at joint.
SP-1105	3	0	3	90	0	90	12	CP	144.89	Aggregate visible (length of pipe)
SP-1106	3	0	3	87	0	87	12	CP	157.19	Aggregate visible (145 LF)
SP-1107	3	2	2.96	165	4	169	12	CP	268.08	Aggregate visible (length of pipe), sediment deposit (5% x2)
SP-1134	5	2	2.75	5	6	11	12	CP	66.806	Encrusted deposits, intruding sealing grout, broken (at joint) with gravel/sediment, possible break in US new CB?
SP-1136	3	2	2.5	6	4	10	12	CMP	97.106	Corrosion length of pipe, sediment deposits (x2), camera unable to pass sediment - remainder of pipe the same
SP-1137	3	0	3	3	0	3	12	CP	72.165	Crack
SP-1144	2	4	3	2	4	6	12	PE	101.64	Sag, gravel at bottom of pipe (near end)
SP-1151	3.25	2.29	2.5	13	32	45	18	RCP	81.091	Mineral deposits at infiltration weeper (break at deposit); infiltration runner, broken with soil visible, deposits attached (multiple locations); 3" yard drain tap-in; Infiltration weeper (multiple locations); sag (2); fine roots at joint
SP-11986	3	1	2	3	1	4	12	CMP	30.979	Surface corrosion (hole in side of pipe), fine roots at joint.
SP-1216	0	3	3	0	3	3	12	CP	75.992	Medium roots at joint (10% full)
SP-1219	1	2.31	2.24	1	37	38	12	CP	51.942	Sediment at bottom (length of pipe), joint offset (medium), deposits at joints (multiple)
SP-14463	0	2	2	0	22	22	24	CMP	61.728	1st report: Encrusted deposits (x2), infiltration weeper (x2); 2nd report: Infiltration weep with deposits at joint, infiltration weeps (10+), water in pipe, inlet 50% blocked with vegetation.
SP-159	3	0	3	3	0	3	12	CP	22.445	Fracture (longitudinal)
SP-1618	0	3	3	0	15	15	12	CP	51.421	1st direction: tap-in; 2nd direction: sediment (15% for 20 LF)
SP-1619	0	2	2	0	26	26	12	CP	129.49	Sediment (10% for 20 LF, 10% for 45 LF)
SP-1621	2	0	2	2	0	2	12	CP	23.386	Joint angular (large)
SP-1622	3.36	2	3.15	37	4	41	12	CP	44.723	Aggregate visible (length of pipe), broken soil visible, small attached deposit (x2), deformation with cracks/fractures
SP-1659	0	2.25	2.25	0	9	9	12	CP	72.911	Roots at joints (x4), two 3" perf pipes at inlet buried

Table 5: Pipes Inspected Through CCTV										
Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam.	Material	Length	Condition
SP-166	0	3.11	3.11	0	28	28	12	CP	65.171	Sediment (15% for 40 LF, 30% for 5 LF)
SP-1778	3	2	2.5	3	2	5	12	CP	20.906	Broken pipe (small piece of pipe missing at joint) with intruding sealing grout (looks like someone tried to seal the hole with grout)
SP-1779	0	2	2	0	2	2	12	CP	39.992	Deposits attached encrusted
SP-1780	0	2.2	2.2	0	11	11	12	CP	77.441	Hole or tap-in at 18 ft (not in report), CMP tap-in (stormwater), sediment at joints (5-10% for 20 LF)
SP-1815	1	0	1	1	0	1	18	RCP	153.48	Joint offset (medium), pipe size change (12" to 8" - poor joint job)
SP-1973	3.67	2.47	2.57	11	79	90	30	CMP	173.57	Pipe 20% full of water, rocks in pipe entire length of pipe, Infiltration stains (40'), infiltration weepers (x3), infiltration dripper at hole, deposits attached encrusted at infiltration weeper, large deformation/hole in top of pipe.
SP-1975	0	3	3	0	21	21	12	CP	99.341	Roots at joints - medium (x11), repaired break at joint (repaired with rock and grout)
SP-1977	0	5	5	0	5	5	12	CP	64.67	Joint offset at 41.9?? Sediment in pipe blocking 50%
SP-1978	3.5	2	2.6	7	6	13	18	CMP	169.83	1st direction: infiltration weeper, deformation at bottom of pipe, repair section (PE for 8 LF), joint offset (large); 2nd direction: infiltration weeper (x2)
SP-1979	0	2	2	0	10	10	18	CMP	29.759	Infiltration weeper with encrusted deposits (x2), infiltration weeper
SP-1980	4	2.33	2.75	4	7	11	24	CMP	123.63	small dents in top of pipe, infiltration weepers at joints (x2), 8" conc pipe active tap break in intruding
SP-1981	0	2.2	2.2	0	11	11	12	CP	28.141	Mineral deposits at infiltration weeper (1); sand at bottom; infiltration dripper
SP-1982	0	1	1	0	2	2	12	CP	80.739	Fine roots at joint (2)
SP-1983	3.36	0	3.36	37	0	37	12	CP	43.551	Broken at joint (2); multiple cracks; 12" conc. pipe tap-in; rough bottom
SP-1984	0	2.5	2.5	0	5	5	12	CP	101.69	Fine roots at joint; sediment and rocks on bottom (25-50% full)
SP-1989	0	2.33	2.33	0	7	7	12	CP	70.591	Gravel at bottom; sediment and rocks for 10' at end
SP-1992	3.41	0	3.41	75	0	75	12	CP	73.179	Exposed aggregate entire length of pipe, hole with visible soil in side of pipe at joint, multiple cracks, 2 holes with visible soil at joint (one on each side), multiple fractures and broken piece on top of pipe.

Table 5: Pipes Inspected Through CCTV										
Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam.	Material	Length	Condition
SP-1993	3	2.4	2.67	12	12	24	12	CP	77.304	Broken pipe at joint, spiral crack, Joint offset medium (x2), deposits attached encrusted (x2), gravel in pipe (10'), broken pipe with visible soil at joint, debris/muck blocking 25% of pipe at separated joint, camera unable to pass, end of pipe visible (approx. 10 feet) and in good condition
SP-1994	1.5	2.5	1.7	12	5	17	12	CP	145.33	Medium joint offset (3); roots tap joint (large roots growing from joint downstream through barrel of pipe) - unable to pass, inspect from other end. Joint separation medium, joint offset (not in report) with plastic intruding into pipe, tap break in with broken mainline pipe, joint offset medium, joint separation medium (x2), medium roots at joint - same roots observed from opposite end.
SP-2519	0	2	2	0	2	2	18	RCP	63.267	Intruding sealing grout, repair patch (defective)
SP-2520	3	0	3	60	0	60	12	CP	101.86	Aggregate visible (100 LF), joint angle for last segment
SP-2684	2	0	2	2	0	2	12	CP	109.2	Longitudinal crack
SP-2686	0	2	2	0	4	4	12	CP	125.85	Rocks, sediment deposit
SP-2878	3	1	2.95	111	1	112	12	CP	192.17	Aggregate visible (length of pipe), roots at joint (fine)
SP-2880	3	4	3.25	9	4	13	18	RCP	197.91	Gas line through pipe with multiple cracks and holes.
SP-2907	5	0	5	5	0	5	12	CP	80.631	Broken pipe with soil visible (large rocks visible)
SP-2908	4	2.2	3	16	11	27	24	CMP	73.631	CB-2701 isn't really a CB, it's a hole cut in top of CMP pipe with CB lid on it. Infiltration weeper (x2), hole with soil visible, broken/bent pipe with infiltration weeper, infiltration weeper with storm debris and sticks, hole repaired with metal patch, deformed/dented pipe with several small holes.
SP-2910	1.67	2.67	2.33	5	16	21	12	CP	190.96	Multiple cracks with infiltration stains, roots at joints (x3), 6 inch abandoned (100% full of deposits) tap break in intruding with fine deposits in pipe, deposits attached encrusted, joint separation medium, joint offset medium
SP-2915	3.5	2.8	3	7	14	21	12	CP	63.905	Broken pipe with fine deposits (20% full), gravel in pipe, fine deposits (45% full), longitudinal crack, fine deposits (x2)
SP-2917	1	0	1	2	0	2	12	CP	43.791	Joint offset (medium x2) - unable to pass, possible other joint offset at end of pipe
SP-3407	1.75	0	1.75	7	0	7	12	CP	102.63	Joint angular (large x2), cracks (circumferential and longitudinal)

Table 5: Pipes Inspected Through CCTV										
Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam.	Material	Length	Condition
SP-349	2	2	2	6	4	10	12	CP	68.686	Mud in bottom of pipe (10 ft), longitudinal crack, multiple cracks, joint offset medium
SP-3563	1.75	2	1.83	7	4	11	12	CP	62.269	Joint separation (medium, large x3), sediment (10% for 10 LF)
SP-3743	0	2	2	0	6	6	12	CP	300.86	Sediment deposit (10% x2, 5%)
SP-3769	2.33	1	2	7	1	8	12	CP	94.949	Fine roots at joint, longitudinal cracks (x2), multiple cracks (15 ft)
SP-3770	0	5	5	0	5	5	12	CP	56.83	Rocks blocking 55% of pipe, camera unable to continue - last 20 ft of pipe in good condition, but full of debris.
SP-3773	0	2	2	0	4	4	24	CMP	55.482	Infiltration weeper (x2), CB-2701 is not a CB - it is a hole cut in top of pipe with a lid on it.
SP-3774	0	3	3	0	3	3	12	PE	5.2058	Leaves
SP-3775	4	0	4	4	0	4	12	PE	114.44	Deformed (10%), shavings from pipe (not an issue)
SP-3778	2	2	2	2	2	4	12	CMP	106.06	MSA due to deposits at joints, and hole in bottom of pipe (35% dirt)
SP-3779	0	3	3	0	9	9	12	CP	41.432	Fine deposits (35 ft), garbage blocking 50%+ of pipe camera unable to continue, end of pipe visible, filled with debris, and in good condition. Basketball stuck in pipe?
SP-3783	3	2	2.58	21	10	31	30	CMP	43.081	Corrosion (full length of pipe)
SP-3785	3.33	1	2.75	10	1	11	12	CP	197.76	Small cracks (multiple), broken at joints, fine roots, CB-953 buried
SP-3786	4.2	3	4.09	42	3	45	12	PE	119.99	Holes (top of pipe), pipe crushed, deformed (5% x3, 10%, 25%, & 20%), hole soil visible, tap-in
SP-3787	1	0	1	1	0	1	12	CP	103.7	Cracks, joint offset (medium)
SP-4084	1	2	1.67	1	4	5	12	CP	59.205	Cracks, sediment at joints (multiple), joint separation (medium, multiple)
SP-4285	3	2	2.06	3	32	35	12	CP	65.1	Sediment (5% for length of pipe), debris (x3), fracture (longitudinal for 5 LF)
SP-449	0	2	2	0	20	20	36	RCP	58.875	Sediment (10% length of pipe)
SP-459	3.2	2.43	2.75	16	17	33	12	CP	90.696	Storm debris in pipe, roots at joint (x5), multiple cracks (x2 + 3 ft), longitudinal cracks, broken pipe (brick intruding or repaired with brick), deposits attached encrusted, infiltration stains (x4)
SP-460	0	2	2	0	10	10	12	CP	47.453	Deposits in bottom of pipe (5-10% full entire length of pipe)
SP-464	2	0	2	2	0	2	12	CMP	103.51	Perforations, sag (5%)
SP-4670	2.5	3	2.8	5	9	14	12	CP	41.054	(Standing water) Cracks (multiple), infiltration stain (x3), sediment, roots (medium, x2)

Table 5: Pipes Inspected Through CCTV										
Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam.	Material	Length	Condition
SP-4673	4.33	2	4	26	2	28	12	CP	17.469	Multiple fractures (entire length of pipe), broken pipe at joint, broken pipe with visible soil, dirt in bottom of pipe at break (10% full for 3 ft).
SP-4677	4	3	3.92	96	6	102	24	CMP	66.047	Squashed pipe or deformed (15%)?, corrosion, obstacle (piece of concrete?)
SP-4678	3	3	3	6	9	15	12	PE	75.215	Deformed (5%), infiltration runner/dripper with deposits (x2), sag (10%)
SP-4679	2	0	2	2	0	2	24	CMP	46.081	Crack
SP-4681	3	3	3	6	3	9	12	CP	45.003	Broken (5 LF, x2), wood/rocks/cloth obstacles, joint offset (medium), pipe bends
SP-4689	3	2	2.67	6	2	8	12	CMP	54.375	Corrosion entire length of pipe, deposits attached encrusted
SP-4690	0	2	2	0	2	2	12	CP	8.2586	Grass, dirt, garbage and debris in pipe
SP-4693	4.2	0	4.2	21	0	21	12	CP	82.07	Broken soil visible (at joints, x4), joint offset (medium)
SP-472	0	2.33	2.33	0	7	7	12	CP	369.14	Deposits at joints (x3, 10% full for 10 ft), tap-in (x2, one is active, other full of roots), 4" corrugated yard/roof drain enters pipe at end of 12" CP, also 2 steel or wood rods? no CB. Pipe cleaned, deposits gone. No reverse inspection. No upstream CB.
SP-4780	3.5	2	2.38	7	12	19	12	CP	90.59	Infiltration stain/weeper (x5), crack, broken (protruding - soil visible), encrusted deposits at joint (x2)
SP-5081	3.33	0	3.33	10	0	10	12	CP	176.6	Sag (20% for 5 LF), fracture, fracture (multiple)
SP-5082	0	2.75	2.75	0	11	11	12	CP	40.694	Sediment deposit, rocks, leaves and dirt (20% for 10 LF)
SP-5150	2	0	2	2	0	2	12	CP	121.96	Fracture (circumferential)
SP-5151	0	3.5	3.5	0	7	7	12	CP	7.049	Encrusted deposits, sediment deposit (40%)
SP-5152	1	2	1.86	1	12	13	12	CP	36.797	Sediment (10% length of pipe), joint offset (medium)
SP-5190	3	3	3	6	3	9	12	CMP	116.86	Roots at joint (medium), material change CMP to CP, Joint offset medium, broken pipe
SP-5506	3	2	2.95	54	2	56	12	CP	92.883	Aggregate visible (length of pipe), rocks
SP-5507	3	0	3	156	0	156	12	CP	259.95	Aggregate visible (length of pipe)
SP-5534	0	2	2	0	28	28	12	CP	75.863	Sediment (10% length of pipe)

Table 5: Pipes Inspected Through CCTV										
Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam.	Material	Length	Condition
SP-5537	1.67	2.1	2	5	21	26	12	CP	112.81	Circumferential crack, longitudinal fracture, joint offset medium, infiltration weeper (45 LF), sediment (5% for 45 LF), encrusted deposits (45 LF), rocks (10% x2), dirt and gravel (20%) - unable to pass, inspection completed from other side and clear
SP-5543	0	1.5	1.5	0	3	3	12	CP	102.16	Roots at joint (fine), encrusted deposits
SP-5544	3.5	1	3.22	28	1	29	12	CP	37.824	Broken soil visible with fracture (x3), roots at joint (fine), broken at repair patch, joint offset (medium x2), joint separation (large) - unable to pass, last 4' is fine
SP-5552	2	0	2	2	0	2	12	CP	69.041	Joint offset (large)
SP-5637	3	0	3	3	0	3	24	RCP	22.807	Cracks (multiple)
SP-5638	0	2	2	0	2	2	12	PE	33.767	Encrusted deposits with possible hole, pipe opening at ditch is blocked 60%
SP-5640	0	2	2	0	28	28	18	RCP	83.237	Sediment (10% for 70 LF)
SP-5991	2	2.5	2.44	2	20	22	12	CP	59.689	Encrusted deposits (20% for 20 LF, 10% x4), crack (longitudinal)
SP-5992	0	2	2	0	2	2	12	CP	7.4632	Leaves and dirt (10%)
SP-5993	3	2	2.75	18	4	22	12	CP	28.403	Aggregate visible (length of pipe), encrusted deposit, sediment deposit
SP-5994	1	2	1.78	4	28	32	12	CP	65.174	Sediment (5% length of pipe), joint offset (medium x3), piece of cardboard, joint separation (medium)
SP-5995	3	0	3	12	0	12	12	CP	88.19	Stop at buried CB. Surface damage, visible aggregate for full pipe length. Upstream catch basin buried under asphalt.
SP-6043	3	1.5	2.5	12	3	15	12	CP	16.05	Exposed aggregate entire length of pipe, deposits (roots?) in bottom of pipe (5% full for 3 ft), fine roots at joint
SP-6140	3	0	3	90	0	90	12	CP	151.61	Aggregate visible (length of pipe)
SP-6141	0	5	5	0	5	5	12	CP	49.611	50% debris
SP-6374	0	2	2	0	4	4	12	CP	150.67	Sediment (10% for 10 LF)
SP-6375	0	3	3	0	3	3	12	CP	69.357	Sediment (15% with dirt attached to the top of the pipe)
SP-6405	5	2.33	2.71	5	14	19	18	CMP	71.558	Deformation in top of pipe (blocking 25% of pipe), gravel, infiltration runner/weeper (x4), encrusted deposits
SP-6406	3	2	2.4	6	6	12	12	PE	79.153	Infiltration weeper (x2) with encrusted deposits, deformation, sag (10%)

Table 5: Pipes Inspected Through CCTV										
Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam.	Material	Length	Condition
SP-6414	3.2	2	3	16	2	18	12	CP	39.284	Gravel, cracks (multiple), broken soil visible, crack (longitudinal), joint offset (medium), broken
SP-6423	0	2	2	0	8	8	12	CP	6.3432	Water 10% full. Constant flow of water also observed from downstream ditch location (not in report). Weeping infiltration observed at joints. Sediment deposits (10% full) at joints.
SP-6514	3	0	3	3	0	3	12	CP	41.86	Crack (multiple)
SP-6515	1.5	1	1.33	3	1	4	12	CP	179.64	Crack (longitudinal), joint offset (medium), roots at joint (fine)
SP-6681	4.2	2	3.83	21	2	23	12	CP	80.678	Repair patch (steel) with cracks at joint (multiple), encrusted deposits, broken soil visible (x3, large rocks protruding through pipe), crack (multiple)
SP-6682	4	0	4	8	0	8	12	CP	116.08	Broken, hole void visible
SP-6822	2	0	2	4	0	4	18	CP	47.803	Joint offset (medium), crack (multiple)
SP-6906	3.5	2	2.6	7	6	13	12	CP	59.996	Roots at joint (fine), sediment (15%, 10%), broken (x2)
SP-6907	3	2	2.46	36	28	64	12	CP	64.399	Sediment (10% length of pipe), aggregate visible (length of pipe), sediment deposit (10% x2)
SP-7050	3	2	2.67	6	2	8	12	CMP	29.71	1st pass: encrusted deposits; 2nd pass: corrosion (length of pipe)
SP-7051	0	2	2	0	8	8	24	CMP	97.607	Infiltration stain, infiltration weeper (x2), tap-in, encrusted deposits, rocks
SP-7052	3	0	3	3	0	3	12	CP	55.046	Crack (multiple)
SP-7053	2.33	3	2.5	7	3	10	12	CP	52.385	Crack (multiple for 10 LF), tap-in, joint offset (medium)
SP-7056	4	4	4	16	8	24	12	CP	50.392	Tap-in, broken (x2), cracks (multiple), gravel blocking 50% of pipe last 2 feet
SP-7058	2.75	2.45	2.53	11	27	38	12	CP	140.97	Crack (multiple), repair patch, roots at joint (medium, 10% for 25 LF, 5%, 15% for 10 LF), roots at joint (fine x3), joint offset (medium), broken, joint offset (large) - unable to pass roots and offset, last 5 LF in good condition with roots
SP-7060	0	2.5	2.5	0	5	5	12	CP	56.159	Rocks (5%, 20%)
SP-7062	5	0	5	100	0	100	36	CMP	99.851	Pipe is oval shape
SP-7066	4	4	4	4	4	8	12	PE	92.603	Deformation, gravel (25%) - unable to pass, last 10 LF in good condition
SP-7069	2.5	0	2.5	10	0	10	12	CP	75.826	Crack (multiple x2, longitudinal x2), infiltration stain
SP-7301	3	0	3	90	0	90	12	CP	150.47	Aggregate visible (length of pipe)

Table 5: Pipes Inspected Through CCTV										
Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam.	Material	Length	Condition
SP-7302	3	0	3	21	0	21	12	CP	37.597	Aggregate visible (length of pipe)
SP-767	0	2	2	0	2	2	12	CP	31.194	Encrusted deposits
SP-768	5	3	4.33	10	3	13	12	CP	9.9661	Sediment deposit, hole soil visible, broken - unable to pass deposits, rest of pipe in good condition
SP-769	3	2	2.92	36	2	38	12	CP	52.518	Visible aggregate entire length of pipe, joint offset medium, longitudinal hinge fracture in top of pipe at joint, longitudinal hinge crack, fine settled (attached?) deposits (2 ft))
SP-770	3	3	3	18	9	27	12	CP	32.36	Visible aggregate entire length of pipe, deposits attached encrusted (14 ft, 15% into pipe, both sides)
SP-771	2.53	0	2.53	48	0	48	12	CP	64.577	Visible aggregate entire length of pipe, longitudinal hinge fracture in bottom of pipe at joint, joint offset medium (x5)
SP-772	0	2.13	2.13	0	32	32	12	CP	65.237	Deposits in bottom of entire length of pipe (10% full), deposits attached to side of pipe (20 ft, 15% full both sides)
SP-816	2.75	2	2.6	11	2	13	12	CP	64.191	Pipe starts as PE for about 3 ft at downstream end, then changes to CP pipe for remaining 63 ft, multiple cracks in 3 ft pipe segment, spiral fracture and broken section at joint of same segment, joint offset medium, deposits attached encrusted at joint
SP-817	3	2	2.5	3	2	5	12	CP	114.56	Sediment (5%), small break at joint
SP-8484	0	2.4	2.4	0	12	12	12	CP	32.926	Deposits and debris in pipe (5% full first 20 ft), pile of rocks and debris (15% blocked at two locations)
SP-8491	5	0	5	5	0	5	18	RCP	125.48	Hole in pipe (small broken chunks at joint)
SP-8495	2.5	0	2.5	15	0	15	12	CP	78.828	Tap-in, crack (longitudinal x3, multiple), hole, small break at joint
SP-8630	0	0	0	0	0	0	18	RCP	175.92	Material changes from RCP to PVC for 3.5 ft, then back to RCP. Branch stuck in pipe material transition (looks like pvc pipe section shoved into RCP pipe).
SP-9016	3.5	0	3.5	84	0	84	36	CMP	66.803	Corrosion length of pipe
SP-9081	3.2	3	3.17	16	3	19	12	CP	80.894	Gravel (15%), cracks (multiple x2), broken soil visible (x2), joint offset (medium)

Table 6: Pipes Inspected Through Candling										
Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam.	Material	Length	Condition
SP-1140	5	0	5	5	0	5	12	PE	47.8	Switches to CP mid pipe run, 50% crushed on D/S side (CP pipe)
SP-1990	0	5	5	0	5	5	12	PE	28.5	Good condition, 50% full of debris
SP-3784	0	1	1	0	1	1	12	CP	27.7	Good condition, switches to PVC mid pipe run, 5% dirt
SP-4625	0	5	5	0	5	5	12	CP	26.2	50% full

Table 7: Pipes Unable to be Inspected				
Asset ID	Diam.	Material	Length	Reason Not Inspected
SP-1135	12	CP	11.88	Too dirty, with 50% water
SP-1143	12	CP	40.45	Too dirty
SP-11511	8		28.68	8" Pipe
SP-13079	12	CP	126.98	On private property
SP-13327	12	CP	102.75	On private property
SP-1633	12	CP	60.28	Too dirty
SP-1976	12	CP	75.39	Too dirty, with 50% debris
SP-1985	12	CP	29.69	Too dirty, with 50% water
SP-1986	12	CMP	40.45	No access; cannot insert camera on upper end, lower end is too dirty
SP-1987	12	CP	31.97	Too dirty, with 30% rocks
SP-2905	12	CP	62.50	Too dirty
SP-2909	12	CP	42.85	Too dirty, with 100% water
SP-3780	12	CP	4.50	Culvert under 25'
SP-4085	12	CP	70.64	Too dirty
SP-461	12	CP	68.93	Too dirty, with 50% debris
SP-4691	12	CP	85.70	Too dirty, with 45% debris
SP-5528	12	CP	76.28	Too dirty
SP-5536	12	CP	250.36	Too dirty, with 40% debris
SP-5538	12	CP	21.31	Too dirty, with 50% debris
SP-6486	8	ALLINGERP	35.94	8" pipe
SP-6516	12	CMP	35.24	Too dirty, with 50% debris
SP-7059	12	PE	8.98	Too dirty, with 50% debris
SP-7067	12	CP	290.75	Too dirty
SP-7771	8	CP	12.25	8" Pipe
SP-8242	12		78.00	On private property
SP-8608	12		55.38	No access
SP-9319			73.83	Too dirty, with 80% water and debris
SP-9475	24	CMP	124.57	On private property
SP-9652			42.37	Upper end is control structure, lower end covered in ditch
SP-9845	12	CMP	20.66	Too dirty, with 85% debris
SP-9846	12	CMP	20.74	Too dirty, with 50% debris
SP-9955	12		40.69	Too dirty, with 50% debris

Table 8: Pipes with Incomplete Inspections											
Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam.	Material	Length	Problem	Reason Incomplete
SP-1132	0	5	5	0	5	5	12	CP	140.1187	Root blockages	Maintenance
SP-1142	0	5	5	0	5	5	12	CP	64.12504	Needs more cleaning (100% water)	Maintenance
SP-1145	0	5	5	0	5	5	12	CP	113.1786	Roots and sediment blocking pipe - 3 passes did not clean	Maintenance
SP-13078	0	5	5	0	5	5	12	CP	135.6308	Needs more cleaning	Maintenance
SP-15051	0	5	5	0	5	5			49.72492	Needs more cleaning (75% debris)	Maintenance
SP-15068	0	2	2				8	PVC	41.46467	Sediment and small rocks at bottom of pipe - not finished	Maintenance
SP-15092	0	0	0	0	0	0	12	CP	90.4893	Bend in pipe 121 ft from MH564, unable to continue. Not inspected from other side.	Structural
SP-15105	5	0	5	5	0	5			80.80183	Pinched at joint, upper new CB partially buried in asphalt	Structural
SP-15136	2	0	2	2	0	2	18	RCP	59.61773	Joint offset (large) - unable to pass	Structural
SP-1991	0	2.75	2.75	0	55	55	18	CMP	139.5928	Infiltration stain; gravel at bottom (2); mineral deposit at infiltration weep (4); 8" CMP tap-in - unable to pass. Inspect from other end (no report from other end), camera only able to inspect 10 ft into pipe, unable to continue through deposits and water in bottom of pipe.	Tap-in and Maintenance
SP-2563	0	5	5	0	5	5	12	CP	36.32201	Pipe 45% full of dirt, rocks and debris. Camera unable to continue past 9 ft.	Maintenance
SP-2683	0	5	5	0	5	5	12	CP	86.80199	Blocked (50% debris)	Maintenance
SP-2906	0	5	5	0	5	5	8	CP	84.42396	Pipe size change (90% debris)	Structural
SP-2916	0	5	5	0	5	5	12	CP	24.15125	Needs more cleaning (75% debris)	Maintenance
SP-3768	0	5	5	0	5	5	12	CP	96.43465	Needs more cleaning	Maintenance
SP-3771	0	3	3	0	9	9	12	CP	77.16087	Debris in pipe, blocking up to 40% of pipe, pipe changes to a smaller size, unable to continue. (unable to survey from opposite direction due to car parked over CB)	Structural
SP-4080	0	4	4	0	8	8	12	CMP	106.8719	Pipe 30% plus full of dirt, rocks (and concrete), camera unable to continue.	Maintenance

Table 8: Pipes with Incomplete Inspections											
Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam.	Material	Length	Problem	Reason Incomplete
SP-4290	0	3.33	3.33	0	10	10	12	Concrete	19.00059	Deposits in bottom of pipe (10-50% full for 52 ft) camera unable to continue past debris.	Maintenance
SP-4672	0	5	5	0	5	5	12	CP	51.52298	Needs more cleaning	Maintenance
SP-4682	4	2.33	2.64	8	21	29	12	CP	359.9463	Two Reports b/c of tee in pipe; US: roots (medium-x4, fine-x3), cracks (multiple), tee at 75.7'; DS: broken (repair patch), tap-in, tee at 274.2'	Structural
SP-4683	1	1.17	1.14	1	7	8	12	CP	65.8484	Gravel (10%), rocks (20%), joint offset/separation (incorrectly called 8" pipe in report/video), camera unable to pass. Pipe cleaned and inspected from opposite end. Fine roots at joint (20 ft), joint offset medium, camera unable to pass joint offset, unable to reach same point from opposite side.	Structural
SP-4688	0	5	5	0	5	5	12	CP	29.14462	Needs more cleaning (50% debris)	Maintenance
SP-5188	0	5	5	0	5	5	12	CP	68.94738	Needs more cleaning	Maintenance
SP-5189	0	5	5	0	5	5	12	CP	120.2618	Needs more cleaning	Maintenance
SP-5531	2.6	0	2.6	13	0	13	12	CP	297.6792	Pipe size reduces to 8". Surface damage, visible aggregate for 20 feet. Pipe jogs down at 46.4 ft mark and level of surface damage increases. Shape size change from 12" to 8" at 67 ft mark, joint separation with visible void (not in report) at pipe size transition. Camera unable to continue due to pipe size change.	Structural
SP-5540	0	5	5	0	5	5	12	CP	71.11877	Needs more cleaning, lower CB not accessible	Maintenance
SP-5542	0	2	2	0	2	2	12	CP	55.19032	Gravel and roots - unable to pass after jetting	Maintenance
SP-6403	0	5	5	0	5	5	12	CP	120.3416	Needs more cleaning	Maintenance

Table 8: Pipes with Incomplete Inspections											
Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam.	Material	Length	Problem	Reason Incomplete
SP-6408	0	5	5	0	5	5	12	CP	25.87571	Candled - 50% full of water, 25% dirt, unable to condition (24 LF)	Maintenance
SP-6415	2	3	2.33	4	3	7	12	CP	12.57698	Cracks (multiple), rocks, connected section (PVC for 40 LF), joint offset (medium) - unable to pass, additional rocks at end of pipe	Structural
SP-6421	2	2.5	2.44	2	20	22	18	CP	59.78706	Infiltration runner/weeper (x4) with encrusted deposits, crack (longitudinal), intruding utility - unable to pass	Tap-in
SP-6823	0	5	5	0	5	5	12	CP	79.35603	Needs more cleaning	Maintenance
SP-7063	0	4	4	0	4	4	12	CMP	100.4983	needs more cleaning (40% debris)	Maintenance
SP-7064	0	5	5	0	5	5	12	CP	82.81736	Needs cleaning	Maintenance
SP-815	0	5	5	0	5	5	12	CP	128.2357	Needs more cleaning	Maintenance
SP-8485	0	0	0	0	0	0	12	CMP	20.37493	12 in high x 24 in wide oval pipe for first 10 ft, then changes to circular 12 in concrete pipe, camera unable to continue to concrete pipe due to material change.	Structural
SP-8496	2	3.5	2.75	4	7	11	12	CP	61.02796	Roots at joint (medium), broken, joint offset (medium), sediment (25%) - unable to pass, rest of pipe in good condition	Maintenance
SP-8497	0	5	5	0	5	5	12	CP	47.88225	Needs more cleaning	Maintenance
SP-8609	2.67	2	2.4	8	4	12	12	CP	83.6159	Crack (multiple x3), roots at joint (fine), tap-in - unable to pass	Tap-in
SP-8647	2	3	2.58	10	21	31	24	CMP	102.0009	Sag (10% full for 25 ft), gravel and debris in bottom of pipe (20% full for 35+ ft), camera unable to reach upstream CB, but visual inspection of last 30 ft of pipe looks good (according to report - difficult to see in video).	Maintenance

Table 8: Pipes with Incomplete Inspections											
Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam.	Material	Length	Problem	Reason Incomplete
SP-8834	2	2.5	2.33	2	5	7	12	CP	77.24213	Abandoned tap break in with encrusted deposits, sag, gravel in bottom of pipe, camera unable to continue - soccer balls and gravel in pipe.	Maintenance
SP-8893	0	5	5	0	5	5	18	CMP	101.5803	Unable to pass due to 50% water. Water 25% full for 16 feet, then increases to more than 50%. Camera unable to complete, unable to evaluate pipe condition due to water.	Maintenance
SP-9304	0	3.67	3.67	0	11	11	12	CP	76.36003	1st inspection: encrusted deposits blocking 15% of pipe; pipe cleaned. 2nd inspection: encrusted deposits blocking 25% of pipe	Maintenance

Table 9: Pipes Not Requiring Further Inspection									
Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam.	Material	Length
SP-1108	0	0	0	0	0	0	18	RCP	191.97
SP-1138	0	0	0	0	0	0	12	PE	140.12
SP-11893	0	0	0	0	0	0	12	PE	64.00
SP-1217	0	0	0	0	0	0	12	PE	73.95
SP-1218	0	0	0	0	0	0	18	RCP	35.20
SP-15126	0	0	0	0	0	0	12	CP	61.00
SP-1775	0	0	0	0	0	0	12	PE	142.15
SP-1776	0	0	0	0	0	0	12	PE	142.28
SP-1988	1	0	1	1	0	1	12	PE	83.79
SP-2681	0	0	0	0	0	0	12	PE	97.01
SP-2879	0	0	0	0	0	0	12	CP	4.93
SP-2881	0	0	0	0	0	0	18	RCP	55.83
SP-3564	0	0	0	0	0	0	12	PE	64.72
SP-3742	0	0	0	0	0	0	12	CP	161.13
SP-378	0	0	0	0	0	0	12	CP	26.20
SP-450	0	0	0	0	0	0	18	RCP	69.78
SP-463	0	0	0	0	0	0	12	CP	8.35
SP-4671	0	0	0	0	0	0	12	CP	48.34
SP-4680	0	0	0	0	0	0	12	PE	17.77
SP-4686	0	0	0	0	0	0	12	PE	11.45
SP-4692	0	0	0	0	0	0	12	CP	77.70
SP-5079	0	0	0	0	0	0	12	PE	14.49
SP-5302	0	0	0	0	0	0	12	PE	112.26
SP-5533	0	0	0	0	0	0	12	CP	90.97
SP-5535	0	0	0	0	0	0	12	PE	21.60
SP-5639	0	0	0	0	0	0	18	RCP	18.72
SP-5989	0	0	0	0	0	0	12	CP	69.82
SP-6041	0	0	0	0	0	0	12	CMP	169.89
SP-6407	0	0	0	0	0	0	12	CP	71.16
SP-6416	0	1	1	0	1	1	12	PE	25.78
SP-7057	0	0	0	0	0	0	12	CP	85.33
SP-8483	0	0	0	0	0	0	12	DIP	12.11

Table 9: Pipes Not Requiring Further Inspection									
Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam.	Material	Length
SP-8489	0	0	0	0	0	0	18	RCP	101.82
SP-8492	0	0	0	0	0	0	12	CP	13.91

Table 10: Recommended Open Cut Pipe Replacement

Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam. (inches)	Material	Length	Problem	Increased Maintenance	Arterial	Basin Location*	Illicit Connection	Possible Utility	Void	Slope >23%	Slide Hazard	Erosion Hazard	Notes	SPR	Diam	Increased Maintenance	Arterial	Basin Location	Illicit Connection	Possible Utility	Void	Slope >23%	Slide Hazard	Erosion Hazard	Total
SP-3786	4.2	3	4.09	42	3	45	12	PE	119.99	Holes (top of pipe), pipe crushed, deformed (5% x3, 10%, 25%, & 20%), hole soil visible, tap-in		N	U	Storm water		X					42	0	0	0	0	1	0	1	0	0	0	44
SP-5544	3.5	1	3.22	28	1	29	12	CP	37.82	Broken soil visible with fracture (x3), roots at joint (fine), broken at repair patch, joint offset (medium x2), joint separation (large) - unable to pass, last 4' is fine		N	U			X				Under NE 204th St at 25th Ave NE	28	0	0	0	0	0	0	1	0	0	0	29
SP-4673	4.33	2	4	26	2	28	12	CP	17.47	Multiple fractures (entire length of pipe), broken pipe at joint, broken pipe with visible soil, dirt in bottom of pipe at break (10% full for 3 ft).		Y	M								26	0	0	1	0	0	0	0	0	0	0	27
SP-4693	4.2	0	4.2	21	0	21	12	CP	82.07	Broken soil visible (at joints, x4), joint offset (medium)		N	U			X					21	0	0	0	0	0	0	1	0	0	0	22
SP-7056	4	4	4	16	8	24	12	CP	50.39	Tap-in, broken (x2), cracks (multiple), gravel blocking 50% of pipe last 2 feet		N	U	Storm water						Only open cut for break at 43.5 ft from J05524	16	0	0	0	0	1	0	0	0	0	0	17

Table 10: Recommended Open Cut Pipe Replacement

Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam. (inches)	Material	Length	Problem	Increased Maintenance	Arterial	Basin Location*	Illicit Connection	Possible Utility	Void	Slope >23%	Slide Hazard	Erosion Hazard	Notes	SPR	Diam	Increased Maintenance	Arterial	Basin Location	Illicit Connection	Possible Utility	Void	Slope >23%	Slide Hazard	Erosion Hazard	Total
SP-10466	3.5	2.7	3.14	14	8	22	12	CMP	119.91	Pipe 20% full of water (40 ft), rocks in bottom of pipe (5% full for 1 ft), tap break ins (x2 stormwater), broken pipe (top of pipe, repaired with metal sleeve?), hole in side of pipe, broken side of pipe, broken/hole at joint.		N	M	Storm water x2	X						14	0	0	0	0	1	1	0	0	0	0	16
SP-15136	2	0	2	2	0	2	18	RCP	59.62	Joint offset (large) - unable to pass		N	M				X			Under 25th Ave NE; site visit 10/15/14 identified as pipe repair CIP - also part of 25th Ave CIP.	2	1	0	0	0	0	0	0	1	0	0	4

Table 10: Recommended Open Cut Pipe Replacement

Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam. (inches)	Material	Length	Problem	Increased Maintenance	Arterial	Basin Location*	Illicit Connection	Possible Utility	Void	Slope >23%	Slide Hazard	Erosion Hazard	Notes	SPR	Diam	Increased Maintenance	Arterial	Basin Location	Illicit Connection	Possible Utility	Void	Slope >23%	Slide Hazard	Erosion Hazard	Total
SP-472	0	2.3	2.33	0	7	7	12	CP	35.50	Deposits at joints (x3, 10% full for 10 ft), tap-in (x2, one is active, other full of roots), 4" corrugated yard/roof drain enters pipe at end of 12" CP, also 2 steel or wood rods? no CB. Pipe cleaned, deposits gone. No reverse inspection. No upstream CB.		N	M	Storm water (x2)						No CB at upstream end. Upstream end of pipe is point where 4 inch plastic pipe enters 12 inch CP pipe. Not inspected from CB-5645. CB-5645 does not connect to SP-472. A pipe extends south towards Ballinger Way from CB-5645 and daylights 30-40 ft downstream. It is not connected to SP-472. Everson's best guess is that the 4 inch pipe at the end of SP-472 is a roof drain, and that the pipe used to be an open ditch that was filled in long ago by a homeowner or homeowners.	0	0	0	0	0	1	0	0	0	0	0	1

* U = Upper Ballinger, M = Middle Ballinger

Table 11: Recommended Trenchless Pipe Repair

Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam. (inches)	Material	Length	Problem	Increased Maintenance	Arterial	Basin Location*	Illicit Connection	Possible Utility	Void	Slope >23%	Slide Hazard	Erosion Hazard	Notes	SPR	Diam	Increased Maintenance	Arterial	Basin Location	Illicit Connection	Possible Utility	Void	Slope >23%	Slide Hazard	Erosion Hazard	Total
SP-1992	3.4	0	3	75	0	75	12	CP	73.18	Exposed aggregate entire length of pipe, hole with visible soil in side of pipe at joint, multiple cracks, 2 holes with visible soil at joint (one on each side), multiple fractures and broken piece on top of pipe.		N	U		X					Multiple fractures look to be in danger of pipe collapse. Possibly caused by another utility? Trenchless repair probably possible now, but if pipe collapses, open cut will become necessary.	75	0	0	0	0	0	1	0	0	0	0	76
SP-1993	3	2	3	12	12	24	12	CP	77.30	broken pipe at joint, spiral crack, Joint offset medium (x2), deposits attached encrusted (x2), gravel in pipe (10'), broken pipe with visible soil at joint, debris/muck blocking 25% of pipe at separated joint, camera unable to pass, end of pipe visible (approx. 10 feet) and in good condition	Y	N	U								12	0	1	0	0	0	0	0	0	0	0	13

Table 12: Illicit Utility Crossing

Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam. (inches)	Material	Problem	Increased Maintenance	Arterial	Basin Location*	Illicit Connection	Possible Utility	Void	Notes
SP-2880	3	4	3.25	9	4	13	18	RCP	Gas line through pipe with multiple cracks and holes.		Y	M	Gas			
SP-6421	2	2.5	2.44	2	20	22	18	CP	Infiltration runner/weeper (x4) with encrusted deposits, crack (longitudinal), intruding utility - unable to pass		N	M	Cable			

* M = Middle Ballinger

Table 13: Improper Storm Drain Connection																
Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam.	Material	Problem	Increased Maintenance	Arterial	Basin Location*	Illicit Connection	Possible Utility	Void	Notes
SP-10466	3.5	2.67	3.14	14	8	22	12	CMP	Pipe 20% full of water (40 ft), rocks in bottom of pipe (5% full for 1 ft), tap break ins (x2 stormwater), broken pipe (top of pipe, repaired with metal sleeve?), hole in side of pipe, broken side of pipe, broken/hole at joint.		N	M	Stormwater x2	X		
SP-472	0	2.33	2.33	0	7	7	12	CP	Deposits at joints (x3, 10% full for 10 ft), tap-in (x2, one is active, other full of roots), 4" corrugated yard/roof drain enters pipe at end of 12" CP, also 2 steel or wood rods? no CB. Pipe cleaned, deposits gone. No reverse inspection. No upstream CB.	Y	N	M	Stormwaterx2			Part of 25th Ave CIP. No CB at upstream end. Upstream end of pipe is point where 4 inch plastic pipe enters 12 inch CP pipe. CB-5645 does not connect to SP-472. A pipe extends south towards Ballinger Way from CB-5645 and daylights 30-40 ft downstream. It is not connected to SP-472.

Table 13: Improper Storm Drain Connection																
Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam.	Material	Problem	Increased Maintenance	Arterial	Basin Location*	Illicit Connection	Possible Utility	Void	Notes
SP-1618	0	3	3	0	15	15	12	CP	1st direction: tap-in; 2nd direction: sediment (15% for 20 LF)	Y	Y	U	Stormwater			
SP-7053	2.3	3	2.5	7	3	10	12	CP	Crack (multiple for 10 LF), tap-in, joint offset (medium)		Y	M	Stormwater			Pipe only needs repair at tap-in
SP-1151	3.3	2.29	2.5	13	32	45	18	RCP	Mineral deposits at infiltration weeper (break at deposit); infiltration runner, broken with soil visible, deposits attached (multiple locations); 3" yard drain tap-in; Infiltration weeper (multiple locations); sag (2); fine roots at joint		N	M	Stormwater			
SP-1780	0	2.2	2.2	0	11	11	12	CP	Hole or tap-in at 18 ft (not in report), CMP tap-in (stormwater), sediment at joints (5-10% for 20 LF)	Y	N	U	Stormwater			
SP-1980	4	2.33	2.75	4	7	11	24	CMP	small dents in top of pipe, infiltration weepers at joints (x2), 8" conc pipe active tap break in intruding	Y	N	L	Stormwater			Site visit 10/15/14 identified as part of 25th Ave CIP.

Table 13: Improper Storm Drain Connection																
Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam.	Material	Problem	Increased Maintenance	Arterial	Basin Location*	Illicit Connection	Possible Utility	Void	Notes
SP-1983	3.4	0	3.36	37	0	37	12	CP	Broken at joint (2); multiple cracks; 12" conc. pipe tap-in; rough bottom		N	M	Stormwater			
SP-1991	0	2.75	2.75	0	55	55	18	CMP	Infiltration stain; gravel at bottom (2); mineral deposit at infiltration weep (4); 8" CMP tap-in - unable to pass. Inspect from other end (no report from other end), camera only able to inspect 10 ft into pipe, unable to continue through deposits and water in bottom of pipe.	Y	N	L	Stormwater			Part of 25th Ave CIP.
SP-1994	1.5	2.5	1.7	12	5	17	12	CP	Medium joint offset (3); roots tap joint (large roots growing from joint downstream through barrel of pipe) - unable to pass, inspect from other end. Joint separation medium, joint offset (not in report) with plastic intruding into pipe, tap break in with broken mainline pipe, joint offset medium, joint separation medium (x2), medium roots at joint - same roots observed from opposite		N	M	Stormwater			

Table 13: Improper Storm Drain Connection

Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam.	Material	Problem	Increased Maintenance	Arterial	Basin Location*	Illicit Connection	Possible Utility	Void	Notes
SP-3786	4.2	3	4.09	42	3	45	12	PE	Holes (top of pipe), pipe crushed, deformed (5% x3, 10%, 25%, & 20%), hole soil visible, tap-in		N	U	Stormwater		X	
SP-4682	4	2.33	2.64	8	21	29	12	CP	Two Reports b/c of tee in pipe; US: roots (medium-x4, fine-x3), cracks (multiple), tee at 75.7'; DS: broken (repair patch?), tap-in, tee at 274.2'		N	M	Stormwater			Need to add CB's at tees
SP-7051	0	2	2	0	8	8	24	CMP	Infiltration stain, infiltration weeper (x2), tap-in, encrusted deposits, rocks	Y	N	L	Stormwater			Part of 25th Ave CIP.
SP-7056	4	4	4	16	8	24	12	CP	Tap-in, broken (x2), cracks (multiple), gravel blocking 50% of pipe last 2 feet		N	U	Stormwater			Only open cut for break at 43.5 ft from J05524
SP-8834	2	2.5	2.33	2	5	7	12	CP	Abandoned tap break in with encrusted deposits, sag, gravel in bottom of pipe, camera unable to continue - soccer balls and gravel in pipe.		N	U	Abandoned Stormwater			

* U = Upper Ballinger, M = Middle Ballinger, L = Lower Ballinger

Table 14: Pipes Recommended for Second Tier Repair

Repair Type	Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam. (inches)	Material	Length	Problem	Increased Maintenance	Arterial	Basin Location*	Illicit Connection	Possible Utility	Void	Slope >23%	Slide Hazard	Erosion Hazard	Notes	OPR	Diam	Increased Maintenance	Arterial	Basin Location	Illicit Connection	Possible Utility	Void	Slope >23%	Slide Hazard	Erosion Hazard	Total
	SP-1151	3.25	2.29	2.5	13	32	45	18	RCP	81.09	Mineral deposits at infiltration weeper (break at deposit); infiltration runner, broken with soil visible, deposits attached (multiple locations); 3" yard drain tap-in; Infiltration weeper (multiple locations); sag (2); fine roots at joint		N	M	Storm water							45	1	0	0	0	1	0	0	0	0	0	47
Trenchless	SP-7058	2.75	2.45	2.53	11	27	38	12	CP	140.97	Crack (multiple), repair patch, roots at joint (medium, 10% for 25 LF, 5%, 15% for 10 LF), roots at joint (fine x3), joint offset (medium), broken, joint offset (large) - unable to pass roots and offset, last 5 LF in good condition with roots	Y	N	M				X				38	0	1	0	0	0	0	0	1	0	0	40

Table 14: Pipes Recommended for Second Tier Repair

Repair Type	Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam. (inches)	Material	Length	Problem	Increased Maintenance	Arterial	Basin Location*	Illicit Connection	Possible Utility	Void	Slope >23%	Slide Hazard	Erosion Hazard	Notes	OPR	Diam	Increased Maintenance	Arterial	Basin Location	Illicit Connection	Possible Utility	Void	Slope >23%	Slide Hazard	Erosion Hazard	Total
	SP-769	3	2	2.92	36	2	38	12	CP	52.52	Visible aggregate entire length of pipe, joint offset medium, longitudinal hinge fracture in top of pipe at joint, longitudinal hinge crack, fine settled (attached?) deposits (2 ft))		Y	U		X					Longitudinal hinge fracture in top of pipe at joint could be damage from adjacent utility.	38	0	0	1	0	0	1	0	0	0	0	40
	SP-1983	3.36	0	3.36	37	0	37	12	CP	43.55	Broken at joint (2); multiple cracks; 12" conc. pipe tap-in; rough bottom		N	M	Storm water							37	0	0	0	0	1	0	0	0	0	0	38
	SP-4682	4	2.33	2.64	8	21	29	12	CP	359.95	Two Reports b/c of tee in pipe; US: roots (medium-x4, fine-x3), cracks (multiple), tee at 75.7'; DS: broken (repair patch?), tap-in, tee at 274.2'		N	M	Storm water						Need to add CB's at tees	29	0	0	0	0	1	0	0	0	0	0	30

* U= Upper Ballinger, M = Middle Ballinger

Table 15: Pipes Recommended for Operations and Maintenance (O&M)

Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam. (inches)	Material	Length	Problem	Inc. Maint.	Arterial	Basin Loc.*	Illicit Conn.	Poss. Utility	Void	Slope >23%	Slide Haz.	Erosion Hazard	Notes	SPR	Inc. Maint.	Arterial	Basin Loc.	Illicit Conn.	Poss. Utility	Void	Slope >23%	Slide Hazard	Erosion Hazard	Total
SP-6414	3.2	2	3	16	2	18	12	CP	39.28	Gravel, cracks (multiple), broken soil visible, crack (longitudinal), joint offset (medium), broken	Y	N	U								16	1	0	0	0	0	0	0	0	0	17
SP-9081	3.2	3	3.17	16	3	19	12	CP	80.89	Gravel (15%), cracks (multiple x2), broken soil visible (x2), joint offset (medium)		N	U								16	0	0	0	0	0	0	0	0	0	16

* U= Upper Ballinger

Table 16: Pipes Recommended for Jetting or Increased Maintenance

Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam. (inches)	Material	Length	Problem	Increased Maintenance	Arterial	Basin Location*	Illicit Connection	Possible Utility	Void	Slope >23%	Slide Hazard	Erosion Hazard	Notes	MPR	Increased Maintenance	Arterial	Basin Location	Illicit Connection	Possible Utility	Void	Slope >23%	Slide Hazard	Erosion Hazard	Total
SP-1219	1	2.31	2.24	1	37	38	12	CP	51.94	Sediment at bottom (length of pipe), joint offset (medium), deposits at joints (multiple)	Y	N	M								37	1	0	0	0	0	0	0	0	0	38
SP-166	0	3.11	3.11	0	28	28	12	CP	65.17	Sediment (15% for 40 LF, 30% for 5 LF)	Y	Y	U								28	1	1	0	0	0	0	0	0	0	30
SP-5534	0	2	2	0	28	28	12	CP	75.86	Sediment (10% length of pipe)	Y	N	M								28	1	0	0	0	0	0	0	0	0	29
SP-6907	3	2	2.46	36	28	64	12	CP	64.40	Sediment (10% length of pipe), aggregate visible (length of pipe), sediment deposit (10% x2)	Y	Y	U								28	1	1	0	0	0	0	0	0	0	30
SP-1619	0	2	2	0	26	26	12	CP	129.49	Sediment (10% for 20 LF, 10% for 45 LF)	Y	Y	U								26	1	1	0	0	0	0	0	0	0	28
SP-8647	2	3	2.58	10	21	31	24	CMP	102.00	Sag (10% full for 25 ft), gravel and debris in bottom of pipe (20% full for 35+ ft), camera unable to reach upstream CB, but visual inspection of last 30 ft of pipe looks good (according to report - difficult to see in video).	Y	Y	M				X				21	1	1	0	0	0	0	1	0	0	24
SP-5537	1.67	2.1	2	5	21	26	12	CP	112.81	Circumferential crack, longitudinal fracture, joint offset medium, infiltration weeper (45 LF), sediment (5% for 45 LF), encrusted deposits (45 LF), rocks (10% x2), dirt and gravel (20%) - unable to pass, inspection completed from other side and clear	Y	N	M								21	1	0	0	0	0	0	0	0	0	22

Table 16: Pipes Recommended for Jetting or Increased Maintenance

Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam. (inches)	Material	Length	Problem	Increased Maintenance	Arterial	Basin Location*	Illicit Connection	Possible Utility	Void	Slope >23%	Slide Hazard	Erosion Hazard	Notes	MPR	Increased Maintenance	Arterial	Basin Location	Illicit Connection	Possible Utility	Void	Slope >23%	Slide Hazard	Erosion Hazard	Total
SP-5991	2	2.5	2.44	2	20	22	12	CP	59.69	Encrusted deposits (20% for 20 LF, 10% x4), crack (longitudinal)	Y	Y	U								20	1	1	0	0	0	0	0	0	0	22
SP-459	3.2	2.43	2.75	16	17	33	12	CP	90.70	storm debris in pipe, roots at joint (x5), multiple cracks (x2 + 3 ft), longitudinal cracks, broken pipe (brick intruding? Repaired with brick?), deposits attached encrusted, infiltration stains (x4)		Y	U								17	0	1	0	0	0	0	0	0	0	18
SP-4290	0	3.33	3.33	0	10	10	12	Conc	19.00	Deposits in bottom of pipe (10-50% full for 52 ft) camera unable to continue past debris.	Y	N	L								10	1	0	0	0	0	0	0	0	0	11
SP-4080	0	4	4	0	8	8	12	CMP	106.87	Pipe 30% plus full of dirt, rocks (and concrete?), camera unable to continue.	Y	N	U								8	1	0	0	0	0	0	0	0	0	9
SP-8893	0	5	5	0	5	5	18	CMP	101.58	Unable to pass due to 50% water. Water 25% full for 16 feet, then increases to more than 50%. Camera unable to complete, unable to evaluate pipe condition due to water.	Y	N	L				X				5	1	0	0	0	0	0	1	0	0	7
SP-2563	0	5	5	0	5	5	12	CP	36.32	Pipe 45% full of dirt, rocks and debris. Camera unable to continue past 9 ft.	Y	N	U								5	1	0	0	0	0	0	0	0	0	6

* U= Upper Ballinger, M = Middle Ballinger, L = Lower Ballinger

Table 17: Pipes Recommended for Relocation to Right of Way

Project	Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam. (inches)	Material	Length	Problem	Increased Maintenance	Arterial	Basin Location*	Illicit Connection	Possible Utility	Void	Notes
Relocate 1	SP-13079							12	CP	126.98	On private property		N	L				Open ditch outlet? Reroute.
Easement 1	SP-13327							12	CP	102.75	On private property		N	U				Connects Drainage channel to main roadway pipe network through one property. Reroute not feasible. Easement needed.
Easement 2	SP-9081	3.2	3	3.17	16	3	19	12	CP	80.89	Gravel (15%), cracks (multiple x2), broken soil visible (x2), joint offset (medium)		N	U				Connects Drainage channel to main roadway pipe network through 2 properties. Reroute not feasible. Need easement.
Other Pipes Crossing Private Property	SP-15092	0	0	0	0	0	0	12	CP	90.49	Bend in pipe 121 ft from MH564, unable to continue. Not inspected from other side.		N	M				Need new CB at bend? Pipe flows outside City Limits
	SP-15136	2	0	2	2	0	2	18	RCP	59.62	Joint offset (large) - unable to pass		N	M				Under 25th Ave NE; site visit 10/15/14 identified as pipe repair CIP - also part of 25th Ave CIP. Pipe is picking up drainage channel on private property.
	SP-3774	0	3	3	0	3	3	12	PE	5.21	Leaves		N	M				Short pipe collecting flow from natural channel on a private residence.
	SP-5637	3	0	3	3	0	3	24	RCP	22.81	Cracks (multiple)		Y	U				Connects stream/drainage channel under 205th (flow comes from Edmonds). ROE granted.
	SP-8242							12		78.00	On private property		N	U				Conveys drainage from gas station to pipe network. ROE granted by property owner, but pipes not inspected.
	SP-9475							24	CMP	124.57	On private property		Y	M				ROE granted. Property owned by King County Housing Authority.

* U = Upper Ballinger, M = Middle Ballinger, L = Lower Ballinger

Lyon Creek Basin Plan

Appendix C:

Service Calls for Lyon Creek Basin

Appendix C
Service Calls
Drainage for Lyon Creek Basin

CALLDATE	PROBLEM	RESPONSIBLE	COMMENTS	ADDRESS
9/19/2002	maintenance	SURFACE WATER	SHE SAID THE VEGETATION IN THE DRAINAGE DITCH HAS GROWN AND SHEWOULD LIKE TO HAVE THE DRAINAGE DITCH ALONG 200TH BWTN 24TH AND THE CREEK MOWED.	2200 NE 201ST PL
10/30/2002	maintenance	SURFACE WATER	STRAW ABOVE CATCH BASIN AND IS CLOGGING STREAM IN SHORELINE PARK . CALL IS CONCERNED SHOULD IT RAIN IT WILL BACK UP AND CAUSE HER CONDO TO FLOOD. ABOU	2200 NE 201ST PL
3/14/2003	drainage	SURFACE WATER	CUSTOMER WOULD LIKE TO TALK ABOUT UPSTREAM WATER DRAINING DOWN ONTO KING COUNTY HOUSING AUTHORITY PROPERTY BALLINGER HOMES.	2200 NE 201ST PL
3/24/2003	drainage	SURFACE WATER	CUSTOMER SAYS A STORM DRAIN MAY BE BLOCKED OR SOMETHING ELSE WRONG. LAST WEEK A LARGE RUSH OF WATER CAME DOWN THE STREET AND ERODED THE SHOULDER, EXP	20006 25TH AVE NE
7/25/2003	drainage	PRIVATE PROPERTY MATTER	CUSTOMER IS HAVING A DRAINAGE PROBLEM UNDER HIS HOUSE AND WOULD LIKE TO KNOW IF IT IS A SURFACE WATER PROBLEM. CUSTOMER REPORTS THERE IS A STORM DRAIN	20003 24TH AVE NE
10/21/2003	drainage	SURFACE WATER	CUSTOMER HAS A SURFACE WATER THAT RUNS OFF THE STREET DOWN INTO HIS DRIVEWAY AND WOULD LIKE TO SPEAK WITH SOMEONE ABOUT IT.	2531 NE 205TH ST
11/19/2003	flood	SURFACE WATER	CUSTOMER REPORTS THEY HAVE FLOODED 2X'S WITHIN THE LAST MONTH THE MAIN DRAIN IN THEIR PARKING LOT IS OVERFLOWING DUE TO SURFACE WATER COME FROM DOWN T	2605 NE 195TH LN
11/24/2003	maintenance	SURFACE WATER	CUSTOMER WOULD LIKE DITCH IN FRONT OF THE BALLINGER REALITY CLEANED OUT. CUSTOMER WOULD LIKE YOU TO CALL BEFORE YOU GO OUT SO THAT SHE MAY MEET YOU O	20324 19TH AVE NE

Appendix C
Service Calls
Drainage for Lyon Creek Basin

CALLDATE	PROBLEM	RESPONSIBLE	COMMENTS	ADDRESS
12/10/2003	maintenance	SURFACE WATER	THE CUST IS THE MAINTENANCE MANAGER FOR THE KC HOUSING. HE SAID THE CB AT THE N/END OF HIS SITE (S/END OF 21ST AVE NE) IS PLUGGED. HE WOULD LIKE TO HA	2200 NE 201ST PL
8/24/2004	maintenance	SURFACE WATER	DITCH IN FRONT OF HOUSE IS FULL OF GRAVEL AT NORTH END OF HOUSE. SHE WOULD LIKE IT CLEANED OUT.	20001 25TH AVE NE
8/25/2004	flood	SURFACE WATER	OUR PROPERTY HAD PROBLEMS FLOODING 3 TIMES SINCE LAST YEAR WHEN THE APARTMENT AT THE CORNER OF 25TH AVE NE & BALLINGER WAY WAS BUILT.	19530 25TH AVE NE
1/24/2005	private	SURFACE WATER	CALLER FEELS THAT THERE IS A BROKEN PIPE UNDER THE ROAD CAUSING WATER TO ENTER HER GARAGE. SHE STATED A PIPE WAS REPAIRED PRIOR TO INCORPORATION AND	20307 25TH AVE NE
1/13/2006	maintenance	SURFACE WATER	STORM DRAIN MAY BE CLOGGED IN FRONT OF CALLER'S HOUSE, A LARGE PUDDLE IS FORMING OVER IT.	2545 NE 205TH ST
1/31/2006	private	PRIVATE PROPERTY MATTER	WATER IS POOLING ON HIS SITE	2503 NE 205TH ST
5/3/2006	drainage	SURFACE WATER	CUSTOMER SAYS THAT THERE IS STANDING WATER NEAR THE RIGHT OF WAY BETWEEN CALLER'S PROPERTY AND A NEIGHBORING PROPERTY. THE WATER IS ORANGE, AND CUSTOM	20014 24TH AVE NE
7/12/2006	drainage	SURFACE WATER	CUSTOMER REQUESTING INSPECTION OF A DRAINAGE SITUATION BY HIS DRIVEWAY. HE STATES THAT RAINWATER RUNS INTO HIS DRIVEWAY FROM THE ROAD (NE 205TH ST). C	2715 NE 205TH ST

Appendix C
Service Calls
Drainage for Lyon Creek Basin

CALLDATE	PROBLEM	RESPONSIBLE	COMMENTS	ADDRESS
10/18/2006	flood	SURFACE WATER	WATER IS FLOWING ONTO HIS PROPERTY IN A CONCENTRATED FLOW FROM THE CITY STREET. HE HAS LIVED HERE FOR 30+ YEARS AND THIS HAS NOT HAPPENED IN THE PAST	2519 NE 200TH ST
12/3/2007	private	SURFACE WATER	CB BLOCKED FLOODING UNITS PUMPS NOT WORKING	2200 NE 201ST PL
5/14/2008	drainage	SURFACE WATER	CALLER'S SITE IS ON A PARTIAL HILL, AND THERE'S NO DRAINAGE AT ALL ON THE SIDE OF THE ROAD. THE CREST OF THE ROAD IS ABOUT 13 INCHES HIGHER THAN CALLE	2559 NE 205TH ST
6/9/2008	water quality	PLANNING AND DEV. SVCS	SUBJECT SITE IS REPORTEDLY DUMPING OIL AND CONCRETE AT THE SOUTHEAST CORNER OF THE PROPERTY.	20001 25TH AVE NE
11/13/2008	maintenance	SURFACE WATER	TREE ON THE SIDE OF THE ROAD IS DROPPING A LARGE AMOUNT OF NEEDLES INTO A STORM DRAIN NEAR THIS HOUSE. THE HOUSE IS CURRENTLY FOR SALE, AND NO ONE IS	20219 25TH AVE NE
9/18/2009	other	SURFACE WATER	WORK DONE RECENTLY IN THE RIGHT OF WAY LEFT A HOLE IN THE SIDE OF THE ROAD IN THE ""FIRE LANE"" NEAR THE DRIVEWAY - CALLER STATES THAT THIS HOLE IS CURR	20021 24TH AVE NE
10/21/2010	other	SURFACE WATER	SOMEONE HAS PLACED BRIGHT ORANGE SAND BAGS ALONG THE S/S OF THE CB. HE WANTS TO KNOW IF WE INSTALLED THEM OR SOMEONE ELSE. HE DOESN'T MIND THEM BUT WO	20345 21ST AVE NE
1/16/2013	maintenance	SURFACE WATER	359317 - Perpetual mud puddle covers walking path	

Appendix C
Service Calls
Drainage for Lyon Creek Basin

CALLDATE	PROBLEM	RESPONSIBLE	COMMENTS	ADDRESS
5/6/2013	maintenance	SURFACE WATER	THE DRAINAGE DITCH BETWEEN HER HOME AND THE NEIGHBORS IS CLOGGED.	20014 24TH AVE NE

Appendix C
Service Calls
Flooding calls for Lyon Creek Basin

CALLDATE	PROBLEM	RESPONSIBLE	COMMENTS	ADDRESS
11/18/2003	FLOODING	SURFACE WATER	BUILDING FLOODING	2518 NE 195TH ST
11/18/2003	FLOODING	SURFACE WATER	PROPERTY FLOODING	19530 25TH AVE NE
8/9/2004	FLOODING	SURFACE WATER	CATCH BASIN ABOVE PROPERTY IS FULL, FLOODING AND DUMPING WATER INTO UNITS.	19851 25TH AVE NE
8/9/2004	FLOODING	SURFACE WATER	KING COUNTY HOUSING AUTHORITY HOUSING LOCATED ON BALLINGER WAY ON-GOING FLOODING AFTER LARGE STORM EVENTS. BALLINGER WAY DRAINAGE DUMPS ONTO THE PROPE	2200 NE 201ST PL
8/10/2004	FLOODING	SURFACE WATER	OBSERVED FLOODING IN ROUTE TO OTHER CALL. 1 FOOT OF WATER IN 4 UNITS.	2522 NE 195TH ST
8/23/2004	FLOODING	SURFACE WATER	POLICE DISPATCH CALLED TO REPORT A RESIDENT AT 2522 NW 195TH ST IN UNIT #1 IS FLOODING.	2522 NE 195TH ST
8/23/2004	FLOODING	SURFACE WATER	POLICE DISPATCH CALLED TO REPORT A RESIDENT AT 2522 NW 195TH ST IN UNIT #1 IS FLOODING.	2522 NE 195TH ST
8/23/2004	FLOODING	SURFACE WATER	THEIR HOUSE FLOODED. WATER HAS RECEDED. NO RESPONSE NEEDED BUT WANTS DOCUMENTATION. SAID THIS WAS THE 3RD TIME SINCE THE NEW APT. WENT IN.	19530 25TH AVE NE
8/23/2004	FLOODING	SURFACE WATER	THEIR HOUSE FLOODED. WATER HAS RECEDED. NO RESPONSE NEEDED BUT WANTS DOCUMENTATION. SAID THIS WAS THE 3RD TIME SINCE THE NEW APT. WENT IN.	19530 25TH AVE NE
11/2/2004	FLOODING	SURFACE WATER	THE CUST SAID THE WATER WAS HIGH IN THE ROAD AND THREATENING THE CONDOS. I TOLD HER WE WOULD RESPOND.	2522 NE 195TH ST
12/3/2012	FLOODING	SURFACE WATER	The resident of 19552 23rd Ave NE reported his basement was flooding and he wanted the catch basin checked.	19552 23RD AVE NE

Appendix C
Service Calls
CW Requests from Geographic Information System for Lyon Creek Basin

PROBLEMCODE	DESCRIPTION	DETAILS	PROBADDRESS	DATETIMEINIT
POOR DRAINAGE	Poor Drainage	Caller is concerned about high groundwater and whether the upstream storm system is flowing correctly.	19851 25TH AVE NE	8/14/2013 10:09
MAINTENANCE	Maintenance	Resident noticed his neighbor diverting stormwater into a hole, and is wondering if this is okay to do. He's hoping City staff can visit the site to confirm the changes his neighbor is making. The pipe is located between the road and the fence. See attached PDF.	2936 NE 198TH PL	9/16/2013 15:00
POOR DRAINAGE	Poor Drainage	a lot of shoulder gravel got washed into the catch basin to the south of their driveway and the catch basin north of their driveway close to 203rd. The catch basins need to be cleared.	20123 30TH AVE NE	9/30/2013 16:18
WATER QUALITY	Water Quality	City of Lake Forest Park notified that a gallon of paint had spilled into the catch basin. LFP responded to the property and requested additional follow up.	2960 NE 200TH ST	3/31/2014 15:09
POOR DRAINAGE	Poor Drainage		19837 25TH AVE NE	5/20/2014 14:23

Lyon Creek Basin Plan

Appendix D:

Water Quality Monitoring Data – Site BL-1 Ballinger Creek

Appendix D
Water Quality Monitoring Data
Site BL-1 Ballinger Creek

Location: Downstream end of Brugger's Bog Park

Date	Dissolved Oxygen (mg/L)	Temp (degC)	Turbidity (NTU)	pH	Flow (cfs)
8/31/2001	7.7	17.8	0	7.72	1.38
9/13/2001	8.2	16.4	0	7.74	1.27
9/26/2001	8.11	15.4	17.05	6.89	4.28
10/9/2001	8.77	11.9	0.32	7.41	1.33
10/24/2001	9.03	10.5	2.54	7.35	3.83
11/14/2001	10.1	11.9	11.63	6.88	43.16
11/30/2001	10.12	8.7	0.98	7.21	25.73
12/12/2001	11.46	6.3	7.55	6.82	11.72
12/26/2001	10.94	7	0	7.43	4.7
1/10/2002	11.24	8.8	0	7.33	8.38
1/24/2002	12.16	6.9	0	7.38	6.41
2/14/2002	10.7	7.9	0	7.36	5.45
2/26/2002	9.87	8.7	0	7.26	6.19
3/14/2002	10.52	8.3		7.41	7.87
3/27/2002	11.48	8.8		7.59	5
4/3/2002	10.13	11.4			3.73
4/18/2002	8.65	12.7		7.39	4.56
4/29/2002	9.94	14.8		7.79	3.51
5/13/2002	9.87	11.3		7.53	4.12
5/22/2002	9.43	12.5		7.47	2.87
6/25/2002	8.27	15.9		7.46	1.93
7/16/2002	7.61	17.4	8.8	7.58	1.83
8/15/2002	8.01	18.6	5.9	7.88	1.36
9/27/2002	7.75	15.6	2.47	7.63	1.32
10/9/2002	8.2	13.4	2.7	7.51	1.62
10/21/2002	8.03	13.3	5.2	7.39	1.58
11/12/2002	8.23	11.7	3.4	7.17	6.96
11/27/2002	8.25	8.7	0.83	7.33	1.9
12/9/2002	10.32	7.4	3.02	7.39	1.83
1/3/2003	10.78	8.4	8.05	7.26	18.06
1/21/2003	9.53	7.6	7.7	7.2	9
2/6/2003	8.68	8.8	5.5	7.42	3.99
3/12/2003	10.42	9.8	130.7	7.04	
4/14/2003	10.39	9.8	7.8	7.42	5.4
5/8/2003	9.26	13.1	6.5		2.92
6/17/2003	9.43	14.2	5.2	7.8	
7/10/2003	7.85	17.8	2.68	7.79	

8/15/2003	8.24	16.2	0.96		
9/17/2003	8.71	14	1.3	7.74	
10/9/2003	8.63	13.6	0.8	7.52	
10/24/2003	8.18	13.1	1.45	6.94	
11/13/2003	8.52	9.8	0.73	7.11	
12/4/2003	10.44	7.9	1.91	6.67	
12/23/2003	10.33	7.7	1.62	6.82	10.75
1/8/2004	10.08	5.3	9.16	7.04	
1/23/2004	9.88	7.9	6.15	6.66	
2/13/2004	10.25	8.4	1.53	7.03	
3/11/2004	9.24	10.3	2.5	7.58	
3/30/2004	8.94	10.8	1.63	7.45	
4/16/2004	9.8	13.2	2.6	7.63	
4/29/2004	9.5	11.7	1.16	7.15	5.76
6/28/2004	8.07	16.9	5.1	7.66	4.68
7/28/2004	7.37	17	1.85		
8/19/2004	7.27	17.1	1.36		
9/23/2004	7.52	14	1.19	7.51	
10/5/2004	8.64	13	2.04	7.3	3.17
11/18/2004	7.88	9.9	5.12	7.35	4.6
12/14/2004	8.43	10.4	5.3	6.94	9.17
1/6/2005	10.1	5.6	2.98	7.56	3.96
2/2/2005	10.41	10.4	0.81	7.48	3.18
2/25/2005	11.34	7.5	1.99	7.56	2.95
3/18/2005	10.57	9	0.91	7.4	2.04
4/21/2005	9.54	13.7	3.62	7.57	3.15
5/26/2005	9.07	17		7.44	1.67
6/28/2005	7.77	15	1.4	7.46	2.1
7/19/2005	8.52	15.4	3.04	7.66	1.4
8/17/2005	7.04	16.8	4.58	7.05	2.6
10/19/2005	7.64	13.5	1.06	7.41	1.46
11/8/2005	9.96	10.3	2.83	7.45	2.72
12/29/2005	10.2	9	6.5	6.75	7.98
1/19/2006	10.64	8.7	5.71	7.23	5.9
2/10/2006	11.38	6.4	5.48	7.26	15.22
3/23/2006	9.4	9.6	8.07	7.43	
4/21/2006	10.35	11.4	3.86	7.52	5.3
5/24/2006	8.58	14		7.4	4.03
6/30/2006		15.3		7.57	1.58
8/2/2006		16.8		7.46	1.04
9/6/2006	7.22	15.3	0.2	7.5	0.96
10/13/2006	9.88	11.8	0.35	7.4	
11/14/2006	10.81	10.1	0.75	6.95	
12/22/2006	10.42	7.7	0.71	7.23	
1/30/2007	10.66	6.6	0.7	7.56	9.01
2/26/2007	10.28	8.5	2	7.53	12.8
3/28/2007	8.65	11	1.38	7.74	10.42

4/25/2007	9.66	10.9	1.05	7.86	5.73
5/29/2007	8.03	14.3	5.92	7.55	
6/27/2007	7.64	13.4	0.45	7.29	11.03
8/2/2007	7.48	15	1.48	7.18	1.4
8/28/2007	6.52	16.3	1.01	7.5	1.5
9/24/2007		14.2	1	7.48	1.6
10/30/2007	8.1	10.4	1.03	7.41	1.91
11/27/2007	9.77	7.6	0.5	7.4	3.83
12/18/2007	10.95	6.6	22.2	6.44	12.14
1/23/2008	11.94	4.2	0.66	7.3	3.6
2/28/2008	10.19	8.8	0.8	7.4	2.65
3/24/2008	10.6	9.1	1	7.21	5.11
4/22/2008	10.63	10.7	0.9	7.33	5.08
5/27/2008	8.85	13.3	0.6	7.53	2.19
6/24/2008	8.3	14.2	0.7	7.63	1.86
7/23/2008	8.2	14	0.5	7.74	1.22
8/28/2008	7.6	15.8	0.9	5.69	1.95
9/23/2008	7.8	13.5	1.4	7.47	1.31
10/28/2008	7.92	10.9	0.6	7.4	1.22
11/25/2008	8.24	8.7	1	7.25	3.19
12/30/2008	8.74	5.8	20.8		11.55
1/30/2009	10.5	7	15	6.95	2.78
2/20/2009	9.94	5.3	1.1	6.83	2.43
4/1/2009	10.59	7		6.63	10.11
4/30/2009	8.09	13.8	1.3	7.29	2.55
5/29/2009	8.73	13.9	1	7.5	2.43
6/23/2009	7.9	14.8	1.7	7.52	1.81
7/28/2009	7.24	18.9	1		1.05
8/27/2009	8.23	16.8	1.3	7.48	0.92
10/7/2009	8.44	13	0.5		1.07
11/4/2009	7.94	9.8	1.4		2.72
12/29/2009	9.96	6	1.3	7.64	3.45
1/29/2010	9.75	9.2	11	7.57	3.97
2/22/2010	9.68	8.6	2.3	7.63	3.51
4/6/2010	9.82	8.8	1.1	7.72	6.55
4/27/2010	8.83	12.1	8.8	7.71	9.51
5/27/2010	8.35	11.8	0.9	7.82	2.82
6/22/2010	7.34	15.3	1.3	7.92	2.38
7/27/2010	7.92	17.4	1.5	8.05	1.11
8/24/2010	7.63	16.8	1.1	8.18	1.2
9/28/2010	7.09	16.6	3	8.01	1.99
10/27/2010	8.65	11.9	1	7.66	3.64
12/3/2010	9.66	8.1	8.8	7.62	3.87
12/30/2010	10.65	5.4	2.2	7.55	6.32
1/26/2011	10.02	8.5	11.5	7.45	5.51
3/3/2011	10.99	7.3	1.9	7.37	8.8
4/12/2011	10.59	8.6	1.9	8.32	4.31

5/2/2011	9.52	10.9	2.7	7.45	6.4
5/31/2011	10.82	12.9	1.6	7.71	2.62
6/29/2011	10.14	13.9	1.5	7.65	1.85
7/28/2011	8.22	16.2	1.2	7.38	1.55
8/23/2011	7.99	16.5	1.2	8.15	1.48
10/10/2011	7.93	13.7	0.8	7.4	2.22
10/25/2011	8.71	11.6	1.7	7.41	1.91
11/30/2011	9.31	8.8	1.1	7.19	3.4
2/6/2012	11.1	7.7	2.31	6.74	3.73
3/27/2012	9.41	12.7	5.23	7.25	3.62
4/24/2012	10.06	11.3	1.59	7.71	2.7
5/22/2012	8.88	12.1	2.09	7.04	3.8
6/26/2012	7.57	13.8	14.73	7.78	3.96
7/24/2012		15.7	1.39	7.25	1.72
8/28/2012		16	0.92	8.01	1.57
9/25/2012		14.7	0.52	8.23	1.33
10/23/2012	9.86	10.9	1.03	7.57	2.59
11/27/2012	10.65	9.1	0.84	7.49	5.3
12/18/2012	10.98	7.8	0.94	6.89	14.29
1/22/2013	12.28	6.1	1.09	7.58	4.12
2/26/2013	11.9	7.9	0.81	7.52	3.48
3/26/2013	11.02	10.7	2.19	7.28	3.8
4/23/2013	10.85	11.8	1.35	7.03	4.59
5/28/2013	9.24	13	1.64	7.88	2.78
6/25/2013	8.39	16.1	4.05	7.84	4.29
7/23/2013	8.84	15.7	0.68	7.91	1.43
8/27/2013	7.92	16.8	0.19	6.55	1.57
9/25/2013	8.35	13.5	0.58	7.68	2.02
10/22/2013	9.01	11.8	0.05	7.39	1.93
11/26/2013	10.09	8	0.29	7.48	2.16
12/23/2013	10.89	6	1.92	6.92	4.7
1/27/2014	11.17	7.9	0.59	7.14	2.64
2/25/2014	11.52	8.2	0.97	6.76	8.28
3/25/2014	10.8	10.4	10.17	6.18	6.18

Lyon Creek Basin Plan

Appendix E:

McAleer Creek and Lyon Creek Basin Plan Public Meeting Summary

Memo

AltaTerra

To:	Brian Landau, PE, LG, City of Shoreline John Fetherstone, City of Shoreline
From:	Erin Nelson, Altaterra Consulting LLC
CC:	Tarelle Osborn, OCI
Date:	5/14/2014
Re:	McAleer Creek and Lyon Creek Basin Plan Public Meeting Summary

---

A public meeting was held at Shoreline City Hall on the evening of May 13, 2014 to inform interested parties about the McAleer Creek and Lyon Creek basin plans and to solicit input on problem areas and concerns that should be addressed. Below is a summary of the meeting.

Time: 6 to 8 p.m.

City representatives:

- Brian Landau
- John Fetherstone
- Erin Nelson (consultant)

Number of attendees: 9 (sign-up sheet is attached)

Format:

An open house format was used for the public meeting, with display boards showing basin maps, planned activities, and schedule. An electronic survey (i-pad) was used to find out where meeting attendees live, and how they rank surface and stormwater issues. The survey was conducted anonymously. Comment cards and notes on the large basin map were utilized by attendees to describe their particular concerns in select locations and in general. A short powerpoint was also provided to those present.

Survey results:
Two questions were asked in the survey, and the following summary of responses were received:

What drainage basin do you live in?

25% reported Thornton Creek
25% reported Lyon/Ballinger Creek
12.5% reported "other"
37.55 reported McAleer/Echo Lake

Rank the surface water issues that are most important to you:
The table below summarizes the results.

Ranking	Water quality	Drainage /	Quality of aquatic	Condition of City's
1	4	2		2
2	2	3	1	2
3	1	1	5	1
4	1	2	2	3

Comments:

Comments received are attached. Additionally, comments written on the basin map are shown below.

Memo

AltaTerra

Memo

AltaTerra

To: John Featherstone, City of Shoreline

From: Erin Nelson, Altaterra Consulting LLC

CC: Tarelle Osborn, OCI

Date: 9/25/2014

Re: McAleer Creek and Lyon Creek Basin Plan Public Meeting Summary

---

A public meeting was held at Brugger's Bog Park on the evening of September 17, 2014 to inform interested parties about initial results from the McAleer Creek and Lyon Creek basin plans and to solicit input on projects and problems that may have been missed in the initial evaluation. Below is a summary of the meeting.

Time: 6 to 8 p.m.

City representatives:

- Brian Landau
- John Featherstone
- Erin Nelson (consultant)

Number of attendees: 13 (sign-up sheet is attached)

Format:

An open house format was used for the public meeting, with display boards showing basin problem areas, and proposed projects. Display boards are shown below.

Flooding along 25th Avenue NE

- Potentially under-sized culvert at 196th NE (border with Mountlake Terrace)
- Pipes in poor condition
- Flat terrain

High groundwater

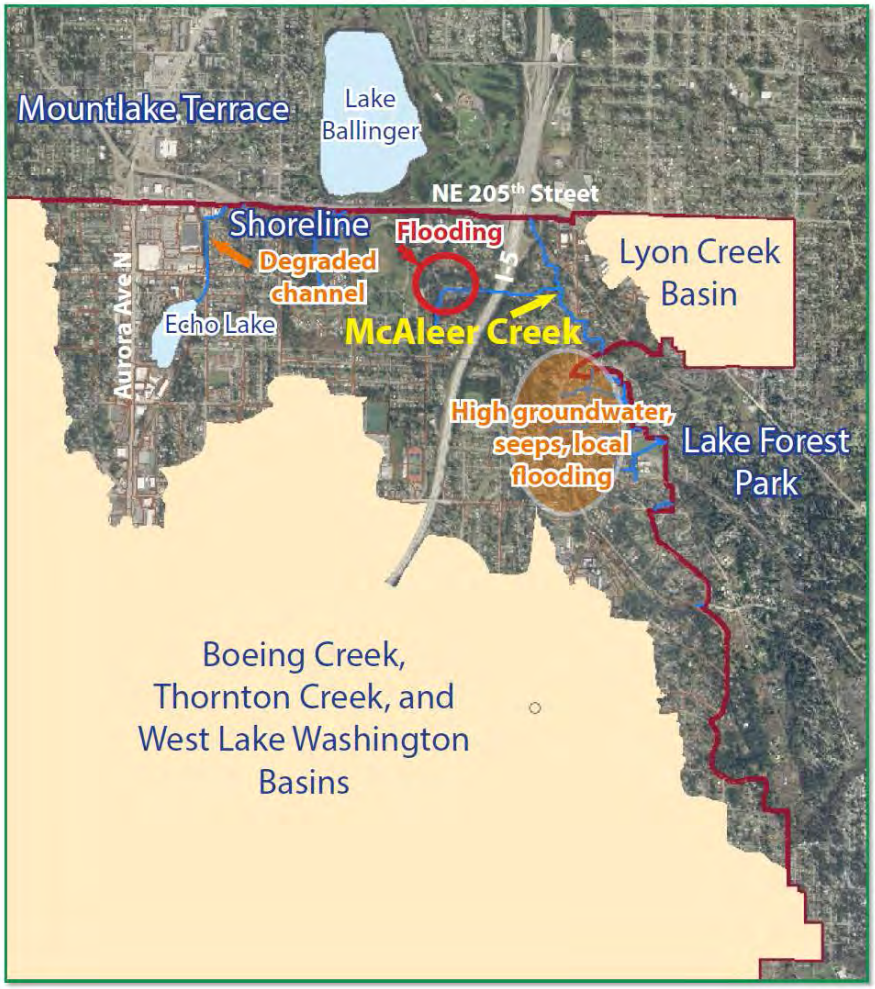
- Limits infiltrative low impact development (LID) techniques
- Seeps cause local problems (e.g., basements, crawl space flooding, etc.)

Poor water quality in Echo Lake

- High phosphorus and temperature, low dissolved oxygen

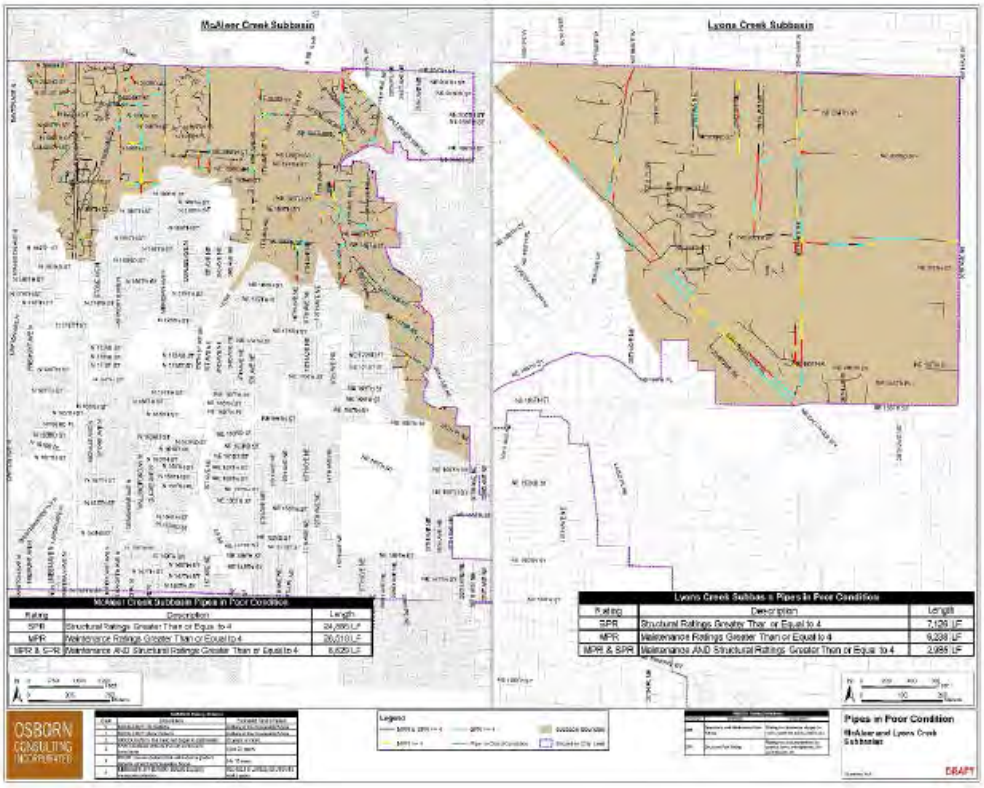
High groundwater east of 15th Avenue NE

- Limits infiltrative low impact development techniques
- Seeps cause local problems (e.g., local flooding)



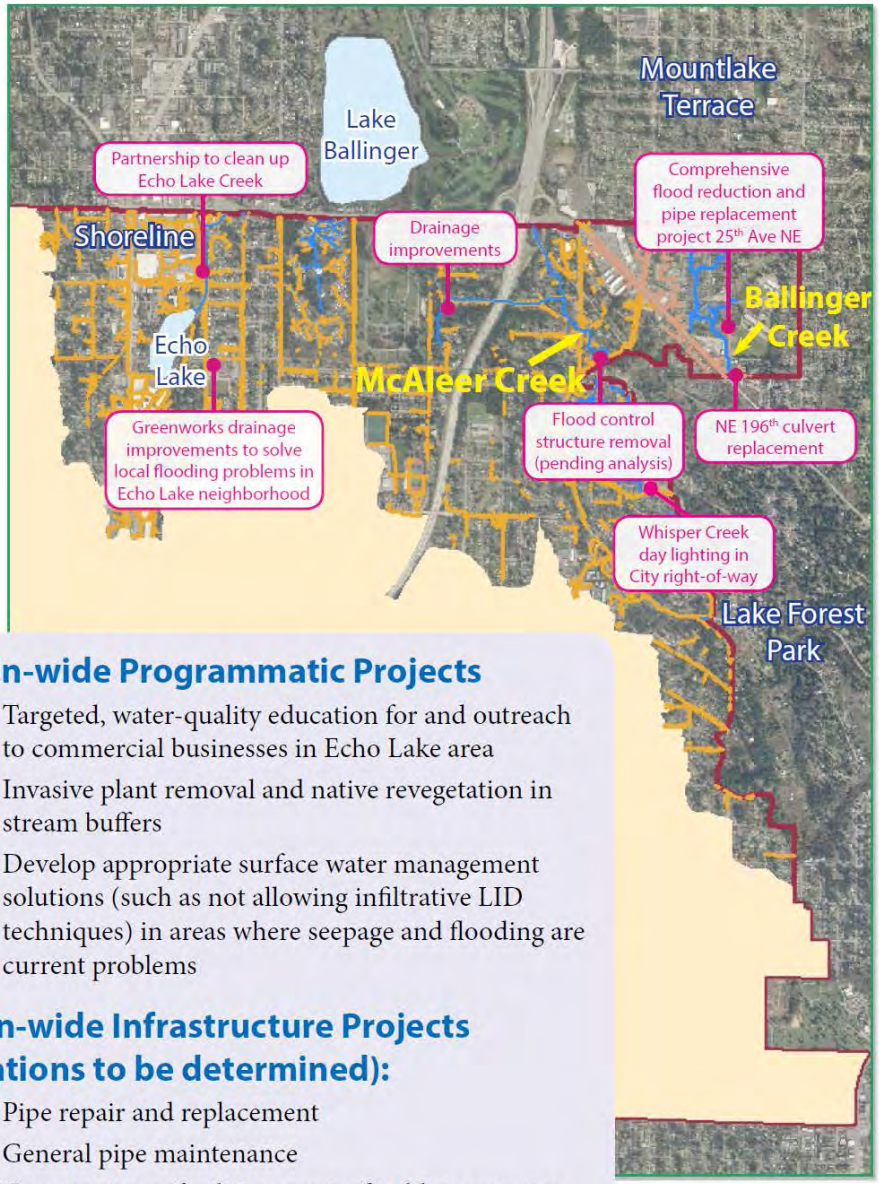
McAleer Creek and Lyon Creek Basin Plans

Pipes in Poor Condition



CITY OF SHORELINE

McAleer Creek and Lyon Creek Basin Plans



Basin-wide Programmatic Projects

- Targeted, water-quality education for and outreach to commercial businesses in Echo Lake area
- Invasive plant removal and native revegetation in stream buffers
- Develop appropriate surface water management solutions (such as not allowing infiltrative LID techniques) in areas where seepage and flooding are current problems

Basin-wide Infrastructure Projects (locations to be determined):

- Pipe repair and replacement
- General pipe maintenance
- Construct new facilities or retrofit old stormwater facilities where stormwater treatment is lacking

Preliminary Site-specific and Basin-wide Projects

CITY OF SHORELINE

Survey:

An electronic survey (i-pad) was used to find out where what surface water issues are most important to the attendees, and what programs respondents would like to see initiated by the City. The survey was conducted anonymously. Results are shown in the table and graph below.

September 17, 2014 Public Meeting Survey Results

What basin do you have the greatest concern?	Rank the surface water issues you think are the biggest problem in the basin?	What is the most beneficial project or program the Shoreline Surface Water Utility should focus its efforts in this basin(s)?	Comments?
Lyon	Water quality,Flooding,Drainage, Pipe condition,Stream and wetland habitat		
Lyon	Pipe condition,Stream and wetland habitat,Water quality,Drainage,Flooding		
Lyon	Water quality,Flooding,Stream and wetland habitat,Drainage,Pipe condition	Water volume management flooding and improve water qualiy and create asustainable habitat for fisf and wildlife.	Thanks for providing this public forum.
Lyon	Drainage,Pipe condition,Water quality,Stream and wetland habitat,Flooding	I just moved here so i dont know this area yet	
McAleer	Water quality,Stream and wetland habitat,Flooding,Pipe condition,Drainage		
Both	Stream and wetland habitat,Water quality,Flooding,Drainage, Pipe condition		
Both	Flooding,Drainage,Water quality,Stream and wetland habitat,Pipe condition	Increase capacity in culverts	Good presentation
Both	Flooding,Stream and wetland habitat,Water quality,Drainage,Pipe condition	Develop surface water mgmt solutions, education of residents	

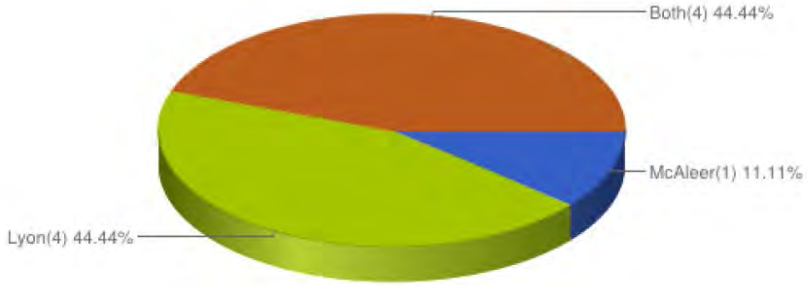
QuickTapSurvey

McAleer Creek and Lyon Creek (Ballinger Creek) Basin Plans Open House

Sep 17, 2014 to Sep 18, 2014

What basin do you have the greatest concern?

Results based on 9 responses to this question.



Rank the surface water issues you think are the biggest problem in the basin?

Results based on 9 responses to this question.

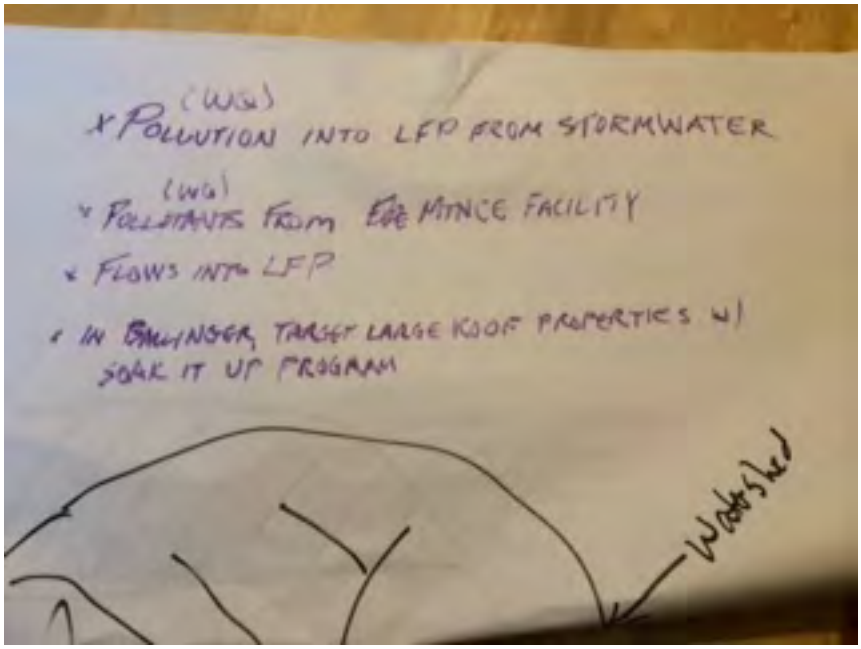
Ranking	Pipe condition	Drainage	Flooding	Stream and	Water quality
1	2	1	2	1	3
2	1	2	2	3	1
3		1	2	1	5
4	2	4		3	
5	4	1	3	1	

Comments:

Comments received included the following:

1. Concern about pollution originating in Shoreline (or Mountlake Terrace) and being transported downstream to Lake Forest Park.
2. Concern about pollutants entering stormwater from the former King County Maintenance Facility on 25th Avenue Northeast.
3. Concern about the volume of flows entering Lake Forest Park.

4. Ideas to mitigate flows in Ballinger Creek by encouraging installation of rain gardens---possibly targeting the “Soak it Up” program to residents with large roofs.



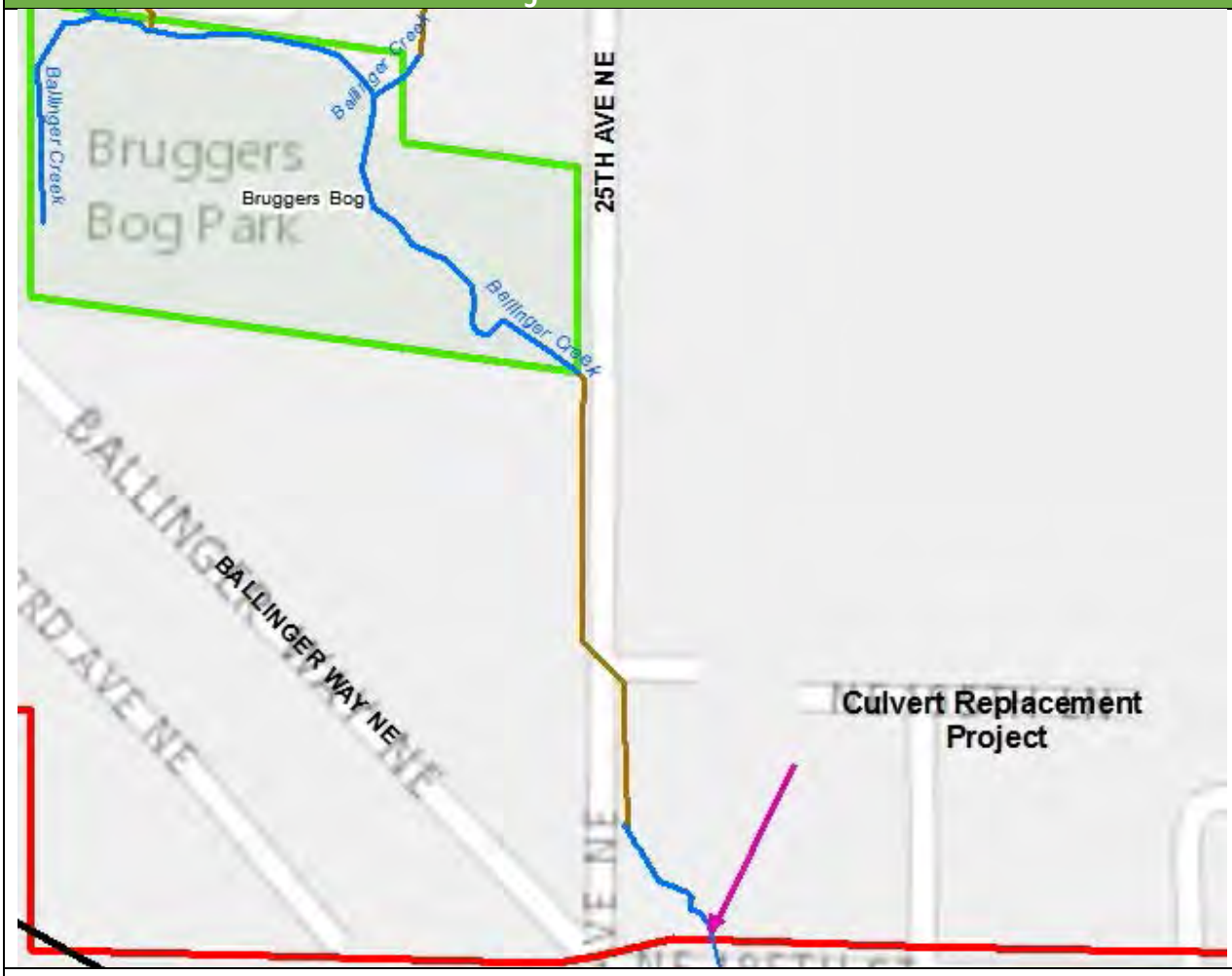
Lyon Creek Basin Plan

Appendix F:

Lyon Creek Basin Proposed Project Summary Sheets

Project ID:	Ba-CIP-1a
NE 195th Street Culvert Replacement	
Preliminary Cost (2015 $): $2,007,300	

Project Location:



Description:

An existing 30-inch corrugated metal culvert conveys Ballinger Creek under NE 195th Street. Modeling results indicate that that the culvert does not have enough capacity to pass the 2-year flood event. The culvert contributes to flooding immediately upstream in the residential area along 25th Avenue NE and at the City's future maintenance facility. The culvert is owned by the City of Lake Forest Park. Recommended in the 2011 Stormwater Management Plan, this proposed CIP (Project L-F2) would increase the culvert size to pass the 100-year event. Project benefits include flood reduction.

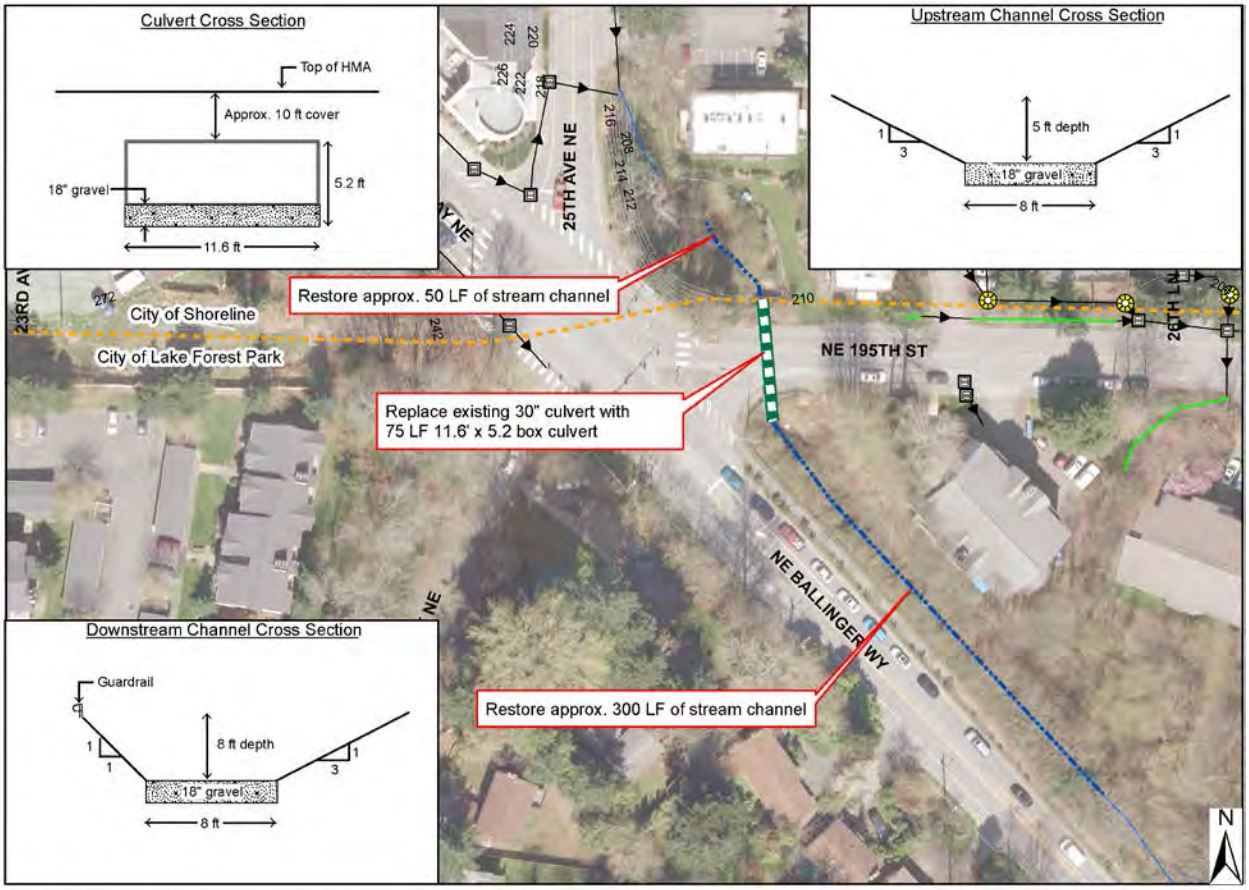
Assumptions and Considerations:

The proposed replacement culvert is 75 linear feet, 11.6 feet wide, and 5.2 feet high. The design assumes that the stream channel through the culvert will be lowered approximately 4 feet from the existing invert elevation in order to match the existing grade downstream (eliminating the existing plunge/drop) and create enough depth for the proposed upstream improvements (Ba-CIP-1b) along 25th Avenue NE. The box culvert will be countersunk with approximately 18 inches of streambed gravel. Approximately 50 linear feet of channel enhancement upstream and 300 linear feet of channel enhancement downstream of the culvert is included in this CIP to provide a smooth transition between the new culvert and the existing channel. Upstream channel enhancements were assumed to be at a 2 percent bottom slope to tie into improvement proposed for the 25th Avenue NE flood reduction CIP (Ba-CIP-1b). Culvert dimensions are based on the WDFW stream simulation method: Width = 1.2*bankfull width of 8 feet plus 2 feet. Height assumes the culvert is 30 percent countersunk. The proposed trapezoidal stream channel cross section has an 8-foot bottom with 3H:1V side slopes. Temporary construction easements will be necessary to construct the channel enhancement portions of the project.

Design considerations include:

1) Project requires coordination with and approval from the City of Lake Forest Park.
2) Environmental permitting includes SEPA determination, WDFW Hydraulic Project Approval (HPA), and USACE Section 401 permit.
3) Combined permitting effort with 25th Avenue NE Flood Reduction (Ba-CIP-1b) project.

Schematic:



0 25 50 100 Feet

Disclaimer: All information obtained from GIS. Not for construction.

Ballinger Creek Basin
NE 195th St. Improvements

Planning-level Cost Estimate:

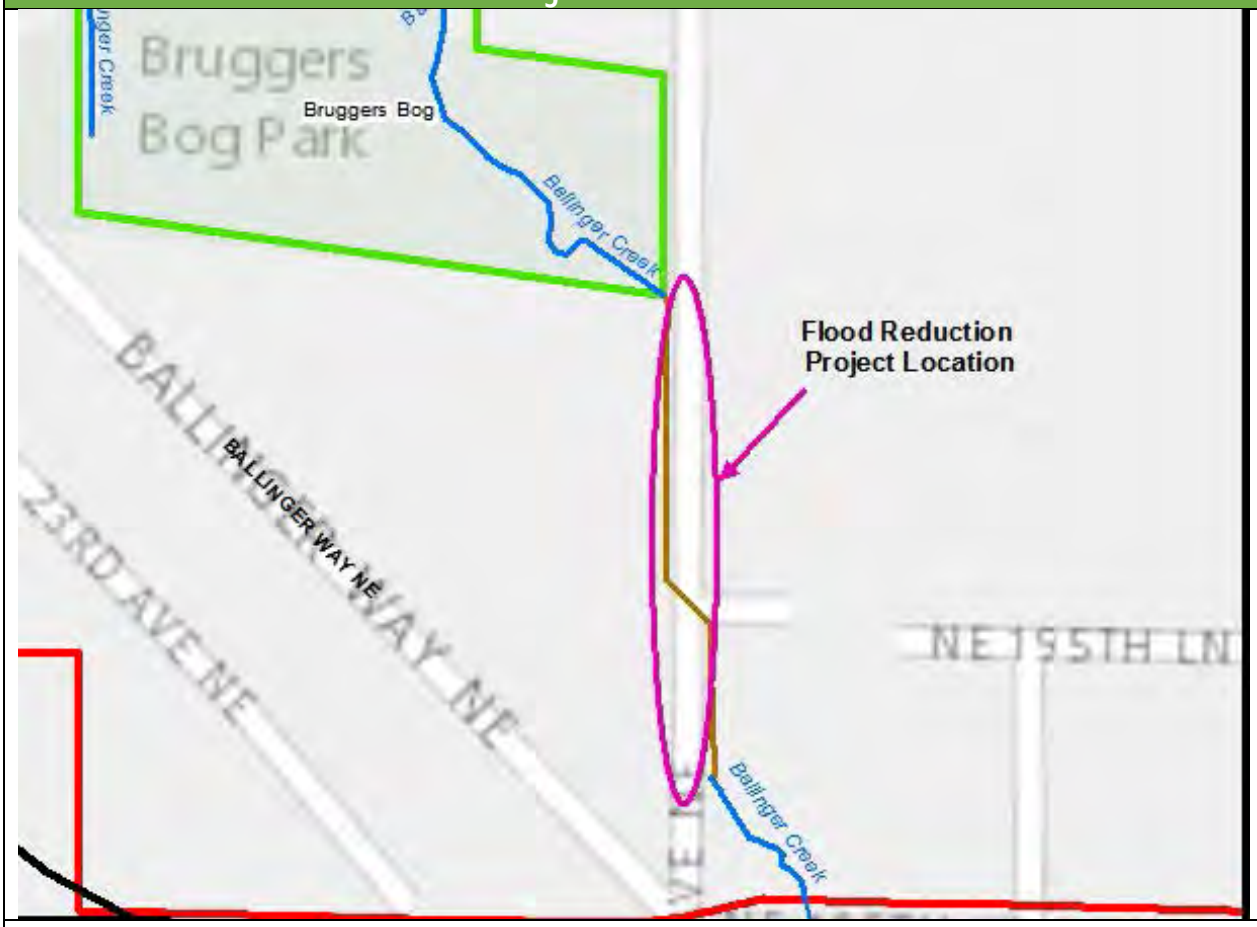
Item	Unit	Unit Cost	Quantity	Cost
Water Pollution/Erosion Control	%	10%		$96,900
SPCC Plan	LS	$500	1	$500
Traffic Control	%	10%		$96,900
Potholing	EA	$1,800	5	$9,000
Clearing & Grubbing	SY	$10	2723	$27,230
Remove Road, Curb & Gutter, and Sidewalk	SY	$150	130	$19,500
Temporary Stream Bypass	LS	$50,000	1	$50,000
Excavation Incl. Haul	CY	$60	3130	$187,800
Embankment Construction	CY	$10	1297	$12,970
Headwall	EA	$60,000	1	$60,000
Streambed Gravel	CY	$65	204	$13,260
Box Culvert (139.2-In. X 62.4-In.)	LF	$1,000	75	$75,000
Planting and Bioengineered Restoration	SY	$100	2412	$241,200
Roadway Restoration	SY	$550	130	$71,500
Guardrail	LF	$25	300	$7,500
Subtotal				$969,260
Contractor overhead, profit, and mobilization			10%	$96,926.00
Washington State Sales Tax			9.5%	$37,119
Construction Contingency			35%	$339,241.00
Subtotal Construction Costs				$1,442,546
City Staff Time			7.5%	$108,190.92
Administration and engineering design			15%	$216,381.84
Design Contingency			15%	$216,381.84
Permitting				$15,000
Land acquisition and easements	SF	$5	1,750	$8,750
Total Project Cost				**$2,007,300**

Note regarding contingencies on this project and Ba-CIP-1b:

*Contingency percentages used to estimate costs for this project are lower than those used for other smaller projects in order to keep the total contingency costs within reasonable amounts, as requested by the City.

Project ID:	Ba-CIP-1b
25th Avenue NE Flood Reduction	
Preliminary cost (2015 $): $3,296,400	

Project Location:



Description:

Flooding on public and private property occurs on Ballinger Creek in the existing channel and pipe network between Bruggers Bog Park and NE 196th Street. Hydraulic modeling indicates that the existing pipe and channel network is undersized to convey the 25-year flow. Currently, the stream is conveyed through a 36-inch culvert under 25th Avenue NE and continues in a pipe south towards NE 195th Street. A high-flow bypass system parallels on the west side of 25th Avenue NE. Both pipes combine into a 36-inch pipe just south of NE 195th Place. The stream daylights on private property just upstream of the NE 195th Street roadway culvert. This proposed CIP project upsizes the existing pipe system with 550 linear feet of 72-inch diameter pipes to pass the 100-year flow event. Open channel and fish passable options were considered for the project, however, the City's preference is to directly address flooding issues by improving conveyance within the existing right-of-way, precluding further development of non-flood-related improvements at this time. Project benefits are flood reduction.

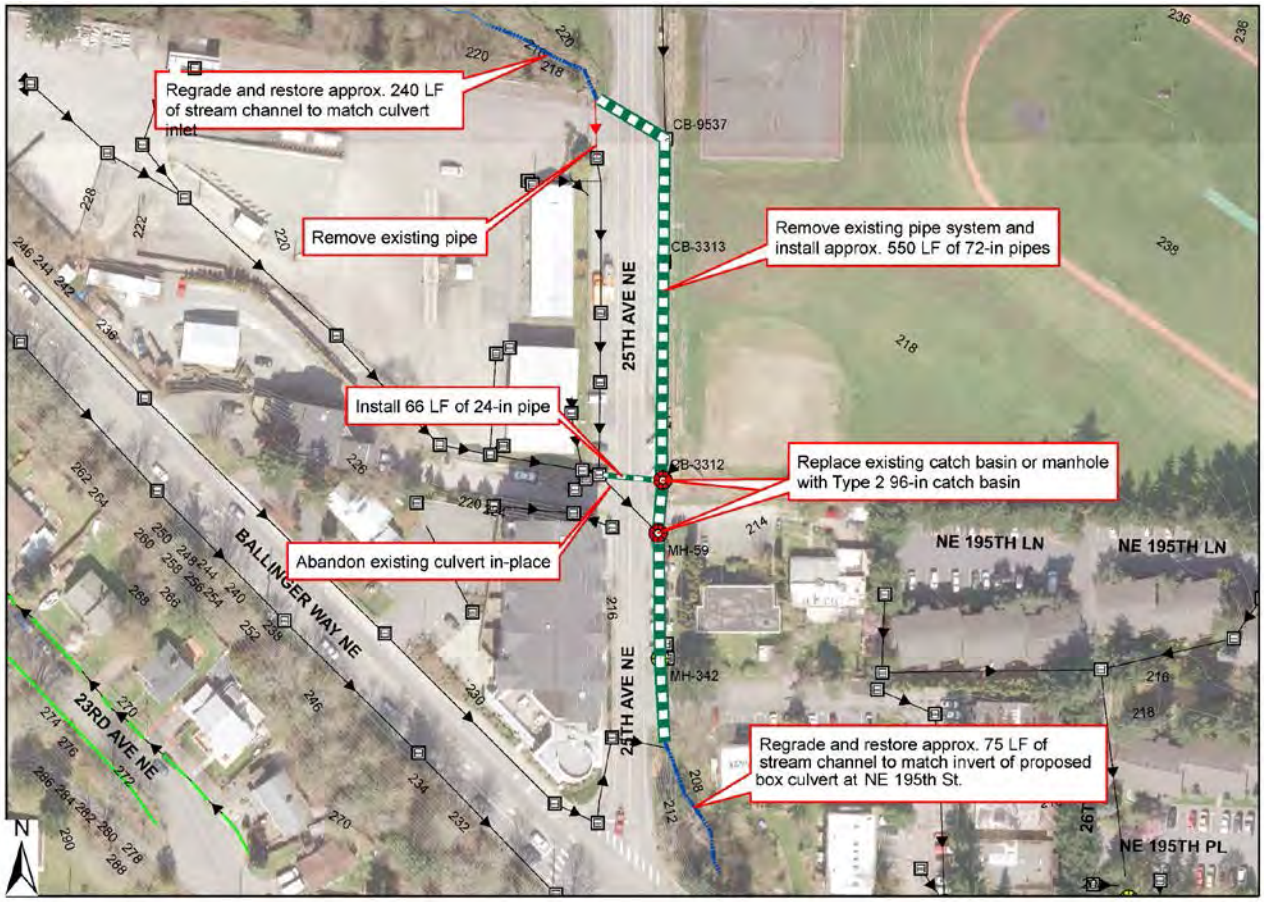
Assumptions and Considerations:

The proposed pipe system consists of four pipes being upsized to 72-inch diameter, and replacing one 24-inch culvert. Existing catch basins are not equipped to handle 72-inch pipes, and must be upsized to Type 2- 96-inch catch basins. Two existing catch basin locations are eliminated, with catch basins placed only where needed because of pipe length and pipe tap-ins.

Design considerations include:

1) HEC-RAS modeling is based on 2012 LiDAR data and 2014 site observations and should be updated with survey data at the time of design.
2) The existing road crossings provide shallow cover over existing pipes and may result in challenges to provide adequate cover over proposed pipes. Regrading the channel between the 25th Avenue NE system and the culvert under NE 195th Street to lower the outlet invert elevation of the system, in addition to regrading a portion of the stream upstream in Brugger's Bog Park is required to allow for adequate cover. Regrading the stream section at Brugger's Bog Park may require additional armoring or a structure to ensure slopes are float enough to avoid sedimentation and a hydraulic jump. The stream regrading cost is included in the cost estimate.
3) Environmental permits and approvals include SEPA determination, WDFW HPA, and USACE Section 401 permit will be required.
4) Offside mitigation costs are not included in the overall CIP costs for this project.

Schematic:



0 25 50 100 Feet

Disclaimer: All information obtained from GIS. Not for construction.

Ballinger Creek Basin
25th Ave NE Flood Reduction Improvements

Planning-level Cost Estimate:

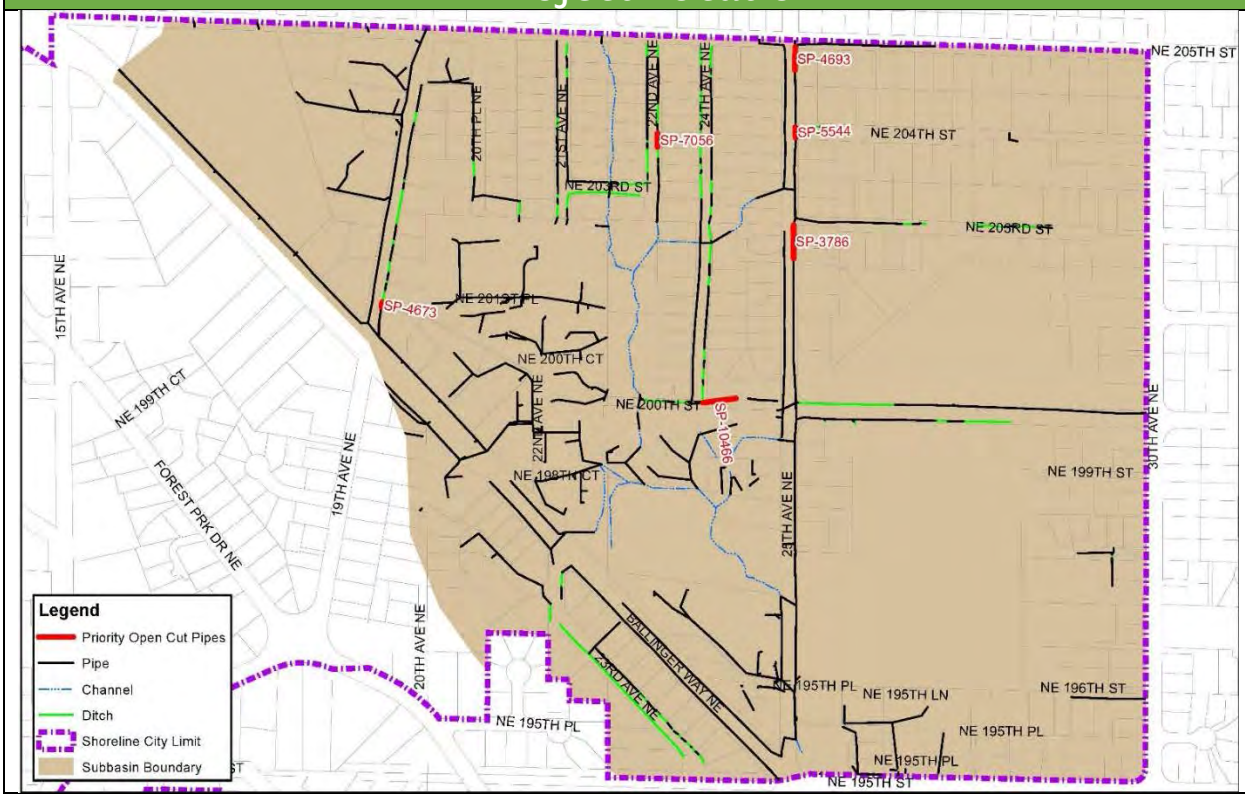
Item	Unit	Unit Cost	Quantity	Cost
Water Pollution/Erosion Control	%	10%		$163,600
SPCC Plan	LS	$500	1	$500
Traffic Control	%	10%		$163,600
Potholing	EA	$1,800	5	$9,000
Clearing & Grubbing	SY	$10	2450	$24,500
Remove Road, Curb & Gutter, and Sidewalk	SY	$150	685	$102,750
Temporary Stream Bypass	LS	$50,000	1	$50,000
Excavation Incl. Haul	CY	$60	3079	$184,740
Embankment Construction	CY	$10	409	$4,090
Streambed Gravel	CY	$65	140	$9,100
Type 2 96-in Catch Basin	EA	$10,000	3	$30,000
Schedule A 24" Storm Sewer Pipe	LF	$176	66	$11,616
Schedule A 72" Storm Sewer Pipe	LF	$525	550	$288,750
Planting and Bioengineered Restoration	SY	$100	2170	$217,000
Roadway Restoration	SY	$550	685	$376,750
Subtotal				$1,635,996
Contractor overhead, profit, and mobilization			10%	$163,599.60
Washington State Sales Tax			9.5%	$14,207
Construction Contingency			35%	$572,599
Subtotal Construction Costs				$2,386,401
City Staff Time			7.5%	$178,980.06
Administration and engineering design			15%	$357,960.12
Design Contingency			15%	$357,960.12
Permitting				$15,000
Off-site Mitigation Cost Not Included				$0
Total Project Cost				**$3,296,400**

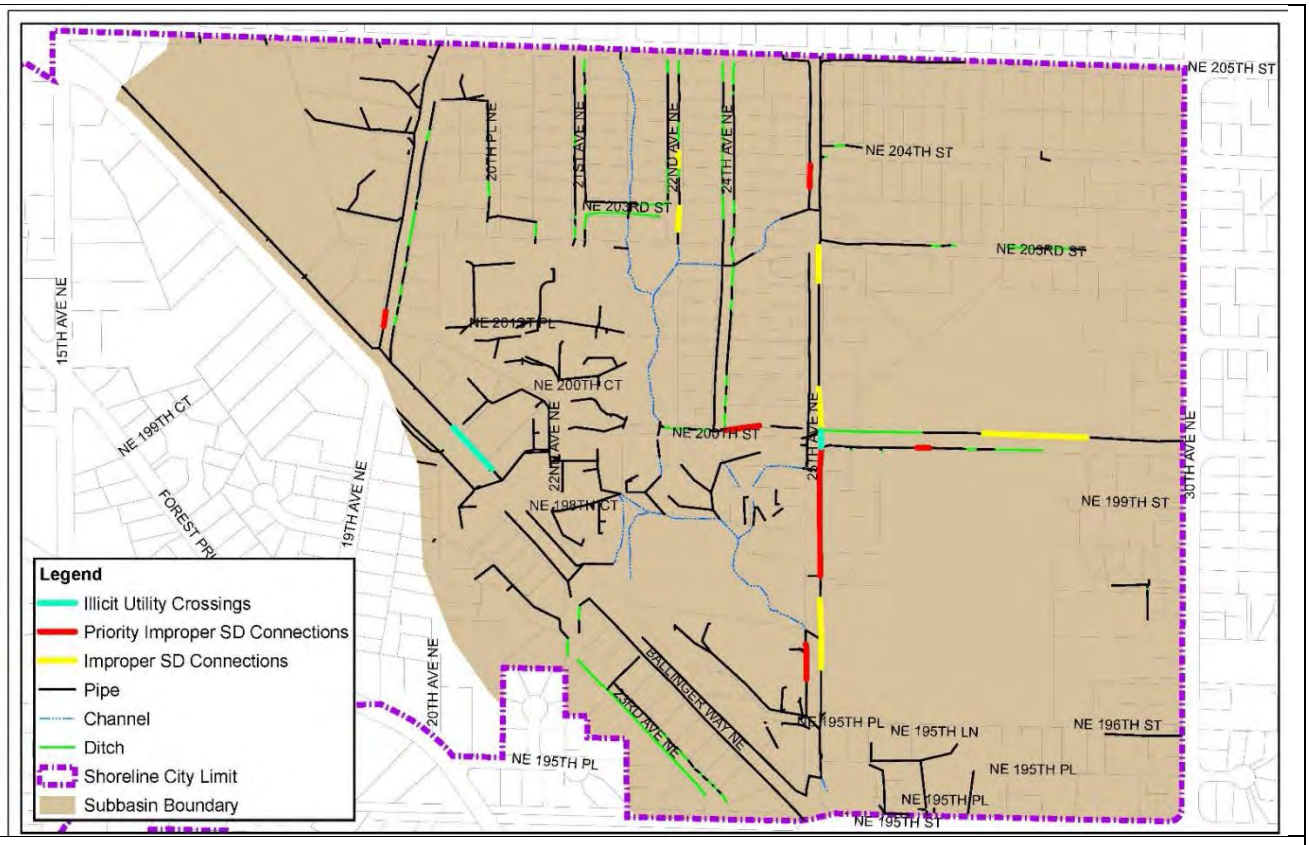
Note regarding contingencies on this project and Ba-CIP-1a:

*Contingency percentages used to estimate costs for this project are lower than those used for other smaller projects in order to keep the total contingency costs within reasonable amounts, as requested by the City.

Project ID:	Ba-CIP-2
Priority Open-cut Pipe Replacement and Storm Drain Connections	
Preliminary Cost (2015 $): $646,700	

Project Location:





Description:

This project would include upgrades and pipe replacement of stormwater pipes (Table 1 below) and structures (Table 2 below) throughout the Ballinger Creek basin. The project would include multiple locations, but be advertised as one construction project. The bid items at each location would be very similar and would achieve economy of scale and ultimately lower bid pricing. The locations would include high-priority, open-cut pipe replacement and installation of storm structures summarized in order of priority in the tables below.

Table 1: Recommended Open Cut Pipe Replacement											
Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam.	Material	Length	Problem	Notes
SP-3786	4.2	3	4.09	42	3	45	12	PE	119.99	Holes (top of pipe), pipe crushed, deformed (5% x3, 10%, 25%, & 20%), hole soil visible, tap-in	
SP-5544	3.5	1	3.22	28	1	29	12	CP	37.824	Broken soil visible with fracture (x3), roots at joint (fine), broken at repair patch, joint offset (medium x2), joint separation (large) - unable to pass, last 4' is fine	Under NE 204th St at 25th Ave NE
SP-4673	4.33	2	4	26	2	28	12	CP	17.469	Multiple fractures (entire length of pipe), broken pipe at joint, broken pipe with visible soil, dirt in bottom of pipe at break (10% full for 3 ft).	
SP-4693	4.2	0	4.2	21	0	21	12	CP	82.07	Broken soil visible (at joints, x4), joint offset (medium)	
SP-7056	4	4	4	16	8	24	12	CP	50.392	Tap-in, broken (x2), cracks (multiple), gravel blocking 50% of pipe last 2 feet	Only open cut for break at
SP-10466	3.5	2.67	3.14	14	8	22	12	CMP	119.91	Pipe 20% full of water (40 ft), rocks in bottom of pipe (5% full for 1 ft), tap break ins (x2 stormwater), broken pipe (top of pipe, repaired with metal sleeve?), hole in side of pipe, broken side of pipe, broken/hole at joint.	
SP-15136	2	0	2	2	0	2	18	RCP	59.618	Joint offset (large) - unable to pass	Under 25th Ave NE; site visit 10/15/14 identified
SP-472	0	2.33	2.33	0	7	7	12	CP	35.5	full for 10 ft), tap-in (x2, one is active, other full of roots), 4" corrugated yard/roof drain enters pipe at end of 12" CP, also 2 steel or wood rods? no CB. Pipe cleaned, deposits gone. No reverse inspection. No upstream CB.	upstream end. Upstream end of pipe is point where 4 inch plastic pipe enters 12 inch CP pipe. Not
								Total Length	427.65		

Table 2. Improper Storm Drain Connection										
Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam.	Material	Problem	Notes
SP-10466	3.5	2.7	3.1	14	8	22	12	CMP	Pipe 20% full of water (40 ft), rocks in bottom of pipe (5% full for 1 ft), tap break ins (x2 stormwater), broken pipe (top of pipe, repaired with metal sleeve?), hole in side of pipe, broken side of pipe, broken/hole at joint.	
SP-472	0	2.3	2.3	0	7	7	12	CP	Deposits at joints (x3, 10% full for 10 ft), tap-in (x2, one is active, other full of roots), 4" corrugated yard/roof drain enters pipe at end of 12" CP, also 2 steel or wood rods? no CB. Pipe cleaned, deposits gone. No reverse inspection. No upstream CB.	Part of 25th Ave CIP. No CB at upstream end. Upstream end of pipe is point whe 4 inch plastic pipe enters 12 inch CP pip CB-5645 does not connect to SP-472. A pipe extends south towards Ballinger W from CB-5645 and daylights 30-40 ft downstream. It is not connected to SP-472.
SP-1618	0	3	3	0	15	15	12	CP	1st direction: tap-in; 2nd direction: sediment (15% for 20 LF)	
SP-7053	2.3	3	2.5	7	3	10	12	CP	Crack (multiple for 10 LF), tap-in, joint offset (medium)	Pipe only needs repair at tap-in
SP-1151	3.3	2.3	2.5	13	32	45	18	RCP	Mineral deposits at infiltration weeper (break at deposit); infiltration runner, broken with soil visible, deposits attached (multiple locations); 3" yard drain tap-in; Infiltration weeper (multiple locations); sag (2); fine roots at joint	
SP-1780	0	2.2	2.2	0	11	11	12	CP	Hole or tap-in at 18 ft (not in report), CMP tap-in (stormwater), sediment at joints (5-10% for 20 LF)	
SP-1980	4	2.3	2.8	4	7	11	24	CMP	small dents in top of pipe, infiltration weepers at joints (x2), 8" conc pipe active tap break in intruding	Site visit 10/15/14 identified as part of 25th Ave CIP.
SP-1983	3.4	0	3.4	37	0	37	12	CP	Broken at joint (2); multiple cracks; 12" conc. pipe tap-in; rough bottom	

CMP Corrugated Metal Pipe
CP Concrete Pipe
MPR Maintenance Pipe Rating (sum of all rated maintenance defects)
MPRI Maintenance Pipe Rating Index (average of all rated maintenance defects)
OPR Overall Pipe Rating (sum of all rated structural and maintenance defects)
OPRI Overall Pipe Rating Index (average of all rated structural and maintenance defects)
PE Polyethlene
RCP Reinforced Concrete Pipe
SPR Structural Pipe Rating (sum of all rated structural defects)
SPRI Structural Pipe Rating Index (average of all rated structural defects)

Planning-level Cost Estimates:

Open-cut Pipe Replacement (pipes listed in Table 1 above)

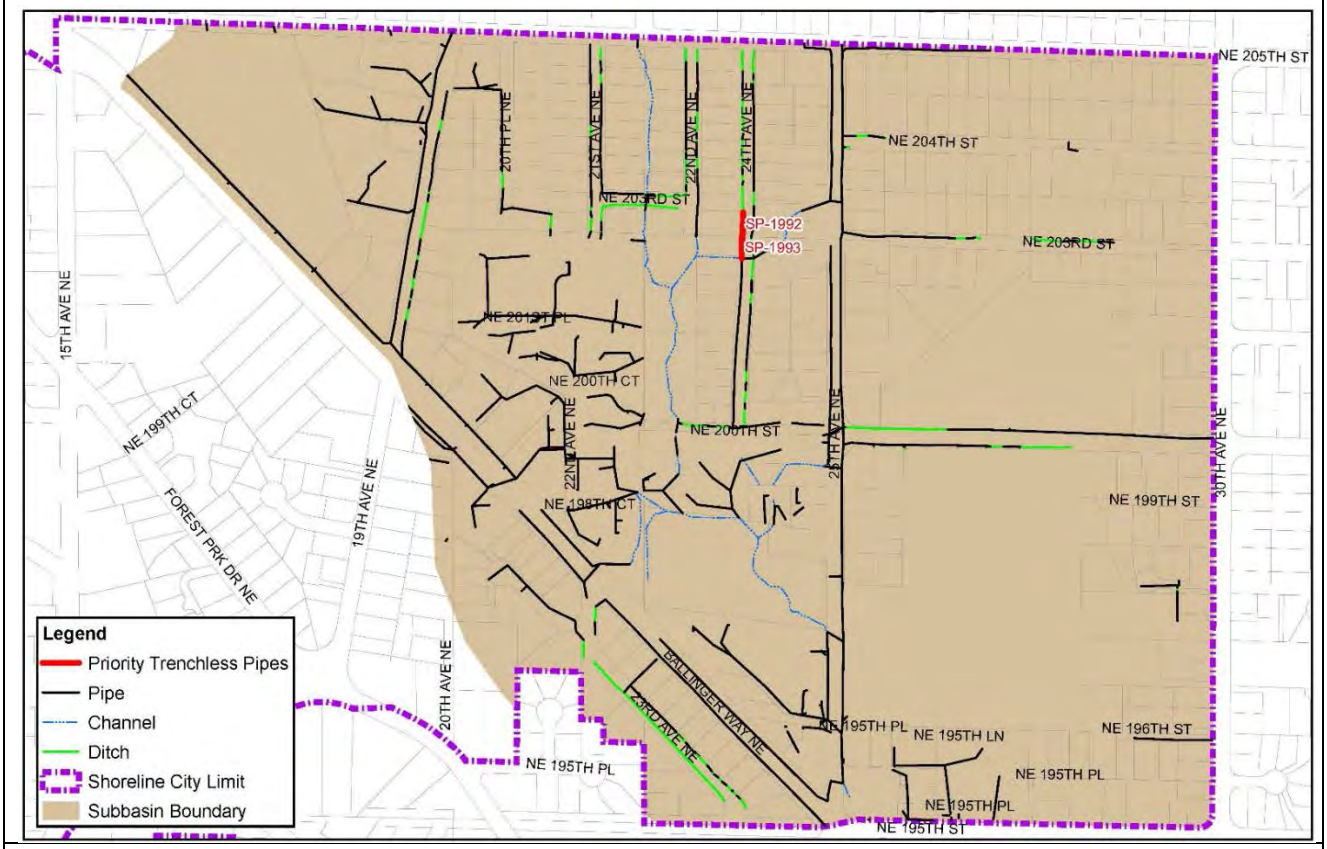
Item	Unit	Unit Cost	Quantity	Cost
Water Pollution/Erosion Control	%	5%		$10,800
SPCC Plan	LS	$500	1	$500
Traffic Control	%	7%		$15,000
Potholing	EA	$1,800	6	$10,800
Remove Road, Curb & Gutter, and Sidewalk	SY	$150	191	$28,650
Removal of Structures and Obstructions	LS	$2,000	2	$4,000
Connect to Existing Drainage Structure	EA	$500	6	$3,000
Schedule A 12" Storm Sewer Pipe	LF	$86	428	$36,808
Roadway Restoration	SY	550	191	$105,050
Subtotal				$214,608
Contractor overhead, profit, and mobilization			10%	$21,461
Washington State Sales Tax			9.5%	$0
Construction Contingency			50%	$107,304
Subtotal Construction Costs				$343,373
City Staff Time			10%	$34,337.28
Administration and engineering design			20%	$68,674.56
Design Contingency			20%	$68,674.56
Permitting				$0
Land acquisition and easements	SF	$5	0	$0
Total Project Cost				**$515,100**

Improper Storm Drain Connection Repair (pipes listed in Table 2 above)

Item	Unit	Unit Cost	Quantity	Cost
Water Pollution/Erosion Control	%	5%		$2,800
SPCC Plan	LS	$500	1	$500
Traffic Control	%	7%		$3,900
Potholing	EA	$1,800	10	$18,000
Remove Road, Curb & Gutter, and Sidewalk	SY	$150	28	$4,200
Tee - 8"	EA	$1,000	10	$10,000
Roadway Restoration	SY	550	28	$15,400
Subtotal				$54,800
Contractor overhead, profit, and mobilization			10%	$5,480
Washington State Sales Tax			9.5%	$0
Construction Contingency			50%	$27,400
Subtotal Construction Costs				$87,680
City Staff Time			10%	$8,768.00
Administration and engineering design			20%	$17,536.00
Design Contingency			20%	$17,536.00
Permitting				$0
Land acquisition and easements	SF	$5	0	$0
Total Project Cost				**$131,600**

Project ID:	Ba-CIP-3
Priority Trenchless Pipe Replacement	
Preliminary Cost (2015 $): $61,600	

Project Location:



Description:

This project would include pipe replacement of stormwater pipes listed in Table 1 (below), which entails replacing approximately 150 linear feet of stormwater pipe in the Ballinger Creek basin using trenchless methods. The project includes 2 pipes that were determined to be of high priority because of deficiencies noted during the condition assessment.

Table 1. Recommended Pipes for Trenchless Repair											
Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam. (in)	Material	Length (ft)	Problem	Notes
SP-1992	3.41	0	3.4	75	0	75	12	CP	73.18	Exposed aggregate entire length of pipe, hole with visible soil in side of pipe at joint, multiple cracks, 2 holes with visible soil at joint (one on each side), multiple fractures and broken piece on top of pipe.	Multiple fractures look to in danger of pipe collapse Possibly caused by anoth utility? Trenchless repair probably possible now, b pipe collapses, open cut v become necessary.
SP-1993	3	2.4	2.7	12	12	24	12	CP	77.3	broken pipe at joint, spiral crack, Joint offset medium (x2), deposits attached encrusted (x2), gravel in pipe (10'), broken pipe with visible soil at joint, debris/muck blocking 25% of pipe at separated joint, camera unable to pass, end of pipe visible (approx. 10 feet) and in good condition	

CP Concrete Pipe
MPR Maintenance Pipe Rating (sum of all rated maintenance defects)
MPRI Maintenance Pipe Rating Index (average of all rated maintenance defects)
OPR Overall Pipe Rating (sum of all rated structural and maintenance defects)
OPRI Overall Pipe Rating Index (average of all rated structural and maintenance defects)
SPR Structural Pipe Rating (sum of all rated structural defects)
SPRI Structural Pipe Rating Index (average of all rated structural defects)

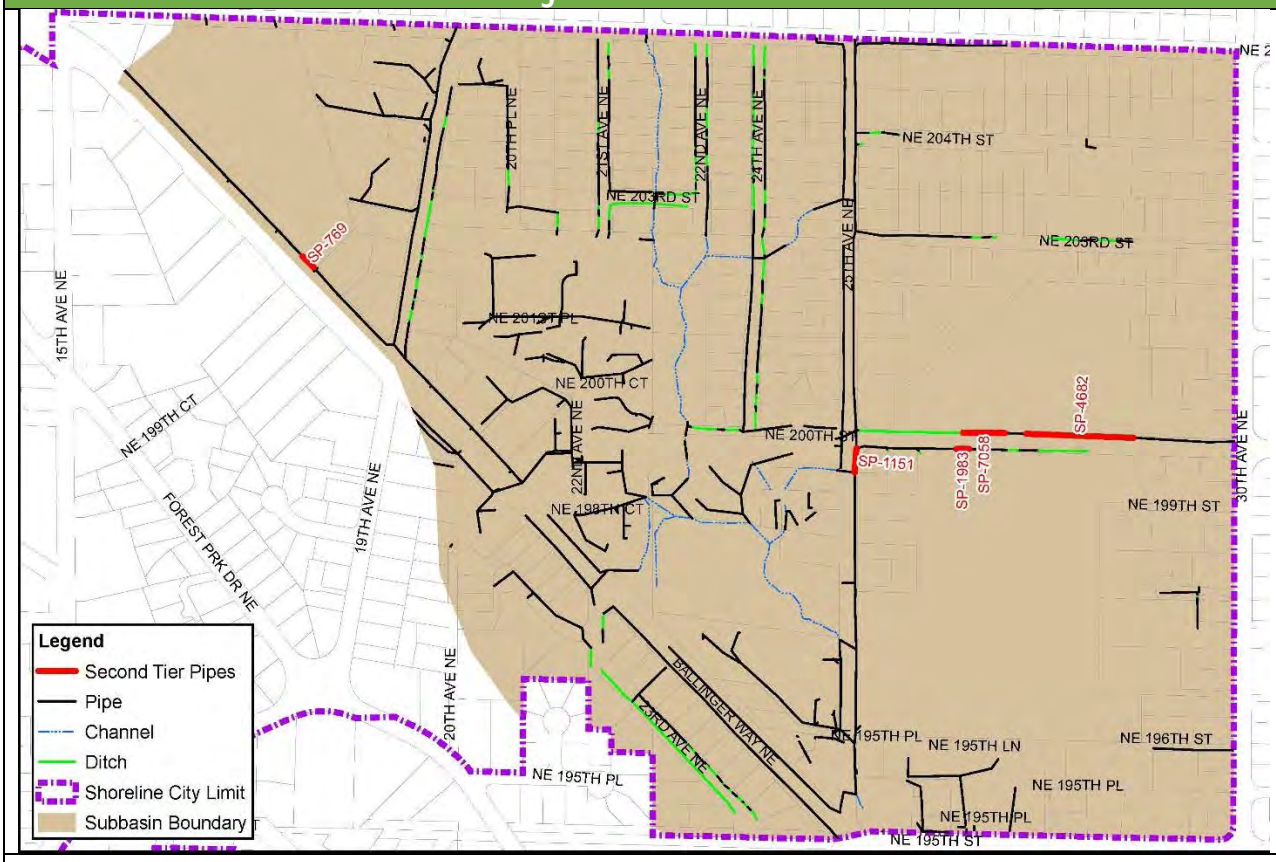
Planning-level Cost Estimate:

Trenchless Pipe Replacement (pipes listed in Table 1 above)

Item	Unit	Unit Cost	Quantity	Cost
Water Pollution/Erosion Control	%	5%		$1,300
SPCC Plan	LS	$500	1	$500
Traffic Control	%	7%		$1,800
Potholing	EA	$1,800	2	$3,600
Removal of Structures and Obstructions	LS	$2,000	1	$2,000
Trenchless Pipe Replacement 12"	LF	$109	151	$16,459
Subtotal				$25,659
Contractor overhead, profit, and mobilization			10%	$2,566
Washington State Sales Tax			9.5%	$0
Construction Contingency			50%	$12,830
Subtotal Construction Costs				$41,054
City Staff Time			10%	$4,105.44
Administration and engineering design			20%	$8,210.88
Design Contingency			20%	$8,210.88
Permitting				$0
Land acquisition and easements	SF	$5	0	$0
Total Project Cost				**$61,600**

Project ID:	Ba-CIP-4
Second Tier Pipe Repair	
Preliminary cost (2015 $): $258,000	

Project Location:



Description:

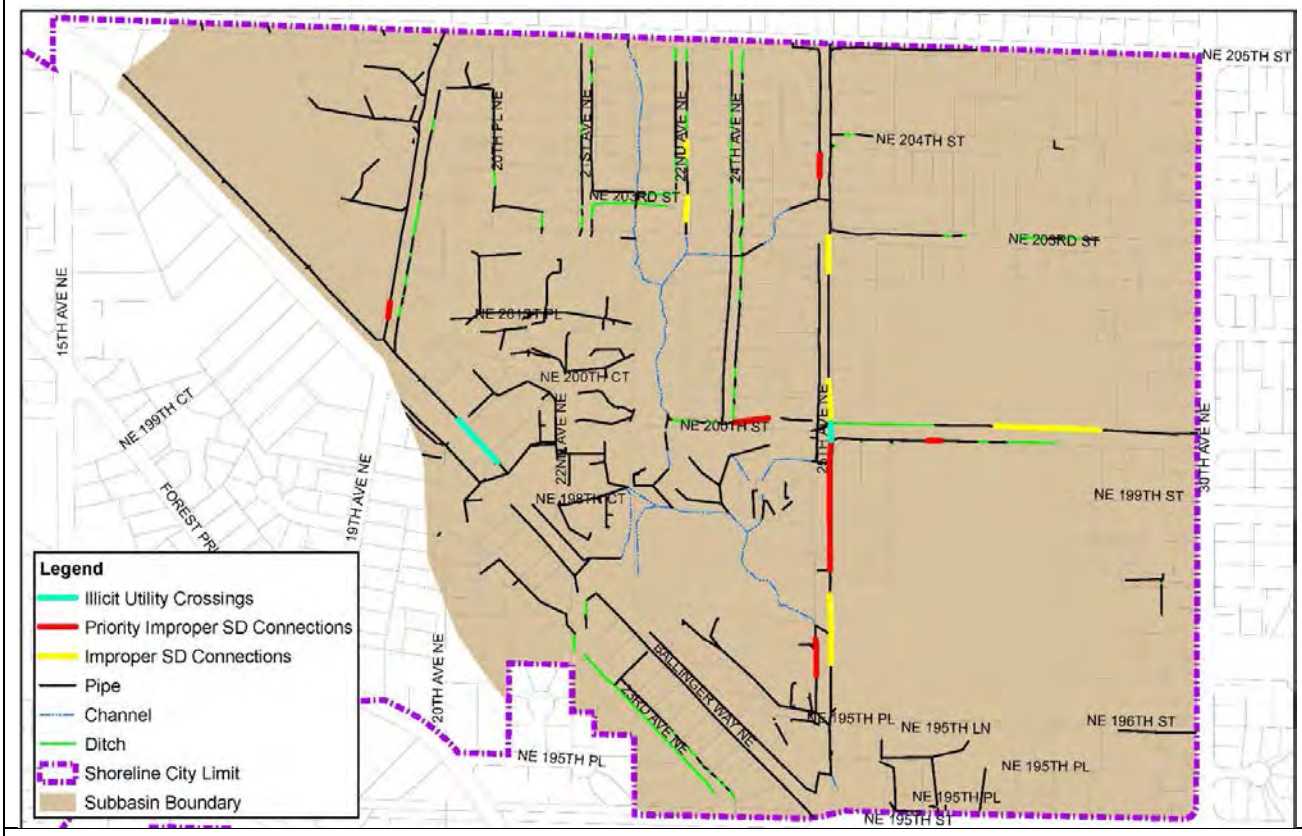
Pipes that did not fall into a category that warranted priority pipe repair by open cut or trenchless technologies, yet have received a poor SPR were included in this category. Structural deficiencies in this category include pipes that have fractures, holes, or minor deformities. It is recommended that the City place these pipes on a “to be repaired” list to ensure the pipe does not fail before the next assessment period. Nearly 6,000 linear feet of pipe fit into this category.

Planning Level Cost Estimate:

Item	Unit	Unit Cost	Quantity	Cost
Water Pollution/Erosion Control	%	5%		$4,900
SPCC Plan	LS	$500	1	$500
Traffic Control	%	7%		$6,900
Potholing	EA	$1,800	6	$10,800
Removal of Structures and Obstructions	LS	$2,000	2	$4,000
Trenchless Pipe Replacement 12"	LF	$109	597	$65,073
Trenchless Pipe Replacement 18"	LF	$189	81	$15,309
Subtotal				$107,482
Contractor overhead, profit, and mobilization			10%	$10,748
Washington State Sales Tax			9.5%	$0
Construction Contingency			50%	$53,741
Subtotal Construction Costs				$171,971
City Staff Time			10%	$17,197.12
Administration and engineering design			20%	$34,394.24
Design Contingency			20%	$34,394.24
Permitting				$0
Land acquisition and easements	SF	$5	0	$0
Total Project Cost				**$258,000**

Project ID:	Ba-CIP-5
Remove Utility Crossings	
Preliminary Cost (2015 $): $3,640 (City staff)	

Project Location:



Description:

This project involves City staff time to coordinate with other utilities to remove their lines and repair the storm drains that have been damaged as a result of improper crossings. Table 1 (below) lists the affected pipes and types of problems. The City was notified of suspected gas line crossings when identified in the condition assessment so that coordination with the gas company could begin immediately.

Table 1. Utility Crossings to be Removed									
Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam. (in.)	Material	Problem
SP-2880	3	4	3.3	9	4	13	18	RCP	Gas line through pipe with multiple cracks and holes.
SP-6421	2	2.5	2.4	2	20	22	18	CP	Infiltration runner/weeper (x4) with encrusted deposits, crack (longitudinal), intruding cable utility - unable to pass

CP Concrete Pipe
MPR Maintenance Pipe Rating (sum of all rated maintenance defects)
MPRI Maintenance Pipe Rating Index (average of all rated maintenance defects)
OPR Overall Pipe Rating (sum of all rated structural and maintenance defects)
OPRI Overall Pipe Rating Index (average of all rated structural and maintenance defects)
RCP Reinforced Concrete Pipe
SPR Structural Pipe Rating (sum of all rated structural defects)
SPRI Structural Pipe Rating Index (average of all rated structural defects)

Planning-level Cost Estimate:

Task	Description	Hours	Rate	Total
1	Contact Utility Companies	4	$ 100.00	$ 400.00
2	Coordinate Utility Work	20	$ 100.00	$ 2,000.00
3	Check that work was completed	4	$ 100.00	$ 400.00
			Subtotal	$ 2,800.00
			Contingency (30%)	$ 840.00
			TOTAL	$ 3,640.00

Project ID:	Ba-CIP-6
Remove Improper Storm Drain Connections	
Preliminary Cost (2015 $): $162,600	

Project Location:

Description:

This project involves fixing improperly installed stormwater drains by adding a structure such as a catch basin or a manhole to connect incoming and outgoing pipes, rather than pipes connecting to one another with no such structure. Several improperly connected storm drains are recommended for modification as part of open-cut pipe replacement; however, the assets listed in Table 1 (below) are not associated with other specific pipe problems that need correction.

Table 1: Improper Storm Drain Connection				
Asset ID	Diam.	Material	Problem	Notes
SP-1994	12	CP	Medium joint offset (3); roots tap joint (large roots growing from joint downstream through barrel of pipe) - unable to pass, inspect from other end. Joint separation medium, joint offset (not in report) with plastic intruding into pipe, tap break in with broken mainline pipe, joint offset medium, joint	
SP-3786	12	PE	Holes (top of pipe), pipe crushed, deformed (5% x3, 10%, 25%, & 20%), hole soil visible, tap-in	
SP-4682	12	CP	Two Reports b/c of tee in pipe; US: roots (medium-x4, fine-x3), cracks (multiple), tee at 75.7'; DS: broken (repair patch?), tap-in, tee at 274.2'	Need to add CB's at tees.
SP-7056	12	CP	Tap-in, broken (x2), cracks (multiple), gravel blocking 50% of pipe last 2 feet	Only open cut for break at 43.5 ft from J05524.
SP-8834	12	CP	Abandoned tap break in with encrusted deposits, sag, gravel in bottom of pipe, camera unable to continue - soccer balls and gravel in pipe.	

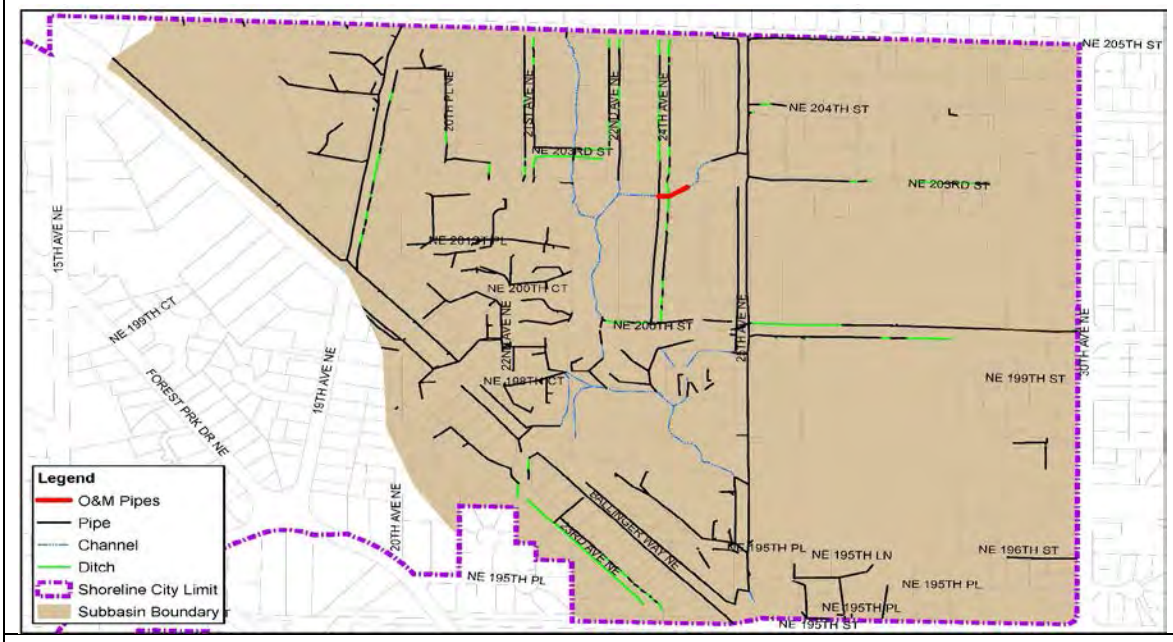
CP Concrete Pipe
MPR Maintenance Pipe Rating (sum of all rated maintenance defects)
MPRI Maintenance Pipe Rating Index (average of all rated maintenance defects)
OPR Overall Pipe Rating (sum of all rated structural and maintenance defects)
OPRI Overall Pipe Rating Index (average of all rated structural and maintenance defects)
PE Polyethylene Pipe
SPR Structural Pipe Rating (sum of all rated structural defects)
SPRI Structural Pipe Rating Index (average of all rated structural defects)

Planning-level Cost Estimate:

Item	Unit	Unit Cost	Quantity	Cost
Water Pollution/Erosion Control	%	5%		$5,700
SPCC Plan	LS	$500	1	$500
Traffic Control	%	7%		$8,000
Potholing	EA	$1,000	5	$5,000
Remove Road, Curb & Gutter, and Sidewalk	SY	$150	56	$8,400
Storm Drain Catch Basin or Manhole	EA	$4,000	5	$20,000
Roadway Restoration	SY	292	56	$16,352
Subtotal				$63,952
Contractor overhead, profit, and mobilization			10%	$6,395
Washington State Sales Tax			9.5%	$6,075
Construction Contingency			50%	$31,976
Subtotal Construction Costs				$108,399
City Staff Time			10%	$10,839.86
Administration and engineering design			20%	$21,679.73
Design Contingency			20%	$21,679.73
Permitting				$0
Land acquisition and easements	SF	$5	0	$0
Total Project Cost				**$162,600**

Project ID:	Ba-CIP-7
Pipes to be Replaced by City Crews	
Preliminary Cost (2015 $): To be Determined	

Project Location:



Description:

This project involves replacement or repair of pipes by City Operations and Maintenance staff. Table 1 (below) lists the affected pipes and types of problems.

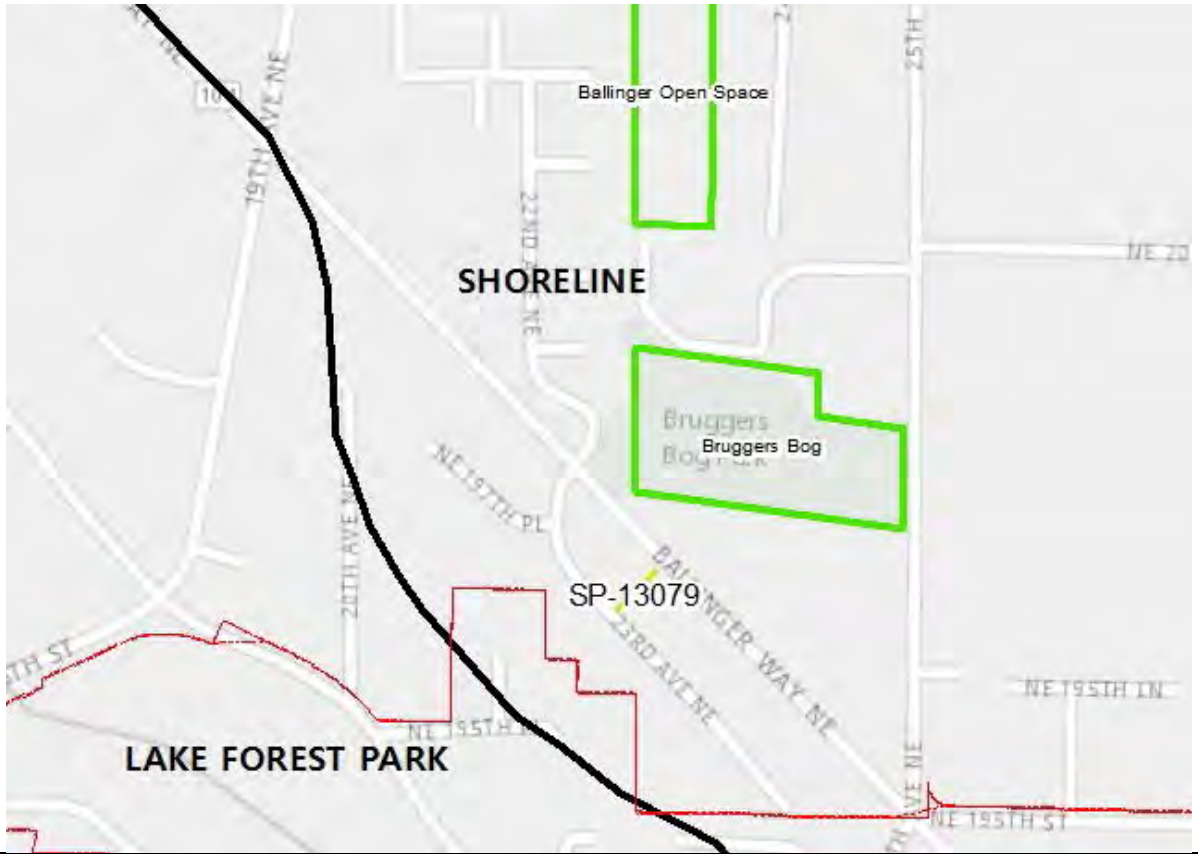
Table 1: Pipes Recommended for Replacement by City Crews

Asset ID	SPRI	MPRI	OPRI	SPR	MPR	OPR	Diam.	Material	Length	Problem
SP-6414	3.2	2	3	16	2	18	12	CP	39.28	Gravel, cracks (multiple), broken soil visible, crack (longitudinal), joint offset (medium), broken
SP-9081	3.2	3	3.17	16	3	19	12	CP	80.89	Gravel (15%), cracks (multiple x2), broken soil visible (x2), joint offset (medium)

CP Concrete Pipe
MPR Maintenance Pipe Rating (sum of all rated maintenance defects)
MPRI Maintenance Pipe Rating Index (average of all rated maintenance defects)
OPR Overall Pipe Rating (sum of all rated structural and maintenance defects)
OPRI Overall Pipe Rating Index (average of all rated structural and maintenance defects)
SPR Structural Pipe Rating (sum of all rated structural defects)
SPRI Structural Pipe Rating Index (average of all rated structural defects)

Project ID:	Ba-CIP-8
Abandon Pipes on Private Property and Relocate to City ROW	
Preliminary Cost (2015 $): $323,700	

Project Location:



Description:

Pipe SP-13079 currently crosses between 2 property lines from 23rd Avenue NE to Ballinger Way NE. The City does not have a drainage easement at the location. This project involves abandoning the existing pipe in place and installing 2 new pipes to connect the existing catch basins within the City's ROW.

Table 1: Pipe Recommended for Relocation to Right of Way

Project	Asset ID	Diam.	Material	Length	Problem	Notes
Relocate 1	SP-13079	12	CP	126.98	On private property	Open ditch outlet? Reroute.

CP Concrete Pipe

Planning-level Cost Estimate:

Item	Unit	Unit Cost	Quantity	Cost
Water Pollution/Erosion Control	%	5%		$6,200
SPCC Plan	LS	$500	1	$500
Traffic Control	%	7%		$8,700
Potholing	EA	$1,800	4	$7,200
Remove Road, Curb & Gutter, and Sidewalk	SY	$150	110	$16,500
Connect to Existing Drainage Structure	EA	$500	2	$1,000
Storm Drain Catch Basin or Manhole	EA	$4,000	1	$4,000
Schedule A 12" Storm Sewer Pipe	LF	$86	222	$19,092
Roadway Restoration	SY	550	110	$60,500
Subtotal				$123,692
Contractor overhead, profit, and mobilization			10%	$12,369
Washington State Sales Tax			9.5%	$11,751
Construction Contingency			50%	$61,846
Subtotal Construction Costs				$209,658
City Staff Time			10%	$20,965.79
Administration and engineering design			20%	$41,931.59
Design Contingency			20%	$41,931.59
Permitting				$0
Land acquisition and easements	SF	$5	1,830	$9,150
Total Project Cost				**$323,700**

Project ID:	Ba-Coor-1
Coordination with City Projects in Lyon Basin	
Preliminary Cost (2015 $): $3,900 annually	

Description:

The 25th Avenue NE corridor was identified as having significant flooding problems and deteriorating pipes in need of replacement. Other City projects have also been slated for this road or adjacent to it. It will be important that the City departments and personnel responsible for the different efforts coordinate and communicate with one another to provide efficient use of City resources and ensure that projects get completed in a logical manner.

This programmatic project involves staff coordination with other City departments as progress is made on:

- Development of Bruggers Bog Maintenance Facility,
- Pedestrian improvements on 25th Avenue NE, and
- Other City-initiated park improvements that intersect or should be coordinated with stormwater improvements in the basin.

Assumptions:

- Coordination with other City initiatives requires active participation and engagement and time.
- Until projects are in the design phase and fully funded, participation by Utility staff will be more limited, but is expected to increase as projects ramp up into design.

Planning-level Cost Estimate:

The cost estimate below is for staff time to keep abreast of new developments on projects in the basin and time to review and participate in planning for improvements.

Task	Description	Staff Hours	Staff Rate	Total	Assumptions
1	Meet with City staff regarding Bruggers Bog maintenance facility, provide input on stormwater facilities	10	$ 100.00	$ 1,000.00	Assume 10 hours per year
2	Coordinate with staff on 25th Avenue NE improvements	20	$ 100.00	$ 2,000.00	Assume 20 hours per year
			Subtotal	$ 3,000.00	
			Contingency (30%)	$ 900.00	
			TOTAL	$ 3,900.00	

Project ID:	Ba-Coor-2
Coordination with Outside Stakeholders in Lyon Creek Basin	
Preliminary Cost (2015 $): $1,820 annually	

Description:

Shoreline's portion of the Lyon Creek basin is very small, compared to other jurisdictions that share the watershed (including Mountlake Terrace and Lake Forest Park). The City has participated in watershed-wide forums and initiatives in the past, and should continue to communicate with its upstream (Mountlake Terrace) and downstream (Lake Forest Park) neighbors regarding issues and impacts to Ballinger and Lyon Creeks.

This programmatic project involves staff time to coordinate with the Cities of Mountlake Terrace and Lake Forest Parks to discuss:

- Overall surface water problems and approaches to solving those problems,
- Upstream flow control in Mountlake Terrace, and
- Site-specific issues such as the NE 195th Street culvert crossing at the boundary with Lake Forest Park.

Assumption:

- General coordination with neighboring jurisdictions is limited to quarterly phone calls and once-yearly
  in-person meetings.

Planning-level Cost Estimate:

The cost estimate below is for staff time to coordinate with Lake Forest Park and Mountlake Terrace on surface and stormwater issues in the Lyon Creek basin.

Task	Description	Staff Hours	Staff Rate	Total	Assumptions
1	Quarterly phone calls and preparation with two jurisdictions	8	$ 100.00	$ 800.00	Assume 8 hours per year
2	Once yearly in-person meetings with two jurisdictions	6	$ 100.00	$ 600.00	Assume 3 hours each meeting
			Subtotal	$ 1,400.00	
			Contingency (30%)	$ 420.00	
			TOTAL	$ 1,820.00	

Project ID:	Ba-Ed-1
Targeted Flood Education	
Preliminary cost (2015 $): $2,600	

Description:

This project involves providing targeted flood-related materials to affected residents in the vicinity of 25th Avenue NE. The City has many flood preparedness documents available to businesses and residents on its website; however, some of the residents that are affected by flooding may not have access to those materials or be aware of them. Targeted outreach to the specific apartment buildings that tend to be impacted by flooding could help lessen impacts.

Planning-level Cost Estimate:

The cost estimate below is for staff time to visit with residents and provide flood materials, such as sand bags.

Task	Description	Hours	Rate	Total
1	Visit residents	10	$ 100.00	$ 1,000.00
2	Provide materials--sand bags, etc.	0		$ 1,000.00
			Subtotal	$ 2,000.00
			Contingency (30%)	$ 600.00
			TOTAL	$ 2,600.00

Project ID:	Ba-Hab-1
Bruggers Bog Park Vegetation Management	
Preliminary Cost (2015 $): $0 (assumed to be volunteer-led)	

Project Location:

Description:

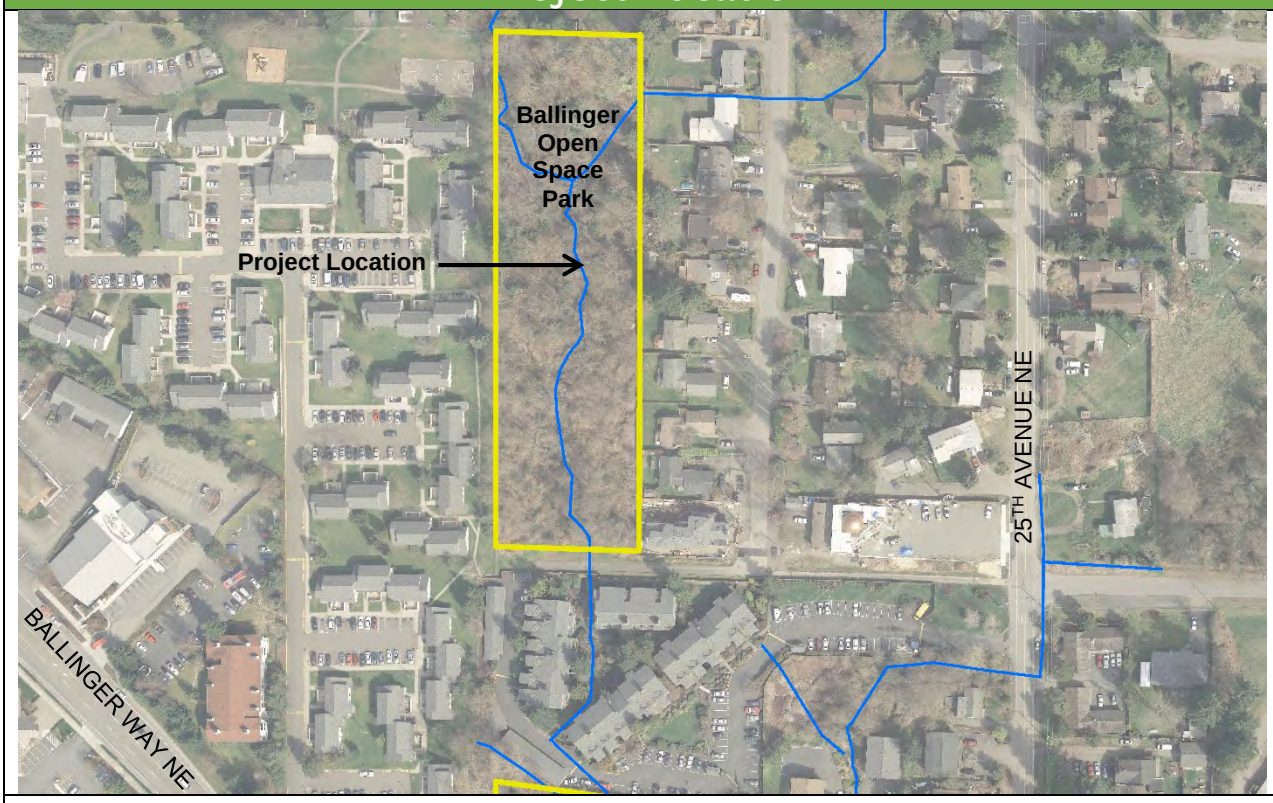
This project recognizes that Bruggers Bog Park is in need of additional vegetation management, including removal of invasive vegetation and replacement with native vegetation. A few restoration projects in the past have improved the ecological health of the park, and the Ballinger Neighborhood Association volunteers have continued to hold work parties to remove non-native plants and conduct general clean-up. This project encourages volunteer work and native vegetation growth in the park to continue.

Planning-level Cost Estimate:

No cost. It is assumed that efforts continue to be a volunteer-led effort. The City could provide support through environmental mini-grants, or provision of equipment for work parties and pick up of debris.

Project ID:	Ba-Hab-2
Ballinger Open Space Stream Restoration and Park Enhancement	
Preliminary Cost (2015 $): $0 (no cost provided)	

Project Location:



Description:

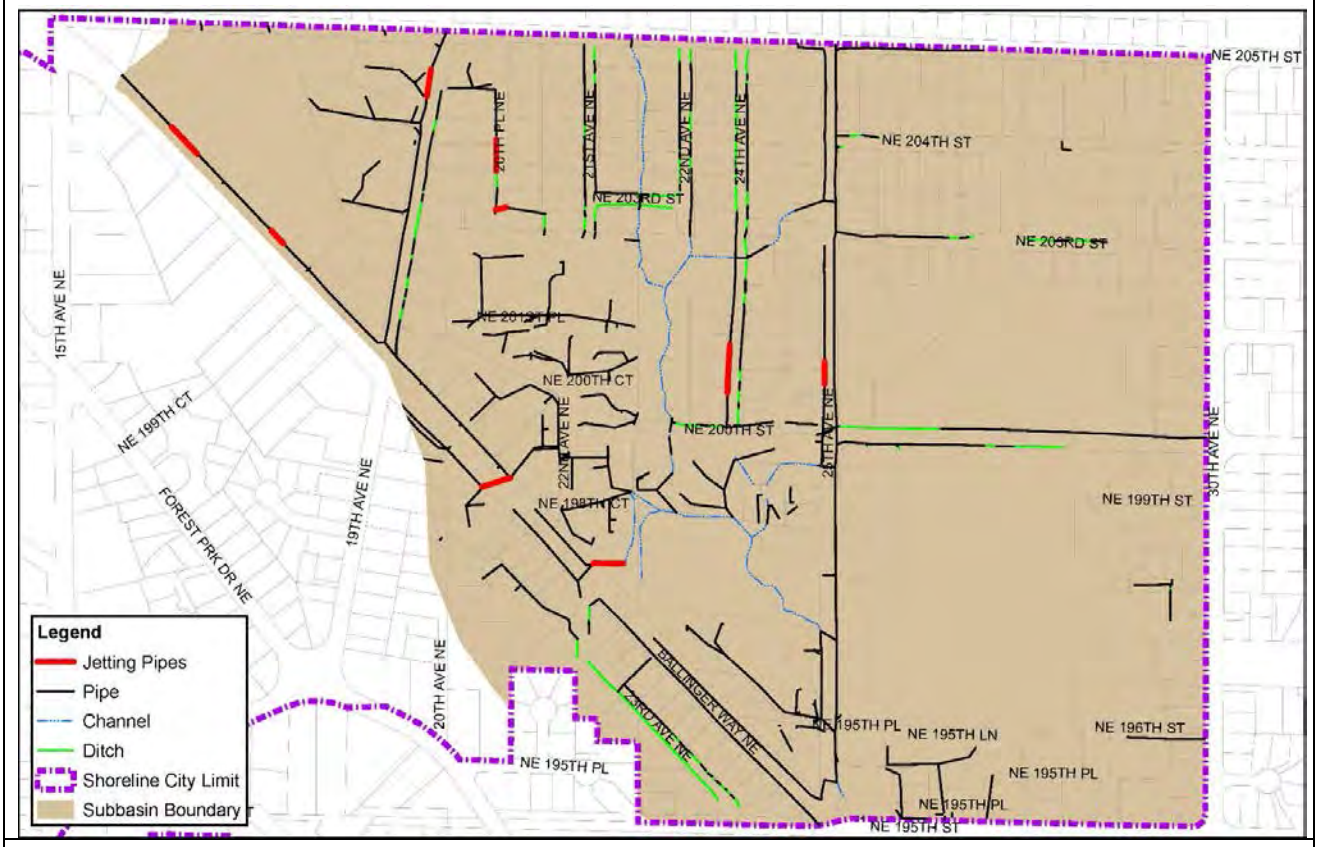
Ballinger Creek is severely degraded in Ballinger Open Space Park. The park is unmaintained and overgrown with non-native vegetation. Access to the park is difficult. The few trails that are present are overgrown and not maintained. While it is not the City's goal to create a more formal park setting in its open spaces, such as Ballinger Open Space Park, the natural resource and recreational qualities of the park could be improved and help improve overall water quality conditions in Ballinger and Lyon creeks.

A specific restoration concept is not presented in this plan, rather a project placeholder is recommended for restoration of Ballinger Open Space Park to:

- Reconnect the channel to its floodplain to help minimize erosion and sedimentation,
- Remove non-native vegetation,
- Plant and encourage growth of native vegetation, and
- Develop safe trails to encourage people to visit and enjoy the park.

Project ID:	Ba-Main-1
Maintenance Modifications	
Preliminary Cost (2015 $): $20,000	

Project Location:



Description:

This project addresses pipes that had a poor MPR (≥ 5) and were identified as being in need of further maintenance, including additional pipe jetting to remove sediment and debris. Several pipes in the condition assessment were completely blocked by obstacles other than sediment (e.g., brick structures or basketballs), which need to be removed to ensure pipe functionality. Table 1 (below) lists pipes recommended for pipe jetting or increased maintenance. These pipes may also need to be potentially replaced in the future if the frequent sedimentation is due to inadequate design.

Table 1: Pipes Recommended for Jetting or Increased Maintenance

Asset ID	SP RI	MP RI	OP RI	S P R	M PR	O PR	Diam.	Material	Length	Problem
SP-1219	1	2.31	2.24	1	37	38	12	CP	51.94	Sediment at bottom (length of pipe), joint offset (medium), deposits at joints (multiple)

SP-166	0	3.11	3.11	0	28	28	12	CP	65.17	Sediment (15% for 40 LF, 30% for 5 LF)
SP-5534	0	2	2	0	28	28	12	CP	75.86	Sediment (10% length of pipe)
SP-6907	3	2	2.46	36	28	64	12	CP	64.40	Sediment (10% length of pipe), aggregate visible (length of pipe), sediment deposit (10% x2)
SP-1619	0	2	2	0	26	26	12	CP	129.49	Sediment (10% for 20 LF, 10% for 45 LF)
SP-8647	2	3	2.58	10	21	31	24	CMP	102.00	Sag (10% full for 25 ft), gravel and debris in bottom of pipe (20% full for 35+ ft), camera unable to reach upstream CB, but visual inspection of last 30 ft of pipe looks good (according to report - difficult to see in video).
SP-5537	1.67	2.1	2	5	21	26	12	CP	112.81	Circumferential crack, longitudinal fracture, joint offset medium, infiltration weeper (45 LF), sediment (5% for 45 LF), encrusted deposits (45 LF), rocks (10% x2), dirt and gravel (20%) - unable to pass, inspection completed from other side and clear
SP-5991	2	2.5	2.44	2	20	22	12	CP	59.69	Encrusted deposits (20% for 20 LF, 10% x4), crack (longitudinal)
SP-459	3.2	2.43	2.75	16	17	33	12	CP	90.70	Storm debris in pipe, roots at joint (x5), multiple cracks (x2 + 3 ft), longitudinal cracks, broken pipe (brick intruding? Repaired with brick?), deposits attached encrusted, infiltration stains (x4)
SP-4290	0	3.33	3.33	0	10	10	12	Concrete	19.00	Deposits in bottom of pipe (10-50% full for 52 feet) camera unable to continue past debris.
SP-4080	0	4	4	0	8	8	12	CMP	106.87	Pipe 30% plus full of dirt, rocks (and concrete?), camera unable to continue.
SP-8893	0	5	5	0	5	5	18	CMP	101.58	Unable to pass due to 50% water. Water 25% full for 16 feet, then increases to more than 50%. Camera unable to complete, unable to evaluate pipe condition due to water.
SP-2563	0	5	5	0	5	5	12	CP	36.32	Pipe 45% full of dirt, rocks and debris. Camera unable to continue past 9 feet.
									1015.84	

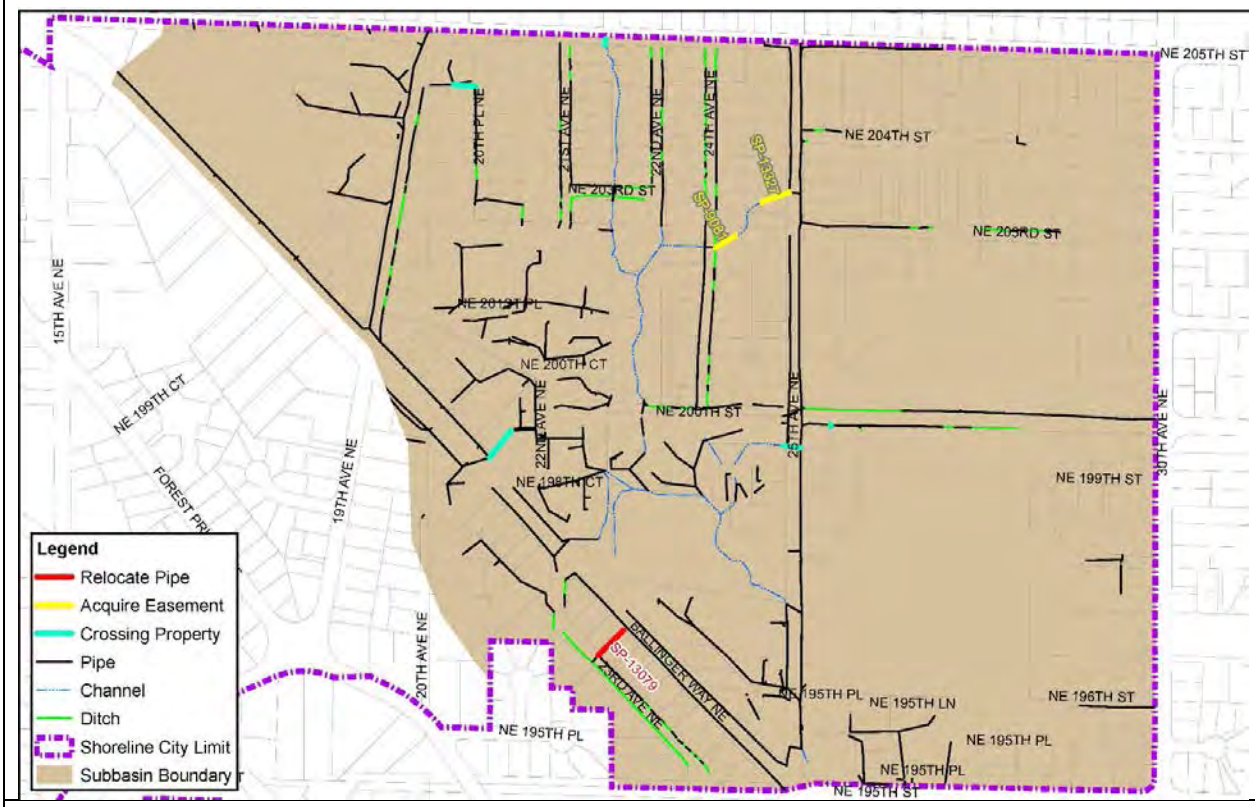
CP Concrete Pipe
LF Linear feet
MPR Maintenance Pipe Rating (sum of all rated maintenance defects)
MPRI Maintenance Pipe Rating Index (average of all rated maintenance defects)
OPRI Overall Pipe Rating Index (average of all rated structural and maintenance defects)
OPR Overall Pipe Rating (sum of all rated structural and maintenance defects)
SPR Structural Pipe Rating (sum of all rated structural defects)
SPRI Structural Pipe Rating Index (average of all rated structural defects)

Planning-level Cost Estimate:

The estimated cost of cleaning or maintenance is estimated to be approximately $20,000 (assumes approximately 1,000 linear feet of pipe).

Project ID:	Ba-Pol-1
Evaluate Easement Acquisition	
Preliminary Cost (2015 $): ~$17,000 per easement	

Project Location:



Description:

This project involves taking steps to either move stormwater pipes off private property and into public ROW or acquire drainage easements so that those pipes can be more easily maintained by City staff. Table 1 (below) lists pipes for which easements are recommended and pipes that cross private properties for which easements might be appropriate. It is assumed that City staff would review options, make contact with property owners, and take the legal steps necessary to acquire the easements. An estimated cost associated with doing that work is provided below.

Table 1: Pipe Recommended for Relocation to Right of Way						
Project	Asset ID	Diam.	Material	Length	Problem	Notes
Easement 1	SP-13327	12	CP	102.75	On private property	Connects Drainage channel
Easement 2	SP-9081	12	CP	80.89	Gravel (15%), cracks	Connects Drainage channel
Other	SP-15092	12	CP	90.49	Bend in pipe 121 ft from	Need new CB at bend? Pipe
Pipes	SP-15136	18	RCP	59.62	Joint offset (large) - unable	Under 25th Ave NE; site visit
Crossing	SP-3774	12	PE	5.21	Leaves	Short pipe collecting flow
Private	SP-5637	24	RCP	22.81	Cracks (multiple)	Connects stream/drainage
Property	SP-8242	12		78.00	On private property	Conveys drainage from gas
	SP-9475	24	CMP	124.57	On private property	ROE granted. Property

CMP Corrugated Metal Pipe
CP Concrete Pipe
PE Polyethylene Pipe
RCP Reinforced Concrete Pipe

Planning-level Cost Estimate:

The cost estimate below is for staff time to acquire a new easement, including boundary survey. Cost of easement is not included.

Task	Description	Hours	Rate	Total
1	Investigate Easement Options	20	$ 100.00	$ 2,000.00
2	Survey	0		$ 3,000.00
3	Staff time/legal	80	$ 100.00	$ 8,000.00
			Subtotal	$ 13,000.00
			Contingency (30%)	$ 3,900.00
			TOTAL	$ 16,900.00

Project ID:	Ba-Pol-2
Evaluate Stream Designations	
Preliminary Cost (2015 $): $10,530	

Project Location:

Description:

Several streams walked or otherwise qualitatively assessed for this basin plan were identified as potentially having an inaccurate stream designation according to SMC 20.40.470 or that are inaccurately depicted in the City's GIS as being in a pipe when the stream is in an open channel or vice versa. This project is to review stream designations, and mapping to ensure accuracy of mapped stream channels in the Lyon Creek basin. If modifications are recommended, implications of potential changes should be considered before any changes are made and planning staff should be consulted.

Planning-level Cost Estimate:

Task	Description	Staff Hours	Staff Rate	Total
1	Stream channel measurements	4	$ 100.00	$ 400.00
2	Electrofishing, historical fish usage on select streams			$ 5,000.00
3	Review of drainage network, stormwater inputs, and flows to channels	12	$ 100.00	$ 1,200.00
4	Develop list of recommended changes and reasons based on quantitative measurements (fish use and/or channel widths)	5	$ 100.00	$ 500.00
5	Coordination with planning for recommended changes	10	$ 100.00	$ 1,000.00
			Subtotal	$ 8,100.00
			Contingency (30%)	$ 2,430.00
			TOTAL	$ 10,530.00

Project ID:	Ba-Stud-1
Ballinger Creek Floodplain Mapping and FEMA Submittal	
Preliminary Cost (2015 $): ~$14,950	

Description:

This project involves formalizing the preliminary floodplain mapping that was conducted in the Lyon Creek Basin Plan with FEMA to create a new floodplain map depicting the 100-year floodplain boundary for Ballinger Creek.

Planning-level Cost Estimate:

The cost estimate below is for staff and consultant time to use modeling data and mapping completed for this basin plan and prepare documentation needed by FEMA to change floodplain boundary maps. The cost estimate also includes coordination time and response for revisions from FEMA.

Task	Description	Staff Hours	Staff Rate ($100/hr)	Consultant	Total
1	Prepare FEMA Documentation	20	$ 2,000.00	$ 5,000.00	$ 7,000.00
2	Coordination with FEMA for map revisions	20	$ 2,000.00	$ 2,500.00	$ 4,500.00
			Subtotal		$ 11,500.00
			Contingency (30%)		$ 3,450.00
			TOTAL		$ 14,950.00