Allen Lake Outlet
Feasibility Study

January 2013

King County

Department of Natural Resources and Parks

Water and Land Resources Division

Capital Services Unit

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Allen Lake Outlet
Feasibility Study

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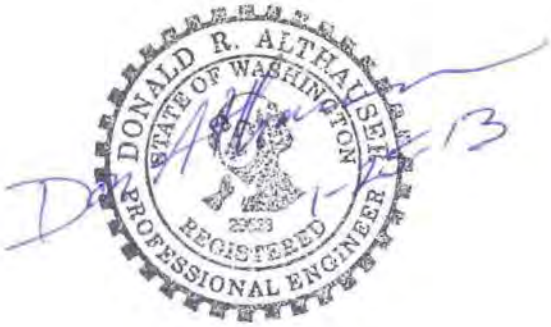
January 2013



1 Introduction and Background 1
1.1 History of Allen Lake Outlet 2
2 Evaluation Objectives 4
3 Early Actions 5
3.1 Hydrologic Impacts of Early Actions 6
4 Existing Conditions 9
4.1 Basin Hydrology 9
4.2 Hydraulic Conditions 12
4.3 Environmental Conditions 13
5 Rapid Assessment 16
5.1 Emergency Access Road 16
5.2 Road Raising 17
5.3 Outlet Channel to West 17
6 Alternatives Analysis 19
6.1 Culvert Replacement/Repositioning 19
6.2 Lowering Farm Crossing at stream station 5573 21
6.3 Stream Channel Dredging 23
6.4 Plant native plants along the Stream 27
6.5 Hydraulic Summary of Alternative Analysis 28
7 Recommendations 30
Appendix A Stream Stationing and Profile 31
Appendix B Maps of Parcels 36
Appendix C Notes from the Public Meeting on February 12, 2011 39
Appendix D Notes from the Public Meeting on October 29, 2011 41
Appendix E Summary Hydraulic Model Results 43
Appendix F Hydraulic Model Output 45
Appendix G Emergency Access Road Alternatives 50
Appendix H Road Raising Alternative 53
Appendix I Outlet Channel to the West 58
Appendix J Investigation of Area West of Allen Lake 60
Appendix K Potential Ditch Alignment and Ground Surface Profile to West 65
Appendix L Hydrologic and Hydraulic Model Figures 69

FIGURES

Figure 1. Vicinity map – location of Northeast 8th Street crossing of WRIA 08-0111A. 1
Figure 2. General Land Office map detail, surveyed March 1874. 3
Figure 3. Urban Growth Area Designations. 14
Figure 4. Critical areas proximate to Allen Lake. 15
Figure 5. Stream stationing at 244th Avenue Northeast. 31
Figure 6. Stream stationing at Northeast 18th Street and 247th Street Northeast. 32
Figure 7. Stream Stationing along 250th Avenue Northeast. 33
Figure 8. Stream stationing proximate to Northeast 8th Street and 250th Avenue Northeast. 34
Figure 9. Stream bed profile and stationing of culverts and bridges. 35
Figure 10. Properties on reach of 08-111A between Allen Lake and 244th Avenue Northeast. 36
Figure 11. Properties on Eden Creek and Wetlands west of Allen Lake. 37
Figure 12. Road Section Maintaining twenty-five foot roadway. 54
Figure 13. Road Section Meeting New Development Standards. 54
Figure 14. Seventeen-foot Road Section minimizing impacts. 55
Figure 15. West Area parcel map on aerial photograph – locations investigated. 62
Figure 16. Aerial photograph taken August 8, 1959 – parcel 3425069043 on left half. 64
Figure 17. Aerial photograph taken June 1, 1970 – parcel 3425069043 on left half. 64
Figure 18. Potential alignment of channel to the west and existing alignment of Allen Lake Outlet channel. 67
Figure 19. Elevation profiles of potential channel to the west and existing Allen Lake Outlet channel. 68
Figure 20. Study area drainage delineation. 69
Figure 21. Elevation map of study area (NAVD88) 70
Figure 22. Map of soil types for study area 71
Figure 23. Map of precipitation monitoring stations. 72
Figure 24. Summary of annual rainfall (Allen Lake is a composite of 18y, 48u, 48y, and SAMP). 73
Figure 25. Map of water level monitoring stations. 74
Figure 26. Observed lake levels and a composite of daily precipitation using four KC gauges (48y, 48u, 18y, and SAMP). Elevations are DRAFT at this time. 75
Figure 27. Monthly regressions scaling SeaTac observed to local conditions. 76

Figure 28. Estimated flood frequencies at the mouth of catchment ALL003, 244th Avenue Northeast crossing. 77

Figure 29. Estimated flood frequencies for outlet of Allen Lake at NE 8th Street (Catchment ALL007). 78

Figure 30. Estimated flood frequencies for Catchment ALL005, outlet at NE 16th Street. 79

Figure 31. Estimated flood frequencies for Catchment ALL005, outlet at NE 16th Street. 80

Figure 32. Water surface profile for Existing and Early Action, steady state 27 cfs. 81

Figure 33. Water surface profile for Existing and Early Action, unsteady 100 year event (39 cfs). 82

Figure 34. Synthetic 100-year storm hydrograph. 83

Figure 35. Example of shifts in timing of WSEL during a storm event (Existing vs. Early Actions). Time at T_1 from Figure 34. 84

Figure 36. Example of shifts in timing of WSEL during a storm event (Existing vs. Early Actions). Time at T_2 from Figure 34. 85

Figure 37. Existing conditions water surface profile at 27 cfs. 86

Figure 38. Synthesized storm events similar to December 2010 event with peaks ranging from 25 to 29 cfs. 87

Figure 39. Estimated 100-year storm hydrograph (39 cfs). 87

Figure 40. Water surface profile for Existing conditions (unsteady) 100-year event (39 cfs). 88

Figure 41. Existing conditions extent of flooding under a 100-year storm (39cfs) near 244th Avenue NE. 89

TABLES

Table 1. Hydraulic model stations of driveways and road crossings. 7

Table 2. 2007 Land cover data 10

Table 3. Summary of soil types in acres. 10

Table 4. Estimated flow frequencies at 244th Avenue Northeast (Catchment ALL003). 12

Table 5. Estimated sediment removal cost. 27

Table 6. Summary proposed actions meeting targets for reducing inundation at Northeast 8th Street. 30

Table 7. Water surface elevations upstream of structures for 100 year storm (39 cfs) hydrograph 43

Table 8. Water surface elevations upstream of structures for approximately 5 year storm (peak near 27 cfs) hydrograph, similar to December 2010 event. 44

Table 9. Hydraulic calculations for December 2010 like event (27 cfs) for Existing and Early Actions, steady state. Starred "*" stations are interpolated cross-sections. 45

Table 10. Allen Lake emergency access easement – proposed alternative cost. 52

PHOTOGRAPHS

Photograph 1. Flooding on Northeast 8th Street. 2
Photograph 2. Hydraulic jetting and vactoring. 5
Photograph 3. Finishing clean up of large rocks. 5
Photograph 4. Vegetation in channel. 6
Photograph 5. Removal of yellow flag iris. 6
Photograph 6. East end of Wetland 9, looking west. 16
Photograph 7. Ash snags on Wetland 9 bog. 16
Photograph 8. View west to inundated area on parcel 3425069043. 63
Photograph 9. View south through inundated area on parcel 3425069045. 63

1 Introduction and Background

Allen Lake is an eleven-acre lake located on the Sammamish plateau near the City of Sammamish (Figure 1). The lake discharges to an unnamed stream referred to as Water Resources Inventory Area, or WRIA, 08-0111A. The stream begins at Allen Lake and flows north, passes through road and driveway culverts, and ultimately flows into Evans Creek.

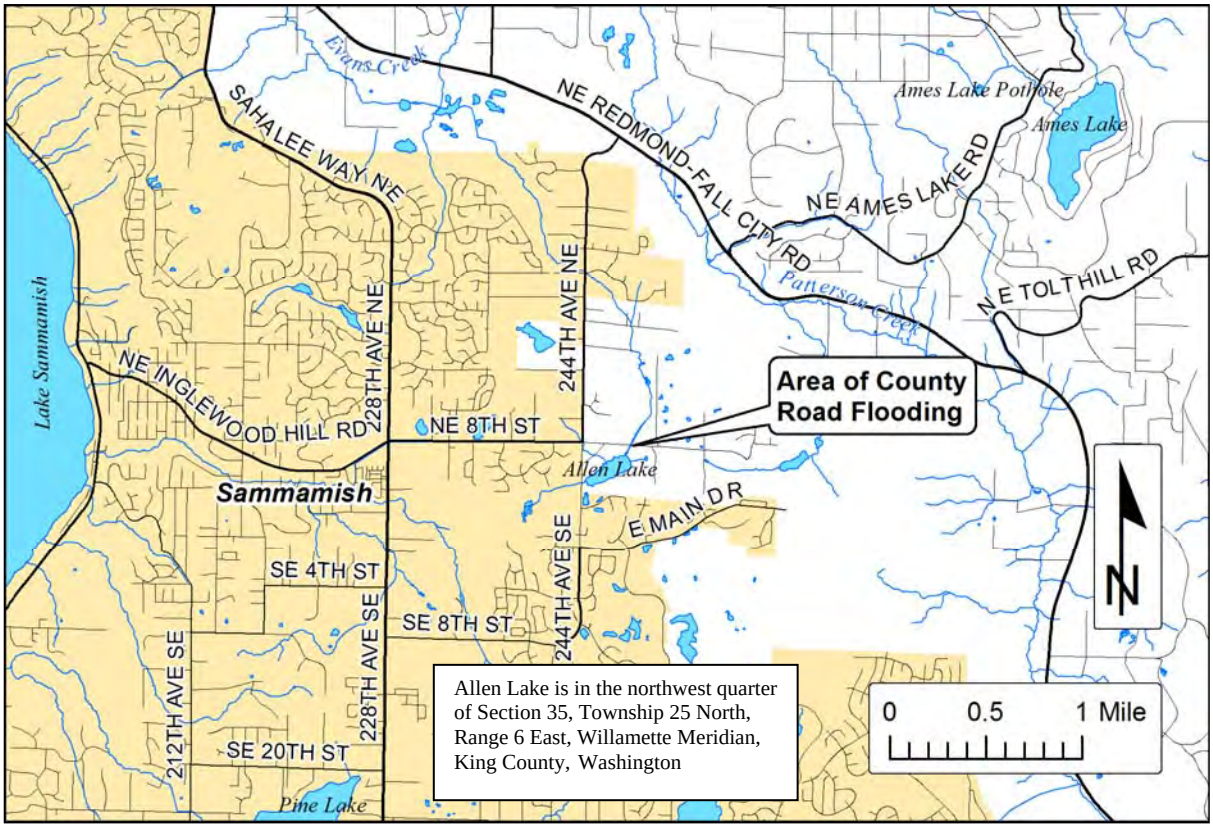


Figure 1. Vicinity map – location of Northeast 8th Street crossing of WRIA 08-0111A.

From the lake, the stream flows through a very low gradient reach for about one and a third miles, losing less than ten feet of elevation in the first mile. This is a stream grade of less than 0.2 percent.

In this reach, the stream passes through shaded and unshaded areas with varying types and densities of vegetation that affect vegetation growth on the banks and in the water. In many places, this reach has dense reed canary grass in the channel or aquatic vegetation such as watercress, water pepper, and duck weed in the channel. About half of this reach has a canopy that is dominantly Douglas fir or has banks that are densely vegetated with shrubs and woods, including Douglas spirea, Himalayan blackberry, willow, and red alder.

Downstream from the low gradient reach, the stream continues to Evans Creek down a steep reach about two-thirds of a mile long, where it loses about 200 feet of elevation. In this steeper reach, vegetation is dominantly Douglas fir canopy with red cedar.

Beavers are active around Allen Lake and WRIA 08-0111A, and have obstructed flow in the channel and through culverts. Nonetheless, there are factors besides beavers that contribute to

flooding on Northeast 8th Street and on privately owned property both upstream and downstream of the street.

The stretch of Northeast 8th Street that is east of 244th Avenue Northeast is maintained by the King County Department of Transportation. Under the tiered service model adopted by the Department of Transportation, this stretch of Northeast 8th Street is a tier 4 road. The Department of Transportation assigns tier 4 to local residential dead-end roads with no other outlet. Tier 4 roads receive virtually no storm and snow response, and maintenance is limited to activities that preserve access.

The stretch of Northeast 8th Street between 244th Avenue Northeast and 250th Avenue Northeast was closed from December 13 to December 16, 2010 and reportedly flooded as deep as eighteen inches. This stretch of Northeast 8th Street is sole access to at least eighty residences.

Photograph 1. Flooding on Northeast 8th Street.

The primary objectives of the Allen Lake Outlet project are to maintain access to the households that use Northeast 8th Street to cross WRIA 08-0111A and to design conveyance for up to the 100-year peak flow.

1.1 History of Allen Lake Outlet

In March of 1874, surveyors for the General Land Office (GLO) staked out corners of Section 35 in Township 25 North, Range 6 East of the Willamette Meridian in what was then

the Washington Territory. While bearing north through a "cranberry marsh" on the west section line (mapped in Figure 2), they noted a small lake about 120 feet east of the section line. On the east side of section 35, they crossed a northeasterly bearing brook, which was six and a half feet wide and likely drained the small lake to Patterson Creek. They did not note that they crossed any watercourse while on the west section line. On the north section line, the GLO surveyors did not note any channel that would drain the lake northerly toward Evans Creek.

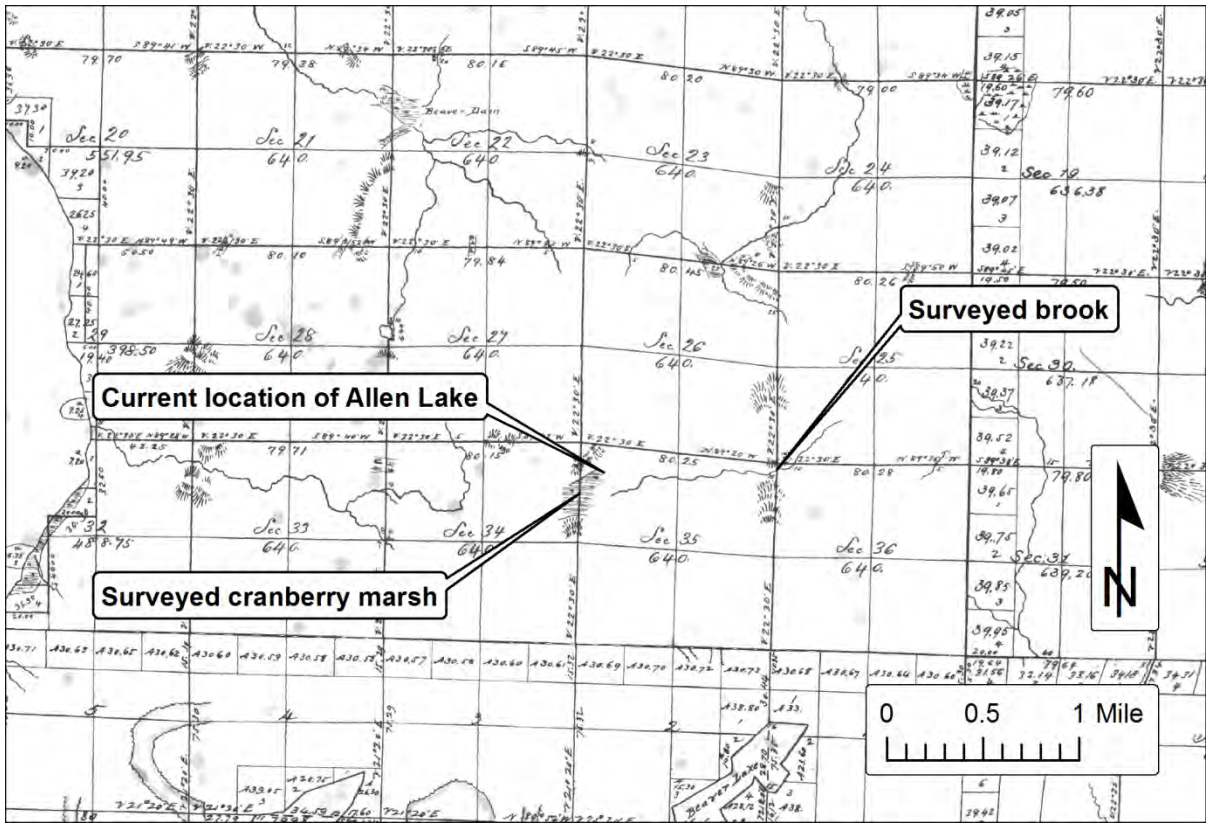


Figure 2. General Land Office map detail, surveyed March 1874.

Part of the presently existing channel that drains Allen Lake to the north was excavated in the 1910s or 1920s, likely employing horses and a dredging dragline. More of the channel was excavated using heavy equipment in the 1970s. The channel to the north is now the established watercourse as a result of this work.

This document refers to locations along WRIA 08-0111A in terms of distance measured in feet upstream from a point on the stream. The point of origin for this measurement is about 850 feet downstream from 244th Avenue Northeast. That location and the stationing were established for the purpose of hydraulically modeling the stream in 1995. This same system was used for recent hydraulic modeling of WRIA 08-0111A. Please see Appendix A starting on page 31 for maps showing the stream stationing used here.

Review of records indicates that on December 2, 1968 G. Robert Schroeder, a King County Inspector, responded to a complaint from Chris Klineburger about flooding at the access to his property on 244th Avenue Northeast, near the southwest end of Allen Lake. Also, Mr. Schroeder identified a partially obstructed 24-inch culvert at what is now stream station 5573

as "the area restricting drainage." He referred to the location of the 24-inch culvert as area "C" and wrote that "removal of the obstruction created in area 'C' can lower the [water surface elevation] of Mud Lake appreciably." Allen Lake was previously called Mud Lake. The complaint does not include record of an outcome, but the obstruction was likely removed from the culvert at that time.

Later in 1995, R.W. Beck consultants recommended replacing the culvert at stream station 5573 and replacing the culvert under Northeast 8th Street to increase flow capacity. King County replaced the 24-inch culvert with a 36-inch smooth corrugated polyethylene pipe (CPEP) culvert; replaced a deteriorated culvert under Northeast 8th Street with a 30-inch CPEP and an additional 18-inch CPEP for overflows; and trapped beavers beginning in 1995, as recommended by R.W. Beck. King County discontinued publicly funded beaver trapping after three years.

In early November 2006, at least eight residents of 250th Avenue Northeast, 258th Avenue Northeast, and Northeast 8th Street submitted drainage complaints online regarding flooding. These complaints followed three similar complaints logged in January and February 2006 and included water in the basement of the house at stream station 6220 and in the crawlspace of the houses at stream stations 5417 and 4715. The online complaints were consolidated and investigated under drainage investigation report number 2006-0075. Technical assistance provided in conclusion of the investigation recommended first improving driveway culverts on private property to improve capacity of the drainage system.

Complaints regarding flooding along 250th Avenue Northeast were also logged in 1987, 1991, 1993, 1994, and 1997. Drainage complaints regarding beaver dams and obstructions at Northeast 8th Street and along 250th Avenue Northeast were logged from property owners adjacent to Allen Lake in 1985, 1996, 1997, 2002, 2010, and 2012.

Complaints regarding impacts of upstream development were submitted for 25025 Northeast 8th Street, which is east of Allen Lake, in 2003 regarding the Beaverdam Division I & II plats and in 2005 regarding the 2006 Seattle Street of Dreams.

2 Evaluation Objectives

The objectives of this Feasibility Study are to

- evaluate the feasibility of alternative solutions intended to improve road access.
- perform hydrologic and hydraulic modeling analysis for each alternative.
- determine a recommended alternative.

Four alternatives were evaluated during the course of this study: 1. construction of an emergency access road, 2. construction of Northeast 8th Street to a higher elevation, 3. construction of an outlet channel to the west, and 4. improvement of the flow capacity of the existing channel.

Flow improvement in the existing channel consisted of several components, some of which were determined to be beneficial and within budget for the Allen Lake Outlet project in 2011 and 2012. We were able to obtain permits and schedule work, so completed some of these flow improvements.

3 Early Actions

Through late spring of 2011, water levels on the upstream side of Northeast 8th Street remained high. Water persisted encroaching on the south shoulder of the road. The King County Department of Transportation (DOT) cleared obstructions from the pair of pipes that convey flow under Northeast 8th Street in June 2011.

After the Northeast 8th Street culverts were cleared, a Washington Conservation Corps crew under the supervision of Paul Adler, King County Water and Land Resources Division (WLRD) ecologist, installed a beaver exclusion fence in the channel on the upstream side of Northeast 8th Street. The beaver exclusion fence is designed to keep beavers away from the upstream end of the culverts, which beavers are attracted to, while providing sufficient screened area for water to flow past.

In July 2011, the DOT followed up on culvert clearing and the installation of the beaver exclusion fence with replacement of the damaged bar rack, called a bird cage, that was on the overflow weir for the secondary culvert under Northeast 8th Street. The purpose of the bar rack is to prevent large debris from entering the culvert, and to prevent people from accidentally being drawn by current into the culvert.

Hydrologist Jeff Burkey modeled hydraulics of the outlet channel under various scenarios. The models show that clearing obstruction in privately owned culverts downstream from Northeast 8th Street would lower the depth of flooding on Northeast 8th Street. Water on the road would be less than six-inches deep for a storm similar to the storm that caused closure of the road in December 2010. While there would still be water over the roadway, it would neither be deep enough to require road closure nor to prevent access by emergency responders. This expected benefit provided justification to use public funds to clear private culverts.

Photograph 2. Hydraulic jetting and vactoring.

Photograph 3. Finishing clean up of large rocks.

In January 2012, the DOT cleared three privately owned driveway culverts at stream stations 5573, 5417, and 5095. Bar racks were removed from the driveway culvert at stream station 5095. Stream stationing used here is mapped in Appendix A starting on page 31.

The driveway culvert at stream station 5095, the third driveway culvert downstream, was found to be in poor condition. Upon dewatering the reach, the corrugated metal culvert was found to be very rusty, pitted, and flaking apart. The condition of the pipe had otherwise

gone unobserved because the pipe was usually submerged under water. After clearing the culvert, about two cubic feet of the driveway surface sank at the location of a previously existing sinkhole.

Failure of the pipe at stream station 5095 was followed by persistent flooding on the next property upstream, including floodwater approaching the foundation of the neighboring house. The backwater was expected also to adversely affect water elevations at stream station 6547 in the case of heavy rain.

The King County WLRD obtained authorization and permits to replace the failed culvert. A DOT special operations crew removed the failed thirty-six-inch corrugated metal pipe and installed a smooth plastic forty-eight-inch culvert matching the elevation of the crown of the old pipe.

Also in January 2012, obstructions were removed from the driveway culvert at stream station 4715, the fourth culvert downstream from Northeast 8th Street. Beams that had fallen across the outlet of the culvert were removed by hand.

In June 2012, King County WLRD personnel measured the depth of sediments and evaluated the extent of flow restricting vegetation in the reach from Northeast 8th Street to approximately 1,100 feet downstream. During this evaluation of stream characteristics, the WLRD personnel found a constructed concrete obstruction submerged in the channel approximately 600 feet downstream from Northeast 8th Street.

A Washington Conservation Corps crew under the supervision of Paul Adler, WLRD Ecologist removed invasive vegetation and the obstruction from this reach by hand in August 2012. This work was done with permission of private property owners and under the Washington Department of Fish and Wildlife pamphlet Hydraulic Project Approval (Publication #APF-1-98).

Photograph 4. Vegetation in channel.

Photograph 5. Removal of yellow flag iris.

3.1 Hydrologic Impacts of Early Actions

As described above, early actions included culvert clearing at Northeast 8th Street, referred to here as stream station 6547, and culvert clearing at privately owned culverts at stream stations 5573, 5417, and 5095, and the replacement of the culvert at stream station 5095.

For the purpose of hydraulically modeling the effects of these changes,

- the culverts and any bar racks are assumed to remain clear over time.
- theoretical channel roughness and obstructions caused by vegetation are assumed to remain unchanged as a result of these actions and over time.
- structures and channel conditions downstream of stream station 4715 are assumed to be unchanged.
- fences are assumed to remain clear of debris where property fences cross the stream, as they are not part of the structures analyzed.

For a listing of structure stationing within the model, see Appendix A, starting on page 31 maps the stream stationing used here.

Table 1 below. Stationing in the model is the distance upstream from a point on the stream west of 244th Avenue Northeast. All water surface elevations (WSEL) reported in this document are based on the North American Vertical Datum of 1988 (NAVD 88). Appendix A, starting on page 31 maps the stream stationing used here.

Table 1. Hydraulic model stations of driveways and road crossings.

Station	Description	Parcel ID	Station	Description	Parcel ID
6547	NE 8th St. Culverts	right-of-way	5095	Michelman Culvert	2625069063
6220	McCoy footbridge	2625069052	4715	Vitale Culvert	2625069010
5975	Lucarelli Footbridge	2625069051	2948.75	NE 18th St. Culvert	right-of-way
5573	Newfeld Culvert	2625069054	2718	247th Pl NE Culvert	right-of-way
5417	Roome Culvert	2625069091	935	244th Ave NE Culvert	right-of-way

December 2010 Storm Event as a Benchmark

For hydraulic modeling in this study, an event similar to the December 2010 storm is used to predict and compare the effects that changes made to the channel are expected to have on flooding. The flow during the December 2010 storm is estimated at 27 cubic feet per second, or cfs. Models using this benchmark vary in design while keeping the flow steady. Results of the models show different potential flood extents.

Given the above assumptions, water surface elevations drop at stream station 6547 from more than 1.5 feet water over the roadway to approximately a quarter foot. It is a drop from water surface elevation (WSEL) 344.68 feet to WSEL 343.3 feet where the low point on crown of Northeast 8th Street is 343.02 feet. This drop in elevation also happens in the stream segment between stations 5573 and 5417, and no driveways are overtopped.

Summary hydraulic model results are in Appendix E. A complete listing of hydraulic calculations is in Appendix F.

100-Year Storm

The flow rate that has a one percent chance of occurring in any given year is called the 100-year flow rate. It is a standard recurrence interval used to evaluate how well engineering designs will perform. The 100-year flow rate in the Allen Lake outlet channel is estimated at 39 cfs. This estimate is discussed in further detail in section 4.1.6 on page 11. A synthetic

storm hydrograph peaking at the estimated 100-year flow rate was used to evaluate the benefits of clearing culverts and replacing the culvert at stream station 5095.

Expected water surface elevations for the 100-year storm were compared for channel conditions before and after clearing the culverts and replacing the culvert at stream station 5095. In general, the work conducted lowers the 100-year water surface elevation about half a foot between Stream station 6547 and stream station 4715.

At Stream station 6547, the depth of water over the road is expected to be reduced from a little over two feet down to one and a half feet. The farm crossing at stream station 5573 is expected to be nearly overtopped without the work conducted, and the water surface here is expected to be lowered about three-quarters of a foot by the work conducted.

The culvert at stream station 5417, and likely the culvert at stream station 5095, would be overtopped with or without the work conducted. The water surface leading up to the culvert at stream station 4715 suggests that the driveway would not be overtopped, but that the water surface would be within a few inches of doing so at the culvert.

From stream station 4715 downstream, there is virtually no change in the water surface elevations because of clearing the culverts and replacing the culvert at stream station 5095. During a 100-year storm, there is expected to be overbank flooding for most of the reach from stream station 4715 to stream station 2949.

Timing of Events and Impacts on 244th Avenue Northeast

During the beginning part of a large storm, when flooding over the stream banks begins between Stream station 6547 and stream station 4715, water is stored in the flooded areas over the banks such that peak flows leaving this reach are reduced, or attenuated. Any improvement to flow capacity in this reach allows water to drain more rapidly, reducing flooding in this reach, albeit with less flow attenuation.

The 24-inch culvert under 244th Avenue Northeast is a smaller diameter than any of the culverts upstream, so high flows pass through it less easily. At high flows, water backs up on the upstream side of 244th Avenue Northeast, and the road embankment with a relatively small pipe effectively creates a stormwater detention pond in the low area upstream.

Water begins backing up at 244th Avenue Northeast sooner if upstream conveyance is improved. The greater the improvement in conveyance capacity, the sooner the water begins backing up at 244th Avenue Northeast and the sooner the backed up water reaches a maximum water surface elevation. Regardless of whether the proposed conveyance improvements upstream are put in place, the maximum water surface elevation at 244th Avenue Northeast remains virtually the same.

High Lake Levels

The Allen Lake water surface elevations during storms are expected to respond to proposed conveyance improvements in the same way the water surface elevations at Stream station 6547 respond, provided the channel between the lake and the street remains free of beaver dams and other obstructions. In addition to property owners along the outlet channel downstream of Stream station 6547 benefiting from reduced flooding, lakefront property owners are expected to benefit from reduced flooding with lower maximum water surface elevations during storm events.

Low Lake Levels

Lake levels associated with base flow conditions or the dry season are expected to remain unchanged subsequent to culvert clearing and replacement of the culvert at stream station 5095. The water surface elevation remains steady during low flow due to high points in the streambed downstream of stream station 6547. These high points, or sills, act as "natural" barriers retaining water. In addition to natural seepage and evaporative losses to the lake, it is possible that during extreme dry conditions the lake level could seep through the sills as well. These conditions could result in lake levels below these high points as well as below invert elevations at Stream station 6547.

The known high points ranges from 340.4 feet to 341.1 feet NAVD88, which correspond to staff plate readings at stream station 6547 of 2.06 and 2.76 feet, respectively. Additionally, these elevations also correlate to a staff plate, maintained by a resident on Allen Lake, of -12.2 and +9.1 centimeters, respectively. For frame of reference, the low point on the road at Northeast 8th Street elevation, 343.02 feet, corresponds to staff plate readings of 4.68 at Northeast 8th Street and 67.7 centimeters at the lake resident's staff plate. *Note: associated lake elevations to resident's staff gauge are estimates at this time.*

In addition to these streambed high points controlling summer lake levels, they are also estimated to control outflow conditions at approximately flow rates of 10 cfs or less. At higher flow rates, other environmental conditions such as culverts, vegetation, channel roughness, and slope become controlling factors for water surface elevations.

4 Existing Conditions

4.1 Basin Hydrology

To characterize the study area hydrology, the contributing drainage basin was delineated, then its soil types categorized into generalized infiltration rates, and its land categorized into types of land use and topographic slopes. These characteristics influence the duration, magnitude, and frequency of storm flows; however, the most important driver of flows is rainfall. The sequence and shape of storms, and the time between storms, typically cause unique conditions. Therefore, in the context of the existing hydrologic conditions, described below, the initial channel hydraulic conditions are compared with proposed designs using representative steady state flows and storm hydrographs to evaluate by comparison how well proposed designs would achieve the desired goals.

4.1.1 Study Area Characteristics

The estimated study area for the Allen Lake Outlet project includes areas draining to Allen Lake from the south and west to approximately 500 feet downstream of 244th Avenue Northeast and totals 686 acres (Figure 20). Of the 686 acres, the basin is nearly equally covered in forest, which is forty-three percent of the area, and residential land, which is forty percent, with the remaining areas comprised of grass and pasture lands (Table 2). The elevation of the basin ranges from a low of 329 feet North American Vertical Datum of 1988 (NAVD88) below 244th Avenue Northeast, to 522 feet in the headwaters south of Allen Lake. The average elevation of the basin is approximately 380 feet (Figure 21).

Table 2. 2007 Land cover data

Land Cover/Use	Area (acres)	Percent of basin
Residential	272.84	39.8%
Grass/pasture	107.15	15.6%
Forest	294.74	43.0%
Open water	11.28	1.6%
Total	686.01	

4.1.2 Soils

For basin scale analyses, uncertainties such as the fine scale variability of underground conditions generally cancel out, allowing for adequate broad scale representation of underground hydrologic processes. Soils are generalized into three broad categories: 1. high infiltration, 2. low infiltration, and 3. saturated, which is generally associated with lakes and wetlands. The drainage basin is dominated by soils with higher infiltration (Table 3), which typically lie on the flatter land in and near the study area (Figure 22). The remaining areas are low infiltrative soils except in Allen Lake and surrounding wetlands.

Table 3. Summary of soil types in acres.

Soil Type	Area (acres)	Percent of Study Area
Low Infiltration	237.6	35%
High Infiltration	393.1	57%
Saturated	55.3	8%
Total	686.1	

4.1.3 Local Rainfall

Rainfall depths for a twenty-year period of record from 1991 to 2011 were assembled from nearby King County precipitation monitoring stations in order to characterize rainfall for the study area. Given the mild topographic relief proximate to the study area and the monitoring stations, topography is not expected to cause significant differences in rainfall between them.

The term "water year" is defined as the 12-month period starting October 1, for any given year, and ending September 30 the following year. For example, water year 1999 is for the period of October 1, 1998 through September 30, 1999.

Annual rainfall for the study area ranged from a low of 31.2 inches in water year 2001 up to 64.9 inches in water year 1997. The two wettest years on record of available data occur consecutively in water years 1996 and 1997. The estimated average annual rainfall of for all years is 45.4 inches.

4.1.4 Stream flows

Spot field estimates of flow rates were the only flow data available during the December 2010 storm event. The estimates ranged from 24 to 30 cubic feet per second (*Allen Lake Outlet Rapid Assessment*. King County Department of Natural Resources and Parks, 2011).

In order to establish a record of stream flows for this project, one stream flow gauge and four stage gauges were installed instream. A stage gauge installed on the upstream side of Northeast 8th Street is expected to represent high lake water surface elevations. This gauge is

not expected to capture lower lake water surface elevations year round because beavers actively maintain dams on the reach between Allen Lake and Northeast 8th Street.

Stage gauges are also installed near the footbridge at stream station 5975, near the driveway at stream station 5095, and near the inlet to the culvert under 244th Avenue Northeast, also referred to here as stream station 935.

4.1.5 Lake Level

An Allen Lake resident reported daily lake elevation data to the King County Lake Stewardship Program from 1993 to 2007 and continues to collect some elevation data to the present. The compiled record has data gaps including a large gap between 2002 and 2004.

During the period of record of available data, the lake levels have been high enough to overtop the roadway approximately 361 days over approximately the last thirteen years, or fourteen percent of the time. Moreover, five of the storm events that lasted at least thirteen days inundated Northeast 8th Street to greater than one foot deep. Lake levels have overtopped the road most years.

Estimates of NE 8th St overtopping are based on current road elevations constant over time. Moreover, the datum of the elevations for the lake stage gauge are estimated using water surface elevations between the lake gauge and the stream gauge at NE 8th Street which has been surveyed (NAVD88). In ideal conditions, the water surface elevation at both gauges would be the same with the exception of during windy conditions. However, beaver activity between the lake and the stream gauge creates a changing condition between the two gauges. On May 22, 2012, the beaver dam was creating an estimated one-foot difference between the lake and NE 8th St. This dynamic condition suggests the reported lake levels and associated overtopping of the road are overestimated.

4.1.6 Stream Flow Recurrence Intervals

Simulated stream flows were generated using a hydrologic watershed model called Hydrologic Simulation Program - FORTRAN (HSPF). The model uses the geology, slopes, and land cover of the study area to convert rainfall to stream flow. Given that there is no available local stream flow record that could be used to calibrate the model stream flow, model parameters for the Allen Lake outlet channel were assumed similar to calibrated model parameters for the Evans Creek basin developed and calibrated by King County in 1989, and updated by Entranco in 1993.

For this model, local rainfall records were used to develop monthly regressions against SeaTac rainfall records. The monthly regressions were then used with SeaTac historical records to generate a 61-year record of hourly rainfall, for water year 1949 through water year 2009, scaled to represent the conditions in the study area.

The HSPF model was used to simulate stream flows for the period of rainfall record and to estimate flow frequencies for the Allen Lake outlet channel. At 244th Avenue Northeast, the estimated flow frequencies range from 11 cfs at the one-year recurrence interval to 39 cfs at the 100-year recurrence interval. See Estimated flow frequencies for the Allen Lake outlet at Northeast 8th Street and at Northeast 16th Street suggest that the magnitude of the December 2010 event, which was estimated at 24 to 30 cubic feet per second, was between a five-year and twenty-year event.

Table 4.

Estimated flow frequencies for the Allen Lake outlet at Northeast 8th Street and at Northeast 16th Street suggest that the magnitude of the December 2010 event, which was estimated at 24 to 30 cubic feet per second, was between a five-year and twenty-year event.

Table 4. Estimated flow frequencies at 244th Avenue Northeast (Catchment ALL003).

Return Period (years)	Flow Rate (cfs)
1.01	11
2	22
5	27
10	30
25	34
50	37
100	39

4.2 Hydraulic Conditions

Flow capacity through the study area during storm events was evaluated using steady state and unsteady hydraulic models. Steady state modeling uses a constant flow rate and is likely to produce conservative results because it does not simulate the flow attenuation that results from overbank flooding. Unsteady modeling uses an event hydrograph and accounts for the flow attenuating effect of overbank storage, which fills during flooding. Events evaluated for this study include conditions similar to the December 2010 event and a synthetic 100-year storm.

December 2010

The December 2010 storm was used as a benchmark to compare steady state and unsteady model results. For the conditions prior to culvert clearing, the models estimated water surface elevations to be virtually the same. An exception is that near 244th Avenue Northeast the unsteady model yields a water surface approximately half foot lower at water surface elevation (WSEL) 335.83 feet than does the steady state model at WSEL 336.25 feet, due to flood attenuation.

Prior to culvert clearing and replacement of the culvert at stream station 5095, an event of this magnitude, 27 cubic feet per second, is estimated to

- inundate the roadway at stream station 6547 to approximately 1.7 feet at the deepest point on the crown
- inundate the two foot bridges just north of stream station 6547 to over a foot deep.
- reach within 0.75 feet of overtopping the farm crossing at stream station 5573.
- cause sheet flow over the driveway at stream station 5417.
- cause substantial sheet flow over the driveway at stream station 5095.
- cause sheet flow over the driveway at stream station 4715.
- impound water at stream station 935 to within about 4.5 feet of the crown of 244th Avenue Northeast.

Synthetic 100-year event

Routing a synthetic 100-year storm using an unsteady model, results in

- overbank flooding.
- inundation of Northeast 8th Street by two feet at WSEL 345.06 feet.
- a water surface within a few inches of the farm crossing at stream station 5573 at WSEL 344.96 feet.
- inundation of the next three driveways downstream.
- impoundment of floodwater at stream station 6547 to within 1.6 feet of overtopping 244th Avenue Northeast at approximately WSEL 339 feet.

At this depth near 244th Avenue Northeast, Camden West properties above the right bank of the stream are several feet above this elevation and set back approximately 100 feet from the flooding extent.

The backwater caused by 244th Avenue Northeast reaches to Northeast 18th Street, and greatly influences water surface elevations up the farm crossing at stream station 5573.

A steady-state hydraulic model with the estimated 39 cfs 100-year flow indicates that prior to culvert clearing, all roads and driveways would be overtopped including 244th Avenue Northeast and the farm crossing at stream station 5573. Depending on the duration and volume of a 100-year event, the actual flooding conditions would likely fall somewhere between those estimated by the steady state and unsteady models.

4.3 Environmental Conditions

4.3.1 Allen Lake Outlet

The Allen Lake outlet is mapped as an Evans Creek tributary, Water Resources Inventory Area (WRIA) 08-0111A. It lies in the headwaters of the Evans Creek Basin. Evans Creek drains into Bear Creek at river mile 2.0, with Bear Creek flowing into the Sammamish River at river mile 12.2.

King County GIS maps the Allen Lake outlet stream variously as Class 3, Class 2, and Class 2S, meaning with salmonids. Under the current Critical Areas Ordinance, the outlet stream would likely be a Type F Aquatic Area, which requires a 165-foot buffer area for reaches outside the Urban Growth Area, and a 115-foot buffer area within the Urban Growth Area. See Figure 3 for an Urban Growth Area map.

Tributary 08-0111A has been reported to have both seasonal and year round flow. The duration of flow periods is variable between different reaches of the stream. The stream appears to flow year round from Allen Lake downstream to some point, then flow subsurface to about half way down the ravine reach, then flow on the surface from that point to the Evans Creek wetland on the valley floor. The point at which stream flow goes subsurface or flows year round likely varies by season and with year-to-year precipitation amounts.

In August 2012, a Washington Conservation Corps crew under King County Water and Land Resources Division supervision did dry season invasive vegetation and obstruction removal in the stream channel between stream station 6547 and the driveway culvert at stream station 5417. Dense in-channel vegetation can obscure viewing of flowing water.

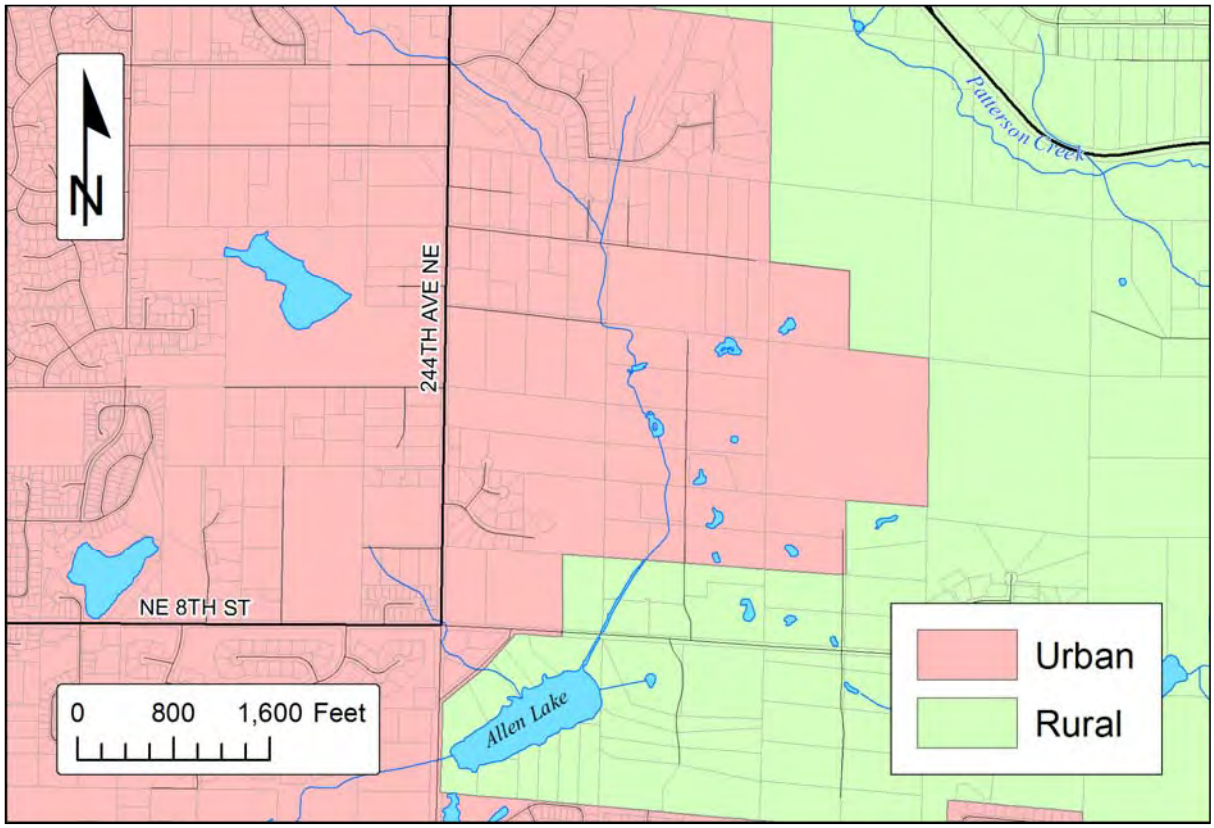


Figure 3. Urban Growth Area Designations.

Residents downstream of this work area note seasonal flow. The King County Allen Lake Creek Stream Gauge at Northeast 25th Street, which is halfway down the ravine reach, shows a seasonal creek flowing from late November 2011 to early July 2012. In the lower third of the ravine reach, the stream flows year round, apparently due to groundwater discharges in the form of springs and seeps.

Under the King County Sensitive Areas Ordinance, Tributary 08-0111A was variously rated by King County Department of Development and Environmental Services (DDES) staff as a perennial stream without salmonids and a stream with salmonids. The stream classifications after 2003 were all Class 2S, with salmonids. Salmonids include both salmon and trout species, including resident trout. There does not need to be year round flow for the stream to be used by fish. The King County Critical Areas Ordinance (CAO) adopted the Washington State water typing system, which would rate the creek as Type F, which means it contains fish or fish habitat (King County Code 21A.24.355 Aquatic areas—water types).

A stream reconnaissance of the reach from 244th Avenue Northeast to the Evans Creek wetland on the valley floor was conducted by King County specialists, a geologist and a fisheries scientist, in 2012. Geologic features, stream habitat, and fish migration barriers specifically were investigated.

The only upstream fish barrier located was at a private driveway crossing at NE 25th, about half way down the ravine reach. All other culverts and barriers in this reach were determined to be fish passable, including the 244th NE culvert. If this manmade barrier was made passable, upstream migrating fish could travel upstream past 244th. Plugged culvert inlets

could cause intermittent fish passage concerns, particularly if they have bar racks. (*Allen Lake Outlet Stream Reconnaissance.* King County Department of Natural Resources and Parks. December 2012.)

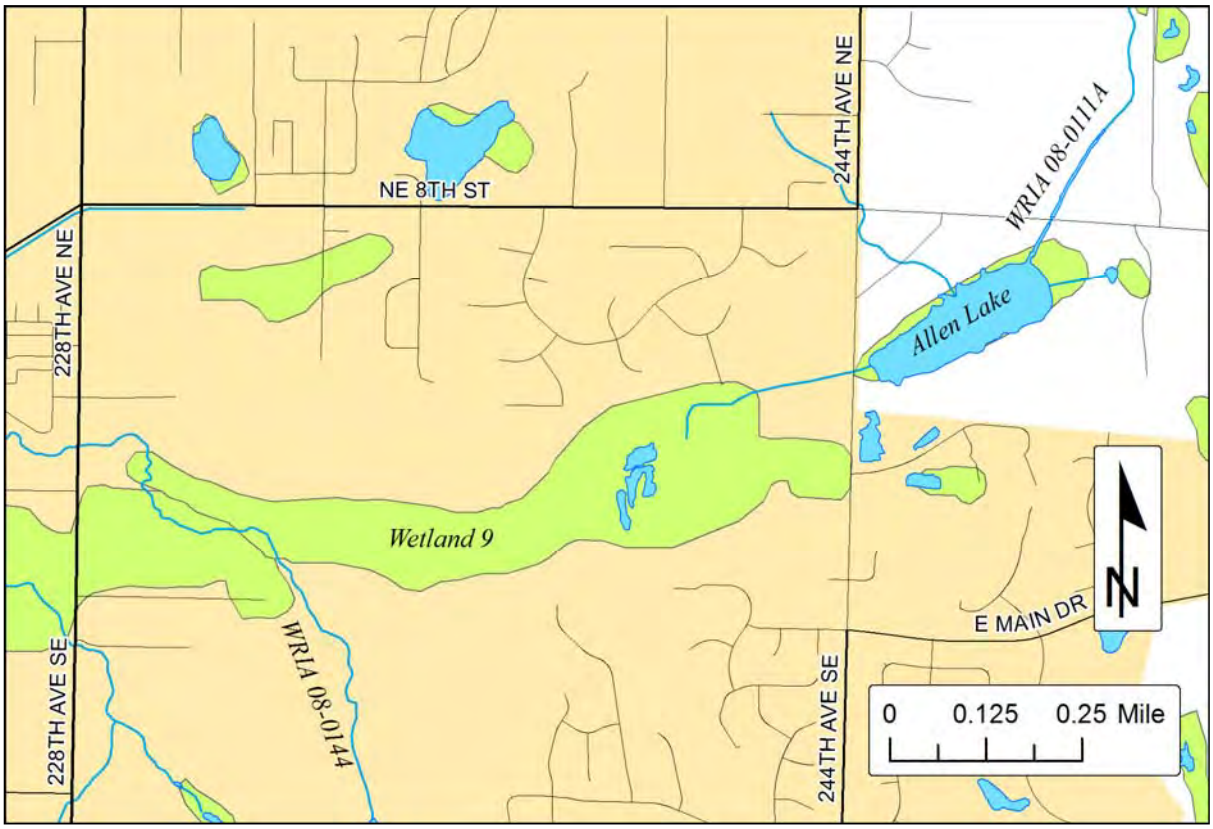


Figure 4. Critical areas proximate to Allen Lake.

4.3.2 Allen Lake

Allen Lake is identified in the 1990 Sensitive Areas Map Folio as Evans Creek Wetland 38, a 14.7-acre wetland. It is rated a King County Class 1(c) wetland containing Palustrine Open Water, Palustrine Scrub-Shrub Broad-leaved Deciduous (Willow), and Palustrine Aquatic Bed Floating-leaved (Yellow Pond Lily).

Current King County Critical Areas Ordinance buffers can only be determined by classifying the wetland into categories based on the adopted Washington State Wetland Rating System for Western Washington. The resulting buffer widths vary based on a numerical rating on the wetland rating forms, intensity of adjacent land use impacts, and the location inside or outside the Urban Growth Area. The buffers around the wetland would be from 100 to 300 feet in width, depending on the classification.

Recent Critical Areas Review of new residential building applications on Allen Lake properties may include a current CAO classification of the wetland and official determination of the regulated buffer widths on the lake.

4.3.3 Eden/George Davis Creek

Eden Creek, also known as George Davis Creek, is mapped as East Lake Sammamish tributary WRIA 08-0144. It lies in the Inglewood Subbasin and drains directly to the north end of Lake Sammamish. Eden Creek is classified as a type F stream, which requires a 150-foot buffer area under the City of Sammamish Municipal Code Chapter 21A.50 Environmentally Critical Areas.

4.3.4 East Lake Sammamish Wetland 9

A 55.0-acre wetland west of Allen Lake is identified in the 1990 King County Sensitive Areas Map Folio as East Lake Sammamish Wetland 9. It is rated a Class 1(d) wetland containing Palustrine Scrub-Shrub Broad-leaved Deciduous (Hardhack), Palustrine Forested Broad-leaved Deciduous (Oregon Ash), Palustrine Scrub-Shrub Broad-leaved Evergreen (Labrador Tea), and Palustrine Forested Needle-leaved evergreen (Western Red Cedar). The 1990 King County Wetlands Inventory indicates that East Lake Sammamish Wetland 9 was an old bog with big stands of Oregon ash.

The City of Sammamish inventoried the areas of East Lake Sammamish wetland 9 and Evans Creek Wetland 38 together as East Lake Sammamish Wetland #1509. The City rated Wetland #1509 as a category I depressional bog wetland, which has a buffer of 215 feet. A City of Sammamish wildlife corridor passes through Wetland #1509 in a more or less east-westerly direction.

Photograph 6. East end of Wetland 9, looking west.

Photograph 7. Ash snags on Wetland 9 bog.

5 Rapid Assessment

Three alternatives were determined not to be feasible: 1. construction of an emergency access road, 2. construction of Northeast 8th Street to a higher elevation, and 3. construction of an outlet channel to the west.

5.1 Emergency Access Road

The King County Department of Transportation (DOT) considered five potential emergency access road routes that could be developed as alternative access to residences whose sole access is along the stretch of Northeast 8th Street, which is sometimes closed due to flooding. Each of the routes that were considered cross private property and would require permission

and easements from the property owners prior to access or construction on their property. Each of the routes posed potential hardship to the property owners, considering that traffic would cross their property during times that Northeast 8th Street is closed.

Residents were adamantly against this alternative during the October 29, 2011 public meeting. See Appendix D on page 41 for the notes of the meeting.

The easement negotiation, planning, permitting, and construction for an emergency access road are estimated to take two years at a minimum cost of $250,000. Hydraulic modeling has shown that improvements to the Allen Lake outlet channel that may be made during that two-year period would reduce or prevent road closures. Because of the timeline, cost, and relative effectiveness of building an emergency access road, it is not considered a feasible solution. Please see Appendix G starting on page 50 for the analysis.

5.2 Road Raising

The King County Department of Transportation (DOT) evaluated the potential for raising about 300 feet of Northeast 8th Street up to two feet, so that the road would be higher than recorded flood elevations. The preferred alternative in the DOT analysis would be a seventeen-foot wide gravel road, which stays within the footprint of the existing road and has the most readily maintainable surface.

There would very likely be high and unknown costs to building a wider asphalt road to current county standards along this stretch. The soils outside of the existing road footprint would likely be difficult to build on and would likely cause the road surface to crack. If a wider road were to be built, permitting and mitigation for impacts to wetlands adjacent to the road would likely be prohibitively expensive.

The King County Department of Transportation recommends against pursuing any road-raising alternative. Per the DOT's recommendation, only after channel maintenance, beaver control, and other measures that reduce the backwater effects at Northeast 8th Street, and only if no lower cost emergency access route can be constructed, should the King County Council consider approving and funding the road-raising alternative.

For the full analysis on the road-raising alternative, see 0 starting on page 52.

5.3 Outlet Channel to West

The King County Water and Land Resources Division (WLRD) acknowledged that maps show that Allen Lake may have an outlet to the west. The WLRD committed to evaluate the potential for establishing a watercourse and allowing Allen Lake to discharge west to Lake Sammamish during the February 12, 2011 public meeting. The meeting notes can be found in Appendix C on starting on page 39.

Current and historical maps variously show streams east, west, and north of the location of Allen Lake. Most of these maps portray a single outlet from Allen Lake. The maps show the outlet discharging in different directions. Some maps show the lake discharging toward Lake Sammamish; other maps show the lake discharging toward Patterson Creek or toward Evans Creek. In some cases, maps depict broad stream meanders where meanders never existed.

Survey and inventory have put people on the ground who evaluated the extent and condition of streams and wetlands in the area between Allen Lake and Lake Sammamish.

The East Lake Sammamish Number 9 wetland was inventoried and described in June of 1981 under the King County Wetlands Inventory. Field staff observed that the "wetland drains to both Evans Creek and East Lake Sammamish basins." Wetland Number 9 lies between Allen Lake and Lake Sammamish. For Wetland Number 9 to drain to Evans Creek, flow would have to pass northeasterly through Allen Lake, discharging northerly.

The King County Basin Reconnaissance Program put field staff on the ground to inventory impacts to streams due to development. Report number 19 of the Basin Reconnaissance Program, which investigated the condition of streams of the West Lake Sammamish Basin, was completed in June of 1987. In this report, a wetland is noted 1.80 miles upstream from Lake Sammamish on Eden Creek, where Eden Creek passes Wetland Number 9. Field staff noted that the wetland mitigates increased flows caused by current development, and proceeded up Eden Creek to the Southeast. They did not pursue any watercourse into or past the wetland in the direction of Allen Lake.

The invert of the culvert that carries Eden Creek under 228th Avenue Northeast is 1.4 feet higher than the invert of the culvert that drains Allen Lake under Northeast 8th Street, as described in Appendix I starting on page 58 of this report. In terms of pipes, an invert is the bottom, or floor, of the inside of a pipe. This difference in elevations suggests that it is unlikely Allen Lake drained to Sammamish Lake in recent history.

Allen Lake and 228th Avenue Northeast are separated by about a mile distance, and buried natural gas transmission line within this span lies across the potential path of an outlet channel to the west. The distance, and adverse difference in elevation, and presence of the gas line make design of a gravity channel to 228th Avenue Northeast a daunting task.

Aside from the engineering aspect of discharging Allen Lake to the west, the task of permitting an outlet channel to the west would be difficult. Construction of a channel through East Lake Sammamish Wetland Number 9 would unavoidably cause incidental discharge of dredge material to the wetland. Therefore, a U.S. Army Corps of Engineers (USACE) Individual permit under Section 404 of the Clean Water Act would be required.

Permitting under Section 404 requires evaluation of alternative solutions to achieve the objectives of a project. In the case of this project, the objective is to reduce flood impacts at Northeast 8th Street. Section 404 further "allows permit issuance for only the least environmentally damaging practicable alternative." This clarification is part of The Determination of Mitigation Under the Clean Water Act Section 404(b)(1) Guidelines agreed upon by the USACE and the U.S. Environmental Protection Agency February 6, 1990.

Since constructing a channel through nearly a mile of class one wetland would be more environmentally damaging than other alternatives that are considered for the purpose of this project, and because a gravity channel is unlikely to work, construction of an outlet channel to Lake Sammamish is considered infeasible for the purpose of this project.

6 Alternatives Analysis

As described in the rapid assessment section, three of the alternatives under consideration for this project were determined to be infeasible. The fourth alternative consists of several components, some of which have been implemented in early actions conducted in 2011 and 2012.

Additional components of flow capacity improvement were evaluated for feasibility as follows:

1. Replace or reposition culverts.
2. Lower farm crossing at stream station 5573.
3. Dredge stream channel.
4. Plant native plants along the stream.

6.1 Culvert Replacement/Repositioning

Under this alternative, three 36-inch diameter culverts, two of which are corrugated metal pipes, on private property would be replaced with 48-inch diameter smooth polyethylene plastic pipes. The culverts are located at stream stations 5573, 5417, and 4715.

6.1.1 Stakeholder Assessment

Residents on 250th Avenue Northeast are likely to be in favor of replacing their culverts with culverts that have greater capacity to pass flows.

The Washington Department of Fish and Wildlife (WDFW) is likely to weigh in with conditions on the design and installation of culverts.

Replacement of the culverts is expected to reduce the attenuation of some peak flows conveyed downstream to 244th Avenue Northeast. Residents near Northeast 18th Street may object to increased water elevations in or adjacent to the channel at their properties.

The City of Sammamish will have interest regarding impacts due to water accumulation at 244th Avenue Northeast, a 24-inch diameter pipe.

6.1.2 Environmental Impacts

Environmental impacts of removing and replacing up to three culverts at driveway crossings downstream of NE 8th on the Allen Lake outlet include de-watering and collection impacts to fish and aquatic organisms, vegetation removal, construction turbidity and sedimentation, and disruption and noise from heavy equipment in-water and near water construction.

Handling and collection of fish and aquatic organisms can cause mortality, delayed stress, and injury, particularly if electrofishing equipment is used. Due to difficult collection conditions, not all fish are able to be physically collected, leading to direct mortalities, as fish are lost in nooks and crannies, vegetation, instream woody debris, the substrate, and turbid water. Physical crushing injuries to fish are common, as well as injuries and mortality due to over-shocking hiding fish.

Construction turbidity on-site and downstream is common during culvert replacement, and can harm fish gill structure, aquatic insects, and overall aquatic productivity. Fortunately, if construction is done during very low or no flow conditions, the turbidity and sedimentation impacts are temporary and will occur during the WDFW approved fish window.

The dewatered section of creek is impacted by excavation for bypass sumps, diversion dam construction, and potentially complete desiccation of the streambed causing a loss of aquatic insects, which form the base of the aquatic food web.

6.1.3 Proposed Implementation Strategy

The culverts at stream stations 5573, 5417, and 4715 would each be isolated by installing cofferdams, bypassing stream flow, and dewatering reaches one at a time. The 36-inch culverts would be removed and 48-inch smooth polyethylene plastic culverts installed in their place, matching the elevation of the crown to the elevation of the previous crown.

Utilities would be located prior to work, and culverts would be replaced during a relatively dry period. Driveways would be restored to equal or better condition as compared with the condition in which they were found prior to work.

Fish would be removed from the reach before and during dewatering. Sediment and erosion control measures would be employed as needed. Any disturbed stream buffer vegetation would be replaced, then monitored and maintained to a standard of 80% survival at three years.

6.1.4 Permits

Local

A King County Department of Development and Environmental Services (DDES) clearing and grading permit is required, and it would include Critical Areas Ordinance (CAO) review and flood review. A short form permit is possible, depending on scope of project and potential impacts. Upstream wetland impacts at Allen Lake will need to be evaluated and, in the event the project lowers the lake below historic levels, mitigation will be required. An extensive wetland impacts analysis may be needed. Cost estimates of modifying similar lakes have been about $20,000 to analyze impacts of lake level changes on wetland hydrology and wetland and buffer plant communities.

State

A WDFW hydraulic project approval (HPA) is required.

A Washington Department of Ecology (WDOE) National Pollutant Discharge Elimination System (NPDES) Construction Stormwater General Permit may be required if multiple “smaller sites are part of a lager common plan of development that will ultimately disturb one acre or more”.

This alternative should be State Environmental Policy Act (SEPA) exempt, if the project stays within the existing footprint.

Federal

A United States Army Corps of Engineers (USACE, Corps) permit is not required unless culvert repositioning requires fill, or dredging of the stream channel upstream or downstream to match a new grade. Any wetland fill adjacent to the creek could also trigger a Corps permit. Careful design can avoid triggering a Corps permit by not exceeding the existing footprint of the structure. Upstream impacts to the Class 1 Wetland, Allen Lake may need to be examined with Corps staff to evaluate the requirement for a permit.

Federal funding provides a federal link that can trigger several additional federal permitting processes such as Section 7 of the Endangered Species Act (ESA) and Section 106 of the National Historic Preservation Act (NHPA).

6.1.5 Cost

Construction

Cost estimate for construction is $124,000. The cost estimate includes labor for 3.5 weeks, equipment, and materials.

Permits

Estimates include staff time to complete permit applications, and regulator permit and review fees.

King County DDES Clearing and Grading - $3500-$5000

WDFW HPA- $1500

	Construction	Permitting	Total*
Replacement of three culverts to increase capacity	$124,000	$6,500	$130,500

*Does not include an estimate for design or project management costs.

6.2 Lowering Farm Crossing at stream station 5573

The farm crossing at stream station 5573 is nearly two feet higher than the low point on the crown of Northeast 8th Street. The culvert in this stream crossing together with the culverts and channel flow resistance downstream from it, can cause water to build up on the upstream side of this crossing to the point that Northeast 8th Street floods.

The farm crossing at stream station 5573 has potential to detain approximately 26 acres of water at the elevation of its crest. This crossing not only has faculty to inundate Northeast 8th Street, but also could rapidly release the stored volume to downstream properties and roadways, were it to fail, potentially causing harm.

Since this stream crossing acts as an impoundment that facilitates inundation of Northeast 8th Street, lowering the top of the crossing one-foot or two-feet is considered as an alternative in this feasibility study.

6.2.1 Stakeholder Assessment

During the October 29, 2011 public meeting, Jeff Newfeld, owner of the property and the stream crossing, expressed objection to allowing water to flow across the access to the back

of their property. Notes from the meeting can be found in Appendix D. Mr. Newfeld clarified during a September 20, 2012 field meeting with King County Water and Land Resources Division staff that he would be more amenable to an alternative that maintains access to the back of his property.

6.2.2 Environmental Impacts

If there is no in-water work, all work is conducted on the existing driveway prism above the ordinary high water mark, and construction is conducted during low or no flow conditions, there should be very few environmental impacts. If any trees or shrubs within the stream buffer are present in the impacted area, they may have to be removed and replaced in kind with native vegetation. Fish and aquatic organisms could be disrupted and displaced by construction noise generated by dumping and positioning rock loads, and heavy construction equipment operation and vibration.

6.2.3 Proposed Implementation Strategy

Fill would be removed from the top of the stream crossing down twenty-four to thirty-six inches depending on finished elevation. The crossing has a base of approximately two- to four-man rock, which would be stockpiled as needed material for use later. A spillway surface would be constructed one foot deep across the crossing with a mix of fifty percent 4” – 8” rock and fifty percent 2” – 4” rock, approximately 10 to 20 cubic yards. The side slopes, or approached would be excavated as needed to accommodate vehicle access. A driving surface composed of 2 ½” minus would be placed on the crossing and on the approaches. Erosion and sediment control measures would be employed as needed. This is a preliminary design description.

6.2.4 Permits

Local

The work would be located within the regulated stream buffer directly above and adjacent to the stream, so a King County Clearing and Grading Permit may be required. Because the proposed work is minor and has very limited environmental impact to the stream, it could fall within “maintenance of bridge or culvert” and be exempt under KCC Chapter 16.82.051. It is an “allowable use” under the King County CAO. There is also a possibility the project could be covered under the King County Department of Transportation programmatic clearing and grading permit with DDES. Another alternative is that a short form Grading permit could be obtained due to the very limited critical areas impact.

State

The work proposed in this alternative would be considered a repair and maintenance activity under the SEPA, and is located out of the water. As such, the proposed alternative would be Categorically Exempt under Washington Administrative Code 197-11-800 (2), and would not trigger the SEPA review process.

An HPA will likely be required, due to close proximity to the stream and the possibility driveway and spillway fill material could fall into the stream and would need to be removed.

Federal

Because there is no fill or work within waters of the United States, no U.S. Army Corps of Engineers permit is required.

6.2.5 Cost

Construction

The cost of lowering the stream crossing is based on removing 40 to 60 cubic yards of dry fill from the top of the crossing and installing a new weir surface composed of 20 cubic yards of rock. Work is estimated to take two days, using a track hoe, and operator, a dump truck and driver, and two utility workers with pickup trucks.

Permits

The estimates include staff time to fill out permit applications and permit review fees by the regulators.

King County DDES Clearing and Grading- $ 1500

WDFW HPA- $1000

	Construction	Permitting	Total*
Lowering gravel road across stream up to 2 feet	$8,500	$1,500	$10,000

*Does not include an estimate for design or project management costs.

6.3 Stream Channel Dredging

In recent decades, little maintenance has been conducted in the channel reach between stream station 6547 and stream station 5573. Sediment appears to have aggraded eighteen to seventy-four inches deep along this reach.

Removal of accumulated sediment in this reach is expected to restore flow capacity and reduce flood elevations at Northeast 8th Street and at Allen Lake.

6.3.1 Stakeholder Assessment

Numerous residents have expressed favor for removal of sediments and vegetation that have built up over time.

Anthony and Marilyn Vitale have expressed opposition to any work upstream of their property that would adversely affect their property.

Work that allows water to flow more effectively out of Allen Lake would remove some peak flow attenuation; in other words, a clearer stream will pass higher peak flows downstream to 244th Avenue Northeast. Downstream property owners may be opposed to the stream passing higher peak flows at their property or to higher water surface elevations.

6.3.2 Environmental Impacts

Complete dewatering of year round stream segment for one to three weeks.

The current channel in the proposed dredging area has water flow year round. Pooled reaches up to 4 feet deep have been recently observed and had invasive plants removed by the Washington Conservation Corps under King County oversight. A flowing stream channel was observed by county staff on September 19, 2012 after 55 days of drought with only one rain event in early September.

There is a chance the dredged stream segment will become intermittent post dredging due to the resulting drawdown of the Allen Lake water surface and its associated extensive headwater wetlands.

This will eliminate any fish habitat at low flow and eliminate any aquatic organism production. Temperature of any ponded water will rise in the summer to a level that will not likely support salmonids. The August 2012 hand vegetation removal in the proposed dredging reach resulted in a reported six-inch water surface elevation drop in Allen Lake. Dredging the stream could be expected to drop the Allen Lake water surface even further.

Fish and aquatic organisms salvage.

During dewatering, permitting conditions will require salvage and collection of aquatic organisms. It is not possible to collect all organisms and fish due to natural hiding behavior, the large area being dewatered, and turbid water conditions created during salvage due to the fine sediment bottom. This will lead to a percentage of mortality and loss that will depend on the length of the reach dewatered and the number of fish collection by staff.

Vegetation removal.

Instream and near bank native vegetation will be removed during dredging, unless specifically marked in the field and avoided. Immediately after dredging, the de-vegetated and silty conditions provide highly degraded fish and aquatic habitat conditions until natural and manmade revegetation regenerates. Overhead cover islands of natural and invasive vegetation may be removed, eliminating instream and overhead fish cover. Overhanging bank vegetation will likely be dewatered and/or removed, further degrading stream habitat.

Further simplification of stream channel.

Dredging the channel will further decrease the limited amount of habitat variability that currently exists. Currently there is a variation of depths and stream widths that provide hydraulic variations beneficial to aquatic stream dwelling organisms. The dark colored water provides fish and aquatic organism hiding cover in the deeper areas. Although subject to change, the current proposal is to dredge the channel two to five feet deeper than present conditions. This will reduce the availability of fish habitat features.

Short term and longer-term turbidity and sedimentation downstream

Once all instream hydraulic variation and vegetation is removed, and water flow is reintroduced to the freshly dredged reach of the stream, mobilization of the freshly exposed sediments can be expected to be transported to downstream reaches. Unseasonal suspended and deposited sediment adversely affect fish and aquatic organisms, particularly aquatic

insects and fishes sensitive gill filaments. High turbidity levels can obscure fish feeding ability and cause an avoidance response out of the turbid conditions.

East Lake Sammamish Wetland #9, Allen Lake (Wetland #38), and adjacent wetlands

In addition to the Lake Allen Wetland, there is a fifty-five acre inventoried Class 1 wetland, East Lake Sammamish Wetland Number 9, draining into Allen Lake from the west that could be negatively affected if the proposed project lowers the current water levels in both Lake Allen and the Lake Allen Outlet. The altered hydroperiods in both wetlands could adversely affect wetland vegetation and community structure in the wetlands and their buffers. An upstream wetland impact study is highly likely to be required to obtain permits for dredging the outlet, and will be expensive. There also appear to be wetlands adjacent to the proposed dredging reach that are not in the King County Wetlands Inventory. Rapid stream dewatering during construction and the subsequent post dredging lower stream levels may adversely affect adjacent wetlands. Sensitive Areas Notice on Titles can identify these wetlands, if any. A wetland impact study of the lands adjacent to the dredging area will also be needed.

Downstream flow increase impacts

Increasing the width and depth of the outlet channel, and eliminating hydraulic complexity will likely increase the amount of flow to downstream reaches during high flow events. Increased high flows may adversely affect streambed and stream bank stability, negatively affecting aquatic habitat and organisms due to increased downcutting, erosion, and turbidity. This effect could be expected to be the most severe in the steeper ravine reach, with its fine sediment terraces and very steep side slopes. Increased erosion and deposition could negatively affect coho spawning habitat and redds in the lower ravine reach. If there are increased amounts of erosion and deposition, it would be an adverse impact to the high diversity, very large 161 acre Class 1 Evans Creek Wetland 22.

Streamside buffer vegetation

Dredging the streambed will rapidly decrease stream water surface elevations, which will quickly and adversely affect water availability for streamside vegetation. Stream bank trees and shrubs may not survive the sudden decrease in water availability due to their inability to grow roots fast enough to match rapidly decreasing water levels. Larger trees may be more at risk of dying, depending on time of year the stream dredging is conducted, as their evapotranspiration rates are higher than smaller trees or shrubs. Summer time is the most likely construction period during the low flow and low precipitation season, but coincides with the highest rate of evapotranspiration.

6.3.3 Proposed Implementation Strategy

The reach of the Allen Lake Outlet that extends 800 feet downstream from stream station 6547 would be isolated in sections using cofferdams and dewatered. During dewatering, the intake for the pump would be screened to prevent taking fish into the pump, and fish would be removed and transferred out of the work area.

A track hoe would be used to remove wet, loose sediment and transfer it away from the stream to be staged on site. Staging the material on site will allow it to drain, decreasing its

volume and weight. The material would be placed far enough away from the stream to avoid allowing sediment to reenter the stream.

The sediment and vegetation would be hauled to another site for disposal.

Water would gradually be reintroduced to the reach with removal of the cofferdams. Erosion control and site stabilization measures will be employed as needed to minimize water quality impacts.

6.3.4 Permits

Local

A DDES Clearing and Grading permit is required, including CAO and flood reviews. If the proposed project is not an allowed alteration under the CAO, an Alteration Exception or a Reasonable Use Exception may be required.

A Clearing and Grading permit is required, if compliance with the CAO can be obtained first.

Stream dredging is not an allowed alteration under the King County CAO. A Critical Areas Alteration Exception (CAAE) is required under King County Code 21A.24.070, but only if a strict set of conditions can be met. If these conditions cannot be met, then a Reasonable Use Exception (RUE) must be obtained. A RUE can only be obtained if the applicant can demonstrate that all reasonable use of the property is denied.

State

An HPA is required.

A NPDES Construction Stormwater General Permit administered by WDOE would be needed if the total disturbed area exceeds one acre in size. There are fees and it requires a stormwater pollution prevention plan (SWPPP).

SEPA is required for instream dredging.

Federal

A U.S. Army Corps of Engineers Nationwide 404 permit is likely required, and the project could require an Individual Clean Water Act Section 404 Permit, based on recent King County experience regarding the Corps decision to require an Individual Permit for the county's proposed May Creek dredging project. The Corps permit is likely to be very time consuming and expensive to obtain. An Individual Permit typically requires extensive stream and wetland studies, alternatives analysis, and mitigation planning. Potential mitigation opportunities along Allen Lake outlet includes revegetating the stream buffer, adding large woody debris, re-meandering the linear alignment, and/or providing fish passage improvements downstream. Any of these potential mitigation options will be expensive to design, permit, and construct.

Even if no federal permits are required, federal funding if used for this project imposes a "federal link" that can trigger several of the same federal permitting processes noted above, such as the ESA Section 7 and NHPA Section 106.

6.3.5 Cost

Construction

The estimated cost of clearing sediment and vegetation from the reach between stream station 6547 and approximately stream station 5750 is based on removing a volume of 1,700 cubic yards of material from the channel. The work is estimated to take four weeks. The cost estimate for this work is $248,000 for labor, equipment, and materials.

Permits

Estimates include staff time to complete permit applications and forms, and regulator's review time and fees.

This alternative has high environmental impact for an activity that is very rarely approved for streams in King County. As such, there will likely be a very high cost for permits, studies, mitigation, and potential appeals.

- King County DDES Clearing and Grading- $20,000
- King County CAO Critical Areas Alteration Exception - $18,000
- WDFW HPA- $2000
- SEPA- $10,000
- WDOE NPDES Stormwater General Construction Permit- $5000
- U.S. Army Corps of Engineers Nationwide Section 404 Clean Water Act Permit, including compliance with NHPA Section 106 and ESA Section 7 - $50,000

  Or

- U.S. Army Corps of Engineers Individual Section 404 Clean Water Act Permit $80,000

The CAO and SEPA cost estimates assume that the permits are not appealed. It is difficult to predict what the costs will be if the permits are appealed.

Table 5. Estimated sediment removal cost.

	Construction	Permitting	Total*
Hauling of sediments and vegetation to disposal	$248,000	$135,000	$383,000

*Does not include an estimate for design or project management costs.

6.4 Plant native plants along the Stream

There is little to no native trees and ground cover along the banks of the channel between stream station 6547 and stream station 5095. Stream station 5573 is the only location with native trees along this stretch of channel and had little to no sediment observed during a June 2012 field visit. In the *September 2008 Study of Agricultural Drainage in the Puget Sound Lowlands to Determine Practices which Minimize Detrimental Effects on Salmonids*, the study recommends farmers to plant native trees and ground cover along streams because it shades out non-native plants like reed canary grass and other invasive aquatic weeds.

6.4.1 Stakeholder Assessment

Some residents between stream station 6547 and stream station 5095 have shown favor for planting native trees and ground cover along the banks of the channel on their property**.**

At stream station 5975, the property owner objected to planting anything that would block the view across their property, per personal communication.

6.4.2 Environmental Impacts

The impact of native plantings would be positive, and would help shade out reed canary grass and other invasive aquatic weeds.

6.4.3 Proposed Implementation Strategy

A Washington Conservation Corps crew with the supervision of King County would plant the native trees and ground cover along the banks of the channel between stream station 6547 and stream station 5095**.**

6.4.4 Permits

No permits would be required for native plantings along the stream banks.

6.4.5 Cost

The cost of native plantings would be approximately $7,500 per property, assuming $5,000 for labor and equipment and $2,500 for materials. There are four properties that could be planted with native plantings: 2625069052, 2625069051, 2625069049, and 2625069063. Four properties at $7,500 each for a total of $30,000. There are no permits required, therefore no costs for permitting.

6.5 Hydraulic Summary of Alternative Analysis

Alternatives evaluated for hydraulic improvements include:

- Lowering of farm crossing at stream station 5573 1-ft (LOWER1)
- Lowering of farm crossing at stream station 5573 2-ft (LOWER2)
- Replacement of culverts with 48 inch diameter pipes (REPLACE)
- Replacement of culverts and lowering of farm crossing two feet at stream station 5573 (REPLACE2FT)
- Replacement of culverts and removal of invasive plants and sediment deposition (SEDIMENT)

6.5.1 Hydrological Impacts

Estimated effects from proposed improvements were evident in two of the alternatives analyzed: upsizing the three remaining culverts (REPLACE) to 48 inches, and removing invasive vegetation and sediment deposition (SEDIMENT). The most effective alternative to reduce flooding is the removal of invasive plants and build-up of sediment (SEDIMENT) which eliminates the 100-year from overtopping Northeast 8th Street with a water surface approximately a half foot below the road surface at water surface elevation (WSEL) 342.6 feet. The replacement of the culverts (REPLACE) was effective enough to reduce the water

surface elevation for the 100-year storm to less than ¾ foot depth of water over the roadway at Northeast 8th Street at WSEL 343.7 feet.

Peak water surface elevations for the 100-year storm were high enough that when lowering the farm crossing (LOWER2) two feet, it would overtop the farm crossing allowing for additional channel capacity beyond the existing 36-inch culvert. This effect of weir flow over the driveway lowers the100-year water surface approximately 0.6 feet just upstream of the farm crossing to WSEL 343.6 feet, with diminishing effects upstream toward Northeast 8th Street, with an estimated 0.4 feet reduction to WSEL 344.0 feet at Northeast 8th Street, inundating the road with one foot of water during the 100-year storm.

Neither lowering the farm crossing one foot (LOWER1) nor lowering of the farm crossing two feet and replacing culverts (REPLACE2FT) provides any added benefit, other than incorporating a safety factor if a system failure occurs with a culvert collapse, blockage, etc., to replacement of the culverts (REPLACE). The lowering of the farm crossing to 344.2 feet still backwaters the stream for the 100-year storm, and replacing the culverts with 48-inch pipes reduces the water surface elevation to WSEL 343.0 feet, just below the elevation of a 2-foot reduced farm crossing at stream station 5573 at WSEL 343.2 feet. However, given how stream channel conditions can vary over time, allowing the water to pass over a lowered farm crossing at stream station 5573 would prevent Northeast 8th Street from closing at one of the currently most controlling structures in the study area.

With the exception of the most aggressive alternative, replacement of culverts and removal of invasive plants and sediment deposition, all alternatives are estimated to flood overbank during the 100-year storm event, but not as deep or as wide spread as with no action. The culvert, invasive plants, and sediment alternative is estimated to prevent overbank flooding for the first 1,200 feet downstream of stream station 6547, at which point overbank flooding resumes similar to the other evaluated alternatives.

Lastly, changes to water surface elevations impounding at 244th Avenue Northeast for all alternatives are marginal for moderately sized storms similar to December 2010, i.e. 0.3 feet higher, and essentially no change to water surface elevation between existing conditions and any proposed actions when evaluating a 100-year storm event with WSEL 339.0 feet. However, a water surface elevation of 339.0 feet is within 1.6 feet of over topping 244th Avenue Northeast (340.6 feet), and any debris collecting on the inlet structure at 244th Avenue Northeast would increasingly reduce conveyance capacity as water pressure builds. This would elevate the projected water surface, possibly overtopping 244th Avenue Northeast, under existing conditions or any of the proposed actions.

The proposed alternatives successes and failures with regard to meeting the project objective at Northeast 8th Street are summarized in Table 6.

Table 6. Summary proposed actions meeting targets for reducing inundation at Northeast 8th Street.

Actions	< .5 ft for Dec. 2010	< 1 ft for 100 year
Prior to early actions	No	No
Culvert clearing and replacement of culvert at stream station 5095	Yes	No
LOWER1 – Lowering of farm crossing at stream station 5573 1-ft	Yes	No
LOWER2 – Lowering of farm crossing at stream station 5573 2-ft	Yes	Yes
REPLACE – Replacement of culverts with 48 inch diameter pipes	Yes	Yes
REPLACE2FT – Replacement of culverts and lowering of farm crossing two feet at stream station 5573	Yes	Yes
SEDIMENT – Replacement of culverts and removal of invasive plants and sediment deposition	Yes	Yes

7 Recommendations

Table 6 illustrates that the targets of preventing closure of Northeast 8th Street during storms similar to the December 2010 storm and of reducing flooding to less than one foot during a 100-year storm are met by the proposed actions, except for by lowering the farm crossing at stream station 5573 by only one foot. The 100-year target was not met by the early actions the were conducted prior to invasive vegetation removal either.

Stream channel dredging is the most expensive (Table 7) and poses a high difficulty in obtaining permits. Therefore, it is not recommended.

Lowering the farm crossing at stream station 5573 is the least expensive, but it would be expected to increase the volume of water detained on the upstream side of 244th Avenue Northeast. Therefore, it is not recommended.

Replacement of three culverts with 48-inch diameter culverts is the middle of the cost range, permitting is medium difficulty, and the property owners may be likely to grant permission.

Planting native plants along the channel is relatively inexpensive and property owners may be likely to grant permission. Planting vegetation that shades the channel would be expected to reduce growth of vegetation that chokes the channel and encourages sediment deposition.

Therefore, the recommendation is to replace three culverts and plant native plants along the channel.

Table 7. Summary of construction and permitting costs for proposed actions.

	Construction	Permitting	Total
Replacement of 3 culverts with 48 inch diameter pipes	$124,000	$6,500	$130,500
Lowering of farm crossing at stream station 5573	$8,500	$1,500	$10,000
Stream Channel Dredging	$248,000	$135,000	$383,000
Planting native plants along the channel	$30,000	$0	$30,000

Appendix A Stream Stationing and Profile

Figure 5. Stream stationing at 244th Avenue Northeast.

Figure 6. Stream stationing at Northeast 18th Street and 247th Street Northeast.

Figure 7. Stream Stationing along 250th Avenue Northeast.

Figure 8. Stream stationing proximate to Northeast 8th Street and 250th Avenue Northeast.

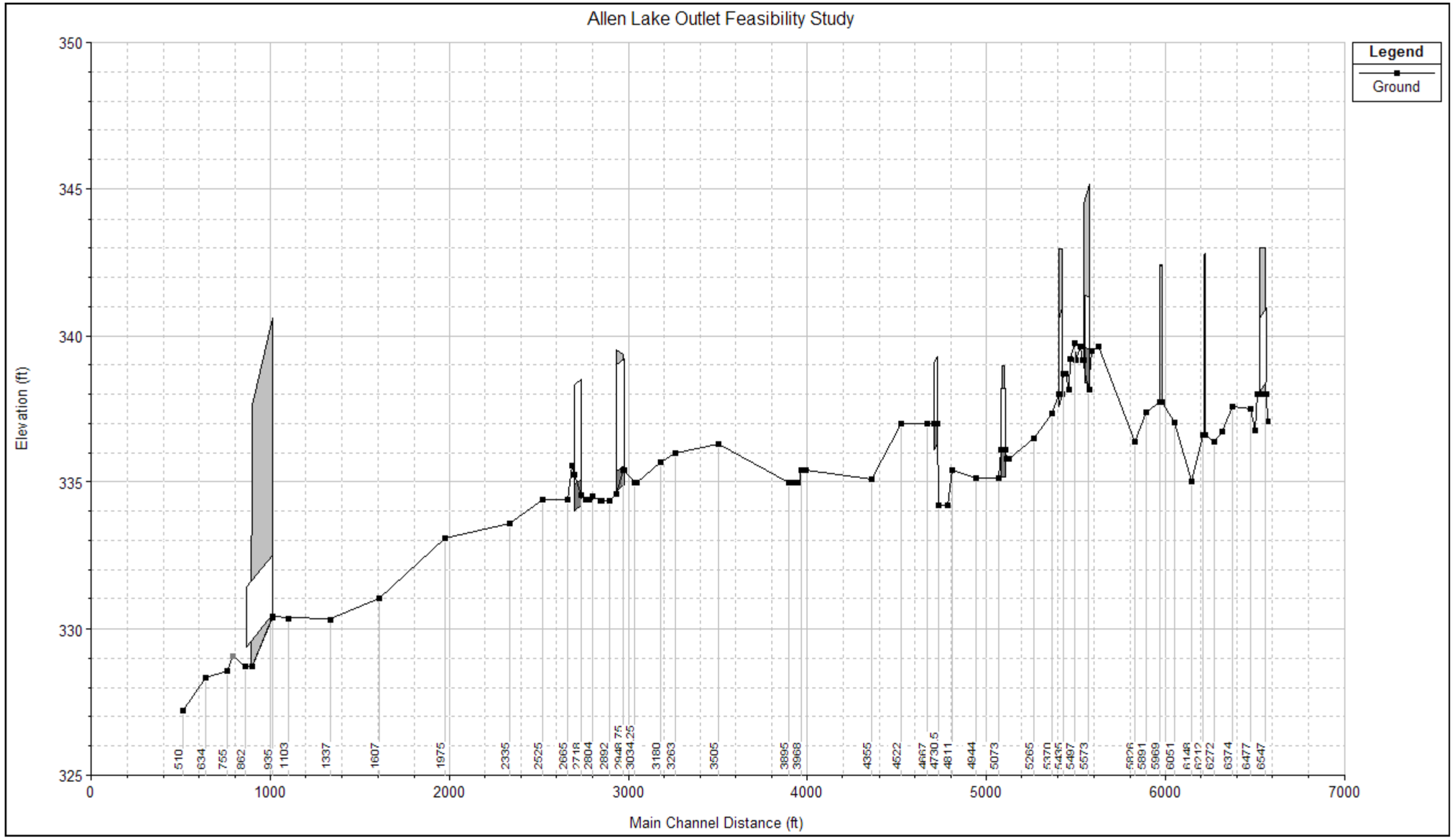


Figure 9. Stream bed profile and stationing of culverts and bridges.

Appendix B Maps of Parcels

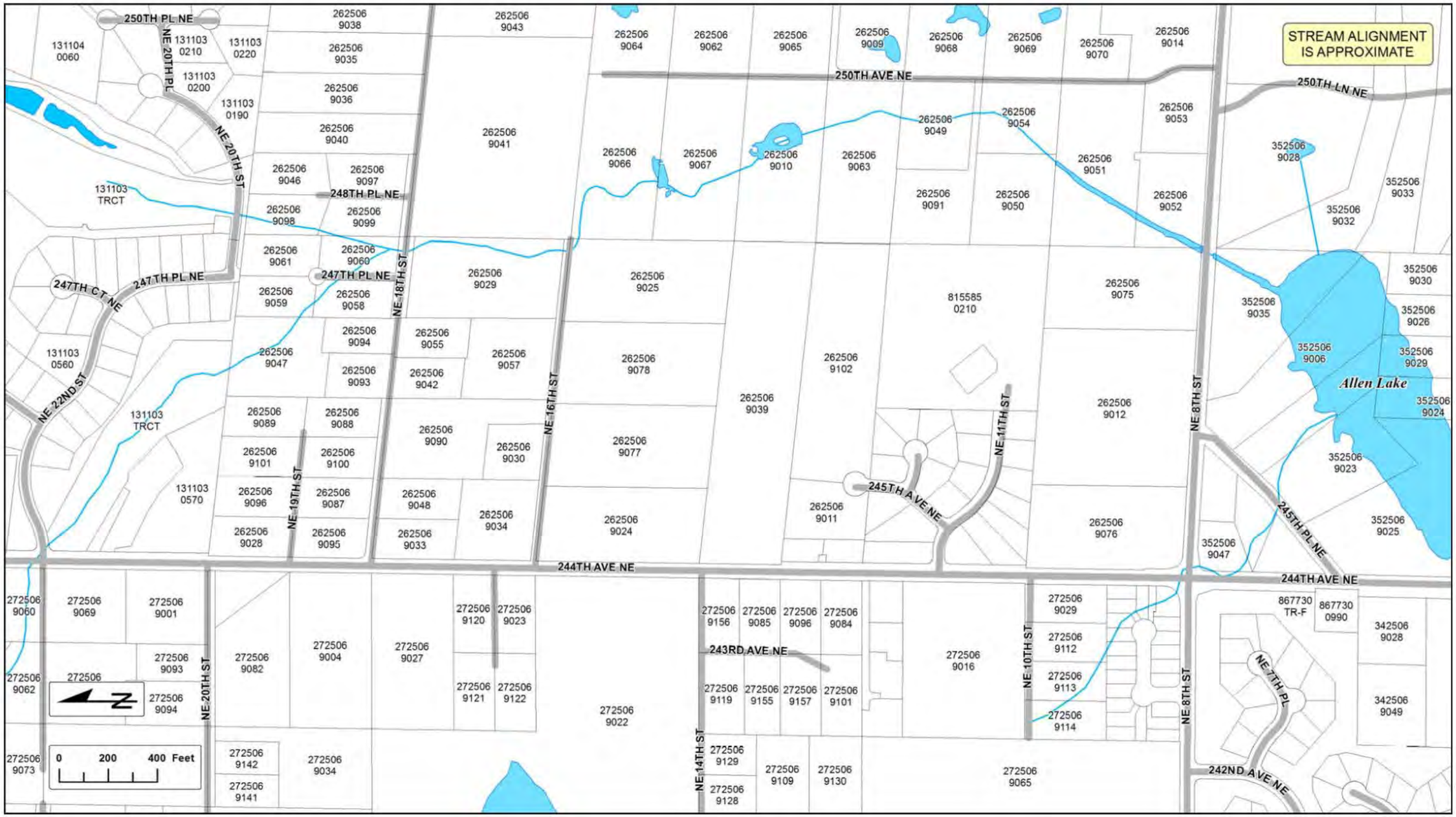


Figure 10. Properties on reach of 08-111A between Allen Lake and 244th Avenue Northeast.

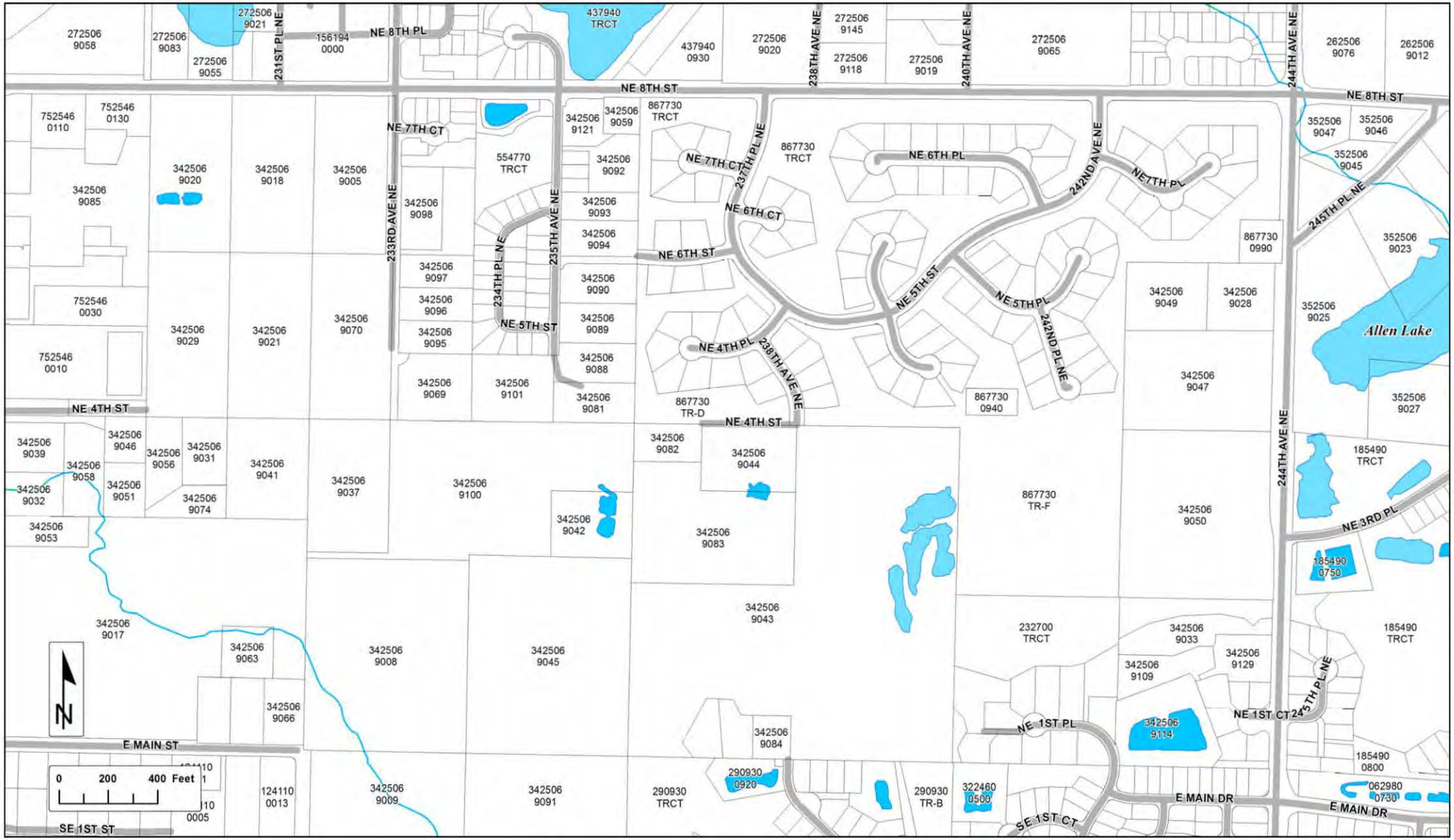


Figure 11. Properties on Eden Creek and Wetlands west of Allen Lake.

Appendix C Notes from the Public Meeting on February 12, 2011

NE 8th Street and Allen Lake Outlet

Final Public Meeting Notes Prepared by Claire Jonson, KC WLRD

February 12, 2011, 10:30 am to 12:00 pm

Action Items:

- King County Water and Land Resources Division (KC WLRD)will provide early action alternatives with schedules on website by end of March 2011
- KC WLRD will provide Draft Feasibility report by October 2011
- KC WLRD will provide Final Feasibility report by end of 2011
- KC WLRD will look at alternative of drainage outlet to the west for Feasibility Report
- King County Department of Transportation (KC DOT) will look into an emergency route – possibly through the power lines
- KC DOT will take down sign for notice of this public meeting at NE 8th Street
- KC DOT will look at replacing culvert cover on NE 8th Street

Notes:

-Curt Crawford made introductions of project, WLRD, DOT, City of Sammamish staff, and meeting facilitators.

-Don Althauser presented the Rapid Assessment Report and Video of King County Sheriff's office aerial footage of the January 2011 storm event.

Public Comments:

Note that these are comments of some of the people who spoke, not all.

-Molly Ciliberti: There is a topographical map from 1950 ARMY CORE showing the drainage from Allen Lake going to the southwest, crossing 228th, and then going to Lake Sammamish. Fred Dodd dug the ditch in 1972. Department of Fish and Wildlife shocked the water in the ditch to the north and found no fish. Development around the area and the golf course were built with inadequate drainage requirements by the County. The current wetlands were artificially created by the surrounding development. The drainage problems were made worse after the 244th road extension was constructed.

-Gail Michelman: Her father dug the ditch to the north. The north ditch cannot contain all the water from all the surrounding development. County must find another way for draining Allen Lake.

-Elliott Alhadloff: Are there any alternatives that have a complete solution, what is the cost, are they immediate, or will they take 3 to 5 years. Don Althauser answered that the Feasibility Study will have alternatives analysis. KC will provide early action alternatives. The feasibility study will provide alternatives that may take 3 to 6 years to implement.

Greg Allen: Agree with Molly Ciliberti about natural flow to the west. Need to look at Allen Lake and vegetation in modeling. The Level 3 detention standard increases duration of flooding. KC Hearing Examiner ignored this and now the nuisance has turned into an emergency. KC must find funding to alleviate emergency. He can volunteer with neighbors to take out blackberries and replant with native vegetation. Need website to show schedule of feasibility study.

Matthew Kona: Make sure that the runoff does not shift to private owners in the area.

Larry Herrick?: Basement flooded. Mold in House. Purchased two additional sump pumps after 2010, after finish of 244th bridge. SW drainage out of Allen Lake needs to be restored.

Keith McCamish?: Second newest resident on Allen Lake. Encouraged, that KC is doing something. Cannot use about an acre of his land once water has receded. Can KC provide property tax relief?

Paul Price: Culverts will not work. Allen Lake is higher than it was. There has been too many environmental studies. They clean their culvert. Three fourths of his land is under water. Used to be a horse land, now is not. Let's make it right.

Dave Burton: More water in Lake Allen. Water is not able to leave the lake. Keep level in the lake lower.

Russell Bennett: Replace culvert cover on NE 8th Street. There is an unauthorized road south of wetlands. There is a membrane left by construction at 244th Ave so that water flows to the east.

Molly Ciliberti: Residents along 250th and Allen Lake are on septic systems.

Jeff Brauns explained that the 244th bridge has no Q value associated with it because it allows water to move freely. There is no backwater from the bridge.

? threatens lawsuit if nothing is done by the next flood.

-Curt Crawford made closing comments and noted that staff will be available for questions or comments.

Appendix D Notes from the Public Meeting on October 29, 2011

NE 8th Street and Allen Lake Outlet

Final Public Meeting Notes Prepared by Claire Jonson, KC WLRD

October 29, 2011, 10:30 am to 12:00 pm

Action Items:

- King County Water and Land Resources Division (KC WLRD) will look into permitting for clearing two driveway culverts and removing trash racks on two other driveway culverts, located north of NE 8th Street.
- Draft feasibility study available on the website for public review by March 31, 2012
- Public meeting to discuss the feasibility study by April 30, 2012
- Finalize the feasibility study and begin design by July 1, 2012

Notes:

-Curt Crawford made introductions of project, WLRD, DOT, City of Sammamish staff, and meeting facilitators.

-Curt Crawford presented the west outlet evaluation. The west outlet survey indicates that 6 feet would have to be removed for the Allen Lake Channel to outlet to the west. This evaluation shows that this alternative is not feasible because of high cost and high difficulty in permitting.

-Jeff Burkey presented the Preliminary Hydraulic Analysis.

-Claire Jonson presented schedule, budget, what has been done, and what 2012 plans are.

-Jon Cassidy presented the emergency access route options. The emergency access routes options are not feasible because the easements would likely not be granted.

-Don Althauser presented the preliminary capital improvement options.

-Call 206-296-1900 for drainage complaints.

-Call 206-296-8100 for the roads helpline.

Public Comments:

Note that these are comments of some of the people who spoke, not all.

-?- What has changed in the last 10 years?

-Scott Miller – In 2001, regulations regarding the trapping of beavers were made more strict.

-Marilyn Vitale has a beaver trapper trap 2 to 3 beavers per year on her property.

-Eric LaFrance pointed out that the west outlet survey indicates that 6 feet would have to be removed for the Allen Lake Channel to outlet to the west. Sediment is accumulated in inches per year, not feet per year.

-Jeff Newfeld suggested taking 1 foot of muck out of Allen Lake for more storage capacity. Curt Crawford clarified that this would require an Army Corps of Engineers permit. This is a complicated permit that requires approximately 1 to 2 years to process.

?- What was the size of the lake prior to impervious surface? Jeff Burkey noted that a 1965 book called "Lakes of Washington" has this information.

-Jeff Newfeld stated that he wouldn't want to sacrifice his property. Don Althauser stated that the feasibility study will look into schedule, permitability, and easement negotiations.

-Randee Fox stated that the most feasible emergency access road alternative of going through the BPA Easement Road is not acceptable. There is already a stream roaring through that area as you walk on the BPA trail.

-Greg Allen asked how you could guarantee that the emergency access roads will only be used during emergencies.

-The $250,000 estimated to build the emergency access road should be used towards fixing the flooding on NE 8th Street, not the emergency access road.

-Marilyn Vitale asked why is there flooding on NE 8th Street but her property could be dry? Jeff Burkey answered because there are high spots in the channel between you and NE 8th Street.

-Keith McCamish stated that he doesn't want King County to come back next year saying we couldn't do anything because of permits and fish window.

-Curt Crawford made closing comments and noted that staff will be available for questions or comments.

Appendix E Summary Hydraulic Model Results

Table 7. Water surface elevations upstream of structures for 100 year storm (39 cfs) hydrograph

Water surface elevations (NAVD 1988) for 100 year event (39 cfs) using Unsteady RAS									
Description	Road/Driveway Elevation	EXISTING	EARLY ACTION	LOWER1	LOWER2	REPLACE	REPLACE2FT	SEDIMENT	Improved 244th
NE 8th St. Culverts Sta. 6547	343.02	345.06	344.41	344.41	344.04	343.73	343.74	342.57	
McCoy footbridge Sta. 6220	342.81	345.06	344.41	344.40	344.03	343.72	343.73	341.32	
Lucarelli Footbridge Sta. 5975	342.73	345.06	344.40	344.40	344.03	343.71	343.72	341.22	
Newfeld Culvert Sta. 5573	345.25	344.96	344.08	344.12	343.58	342.94	342.98	340.71	
Reimer Culvert Sta. 5417	342.99	343.29	342.26	342.30	342.31	340.80	340.80	340.45	
Michelman Culvert Sta. 5095	341.02	341.48	340.96	341.00	340.98	340.02	340.02	340.03	
Vitale Culvert Sta. 4715	341.06	341.23	340.80	340.80	340.82	339.77	339.77	339.75	
NE 18th St. Culvert Sta. 2948.75	339.86	339.10	339.13	339.13	339.14	339.15	339.15	339.15	
247th Pl NE Culvert Sta. 2718	337.98	338.99	339.02	339.02	339.03	339.04	339.04	339.04	
244th Ave NE Culvert Sta. 935	340.63	338.96	338.99	338.99	339.00	339.01	339.02	339.01	

Table 8. Water surface elevations upstream of structures for approximately 5 year storm (peak near 27 cfs) hydrograph, similar to December 2010 event.

Water surface elevations (NAVD 1988) for appx. 5 year event (appx. 27 cfs) using Unsteady RAS									
Description	Road/Driveway Elevation	EXISTING	EARLY ACTION	LOWER1	LOWER2	REPLACE	REPLACE2FT	SEDIMENT	Improved 244th
NE 8th St. Culverts Sta. 6547	343.02	344.72	343.57	343.56	343.57	343.34	343.34	341.51	
McCoy footbridge Sta. 6220	342.81	344.72	343.56	343.55	343.56	343.22	343.22	340.82	
Lucarelli Footbridge Sta. 5975	342.73	344.72	343.55	343.55	343.55	343.20	343.20	340.71	
Newfeld Culvert Sta. 5573	345.25	344.54	343.10	343.09	343.11	342.40	342.40	340.22	
Reimer Culvert Sta. 5417	342.99	343.03	341.23	341.23	341.23	340.46	340.46	339.99	
Michelman Culvert Sta. 5095	341.02	341.30	340.22	340.22	340.22	339.70	339.70	339.62	
Vitale Culvert Sta. 4715	341.06	340.76	340.11	340.11	340.11	339.56	339.56	339.46	
NE 18th St. Culvert Sta. 2948.75	339.86	337.64	337.72	337.72	337.72	337.72	337.72	337.72	
247th Pl NE Culvert Sta. 2718	337.98	337.28	337.35	337.35	337.35	337.35	337.35	337.35	
244th Ave NE Culvert Sta. 935	340.63	335.79	336.10	336.10	336.09	336.12	336.12	336.11	

Appendix F Hydraulic Model Output

Table 9. Hydraulic calculations for December 2010 like event (27 cfs) for Existing and Early Actions, steady state. Starred "*" stations are interpolated cross-sections.

River Station	Profile	Plan	W.S. Elev. (NAVD 88)	Velocity Channel	Top Width
			(ft)	(ft/s)	(ft)
6576	27 cfs	Existing	344.68	0.05	542.98
6576	27 cfs	Early Action	343.3	0.13	300.35
6565	27 cfs	Existing	344.68	0.07	501.92
6565	27 cfs	Early Action	343.3	0.2	267.75
6547	NE 8th Street				
6514	27 cfs	Existing	344.68	0.07	501.85
6514	27 cfs	Early Action	343.19	0.21	237.44
6503	27 cfs	Existing	344.68	0.06	397.54
6503	27 cfs	Early Action	343.19	0.19	330.01
6477	27 cfs	Existing	344.68	0.06	379.18
6477	27 cfs	Early Action	343.19	0.24	178.29
6459.83*	27 cfs	Existing	344.68	0.06	363.25
6459.83*	27 cfs	Early Action	343.19	0.29	168.61
6442.66*	27 cfs	Existing	344.68	0.07	340.49
6442.66*	27 cfs	Early Action	343.19	0.34	160.37
6425.5*	27 cfs	Existing	344.68	0.07	330.43
6425.5*	27 cfs	Early Action	343.18	0.35	138.43
6408.33*	27 cfs	Existing	344.68	0.07	320.62
6408.33*	27 cfs	Early Action	343.18	0.37	118.19
6391.16*	27 cfs	Existing	344.68	0.08	311.49
6391.16*	27 cfs	Early Action	343.18	0.34	106.17
6374	27 cfs	Existing	344.68	0.08	326.24
6374	27 cfs	Early Action	343.18	0.35	91.61
6355.66*	27 cfs	Existing	344.68	0.09	307.73
6355.66*	27 cfs	Early Action	343.18	0.22	110.93
6337.33*	27 cfs	Existing	344.68	0.09	311.37
6337.33*	27 cfs	Early Action	343.18	0.19	117.76
6319	27 cfs	Existing	344.68	0.08	317.55
6319	27 cfs	Early Action	343.18	0.17	122.01
6272	27 cfs	Existing	344.68	0.09	275.03
6272	27 cfs	Early Action	343.17	0.21	146.27
6224	27 cfs	Existing	344.68	0.11	209.78
6224	27 cfs	Early Action	343.17	0.26	100.56
6220	Footbridge				
6212	27 cfs	Existing	344.68	0.11	209.78
6212	27 cfs	Early Action	343.17	0.26	100.09
6148	27 cfs	Existing	344.68	0.14	212.59
6148	27 cfs	Early Action	343.16	0.33	77.45
6051	27 cfs	Existing	344.68	0.13	195.33
6051	27 cfs	Early Action	343.16	0.4	113.56
5980	27 cfs	Existing	344.68	0.08	251.96

River Station	Profile	Plan	W.S. Elev. (NAVD 88)	Velocity Channel	Top Width
5980	27 cfs	Early Action	343.15	0.28	144.16
5975 Footbridge					
5969	27 cfs	Existing	344.68	0.08	251.96
5969	27 cfs	Early Action	343.15	0.28	143.85
5891	27 cfs	Existing	344.68	0.14	274.26
5891	27 cfs	Early Action	343.14	0.48	67.09
5826	27 cfs	Existing	344.68	0.07	345.38
5826	27 cfs	Early Action	343.13	0.51	140.21
5807.45*	27 cfs	Existing	344.68	0.1	328.58
5807.45*	27 cfs	Early Action	343.11	0.73	59.32
5788.90*	27 cfs	Existing	344.68	0.14	312.42
5788.90*	27 cfs	Early Action	343.09	0.87	28.74
5770.36*	27 cfs	Existing	344.68	0.2	289.02
5770.36*	27 cfs	Early Action	343.05	1.06	25.7
5751.81*	27 cfs	Existing	344.68	0.29	167.69
5751.81*	27 cfs	Early Action	342.97	1.36	22.87
5733.27*	27 cfs	Existing	344.68	0.38	120.3
5733.27*	27 cfs	Early Action	342.9	1.52	6.8
5714.72*	27 cfs	Existing	344.67	0.46	66.41
5714.72*	27 cfs	Early Action	342.86	1.51	6.75
5696.18*	27 cfs	Existing	344.67	0.53	46.03
5696.18*	27 cfs	Early Action	342.82	1.49	6.71
5677.63*	27 cfs	Existing	344.66	0.58	29.21
5677.63*	27 cfs	Early Action	342.78	1.47	6.67
5659.09*	27 cfs	Existing	344.65	0.65	25.69
5659.09*	27 cfs	Early Action	342.75	1.45	6.63
5640.54*	27 cfs	Existing	344.64	0.72	23.75
5640.54*	27 cfs	Early Action	342.71	1.44	6.59
5622	27 cfs	Existing	344.62	0.81	21.96
5622	27 cfs	Early Action	342.68	1.43	6.55
5604.5*	27 cfs	Existing	344.59	0.92	21.79
5604.5*	27 cfs	Early Action	342.63	1.62	5.77
5587	27 cfs	Existing	344.53	1.1	21.46
5587	27 cfs	Early Action	342.52	1.91	5
5574	27 cfs	Existing	344.48	1.2	20.34
5574	27 cfs	Early Action	342.38	2.25	5.71
5573					
5541	27 cfs	Existing	343.19	1.45	18.18
5541	27 cfs	Early Action	341.87	2.23	12.63
5526	27 cfs	Existing	343.2	0.46	33.19
5526	27 cfs	Early Action	341.85	1.23	20.37
5503	27 cfs	Existing	343.12	1.53	5
5503	27 cfs	Early Action	341.74	1.47	12.56
5497	27 cfs	Existing	343.08	1.68	5
5497	27 cfs	Early Action	341.69	1.69	12.41
5470	27 cfs	Existing	343.03	0.58	50.75

River Station	Profile	Plan	W.S. Elev. (NAVD 88)	Velocity Channel	Top Width
5470	27 cfs	Early Action	341.59	1.02	17.4
5464	27 cfs	Existing	343.02	0.41	49.57
5464	27 cfs	Early Action	341.59	0.8	26.25
5447	27 cfs	Existing	343.02	0.51	50.49
5447	27 cfs	Early Action	341.56	0.9	17.36
5435	27 cfs	Existing	343.01	0.52	50.34
5435	27 cfs	Early Action	341.54	0.91	17.3
5427	27 cfs	Existing	343.01	0.34	78.46
5427	27 cfs	Early Action	341.5	1.69	21
5417	Culvert				
5407	27 cfs	Existing	341.3	1.8	19.69
5407	27 cfs	Early Action	340.94	2.04	17.21
5370	27 cfs	Existing	341.28	0.46	33.97
5370	27 cfs	Early Action	340.9	0.57	29.22
5265	27 cfs	Existing	341.27	0.38	123.09
5265	27 cfs	Early Action	340.87	0.59	83.52
5125	27 cfs	Existing	341.26	0.17	202.66
5125	27 cfs	Early Action	340.85	0.26	189.28
5116.9	27 cfs	Existing	341.26	0.14	202.65
5116.9	27 cfs	Early Action	340.85	0.23	189.27
5106	27 cfs	Existing	341.26	0.41	215.39
5106	27 cfs	Early Action	340.8	1.44	149.07
5095	Culvert				
5084	27 cfs	Existing	340.73	0.45	140.99
5084	27 cfs	Early Action	340.1	1.76	22.5
5073	27 cfs	Existing	340.73	0.12	269.68
5073	27 cfs	Early Action	340.12	0.17	227.49
4944	27 cfs	Existing	340.73	0.1	285.71
4944	27 cfs	Early Action	340.12	0.14	263.6
4811	27 cfs	Existing	340.73	0.13	391.82
4811	27 cfs	Early Action	340.12	0.18	303.26
4785	27 cfs	Existing	340.73	0.29	193.7
4785	27 cfs	Early Action	340.12	0.4	136.81
4730.5	27 cfs	Existing	340.73	0.29	193.63
4730.5	27 cfs	Early Action	340.11	0.4	136.74
4725	27 cfs	Existing	340.72	0.41	134.95
4725	27 cfs	Early Action	340.04	1.9	40.87
4715	Culvert				
4705	27 cfs	Existing	339.46	2.38	30.75
4705	27 cfs	Early Action	339.51	2.34	30.98
4667	27 cfs	Existing	339.46	0.93	64.82
4667	27 cfs	Early Action	339.5	1.05	24.9
4522	27 cfs	Existing	339.33	1.1	58.65
4522	27 cfs	Early Action	339.36	1.17	20.64
4355	27 cfs	Existing	339.25	0.46	246.2
4355	27 cfs	Early Action	339.26	0.54	85.88

River Station	Profile	Plan	W.S. Elev. (NAVD 88)	Velocity Channel	Top Width
3995	27 cfs	Existing	339.2	0.59	76.2
3995	27 cfs	Early Action	339.2	0.59	76.2
3968	27 cfs	Existing	339.19	0.59	75.68
3968	27 cfs	Early Action	339.19	0.59	75.68
3955	27 cfs	Existing	339.19	0.72	99.75
3955	27 cfs	Early Action	339.19	0.72	99.75
3935	27 cfs	Existing	339.19	0.72	99.43
3935	27 cfs	Early Action	339.19	0.72	99.43
3907	27 cfs	Existing	339.18	0.47	131.06
3907	27 cfs	Early Action	339.18	0.47	131.06
3895	27 cfs	Existing	339.18	0.47	131.02
3895	27 cfs	Early Action	339.18	0.47	131.02
3505	27 cfs	Existing	338.97	1.08	101.97
3505	27 cfs	Early Action	338.97	1.08	101.97
3263	27 cfs	Existing	338.26	1.91	16.56
3263	27 cfs	Early Action	338.26	1.91	16.56
3180	27 cfs	Existing	338.02	1.5	13.9
3180	27 cfs	Early Action	338.02	1.5	13.9
3045	27 cfs	Existing	337.84	1.2	31.68
3045	27 cfs	Early Action	337.84	1.2	31.68
3034.25	27 cfs	Existing	337.82	1.22	31.22
3034.25	27 cfs	Early Action	337.82	1.22	31.22
2972	27 cfs	Existing	337.67	1.83	13.67
2972	27 cfs	Early Action	337.67	1.83	13.67
2948.75 NE 18th Street CMP					
2931	27 cfs	Existing	337.52	1.34	16.58
2931	27 cfs	Early Action	337.52	1.34	16.58
2892	27 cfs	Existing	337.49	0.87	20.43
2892	27 cfs	Early Action	337.49	0.87	20.43
2850	27 cfs	Existing	337.45	0.9	20.1
2850	27 cfs	Early Action	337.45	0.9	20.1
2804	27 cfs	Existing	337.39	0.96	19.69
2804	27 cfs	Early Action	337.39	0.96	19.69
2790	27 cfs	Existing	337.37	0.95	19.56
2790	27 cfs	Early Action	337.37	0.95	19.56
2764	27 cfs	Existing	337.34	0.97	19.34
2764	27 cfs	Early Action	337.34	0.97	19.34
2737	27 cfs	Existing	337.27	1.59	13.36
2737	27 cfs	Early Action	337.27	1.59	13.36
2718 247th Ave Pl CMP					
2699	27 cfs	Existing	337.09	2.44	10.86
2699	27 cfs	Early Action	337.09	2.44	10.86
2689	27 cfs	Existing	336.99	2.85	9.22
2689	27 cfs	Early Action	336.99	2.85	9.22
2665	27 cfs	Existing	336.95	1.45	16.3
2665	27 cfs	Early Action	336.95	1.45	16.3

River Station	Profile	Plan	W.S. Elev. (NAVD 88)	Velocity Channel	Top Width
2525	27 cfs	Existing	336.57	1.99	12.14
2525	27 cfs	Early Action	336.57	1.99	12.14
2335	27 cfs	Existing	336.28	0.51	97.67
2335	27 cfs	Early Action	336.28	0.51	97.67
1975	27 cfs	Existing	336.25	0.24	130.4
1975	27 cfs	Early Action	336.25	0.24	130.4
1607	27 cfs	Existing	336.25	0.1	140.81
1607	27 cfs	Early Action	336.25	0.1	140.81
1337	27 cfs	Existing	336.25	0.08	130.93
1337	27 cfs	Early Action	336.25	0.08	130.93
1103	27 cfs	Existing	336.24	0.07	143.2
1103	27 cfs	Early Action	336.24	0.07	143.2
1012	27 cfs	Existing	336.12	2.4	82.03
1012	27 cfs	Early Action	336.12	2.4	82.03
935	244th Ave NE CP				
862	27 cfs	Existing	331.17	5.95	19.58
862	27 cfs	Early Action	331.17	5.95	19.58
788.*	27 cfs	Existing	330.37	2.12	23.41
788.*	27 cfs	Early Action	330.37	2.12	23.41
755	27 cfs	Existing	330.15	1.96	21.35
755	27 cfs	Early Action	330.15	1.96	21.35
634	27 cfs	Existing	329.44	1.75	21.91
634	27 cfs	Early Action	329.44	1.75	21.91
510	27 cfs	Existing	328.43	2.31	14.53
510	27 cfs	Early Action	328.43	2.31	14.53

Appendix G Emergency Access Road Alternatives

Note: An Emergency Access Road is considered not feasible.

Prepared by

Jon Cassidy, King County Department of Transportation

Alternatives evaluated were as follows:

a. Extension of 205th Lane Northeast to 249th PL Northeast
b. Extension of 254 Avenue Northeast through to Northeast 3rd Street
c. Extension of 250th Avenue Northeast through to Northeast 16th Street
d. Extension of 254 Avenue Northeast through to the power line easement and open the easement road up to East Main
e. Opening the power line easement up from Northeast 8th Street to East Main Street.

Stakeholder Assessment

Each alternative requires obtaining easements from property owners prior to construction or improvement of the access road.

a. This alternative requires easements from six property owners and purchase of a right to construct a new short road segment through either one of two properties. As all of these properties have very high-assessed values and are in a gated community, the cost of this alternative was anticipated to be excessively high. Additionally, traffic impacts to property owners will be significant due to the proximity of traffic to existing homes.
b. This alternative requires easements from eight property owners as well as crossing a stream and a wetland. Additionally, there are significant elevation differences between the City of Sammamish end of 254th Northeast and the unincorporated private road of the same name. To make the road grade reasonable to vehicles would require fill in a wetland, which would not be allowed as long as there were other alternatives. Traffic impacts to property owners will be significant due to the proximity of traffic to existing homes.
c. This alternative requires easements from 25 property owners and construction of up to 600 feet of new roadway and crossing a stream. Traffic impacts to property owners will be significant due to the proximity of traffic to existing homes.
d. This alternative is similar to alternative b but would utilize a driveway at the end of the private road to gain access to the power line easement. This option would require easements from nine property owners a homeowners association and the BPA. Additionally a new road would need to be built through an existing pasture. Traffic impacts to property owners will be significant due to the proximity of traffic to existing homes.
e. This last alternative was determined to be the best candidate but would still require easements from nine property owners the BPA and a homeowners association. An

existing gravel road is currently used as a trail on the south end. This alternative provides the best buffer to adjacent homes.

Hydrological Impacts

None of the alternatives looked at pose significant hydrologic impacts. Most will require some new pollution generating surface to be installed which will increase runoff slightly but it is anticipated that it can be dissipated through dispersion methods with minimal impact the lake hydrology or other wetlands in the area.

Environmental Impacts

a. This alternative has the least impact to sensitive areas as the new road construction can occur within an upland area. This would require clearing of some significant trees as well as damage to established landscaping. Of more concern with this alternative is the impact due to proximity of the new road to existing homes and the potential to impact them with noise.

b. This alternative would have significant impacts to an existing stream corridor and adjacent wetlands due to the size of the fill required to raise the road to an elevation necessary to access Northeast 3rd Street.

c. This alternative would also impact a stream corridor and associated wetlands due to the required new road construction at the end of 254th and Northeast 16th. This alternative would also have significant impacts from traffic to adjacent homes.

d. This alternative would minimize the critical area problems identified in b above but would result in significant traffic impacts to adjacent homes as well as limit equestrian use of the existing pasture.

e. This alternative minimizes the traffic impacts to adjacent homes by maximizing the buffer between the roadway and any residences. There would be some impacts to adjacent wetlands and associated buffers, but through the use of an existing service roadway for the power line it is anticipated to avoid most significant impacts.

Proposed Implementation Strategy

It is proposed that alternative “e” be pursued. The initial steps require meetings with the property owners to negotiate for durable temporary easements while a permanent solution for the Northeast 8th Street roadway flooding is resolved. Procedures for opening the roadway during emergencies will be established during easement negotiation. Once easements are obtained from all involved parties permits applications will be submitted. Once permits and easements are in hand, road construction will begin.

Permits

Permits for the proposed alternative “e” include a Clearing and Grading permit from King County and the City of Sammamish. In addition, a Hydraulic Project Approval may be needed from the State Department of Fish and Wildlife. If the King County Roads Maintenance Section performs the roadwork with in-house staff it may be able to utilize its programmatic permits for the work to reduce the time required to obtain permits and costs to

the county. If fill is required in waters of the USA, an Army Corps of Engineers Permit will be required. Once easements have been obtained, a more extensive investigation can be performed to determine if other permits are required.

Cost

Table 10 shows the estimated cost for easements for emergency road access alternative e.

Table 10. Allen Lake emergency access easement – proposed alternative cost.

Parcel	Owner	Estimated Total Value	Total Area	Value/sq.ft.	Affected Area (sq.ft.)	Value at 25% of full
3525069039	King County	$9,000	71,874	$0.13	3,000	$93.91
3525069038	King County	$556,000	223,027	$2.49	9,300	$5,796.16
3525069005	Boggs	$857,000	393,782	$2.18	6,000	$3,264.50
3525069032	Baker	$527,000	217,800	$2.42	2,400	$1,451.79
3525069033	Plummer	$556,000	219,978	$2.53	6,000	$3,791.29
3525069034	Insite Homes LLC	$556,000	224,334	$2.48	6,840	$4,238.14
3525069018	Bononcini	$650,000	291,416	$2.23	9,900	$5,520.46
571190TRCT	Muirfield HOA	$5,000	585,133	$0.01		-
5711900320	Muirfield HOA	$1,000	131,686	$0.01		-
Total						$24,156.25

The estimated cost for the actual road improvements are $80,000. This includes minor widening, clearing to ensure adequate site distance and placement of fresh gravel for a road surface. In addition, funds will be necessary to negotiate the easements and prepare the necessary permit applications. This is estimated to cost of the permits is $4500, not including inspection fees. This cost may depend on both upon the width and length of the needed access road and upon whether the Roads Maintenance Programmatic Permit can be used.

The total estimated cost for easements, permits, construction, and engineering is $250,000.

Effectiveness

Regardless of the resolution for the Northeast 8th Street flooding problem the emergency access road will provide an effective emergency outlet for the area. It is likely to take 1-2 years to complete the easement negotiations and obtain the necessary permits once funding is obtained. While in the long-term this will provide effective ingress and egress to the area during times of flooding, due to the number of parties involved it may be difficult to have the emergency route in place before the next two flooding seasons.

Appendix H Road Raising Alternative

Note: Raising Northeast 8th Street is considered not feasible.

Prepared by

Mike O'Neil, King County Department of Transportation (KCDOT)

Stakeholder Assessment

Northeast 8th Avenue, east of the Allen Lake outlet, is the sole access to 90 to 100 residential lots. The backup of water downstream of the roadway results in water over the roadway on occasion annually. In December 2010, the road was closed for three days when the water was up to 17 inches deep. The approximate peak flow was 30 cubic feet per second (cfs). The principal cause of the flooding is downstream channel depth, roughness, and downstream blockages in private culvert crossings.

Because the road is a sole access to this community, it is rated as a Tier 4 roadway. One of the potential solutions examined as part of this feasibility study was to maintain access to the community by raising Northeast 8th Street above the flood level.

The road currently has a pavement width of approximately 25 feet bounded by wetlands on either side. The current outlet to Allen Lake crosses the road in two culverts one is designed to operate if the other becomes plugged. These culverts are adequately sized to convey expected flows from the lake although they have been subject to plugging by beavers on occasion.

There has been a long history of flooding of the road. Some of this was caused by beaver activity. In the summer of 2011 beavers constructed dams within the culverts causing water to back up over the south edge of the road. This was remedied by the removal of the blockage and construction of wire caging to reduce beaver access.

Besides the beaver activity at the road culverts, the downstream normal water level rose approximately 6 inches in the last year. This will be discussed in the feasibility alternative to improve flows in the channel downstream of the roadway.

Raising the road may address immediate access issues but unless the downstream issues are addressed, the resolution will be temporary. As downstream blockages grow, water will backup over the top of the proposed raised road alternative.

The road would need to be raised approximately two feet above the low point to minimize the flooding and would affect approximately 300 feet of the road length. Raising the road will require placement of 12 inches of quarry spalls at the base, six inches of base course crushed surfacing, and six inches of top course crushed surfacing.

To raise the 2 feet and maintain the existing road width (25 feet, Figure 12) or widen it to meet minimum new development standards (32 feet, Figure 13) require expanding the road footprint. To keep the road edge stable and provide a safer condition for cars running off it the side slopes will extend 4 feet beyond the edge of pavement on each side.

The existing road surface is bound on either side by wetlands. Wetland soil is a poor foundation and if not removed will result in near immediate road cracking, sinking and potholing. Treatment of the soil to prevent this is expensive. Besides the expense of

addressing the soil stability, there is also the cost of mitigation for lost wetland habitat and flood storage.

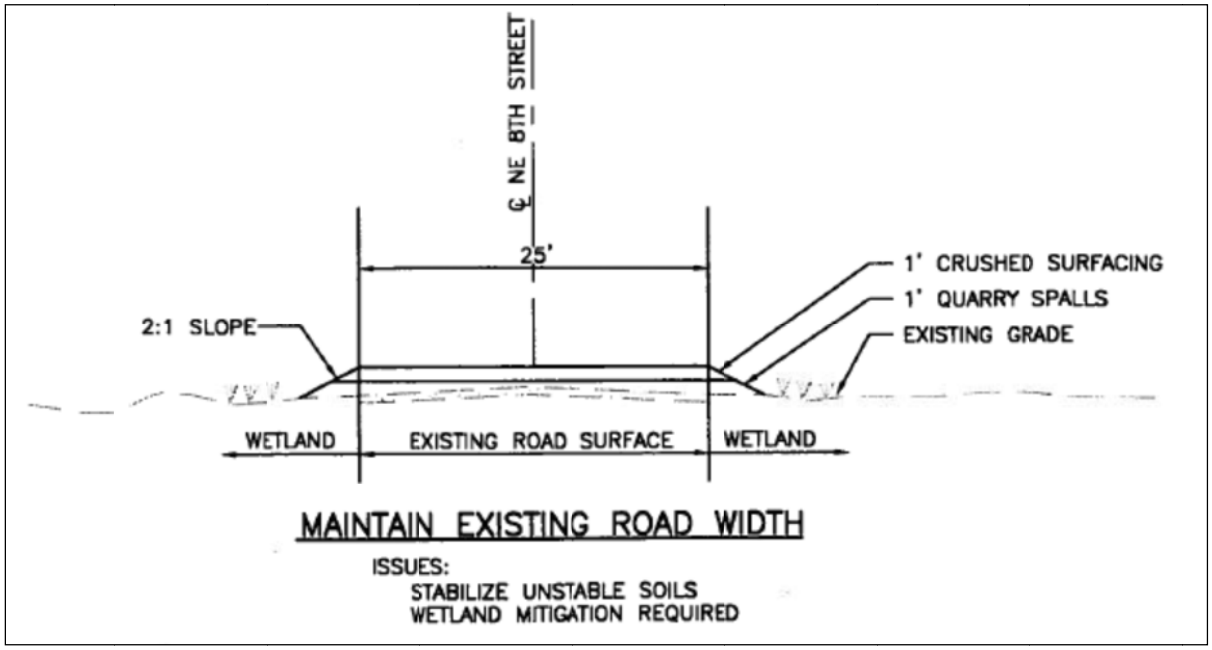


Figure 12. Road Section Maintaining twenty-five foot roadway.

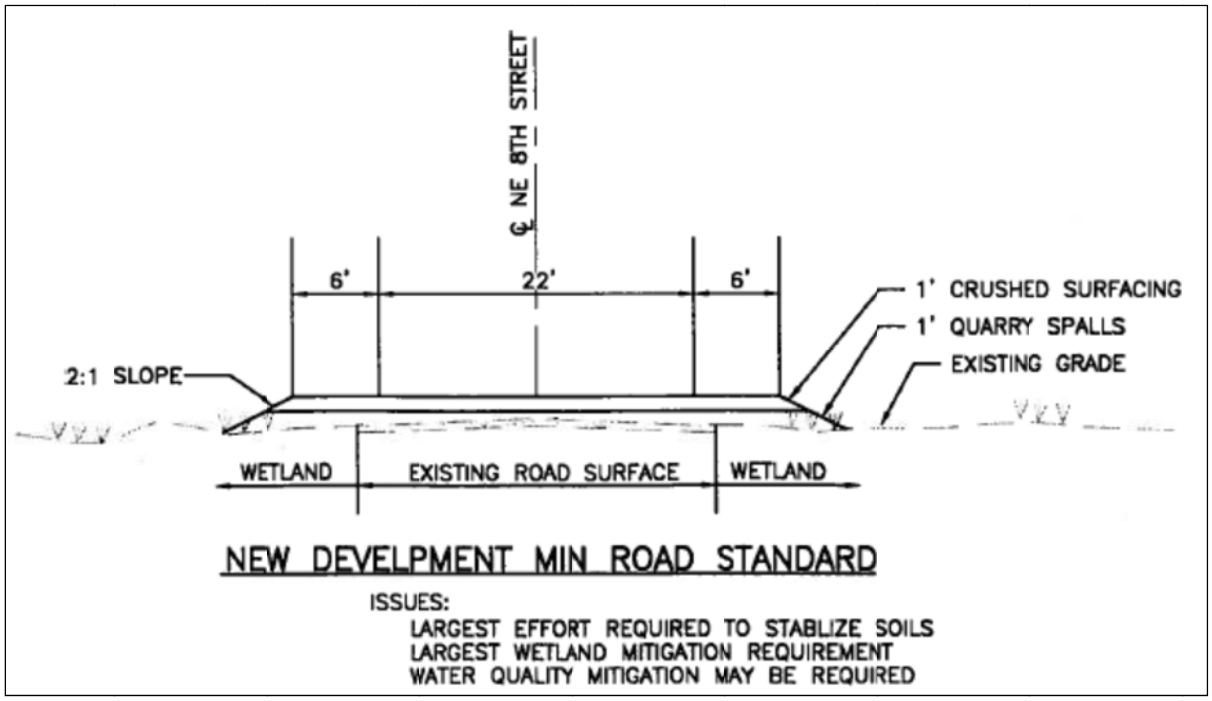


Figure 13. Road Section Meeting New Development Standards.

A deep economic downturn, passage of statewide initiatives affecting revenue for road maintenance and construction, annexations, and rising transportation costs have all had significant impacts on King County's ability to preserve and maintain its unincorporated

roadways. To better manage these challenges, the County has developed a new system for prioritizing road services by assigning them to service-level tiers. Guided by key recommendations in the Road Services Strategic Plan, the Road Services Division has developed a tiered service model that will set priorities for future road investment. In essence, this is a system of triage that will allow the County to direct the most resources to roads that are used by the most people. More information can be found at the following web site: http://www.kingcounty.gov/transportation/kcdot/Roads/NewServiceLevels.aspx

Northeast 8th Street is classified as a Tier 4 road, a local residential dead end road with no other outlet. It is classified as a Tier 4 road, the second lowest priority of the county's 5 tier ranking system; 1 being the highest priority and 5 the lowest. Most local roads are classified as Tier 5; however, Northeast 8th Street is raised one level to Tier 4 because it is a sole access road. Maintenance for Tier 4 roads is limited to activities that preserve access. Users may expect to see a number of one-lane roads with some roads downgraded to a gravel surface, depending on the level of deterioration and availability of funding. Construction of an equivalent asphalt road to what exists today will require substantial resources reducing the county's ability to respond to higher priority issues. This amount of work is outside the guidelines for maintenance of Tier 4 roads and therefore is not an acceptable alternative.

To minimize costs, schedule, and impacts resulting from building in wetland soils the construction footprint will be limited to the existing pavement width of 25 feet, resulting in the surface width of the road being reduced to 17 feet (Figure 14).

Figure 3- 17' Road Section minimizing impacts

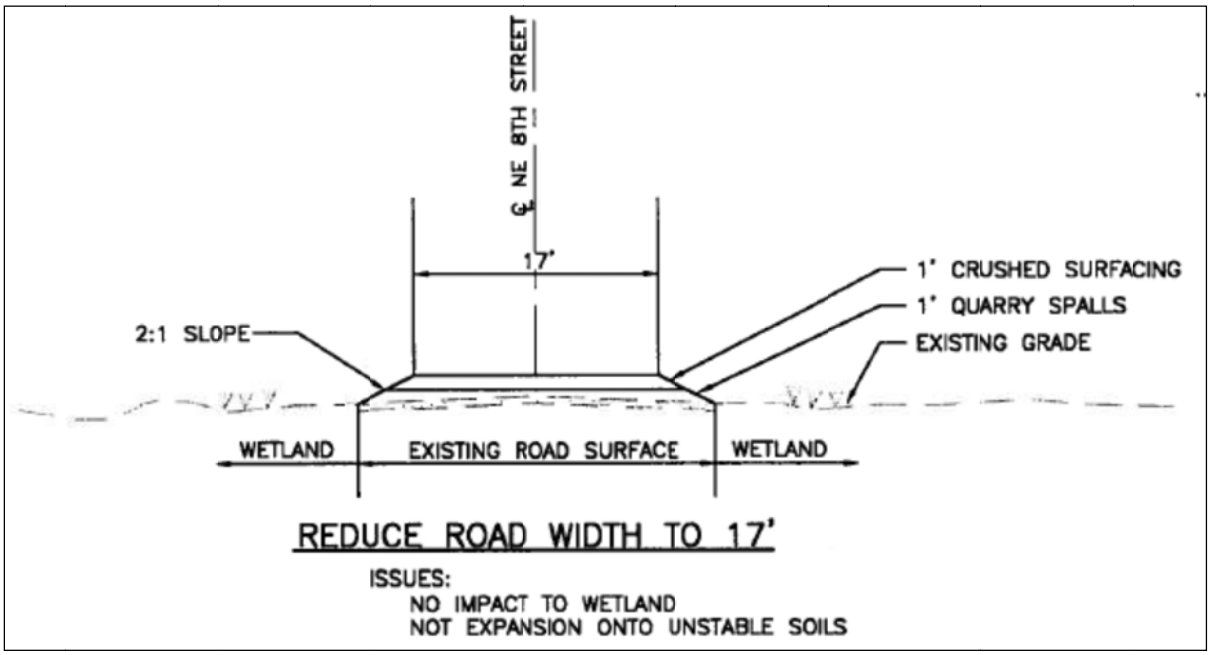


Figure 14. Seventeen-foot Road Section minimizing impacts.

For the road to be considered safe at this width, it may need to be reduced to one lane with the installation of stop signs at either end of the narrowed raised section.

Hydrological Impacts

The raising of the road should have little impact on the flood levels in the area as long as the beavers are not allowed to block the culverts. Besides the culvert and the overflow pipe that are in place, two additional 24-inch culverts may be placed just above the existing ordinary high water mark in the area of the stream crossing (Allen Lake outlet). These plus the flow that will be able to move through the quarry spall base will help reduce the potential for overtopping the road.

Environmental Impacts

If the placement of the road is within the existing pavement limits, there should be no significant impacts. If the road base is wider, there will be wetland and stream impacts requiring mitigation.

Proposed Implementation Strategy

If it is found that other alternatives, including emergency access, will not provide access, then a project may be added to the KCDOT Transportation Needs Report and prioritized against other capital projects.

Permits

If the road improvement is limited to the width of the existing pavement, no permits should be required. If the improvements extend beyond the pavement and into the wetland and stream, then permits such as the HPA, Corps, Clearing and Grading will be required.

Cost

All costs to design, inspect, mitigate, and construct various road scenarios are as follows:

Width	Surfacing	Cost	Comment
17 feet	gravel	$150,000	Easily repaired if settlement occurs
17 feet	4” asphalt	$180,000	Will match existing drivability. Soil conditions may result in cracking
17 feet	Double chip seal	$160,000	Will match existing drivability but fails under heavy loading
county standard 22+6+6= 34 feet	Asphalt	$1,000,000+	Mitigation cost and settlement issues unknown

Effectiveness

Only consider raising the road if downstream measures and emergency access route construction are not effective. Even if raised without the control of downstream blockages the benefits of the raising the road maybe short lived as the downstream water level rises each year.

Pros and Cons of Road Raising Alternatives

Pros:

Raising the road will result in a temporary relief of driving through a flooded road conditions.

Cons:

The raised road will result in a permanent gravel road with a narrower width.

Because soil borings were not performed for the roadway and the road passes over a wetland, there is a high potential that raising the road two feet will result in settlement issues. Settlement problems will have the least effect on a gravel roadway.

Normal design and construction of the road will take approximately two years, if it is authorized and funded by the King County Council. Even in an emergency condition where the road is already flooded construction of the road will require more time than the length of the flooding event. By the time it is constructed the flooding will have already passed. To be effective, the gravel road must be constructed in advance of the flooding event that will make it a permanent road condition. The county currently does not have the resources or finance to build and remove the gravel improvement year after year.

A gravel road will likely develop potholes. Because of the low Tier ranking, there will not be significant maintenance resulting in a rough ride and reduced speeds. Raising the road will also result in a continuous slope along the road edge where there is little slope now. Combined with a narrowed, substandard road width, the risk of vehicles driving off the edge during flooding events is high compared to the minimal benefits of a few days of drivability every 3 to 4 years.

The road will at some point on the future be flooded again by rising downstream water levels.

Because of these issues,

The Department of Transportation recommends against raising the road. Only if removal of downstream blockage and control of beaver activity cannot remedy the flooding issue and no other emergency route can be provided at a lesser cost should the King County Council consider funding its construction.

Appendix I Outlet Channel to the West

Note: Construction of an outlet channel to the west is considered not feasible.

Proposed Implementation Strategy

Construct a channel from 228th Avenue Northeast to Allen Lake using the alignment of existing drainage ditches where they are present at either end.

Permits

East Lake Sammamish Wetland 9, a 55-acre class 1 wetland, lies between Allen Lake and Eden/George Davis Creek. Mitigation would likely be cost prohibitive, if this alternative were permitted.

The City of Sammamish has identified a wildlife corridor critical area that passes through the length of East Lake Sammamish Wetland 9 under Sammamish Municipal Code SMC 21A.50.327.

Rearing Coho salmon have been inventoried in Eden/George Davis Creek. Puget Sound/Strait of Georgia Coho salmon have been listed by the State of Washington as a species of concern.

Each property owner along Eden/George Davis Creek would have to agree to a "drainage release" (a hold harmless agreement) to allow drainage from Allen Lake to go to that creek.

The City of Sammamish would likely administer a grading permit for construction under this alternative.

Cost

Based on prior excavation work conducted by King County Water and Land Resources Division, excavation, transport and placement of 2,400 cubic yards from this site would cost at least about $120,000. This cost does not include dewatering the area prior to heavy equipment work.

The estimate of 2,400 cubic yards of excavation is based on a minimally sized triangular channel that extends from Allen Lake to 228th Avenue Northeast. This baseline channel would have 3:1 side slopes per King County Surface Water Design Manual design standards, and would have no longitudinal slope. The invert of this baseline channel would be a level shot from the culvert under 228th Street to Allen Lake at 241.5 feet elevation.

Based on current experience with permitting, to dredge an existing channel a United States Corps of Engineers Individual permit to construct the proposed conveyance would cost greater than $200,000, that is with no assurance that an Individual permit would be issued.

If permits were issued, mitigation would likely increase the cost of the project.

Effectiveness

The invert of the Eden/George Davis Creek culvert at 228th Avenue Northeast is 1.4 feet higher than the culvert draining Allen Lake at Northeast 8th Street. Flow would have to be pumped. A gravity channel would not work.

The Eden/George Davis Creek culvert at 228th Avenue Northeast is a mile away from Allen Lake.

The maximum recorded Allen Lake elevation is about 1 foot lower than the saddle point between Allen Lake and 228th Avenue Northeast, i.e. at the gas line. 345.5 feet. – 344.57 feet.

Pros and Cons of Outlet Channel to the West

Pros:

Discharging Allen Lake to the west may reduce flooding to the north of the lake.

Cons:

A buried natural gas transmission line crosses the potential paths for constructing a channel from Allen Lake to Eden Creek. It is at the highest point, and would have to be excavated.

Erosion and Flooding that resulted from upstream development have been repeated problems at Eden Creek. Increasing flow in Eden Creek would likely worsen the problems.

Appendix J Investigation of Area West of Allen Lake

Scott Miller assisted by Jennifer Woodham, August 8, 2011

Purpose

Determine whether obstruction is preventing discharge of Allen Lake to west. Evaluate the capacity of westerly conveyance as compared with the present Allen Lake outlet channel.

Summary of findings

This investigation did not conclusively determine whether Allen Lake historically would have discharged to the west. Observations suggest that it is unlikely Allen Lake discharged west prior to development of the region.

Evidence in the field and on historic aerial photography indicates that beavers impounded and inundated an area west of Allen Lake within the last forty years. Allen Lake may be receiving water that would have flowed to Lake Sammamish, as a result of beaver activity.

Field investigation

Jenn Woodham and I traversed along a road on the west boundary of the south approximately 700 feet of parcel 867730-TR-F and on the west boundary of 232700-TRCT (Figure 15, label "A"). A beaver dam stretched along the west side of the road approximately 800 feet in length. A dense hedge of hardhack vegetated the crown of the dam along its length. The beaver dam impounded water to its west, about 0.9 foot higher than the water surface on the east of the road. Open water surface spread 250 to 300 feet to the west of the road (Photograph 8). Through "ports" in the hedge, we could see another hedge of shrubby plants to the west on parcel 3425069043, on what may be another beaver dam. Access to parcel 342506-9043 was explicitly denied at this time.

The east side of the road was dominantly vegetated with impassible hardhack. Toward the south end of the transect the road was at its lowest, the east side of the road was not inundated, and no channels were present on the east side of the road.

On the north periphery of the dense hardhack area on parcel 867730-TR-F (Figure 15, label "B"), we observed two 36-inch plastic culverts at different parts of a private path owned by the Tree Farm homeowners association. The more westerly culvert had open water to its west and no inundation to its east. The more easterly culvert appeared to be backwatered such that the water surface was the same on both sides of the culvert.

We attempted to approach an inundated area visible in 2009 aerial photography from the southwest corner of parcel 342506-9008 (Label "C"), but the vegetation was impassible.

We accessed this inundated area at the north of parcel 342506-9045 (Photograph 9) from Eastlake High School. I traversed southward in knee deep water with floating vegetation approximately 275 feet (Figure 15, label "D"), at which point the water became too deep to cross in hip waders, and too deep for the floating vegetation. There were numerous Oregon ash snags extending east and west throughout the inundated area. From a high point, I looked for a flow path through the vegetation that might indicate a deeper channel. I did not see any evident path. The water was still and did not visibly move east or west.

Ground surface elevations derived from LIDAR data collected in 2000/2001 may represent the elevation of floating vegetation in this area.

We were not able to determine whether the water surface elevation is the same elevation through the observed inundated areas. In order to evaluate the extent of the catchment contributing to Allen Lake as modified by beavers, it would be helpful to survey water surface elevations at the observed transects and culverts, and to determine whether there is a water surface elevation difference across parcel 3425069043.

Beaver dam breaching or removal that has occurred toward the east of the inundated areas may have enlarged the catchment tributary to Allen Lake over its historic catchment, if unmatched by beaver dam breaching or removal toward the west.

We attempted to access the culvert at 228th Avenue Northeast (Label "E"), but the embankment and vegetation were impassible. The intent of examining the conveyance here would be to compare its capacity with that of the existing outlet of Allen Lake.

Review of historic documents

The General Land Office (GLO) surveyed along section lines in the Allen Lake area in March of 1874. Brooks were identified three quarters of a mile east and two miles west of Allen Lake, each ten links (6.6 feet) wide. There were also a "cranberry marsh" at the west side of Allen Lake and three "spring brooks" a mile west of Allen Lake. The GLO survey provides distances to observed features, but does not provide sufficient information to determine whether there was surface water connection from Allen Lake to Lake Sammamish.

Aerial photographs taken August 8, 1959 and June 1, 1970 show that canopy within the mile between the GLO surveyed cranberry marsh and the spring brooks had foliage. At the time of these aerial photograph, the Oregon ash trees had not been killed by inundation. The living canopy suggests that the ground was higher between Allen Lake and the tributary to Lake Sammamish. The canopy also would conceal any channels that may have been beneath it. The canopy was approximately 2,200 feet from end to end.

Aerial photographs taken from the late 1990's through the 2000's show that foliage appears to have been lost from the canopied area between 2000 and 2002.

An area without canopy between Allen Lake and the canopied area described above is visible in the 1959 and 1970 aerial photographs (Figure 16 and Figure 17). These photographs each show ditches in this area that appear to have been dug to drain water to a 2,000 foot reach easterly toward Allen Lake.

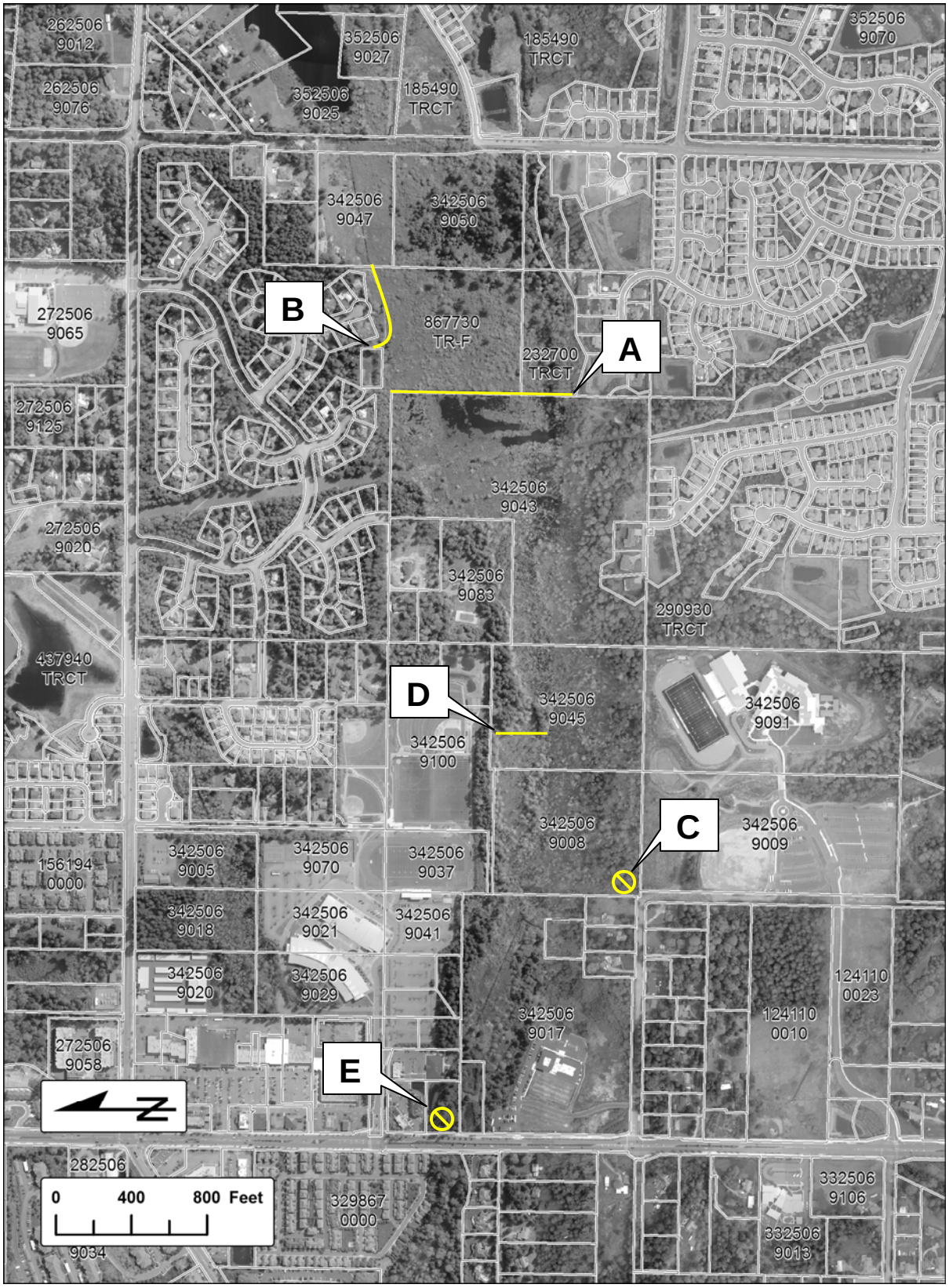


Figure 15. West Area parcel map on aerial photograph – locations investigated.

Photograph 8. View west to inundated area on parcel 3425069043.

Photograph 9. View south through inundated area on parcel 3425069045.

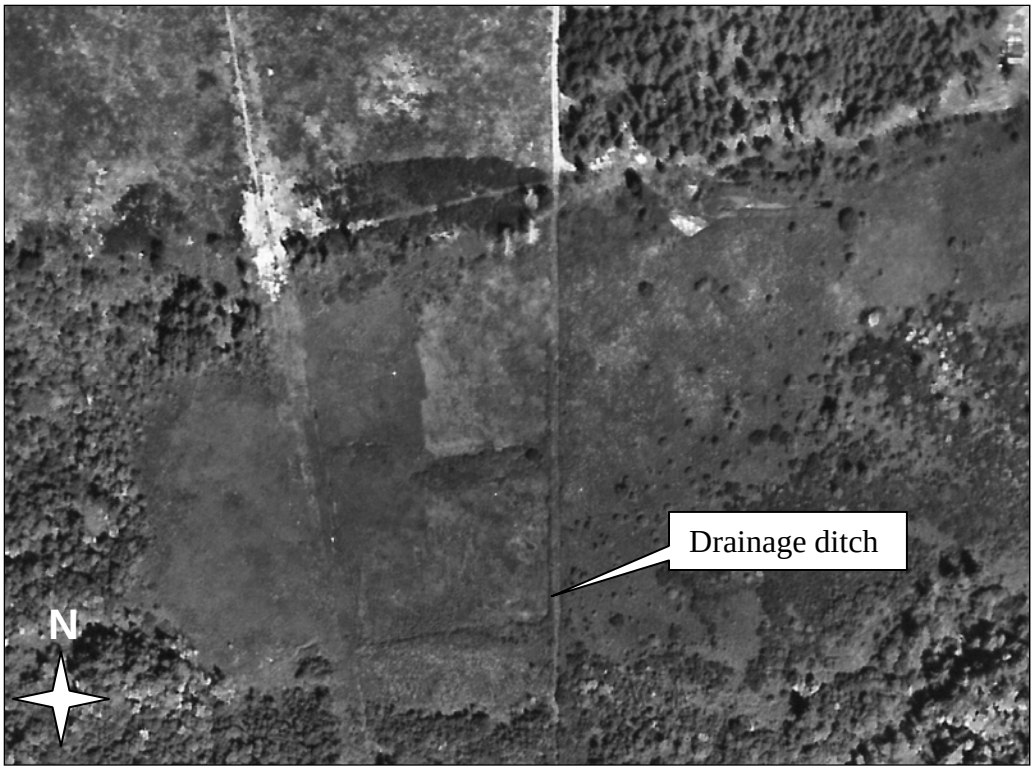


Figure 16. Aerial photograph taken August 8, 1959 – parcel 3425069043 on left half.

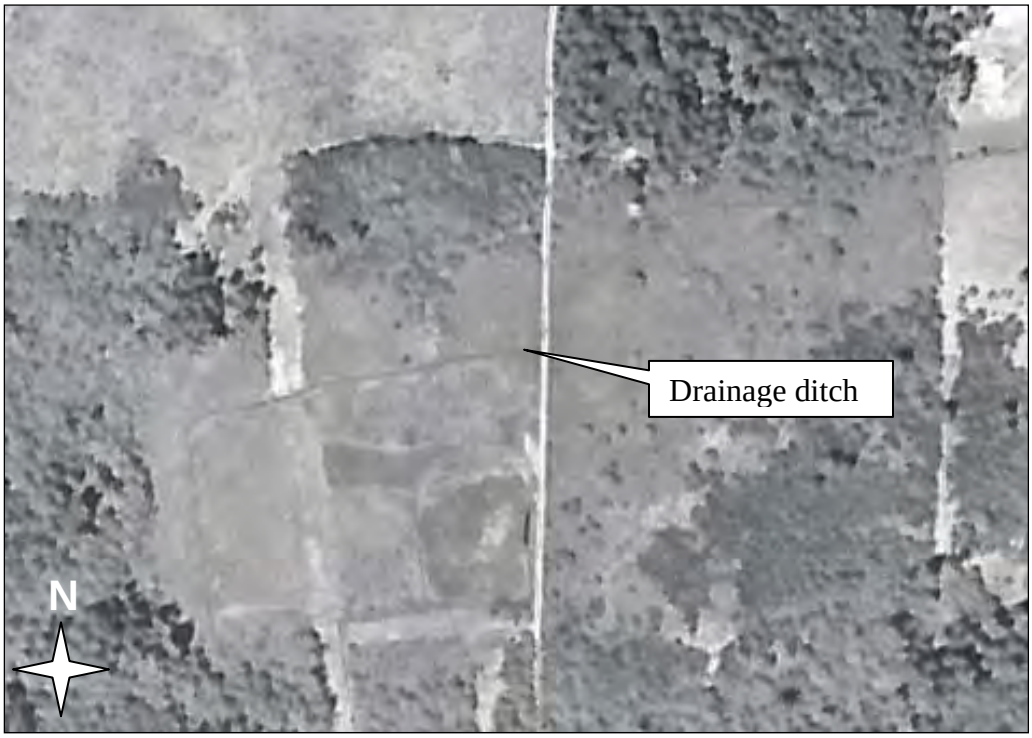


Figure 17. Aerial photograph taken June 1, 1970 – parcel 3425069043 on left half.

Appendix K Potential Ditch Alignment and Ground Surface Profile to West

In order to determine a potential route for the proposed channel from Allen Lake to Eden Creek/George Davis Creek, topographic light detection and ranging LIDAR data was used to evaluate a route of least depth of cut. Existing drainage ditches at the east and west ends of the area are incorporated into the proposed drainage alignment.

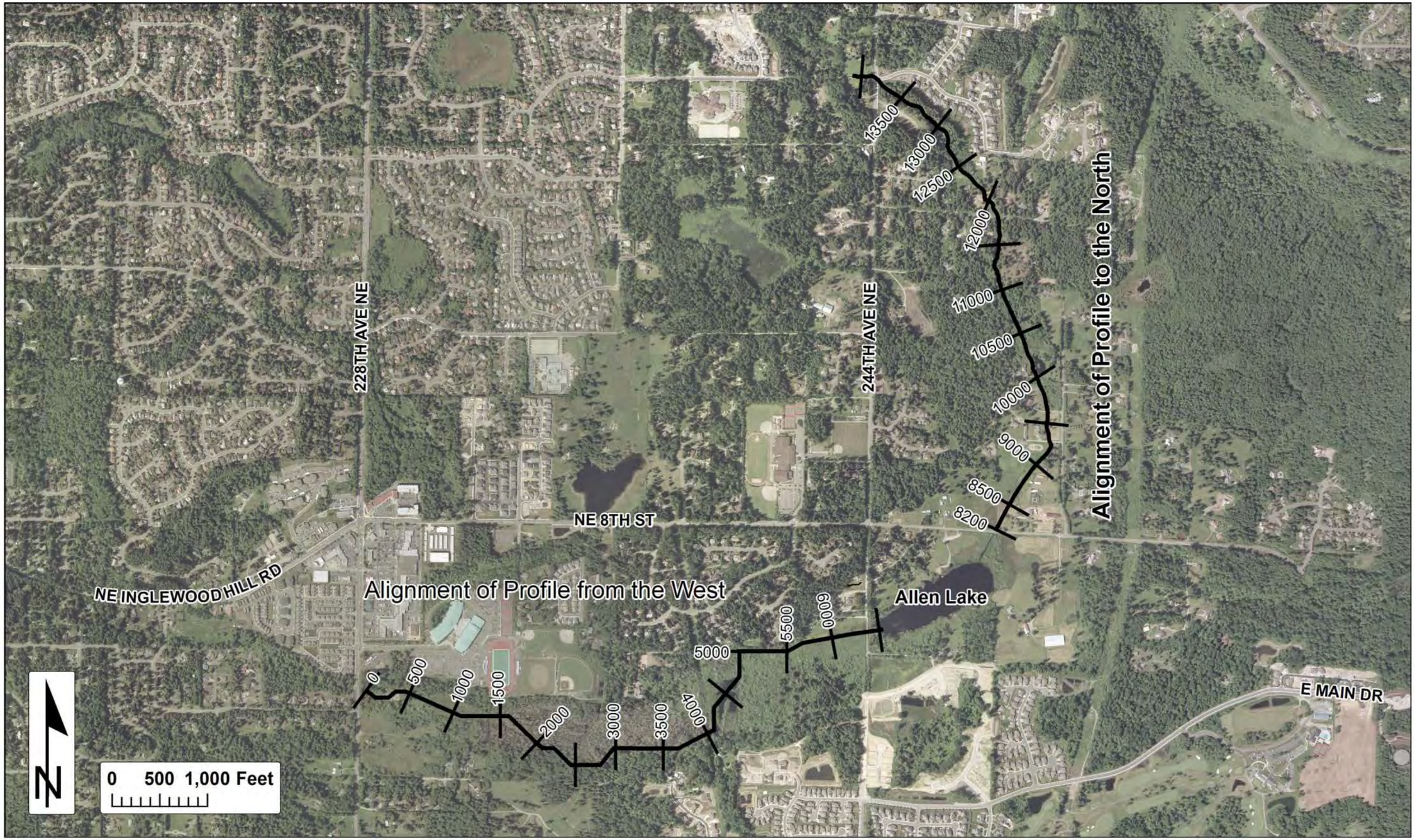


Figure 18. Potential alignment of channel to the west and existing alignment of Allen Lake Outlet channel.

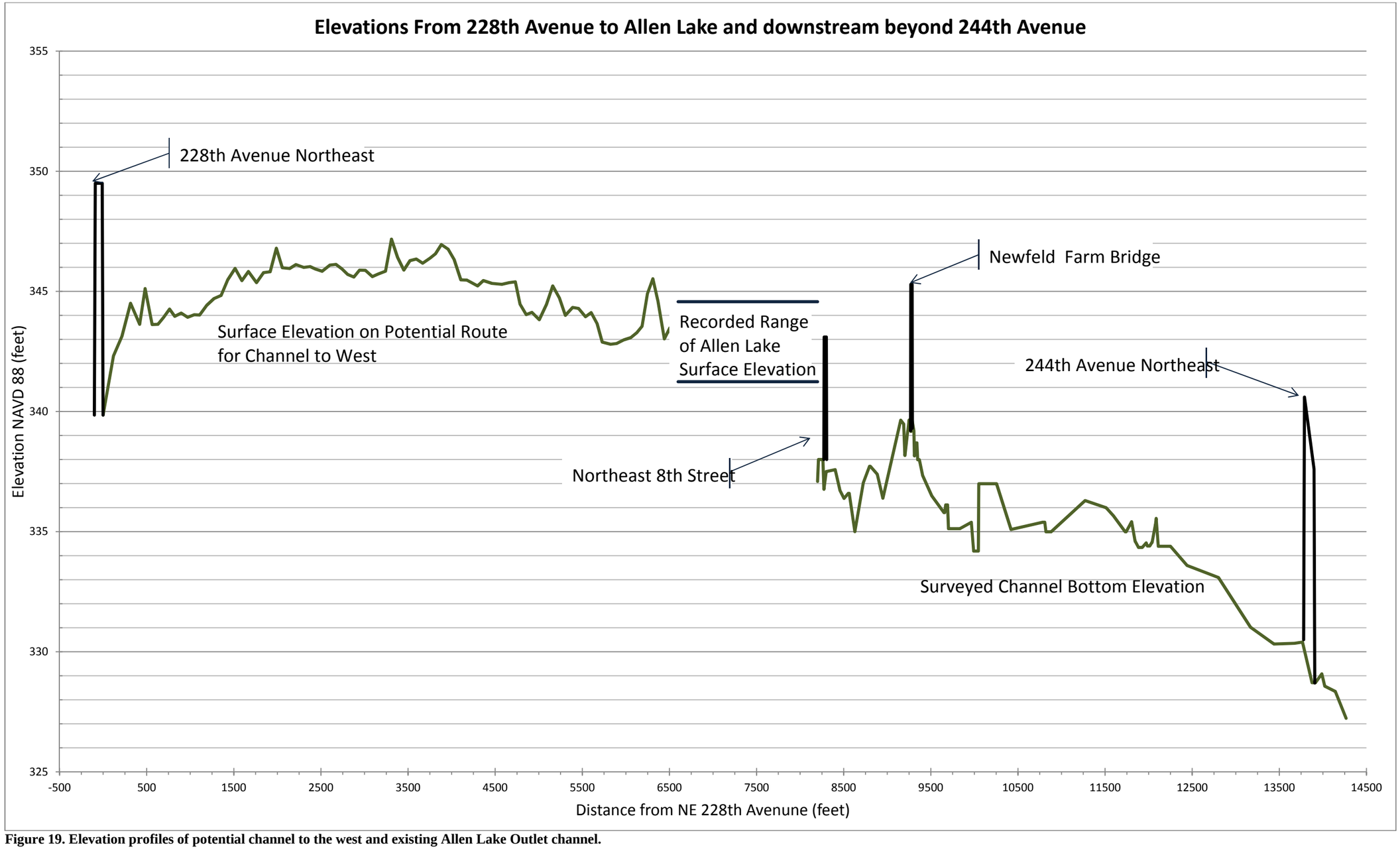


Figure 19. Elevation profiles of potential channel to the west and existing Allen Lake Outlet channel.

Appendix L Hydrologic and Hydraulic Model Figures

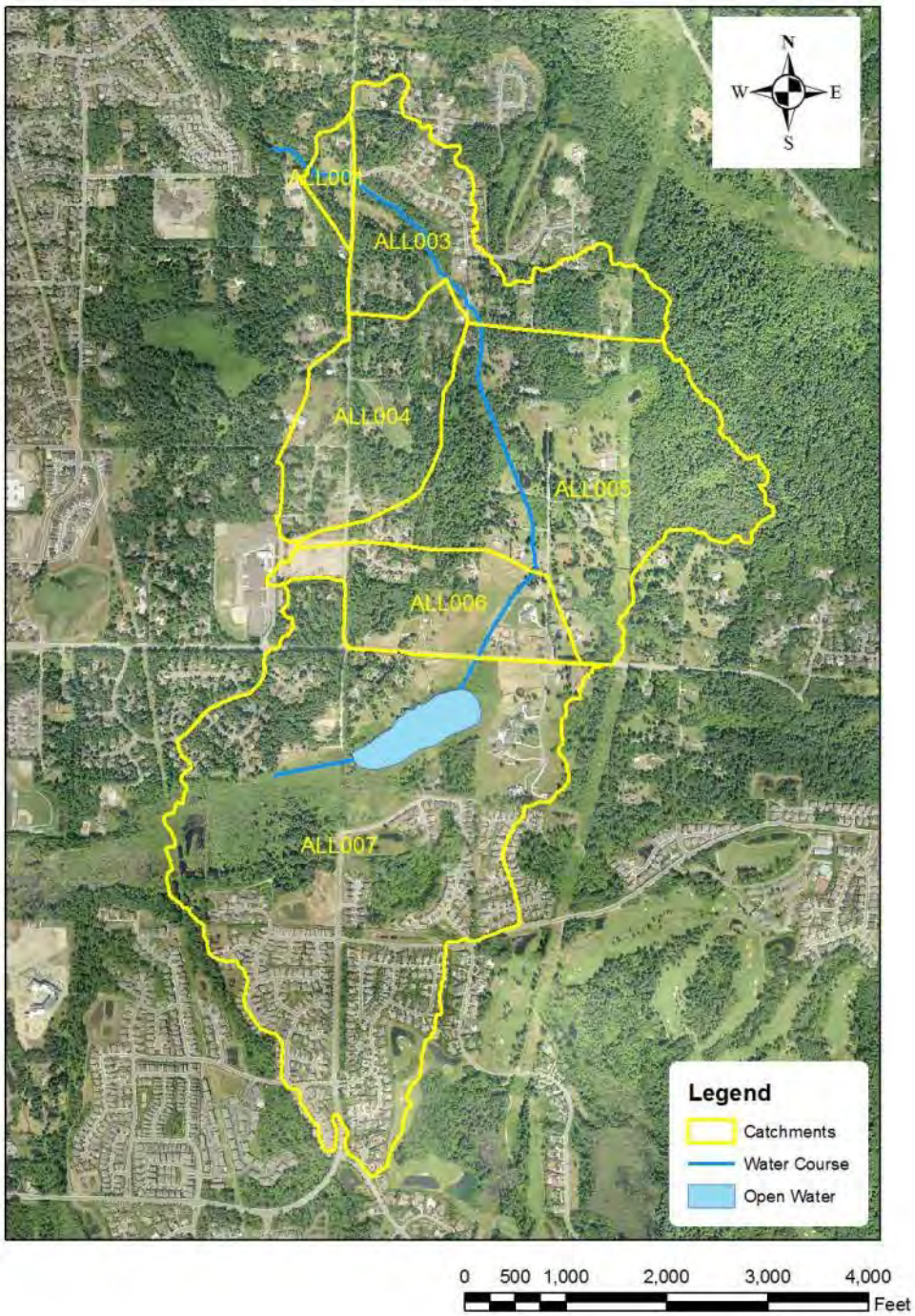


Figure 20. Study area drainage delineation

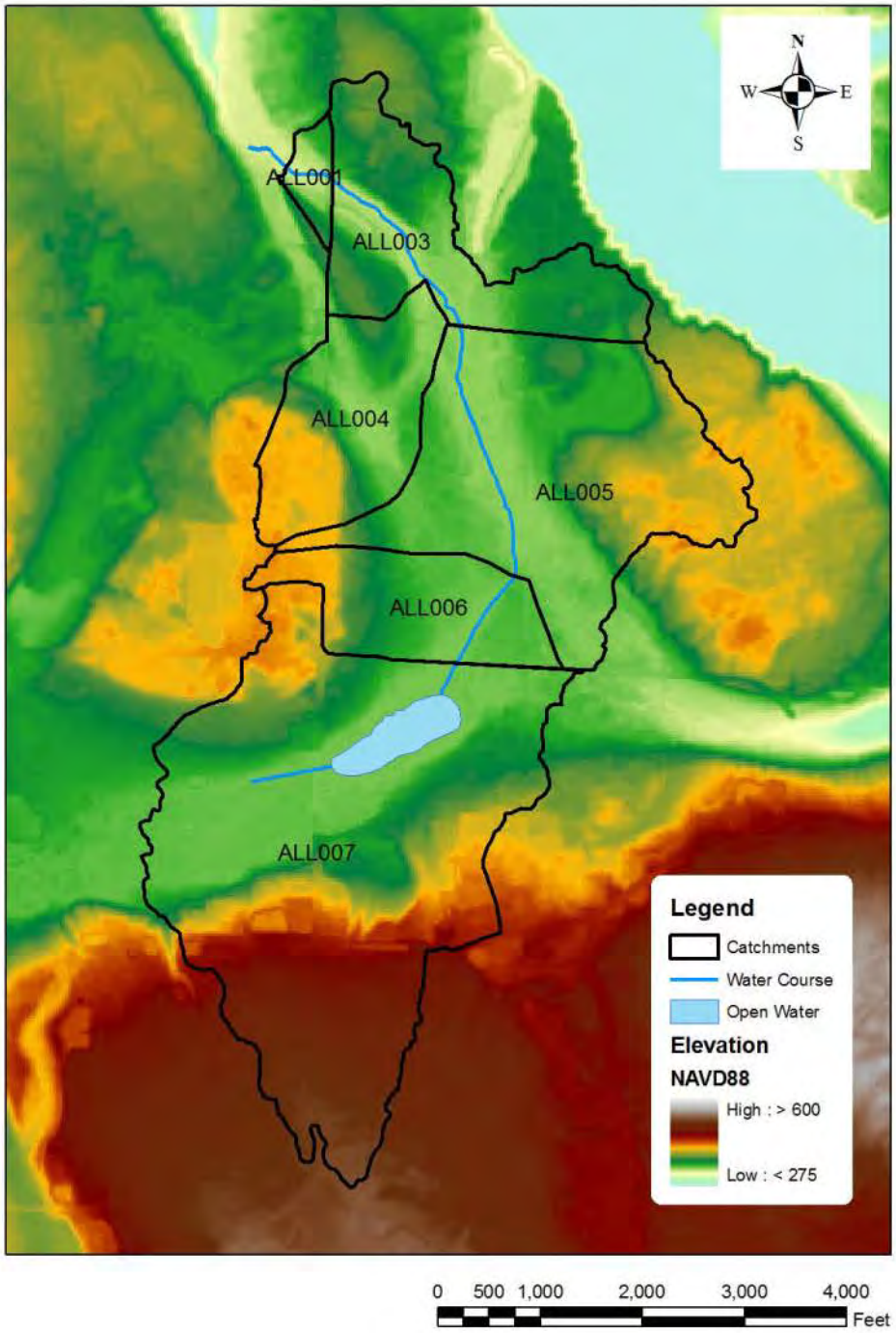


Figure 21. Elevation map of study area (NAVD88)

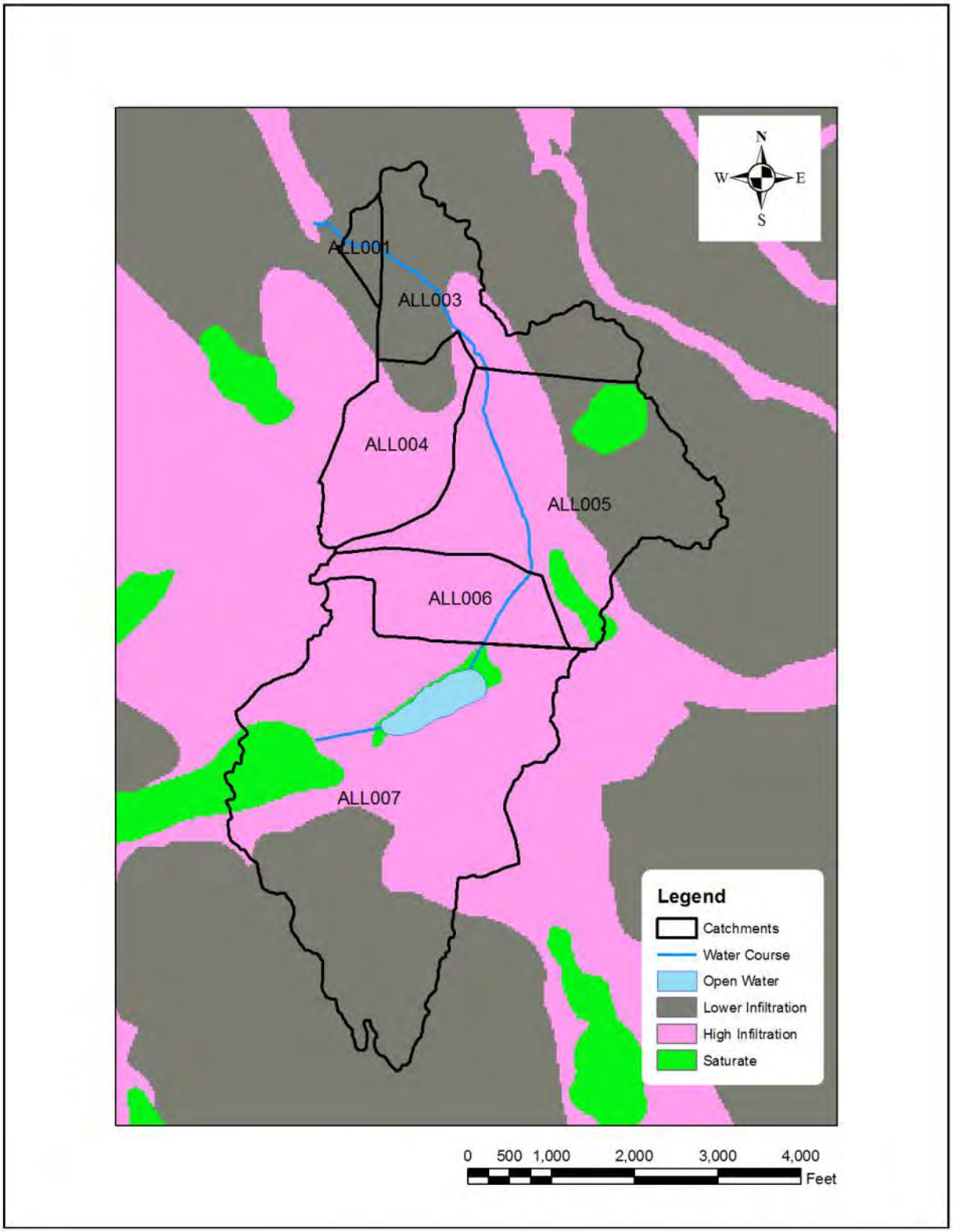


Figure 22. Map of soil types for study area

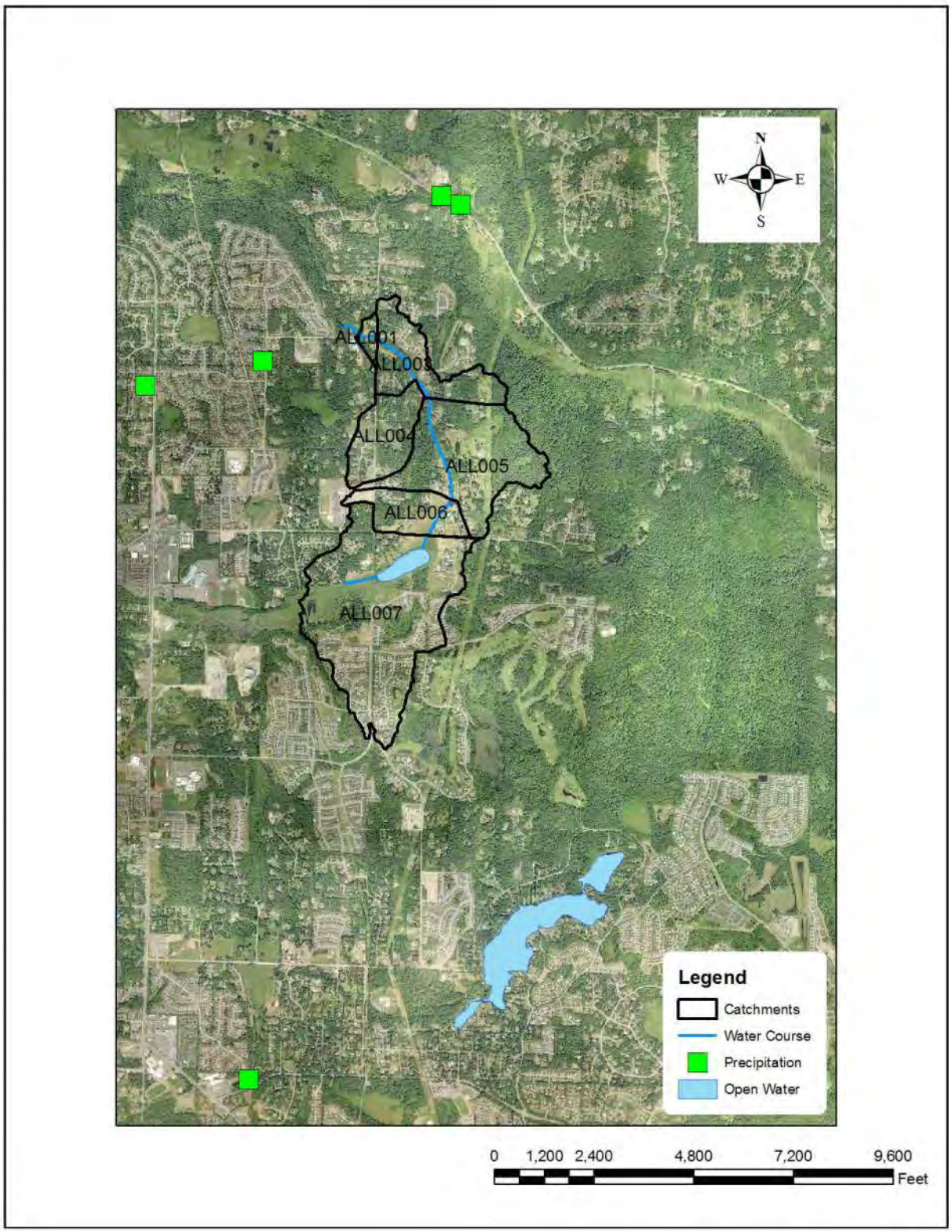


Figure 23. Map of precipitation monitoring stations.

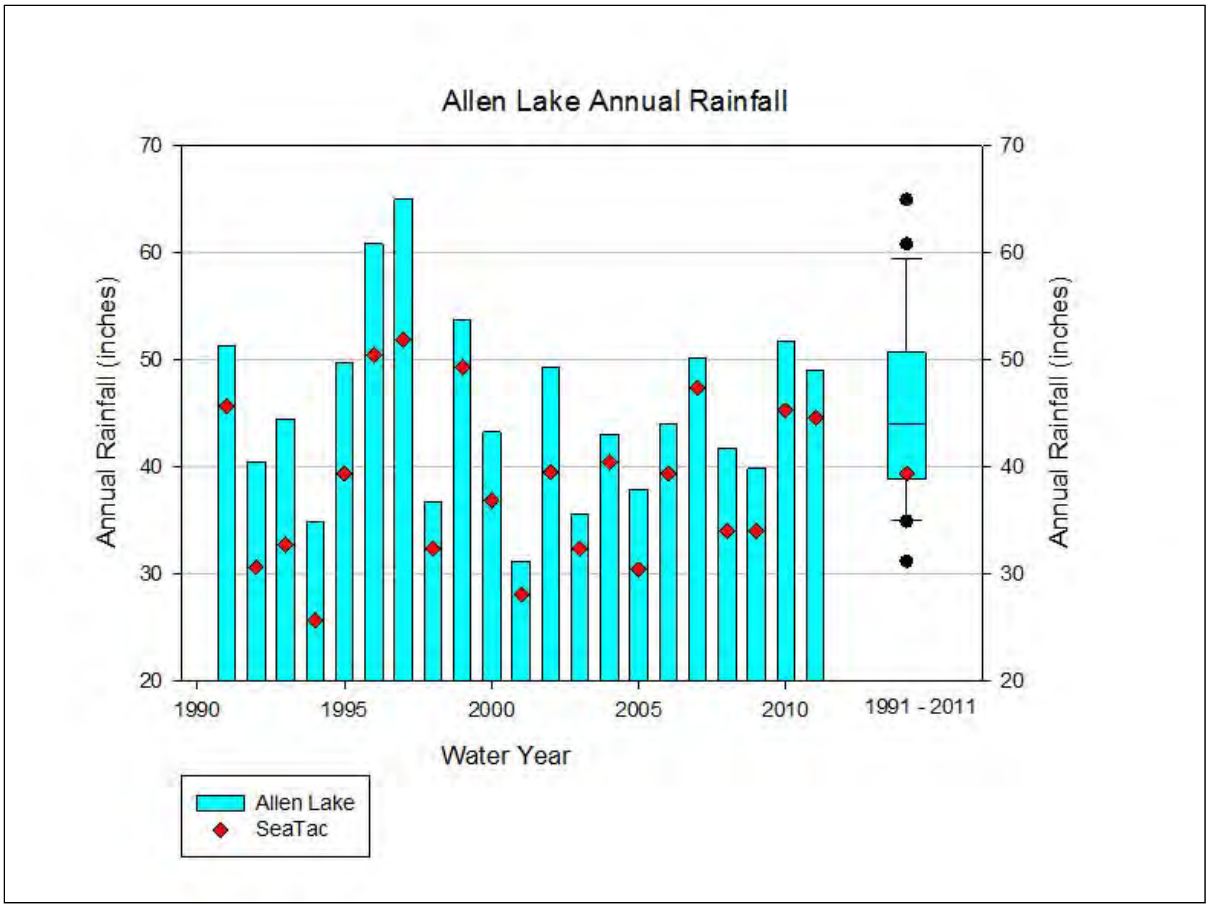


Figure 24. Summary of annual rainfall (Allen Lake is a composite of 18y, 48u, 48y, and SAMP).

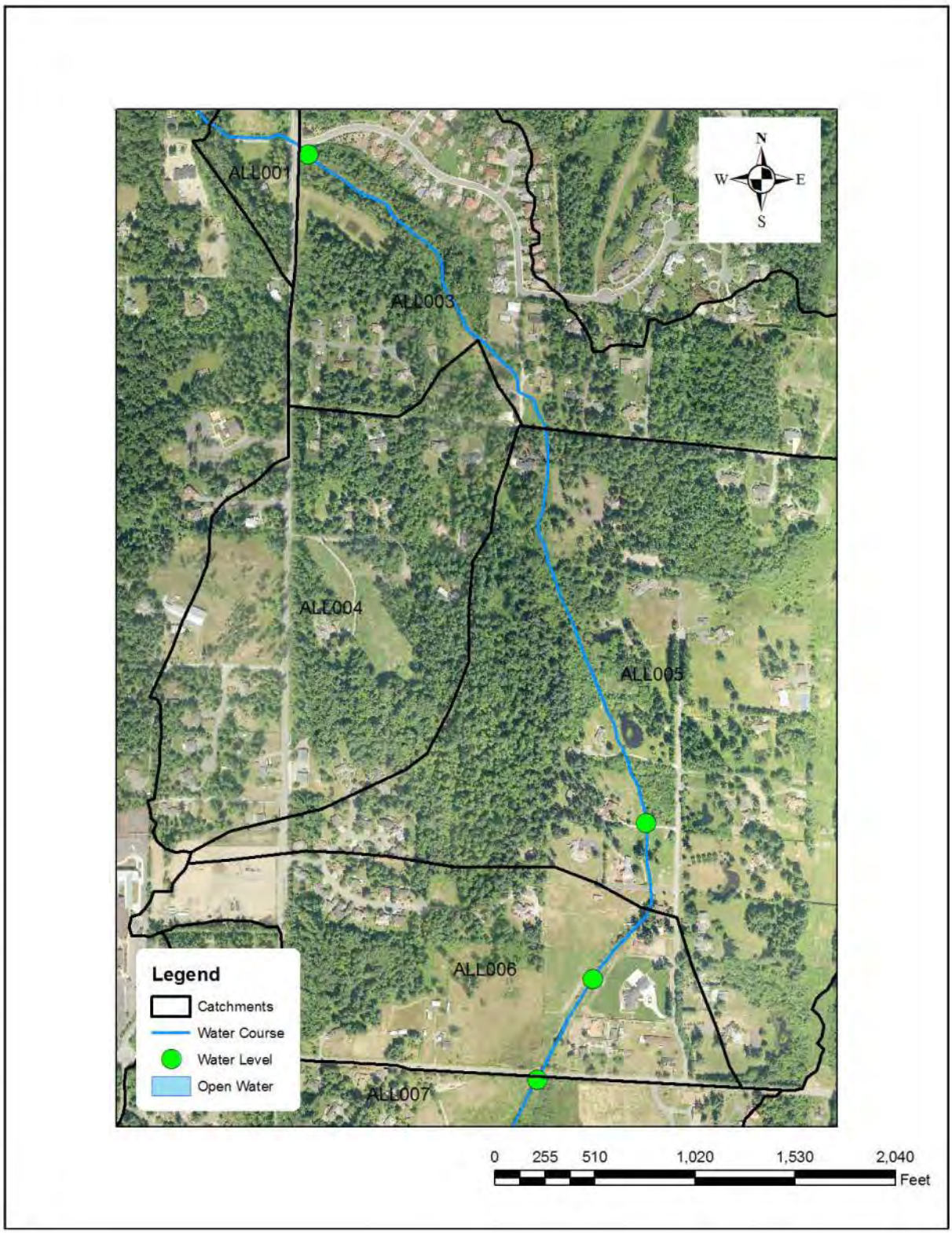


Figure 25. Map of water level monitoring stations.

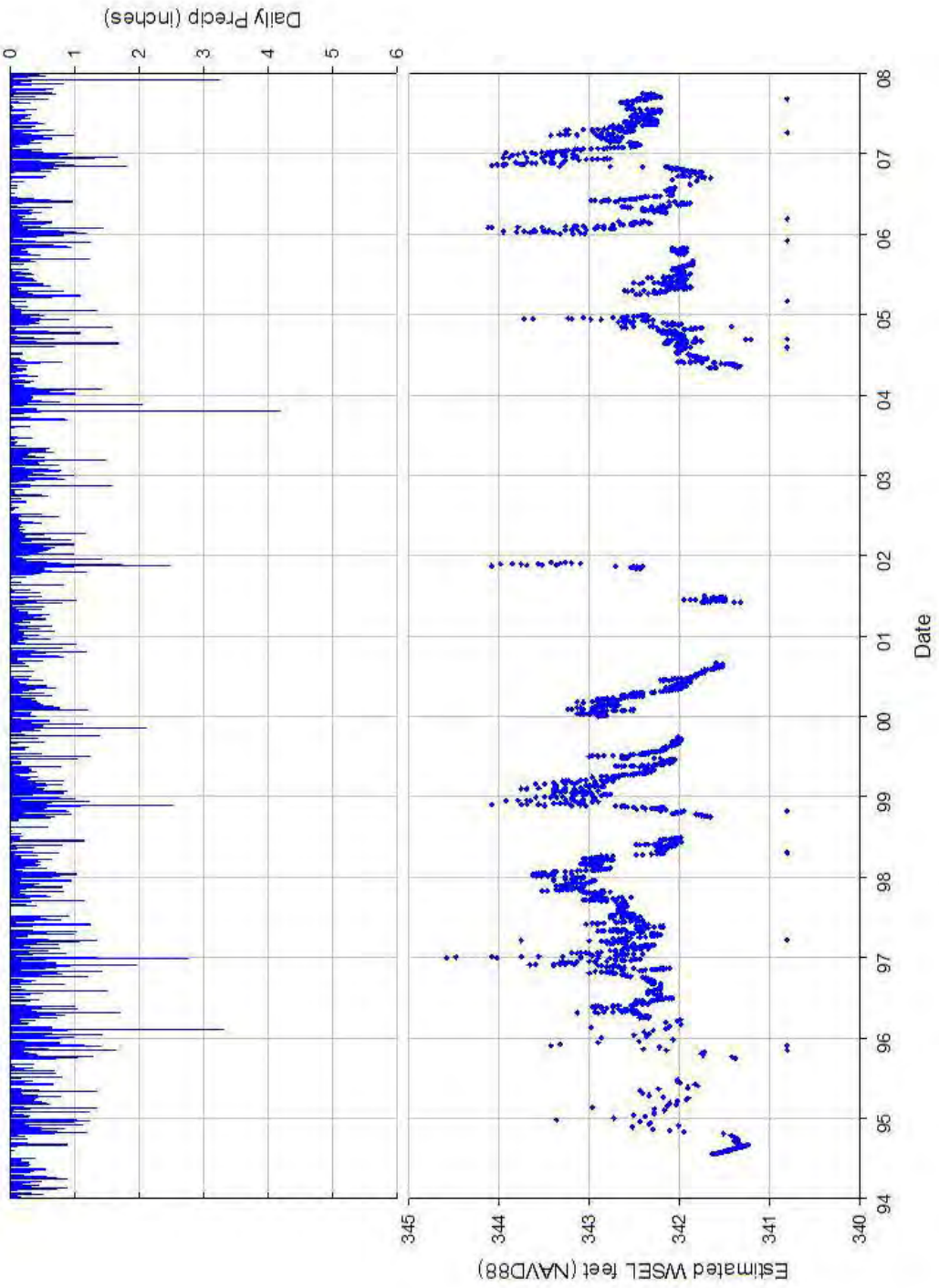


Figure 26. Observed lake levels and a composite of daily precipitation using four KC gauges (48y, 48u, 18y, and SAMP). Elevations are <u>DRAFT</u> at this time.

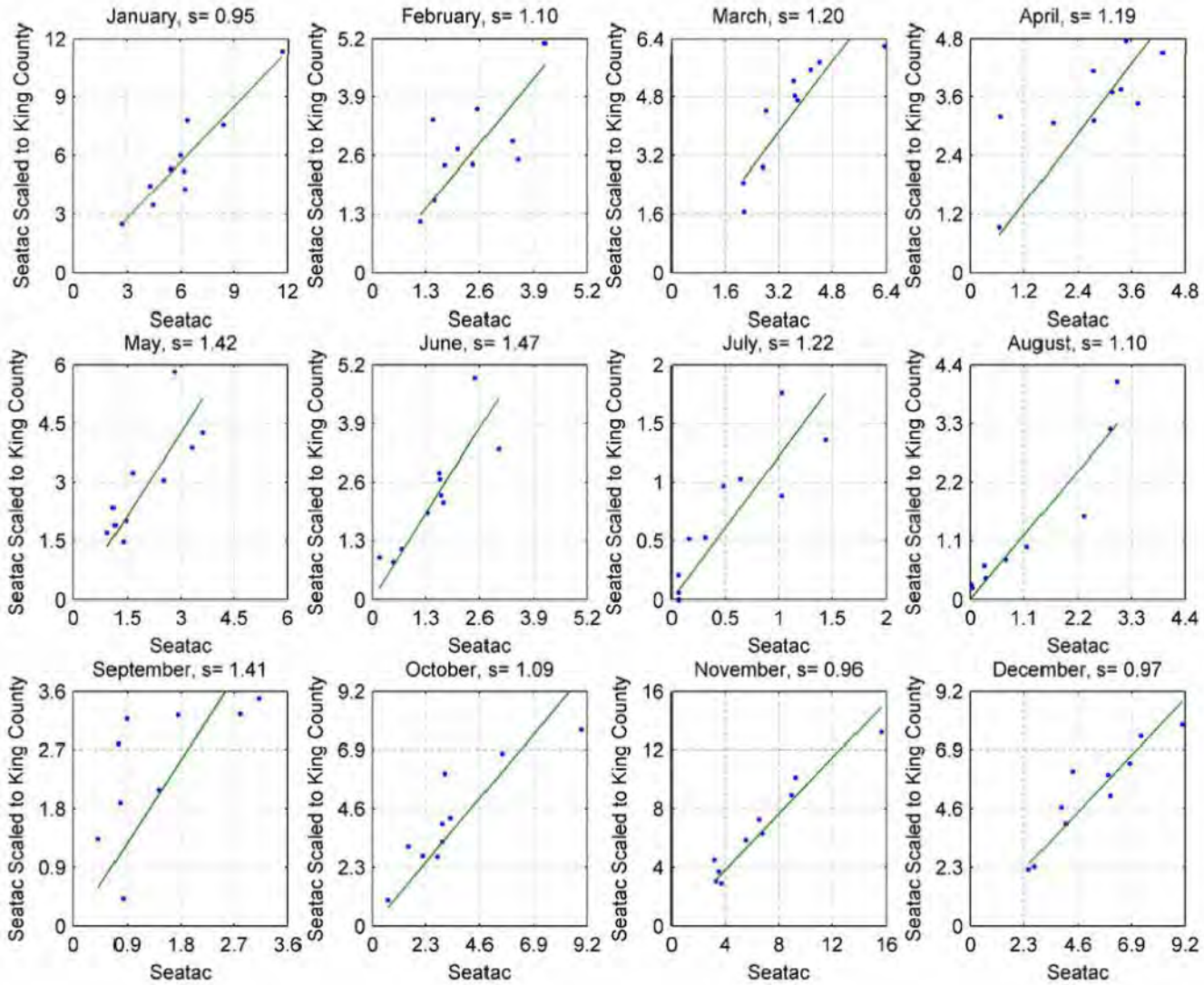
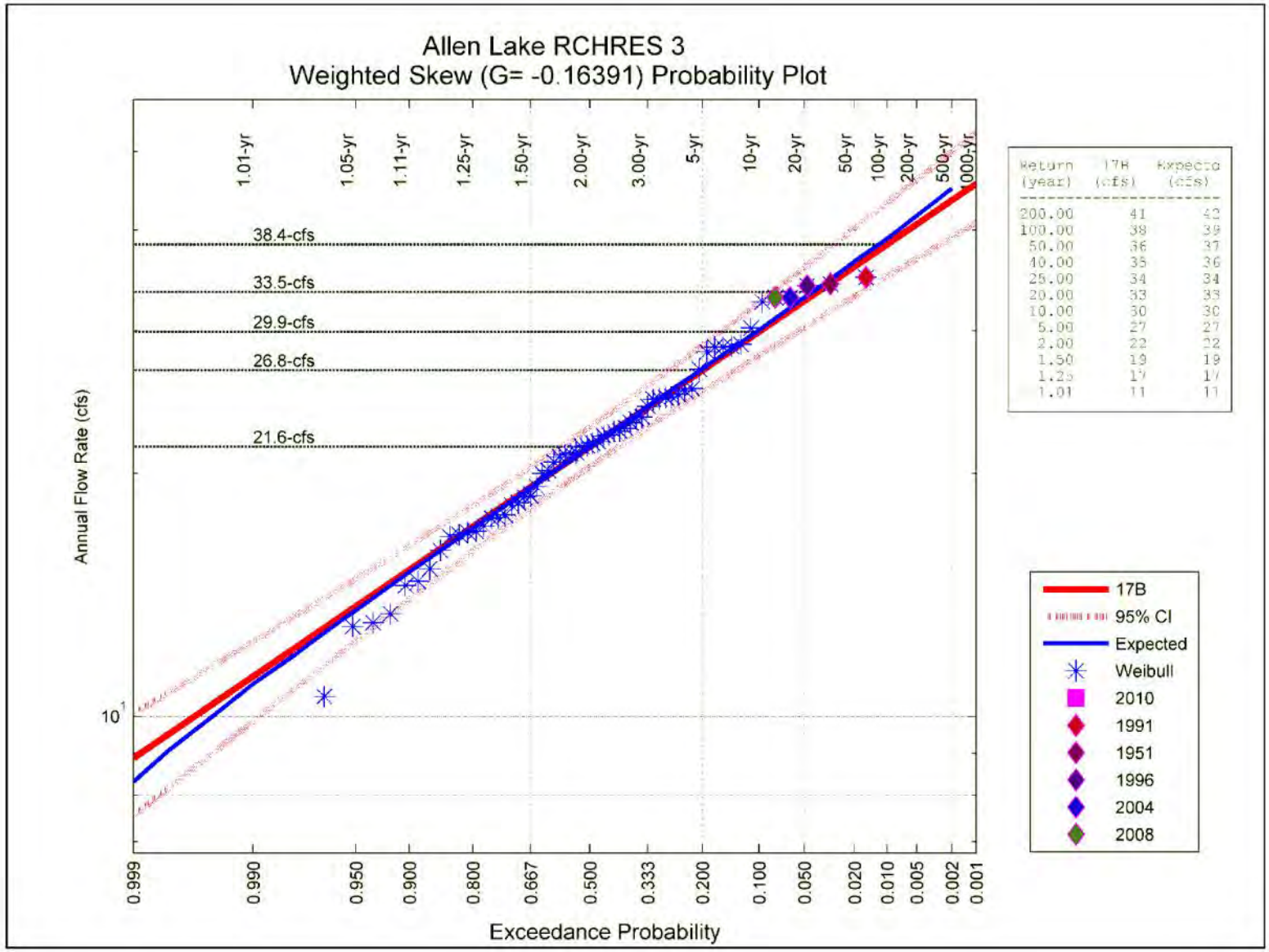
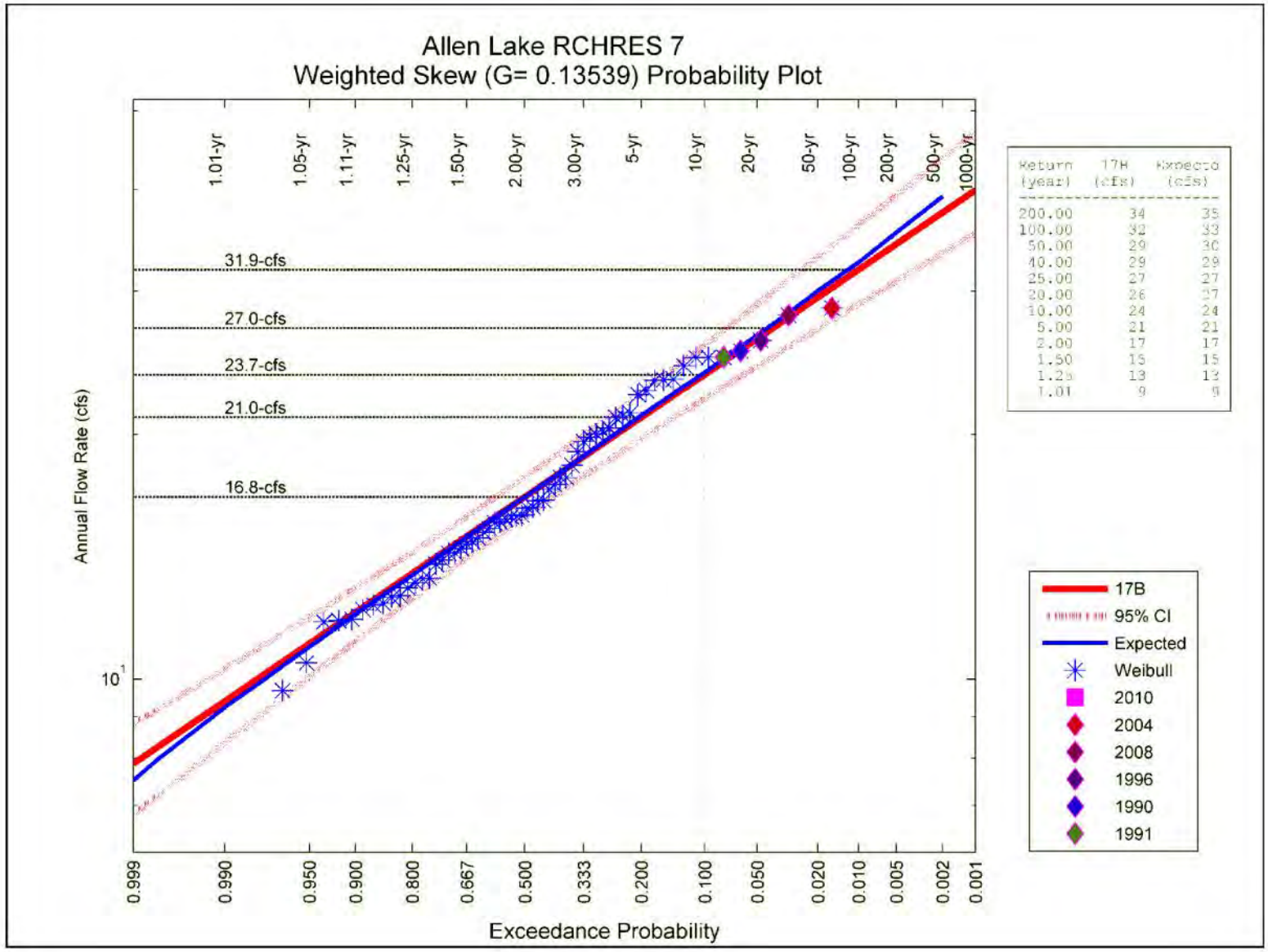


Figure 27. Monthly regressions scaling SeaTac observed to local conditions.



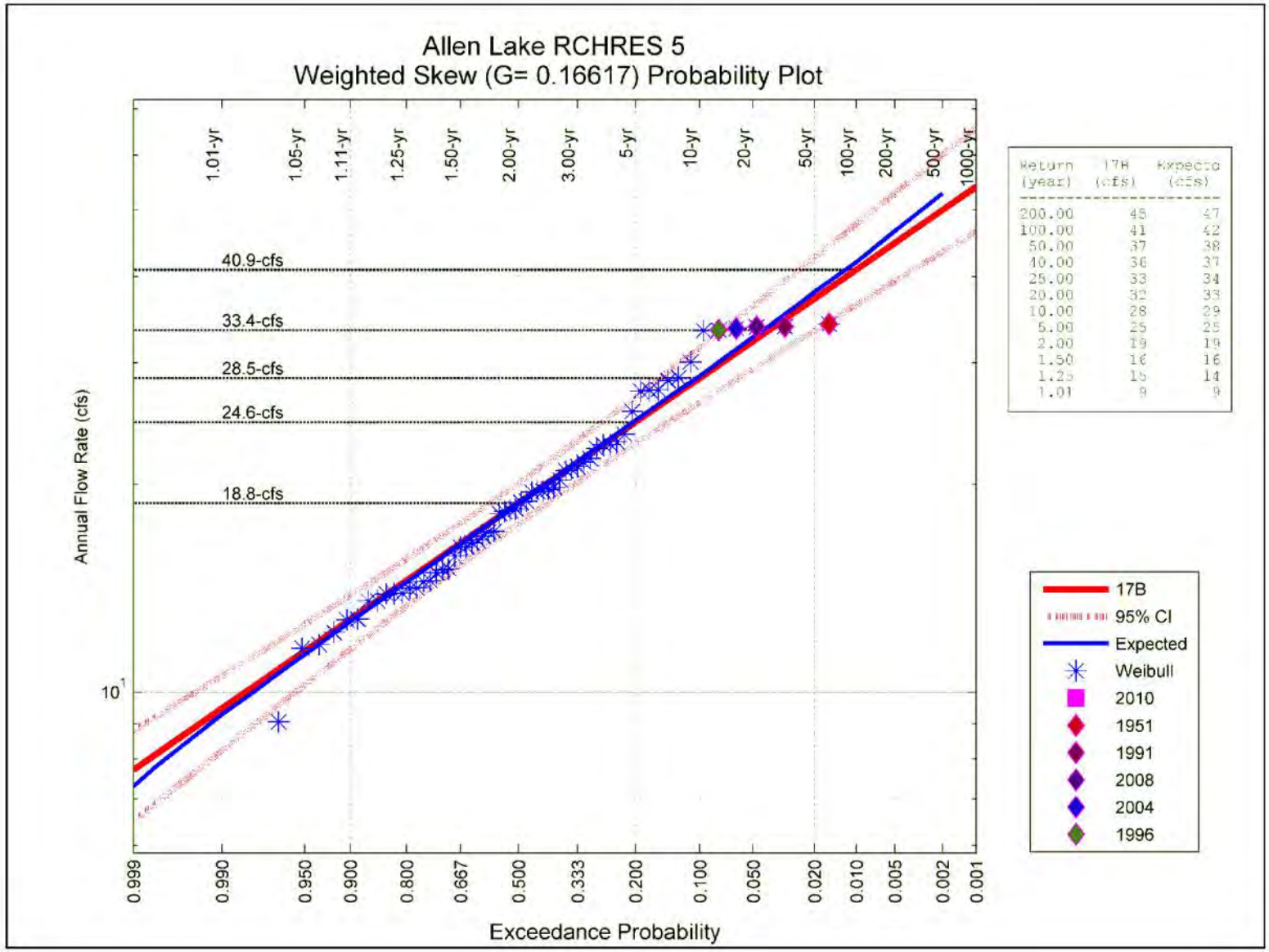
Return (year)	17B (cfs)	Expecta (cfs)
200.00	41	42
100.00	38	39
50.00	36	37
40.00	35	36
25.00	34	34
20.00	33	33
10.00	30	30
5.00	27	27
2.00	22	22
1.50	19	19
1.25	17	17
1.01	11	11

Figure 28. Estimated flood frequencies at the mouth of catchment ALL003, 244th Avenue Northeast crossing.



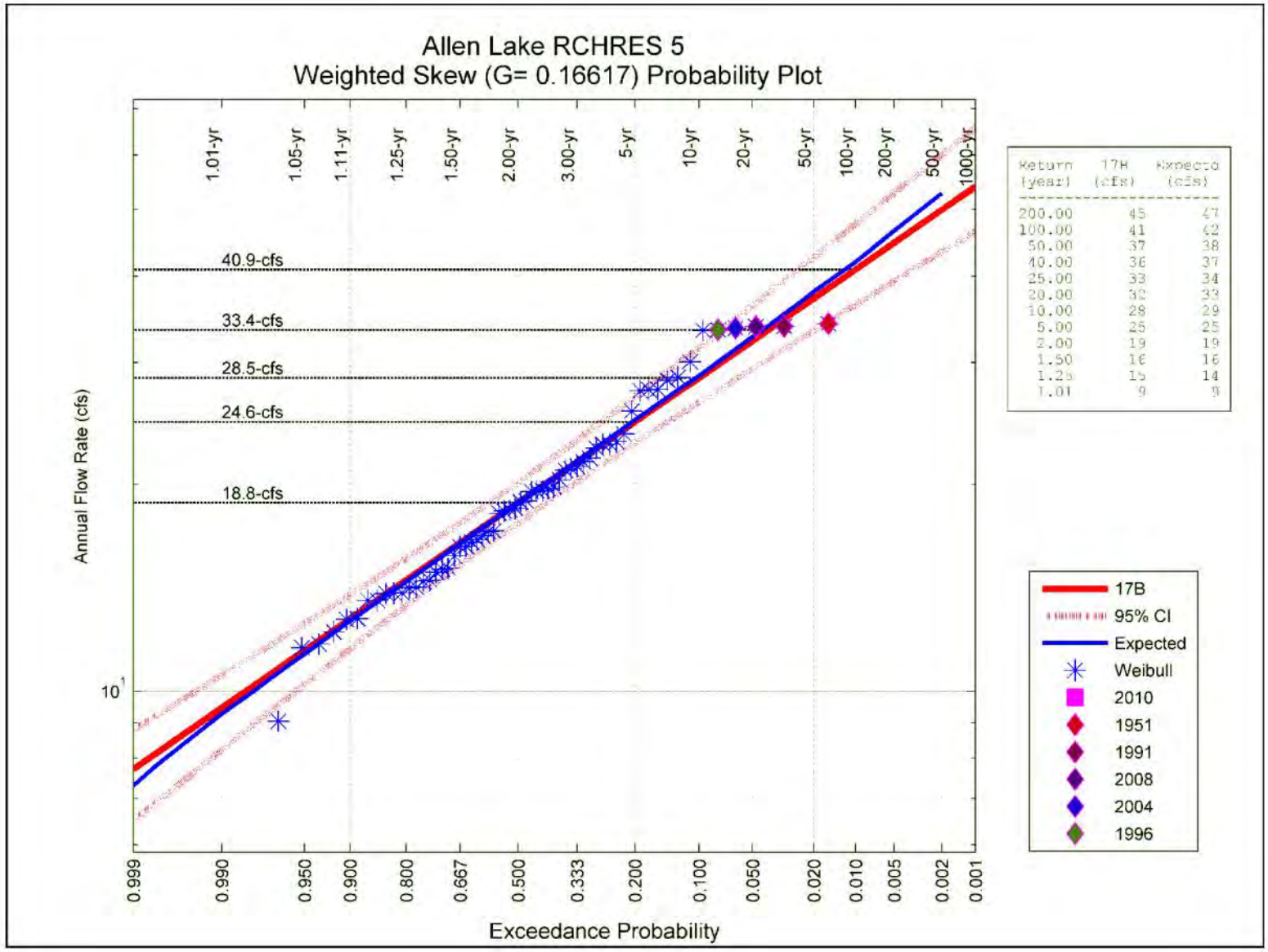
Return (year)	17B (cfs)	Expected (cfs)
200.00	34	35
100.00	32	33
50.00	29	30
40.00	29	29
25.00	27	27
20.00	26	27
10.00	24	24
5.00	21	21
2.00	17	17
1.50	15	15
1.25	13	13
1.01	9	9

Figure 29. Estimated flood frequencies for outlet of Allen Lake at NE 8th Street (Catchment ALL007).



Return (year)	17B (cfs)	Expecta (cfs)
200.00	45	47
100.00	41	42
50.00	37	38
40.00	36	37
25.00	33	34
20.00	32	33
10.00	28	29
5.00	25	25
2.00	19	19
1.50	16	16
1.25	15	14
1.01	9	9

Figure 30. Estimated flood frequencies for Catchment ALL005, outlet at NE 16th Street.



Return (year)	17B (cfs)	Expected (cfs)
200.00	45	47
100.00	41	42
50.00	37	38
40.00	36	37
25.00	33	34
20.00	32	33
10.00	28	29
5.00	25	25
2.00	19	19
1.50	16	16
1.25	15	14
1.01	9	9

Figure 31. Estimated flood frequencies for Catchment ALL005, outlet at NE 16th Street.

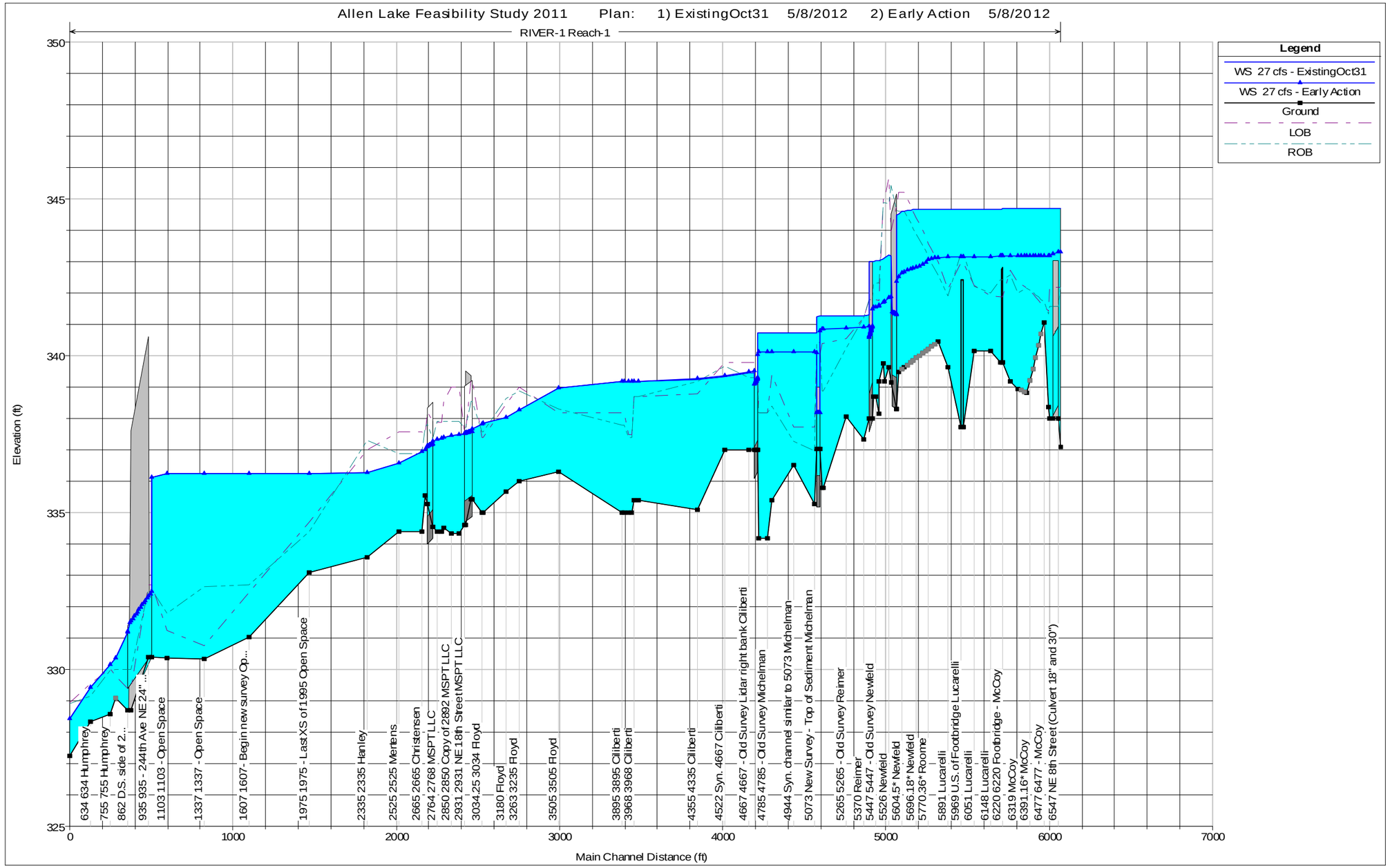


Figure 32. Water surface profile for Existing and Early Action, steady state 27 cfs.

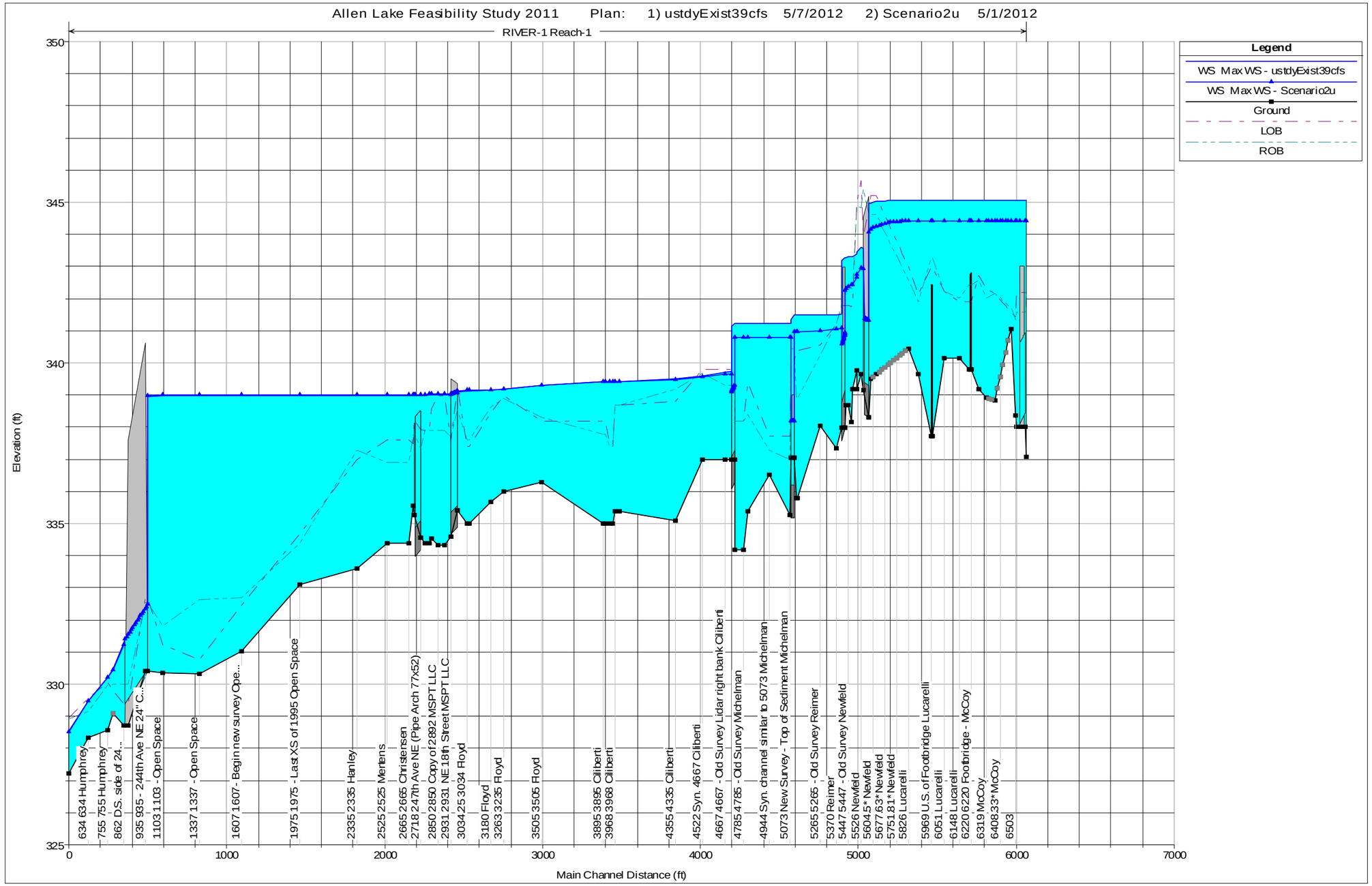


Figure 33. Water surface profile for Existing and Early Action, unsteady 100 year event (39 cfs).

Figure 34 illustrates the rise, peak, and recession of flow rates associated with a 100-year storm. At time T_1, the water surface elevation at 244th Avenue Northeast is expected to be nearly one foot higher with the conveyance improvements that have been completed than it would have been without. At time T_2, after the peak of the storm, the maximum water surface elevation without the conveyance improvements is essentially identical in magnitude and timing to the maximum water surface elevation with the improvements, but occurs later.

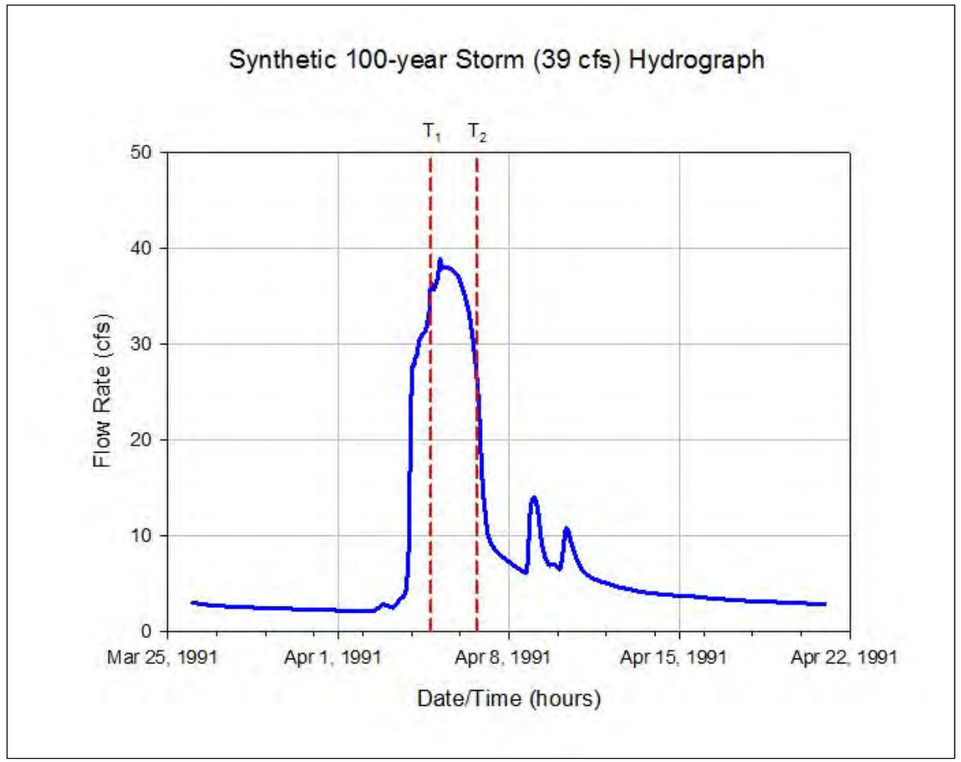


Figure 34. Synthetic 100-year storm hydrograph.

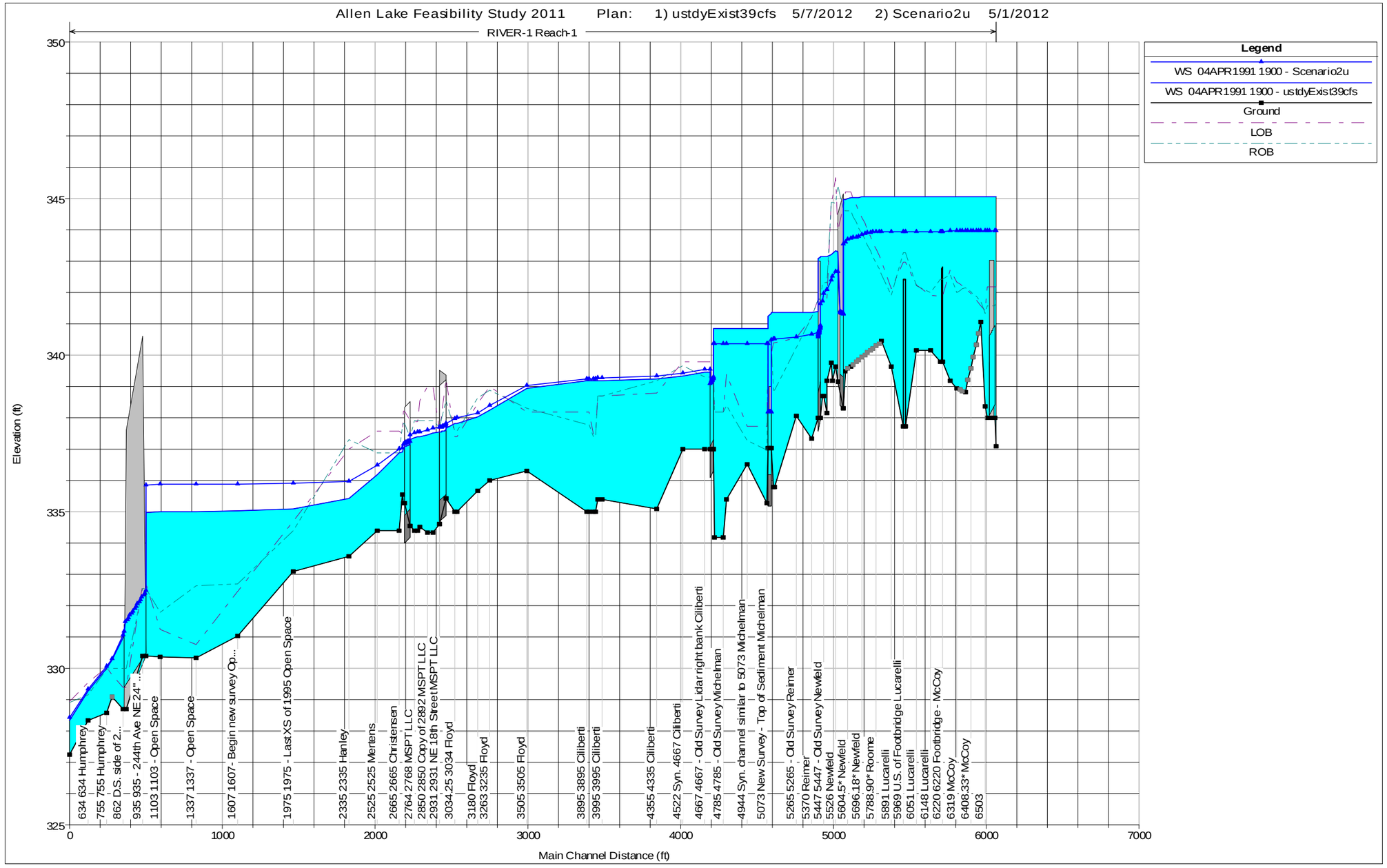


Figure 35. Example of shifts in timing of WSEL during a storm event (Existing vs. Early Actions). Time at T_1 from Figure 34.

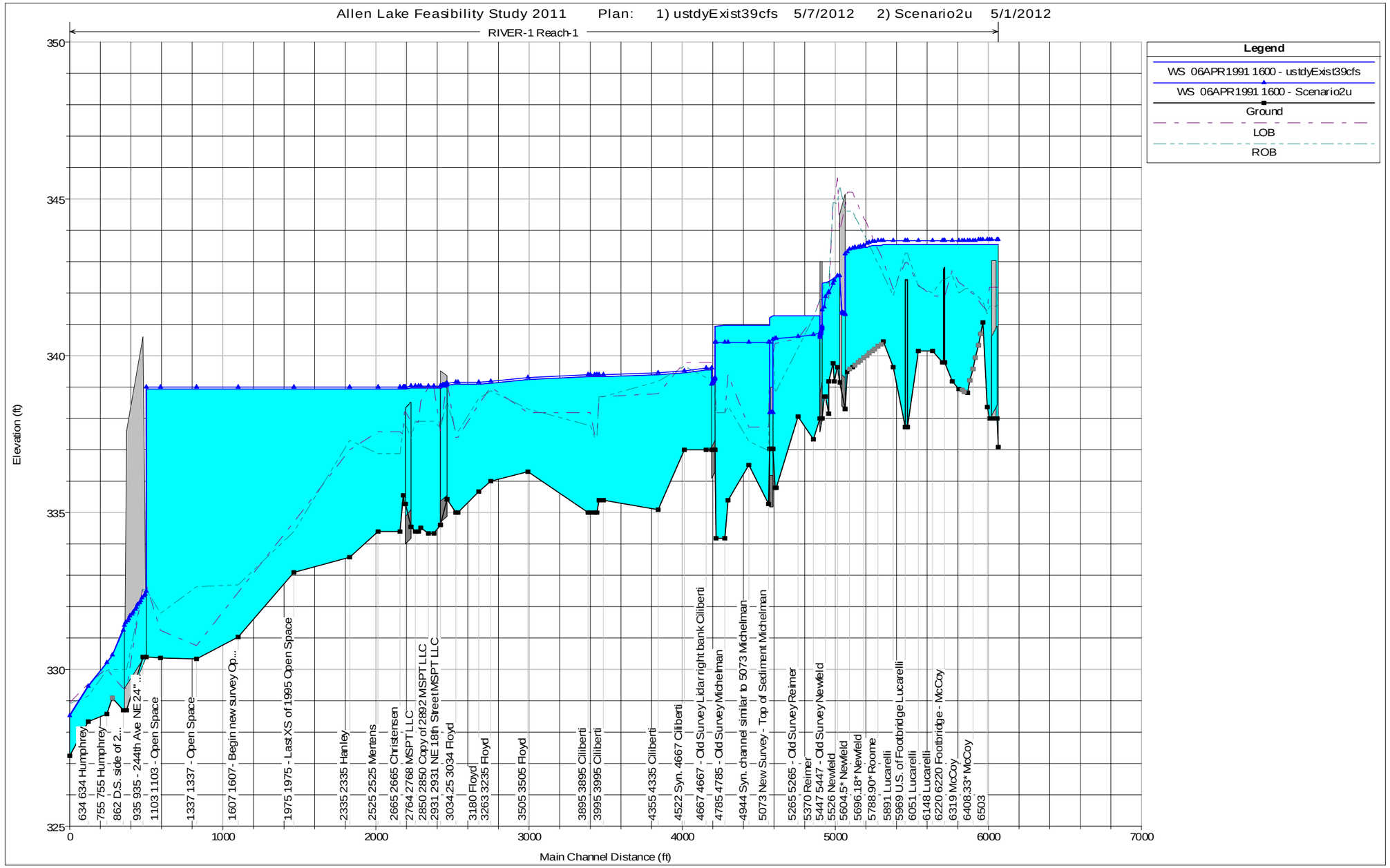


Figure 36. Example of shifts in timing of WSEL during a storm event (Existing vs. Early Actions). Time at T_2 from Figure 34.

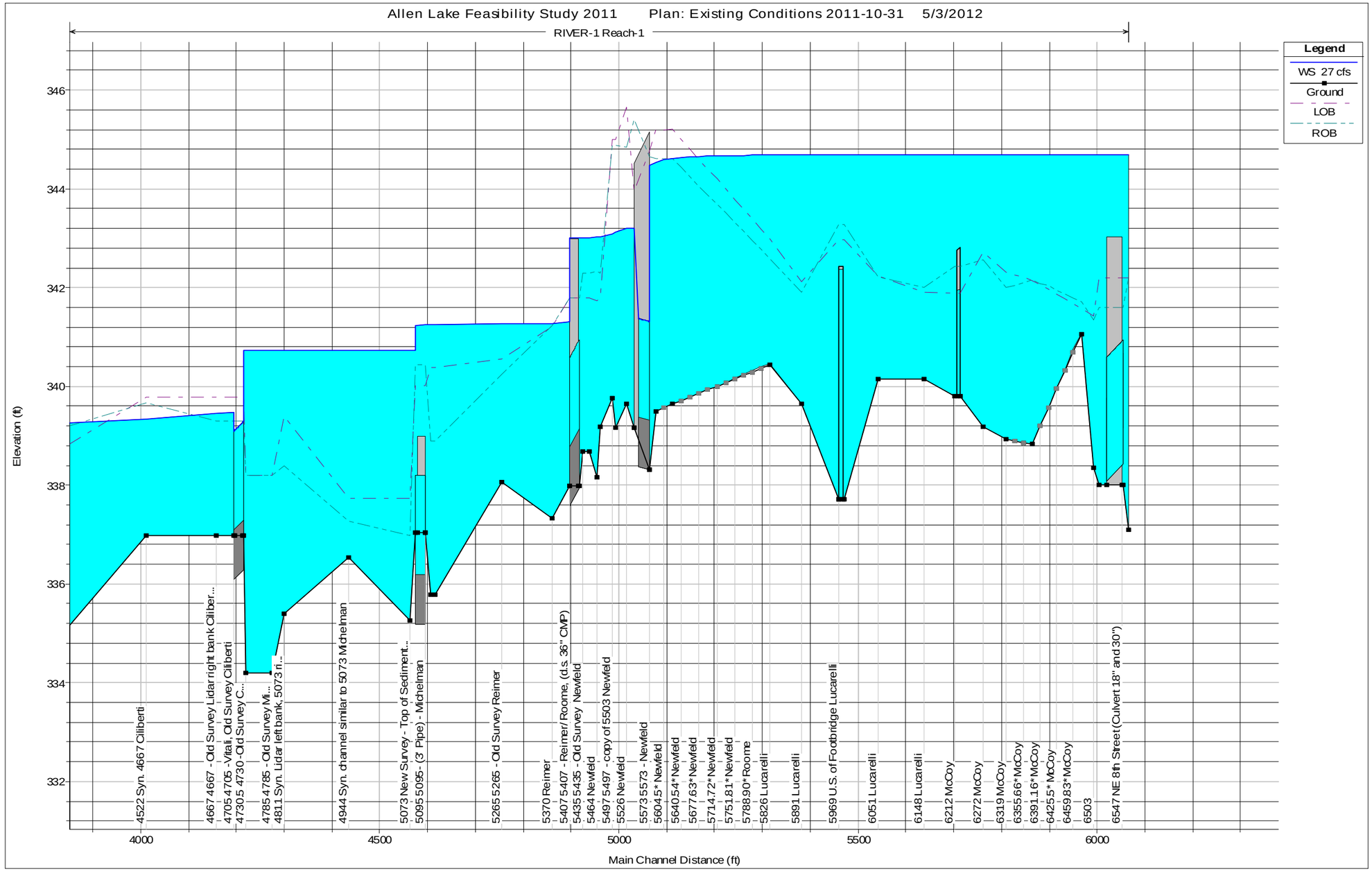


Figure 37. Existing conditions water surface profile at 27 cfs.

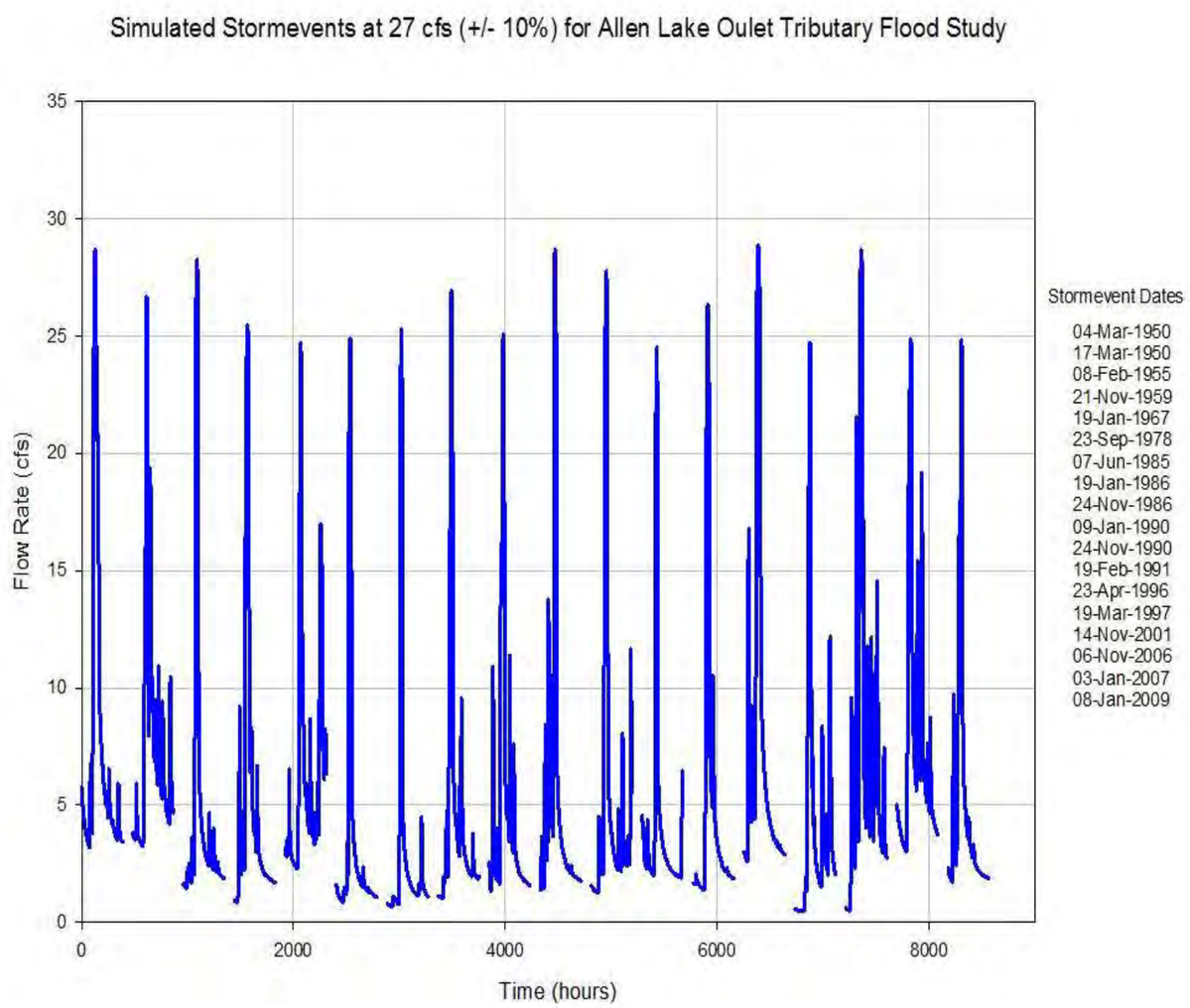


Figure 38. Synthesized storm events similar to December 2010 event with peaks ranging from 25 to 29 cfs.

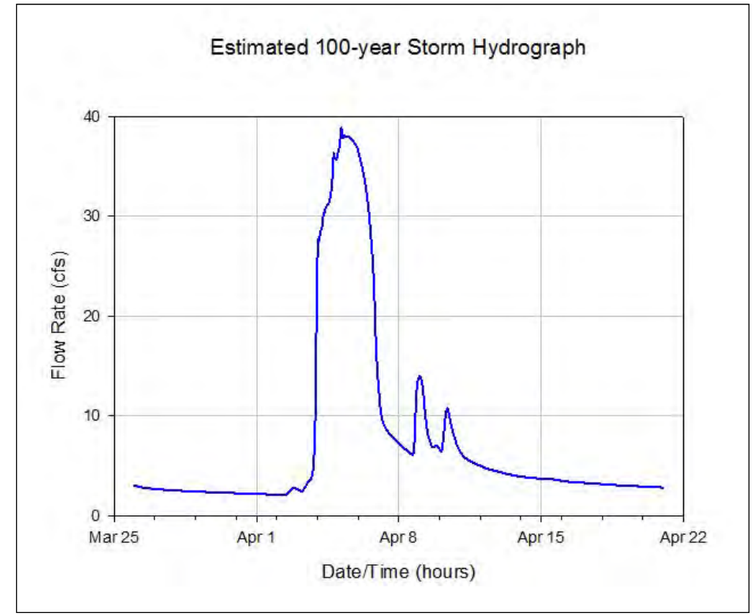


Figure 39. Estimated 100-year storm hydrograph (39 cfs).

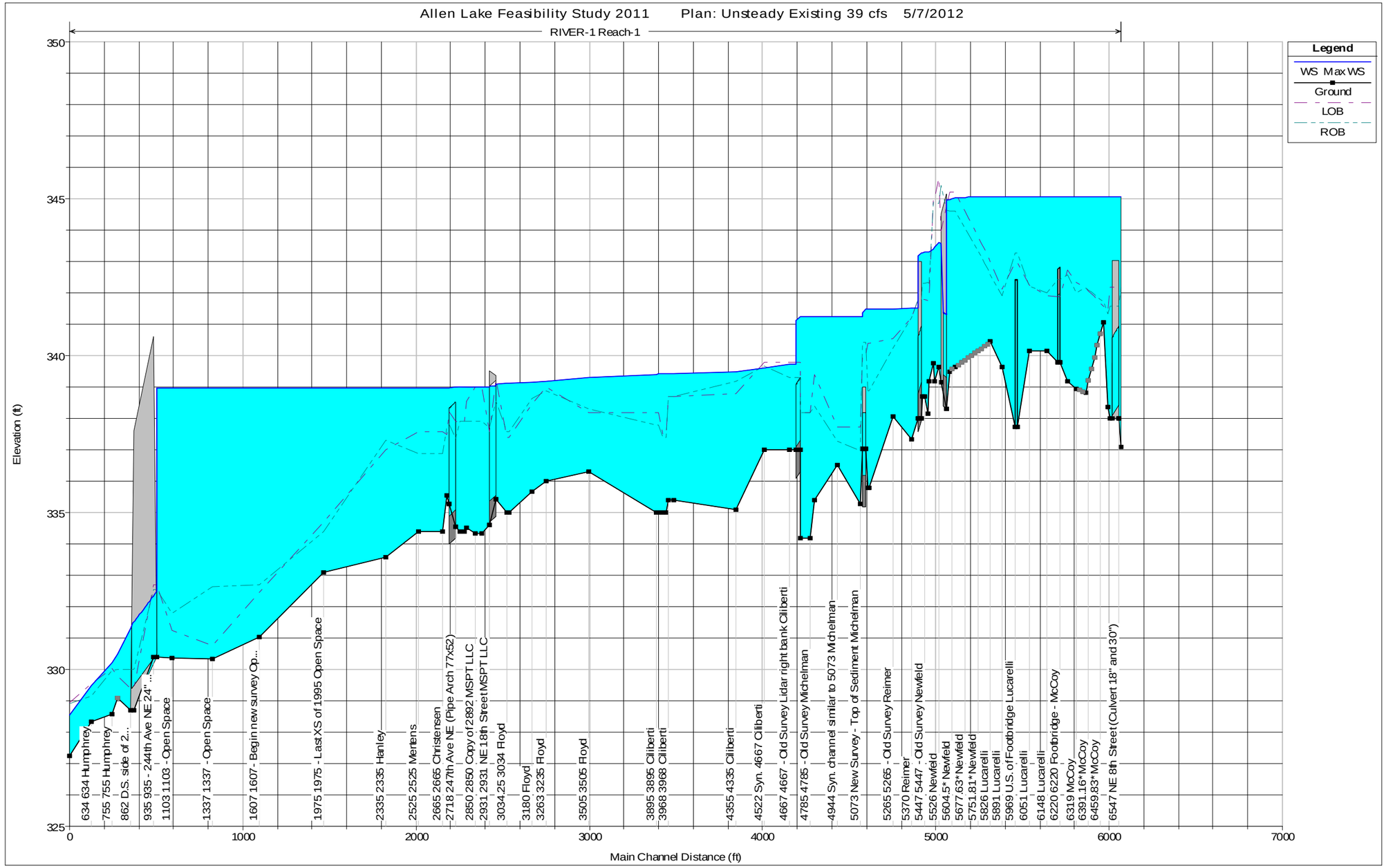


Figure 40. Water surface profile for Existing conditions (unsteady) 100-year event (39 cfs).

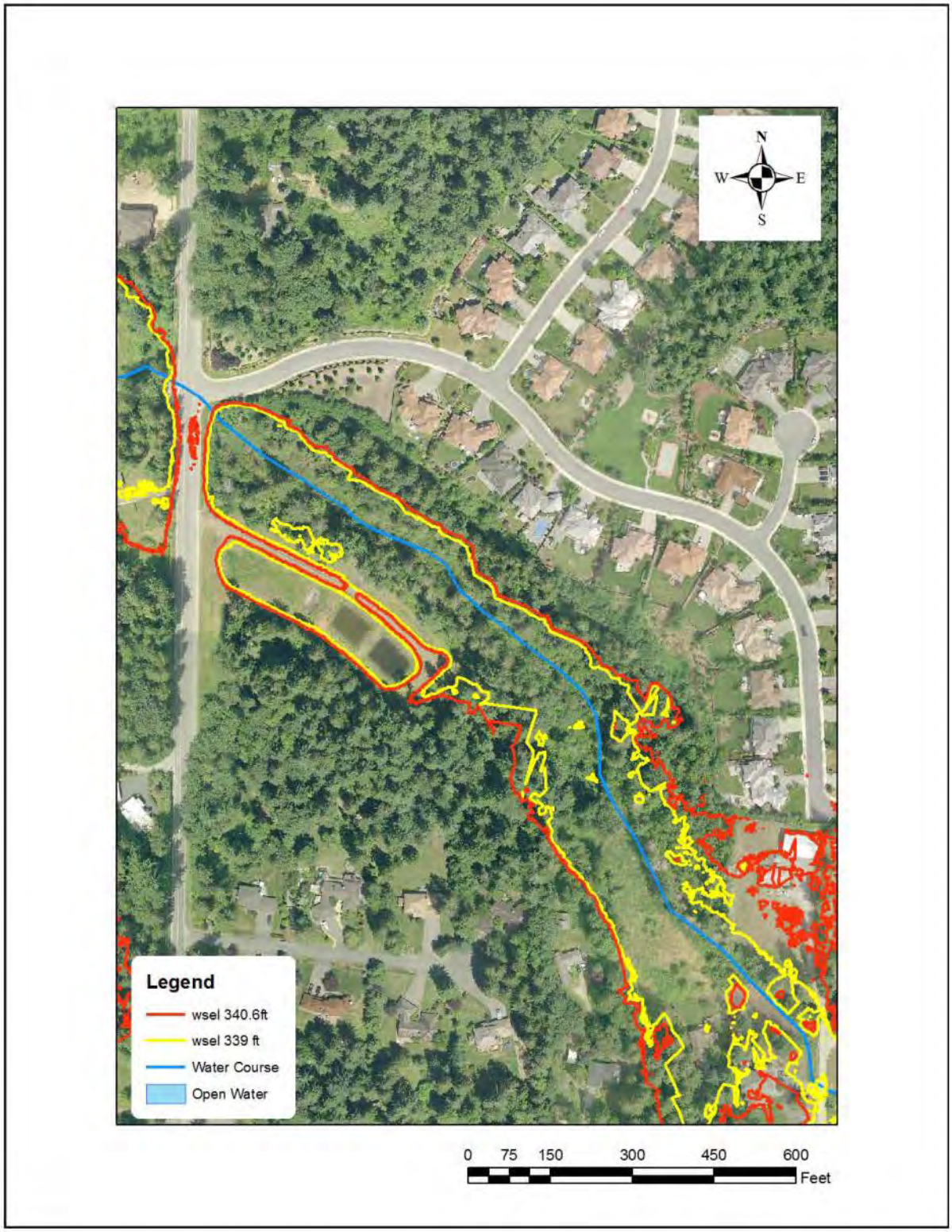


Figure 41. Existing conditions extent of flooding under a 100-year storm (39cfs) near 244th Avenue NE.

The yellow boundary represents the estimated extent of flooding during a 100-year storm. The red boundary represents the estimated extent of flooding at the point 244th Avenue Northeast would be overtopped.