

TECHNICAL MEMORANDUM

DATE: February 26, 2015
TO: King County
FROM: Paul Fendt
SUBJECT: Evaluation of Existing Drainage Structures for Replacement in the South Sammamish Segment
CC: Craig Buitrago, Jenny Bailey
PROJECT NUMBER: 554-1521-075 (20/05)
PROJECT NAME: East Lake Sammamish Trail

INTRODUCTION

King County received feedback on its assessment of trail culverts from commenters to the critical areas permit applications with the City of Sammamish. King County Parks has directed that an enhanced, supplemental analysis be made to collect data and evaluate the existing drainage structures located on the East Lake Sammamish Trail (ELST) South Sammamish Segment to further identify drainage structures requiring and suited for potential fish passage improvements. The process consists of screening criteria, each of which evaluates a critical characteristic for considering a viable structure replacement with a fish-passable culvert and removes from consideration those structures that do not serve a natural or modified stream.

The term “drainage structure” is used to refer to any pipe, storm sewer, culvert, bridge, or other water conveyance device or path that moves water from one side of the trail embankment to the other. This term is used so as to not presuppose that every water conveyance device is a “culvert” that conveys natural or modified streams and waterways. Conveyance devices also provide local land and roadway drainage, prevent standing water from collecting along constructed embankments, or are a continuation of a storm sewer system from a developed area. Developed and constructed artificial drainage systems often necessarily have the same dimensions and characteristics of waterways meeting the stream definitions. While usually only flowing in response to rain and runoff from developed areas, at times these built systems collect drainage from seeps and springs or stormwater facilities, thereby flowing seasonally for more extended times. The purpose of this evaluation is to inform a clearer distinction between natural streams and constructed drainage systems and identify segments that have characteristics (i.e. hydrology, catchment area, adequate channel and buffer width, etc.) that could support a viable enhanced stream or restore a lost stream, thus supporting a structure replacement.

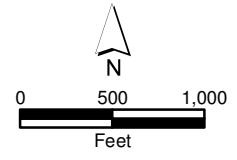
Each of the screening steps were performed on all 41 structures in the South Sammamish Segment (Figures 1A and 1B), which includes nine structures in South Sammamish Segment A, shown as the southern-most nine structures on Figure 1A (stations 218+45 through 276+00). Consequently, if additional data is found that may change a decision on a culvert for one screen, other screens may be reviewed to confirm the original decision. This analysis was a combination of desk top reviews of maps and plans, site photographs, and personal knowledge of the sites based on multiple field visits. Additional field verification may be needed to confirm findings in selected areas.



Path: P:\554 1521 075 SammamishTrail\Figures 1A 1B\Figure 1A_SSamamish TDA Segment A Basins.mxd

Source: King County, City of Sammamish, National Geographic Society, I-cubed.

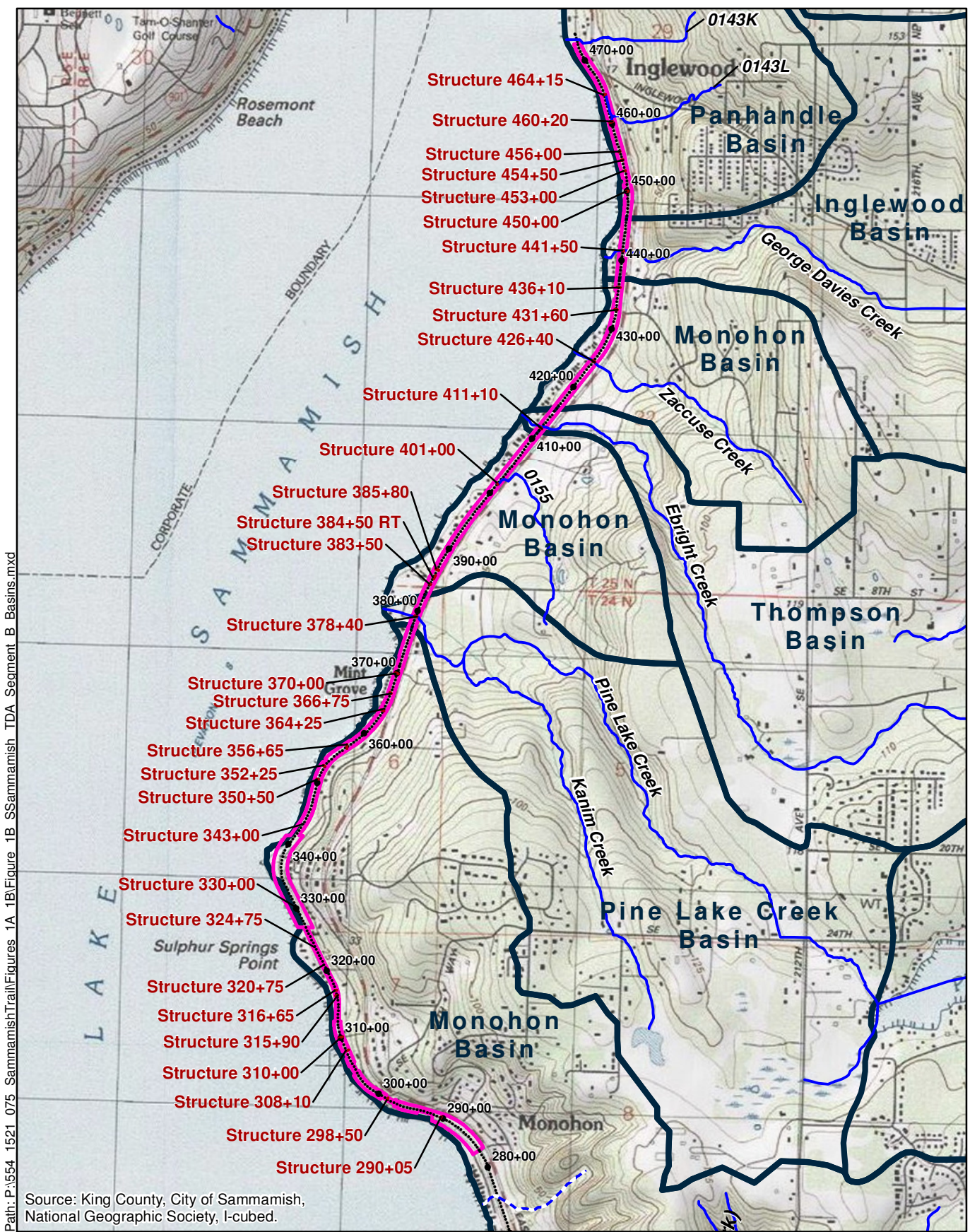
Parametrix



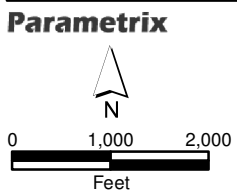
- █ South Sammamish Segment A Project Location
- █ Stream Crossing Field-verified by Parametrix
- - - Stream Crossing Not Found within Trail Corridor
- City of Sammamish Drainage Basin



**Figure 1A
Drainage Structure
Locations**



Path: P:\554 1521 075 SammamishTrail\Figures 1A 1B\Figure 1B_Ssamamish TDA Segment B Basins.mxd



- █ South Sammamish Segment B Project Location
- █ Stream Crossing Field-verified by Parametrix
- - - Stream Crossing Not Found within Trail Corridor
- City of Sammamish Drainage Basin

- ● ● ● ● Proposed Trail Stationing

**Figure 1B
Drainage Structure
Locations**

Structures remaining after the screening are subject to detailed site-specific evaluations. The characteristics evaluated in the screens would still be used to further consider replacement or exclusion - additional information may come to light that would change the conclusions of the screening process. In addition, further evaluation will consider the overall benefits to the entire system provided by replacing the trail structure, which will either make the improvements impracticable (no benefits can be realized because of other permanent constraints in the system) or more favorable when other replacements can be included as mitigation that provide significant access to habitat.

The 41 structures in South Sammamish have been identified by their station location along the corridor to provide a unique identifier for each drainage path. Figures 1A and 1B shows the trail stationing, location of the 41 structures, and general drainage catchment areas as defined in the King County GIS hydrography layer.

Screening Steps

Multiple screening steps were performed for each structure: natural systems; stream length and basin area; and conditions for a restorable habitat. In the description of each screening process, conditions for including or excluding a structure from replacement consideration is described. The process is intended to remove structures from further consideration for replacement using multiple lines of evidence so that the focus remains on structures that should be replaced to enhance accessible quality habitat.

Natural Systems Screen

This screen focuses first on whether or not the existing drainage system has indicators or remnants that a natural stream system was in place prior to basin development and construction of the railroad grade and East Lake Sammamish Parkway (ELSP). If a natural system existed or is still present, the benefits of improved fish passage can be realized and there is potential that restored habitat will be successful. If the conditions did not exist, such as no channels present or a basin of insufficient size to provide appropriate flows and hydrology, the likelihood of a successful habitat improvement is low.

The basin delineations of streams and catchments along the Lake Sammamish shore indicate a typical pattern often found along lakes and shorelines. Typically, a combination of larger named-stream watersheds are found interspersed with very small catchments that drain directly to the lake without forming notable perennial streams or defined drainageways. These small catchments are often grouped together into a single 'drainage basin', in this case the "Monohan Subbasin" (see Figures 1A and 1B). In most existing circumstances, the road and railroad grade collect and concentrate runoff and define the basin, and the existing structures are in place to pass collected drainage to the lake.

The primary indicator of a natural drainage basin used in the desk-top screen is the presence or absence of natural contours that would indicate a stream or drainage channel. The size of the drainage basins not meeting this screen is less than 32 acres for all but one structure; there are, however, some smaller basins showing contours indicating historic drainage. This initial screen includes no evaluation of annual flow regimes for small catchments, although very small and modified basins would be expected to have minimal flow, if any, during the dry season. Only those structures with no apparent historic streams or basins were screened out of further consideration for replacement; the basin size is used as an additional line of evidence that supports the exclusion. Table 1 lists the structures and the presence or absence of natural drainage basin characteristics along with the approximate drainage catchment area to each structure. Structures with no natural drainage basin are shown in red and will be removed from consideration for replacement. Figures 2A-2F show the approximate catchment areas to the trail structures.

Table 1. Structures with Historic Natural Drainage Basin Features

Structure Location Station Number	Natural drainage basin features?	Catchment Area (ac)
218+45	NO	31.7
220+00RT ¹	NO	16.4
224+00	NO	1.8
229+85	YES	6.0
239+60	YES	117.0
241+15	YES	28.2
256+40	YES	42.0
270+00	YES	34.7
276+00	YES	76.2
290+05	YES	135.7
298+50	NO	0.8
308+10	NO	1.3
310+00	YES	3.9
315+90	NO	47.5
316+65	YES	24.7
320+75 ²	NO	n/a ²
324+75 ²	NO	n/a ²
330+00 ³	YES	65.4
343+00 ³	YES	30.6
350+50	NO	1.0
352+25	NO	1.0
356+65	YES	60.6
364+25	YES	8.1
366+75	NO	13.5
370+00	NO	4.2
378+40	YES	1206.3
383+50 ²	NO	n/a ²
384+50RT ^{1,4}	NO	31.9
385+80 ⁴	NO	31.9
401+00	YES	128.7
411+10	YES	427.8
426+40	YES	160.1
431+60	YES	27.5
436+10	NO	18.0
441+50	YES	1717.9
450+00	NO	17.4
453+00	NO	7.3
454+50	NO	17.6
456+00	NO	7.8
460+20 ⁴	YES	100.3
464+15 ⁴	YES	100.3

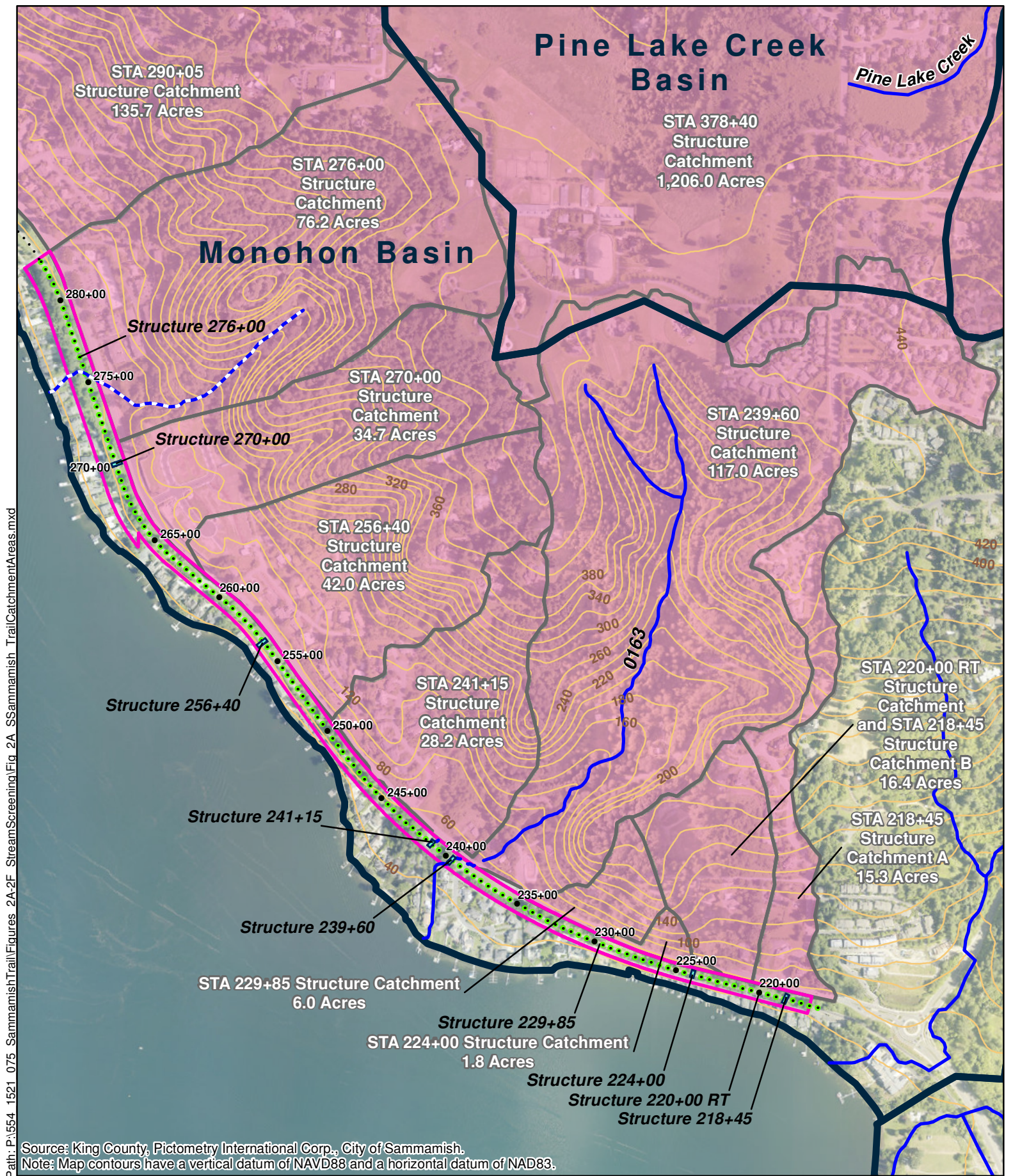
¹ Structure is in trail section but does not cross under the trail

² There is no catchment draining to these structures – they serve local drainage only

³ No structure was found. This structure location is the approximate location of catchment low point to where the catchment drains

⁴ This structure drains the same catchment as adjacent structure

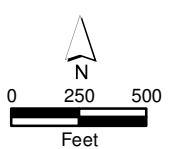
Based on this screen alone, 20 of 41 structures are removed from replacement consideration, of which three are located in South Sammamish Segment A.



Path: P:\1554_1521_075_SammamishTrail\Figures_2A-2F_StreamScreening\Fig_2A_Sammamish_TrailCatchmentAreas.mxd

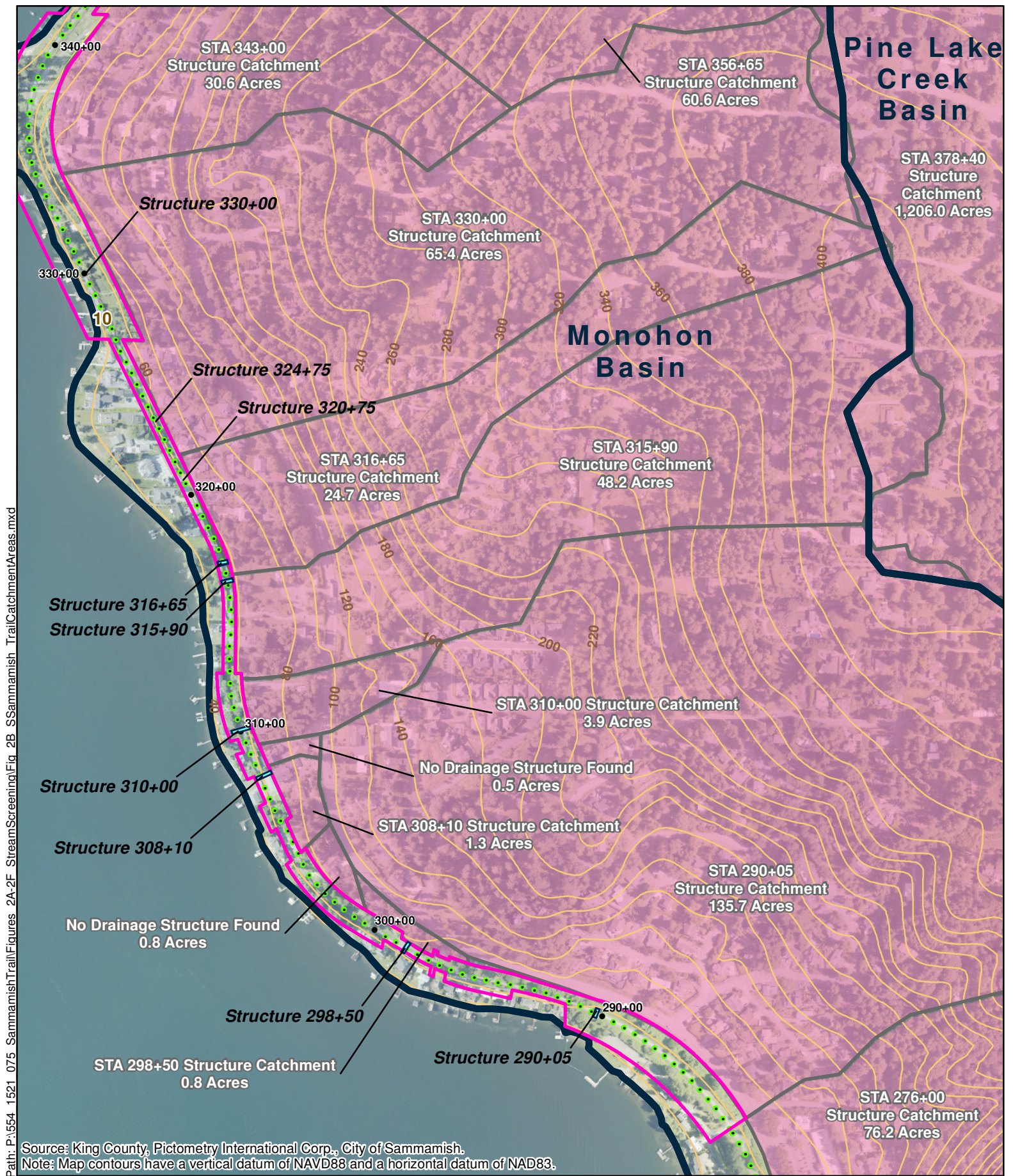
Source: King County, Pictometry International Corp., City of Sammamish.
 Note: Map contours have a vertical datum of NAVD88 and a horizontal datum of NAD83.

Parametrix



- South Sammamish Segment A Project Location
- Stream Crossing Field-Verified by Parametrix
- Stream Crossing Not Found Within Trail Corridor
- City of Sammamish Drainage Basin
- Catchment Area
- Contour - 20ft
- Drainage Structure
- Proposed Trail Stationing

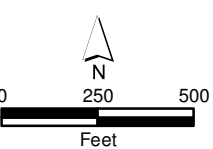
Figure 2A
Trail Drainage Structure
Catchment Areas



Path: P:\554_1521_075_SammamishTrail\Figures_2A-2F_StreamScreening\Fig_2B_Sammamish_Trail\CatchmentAreas.mxd

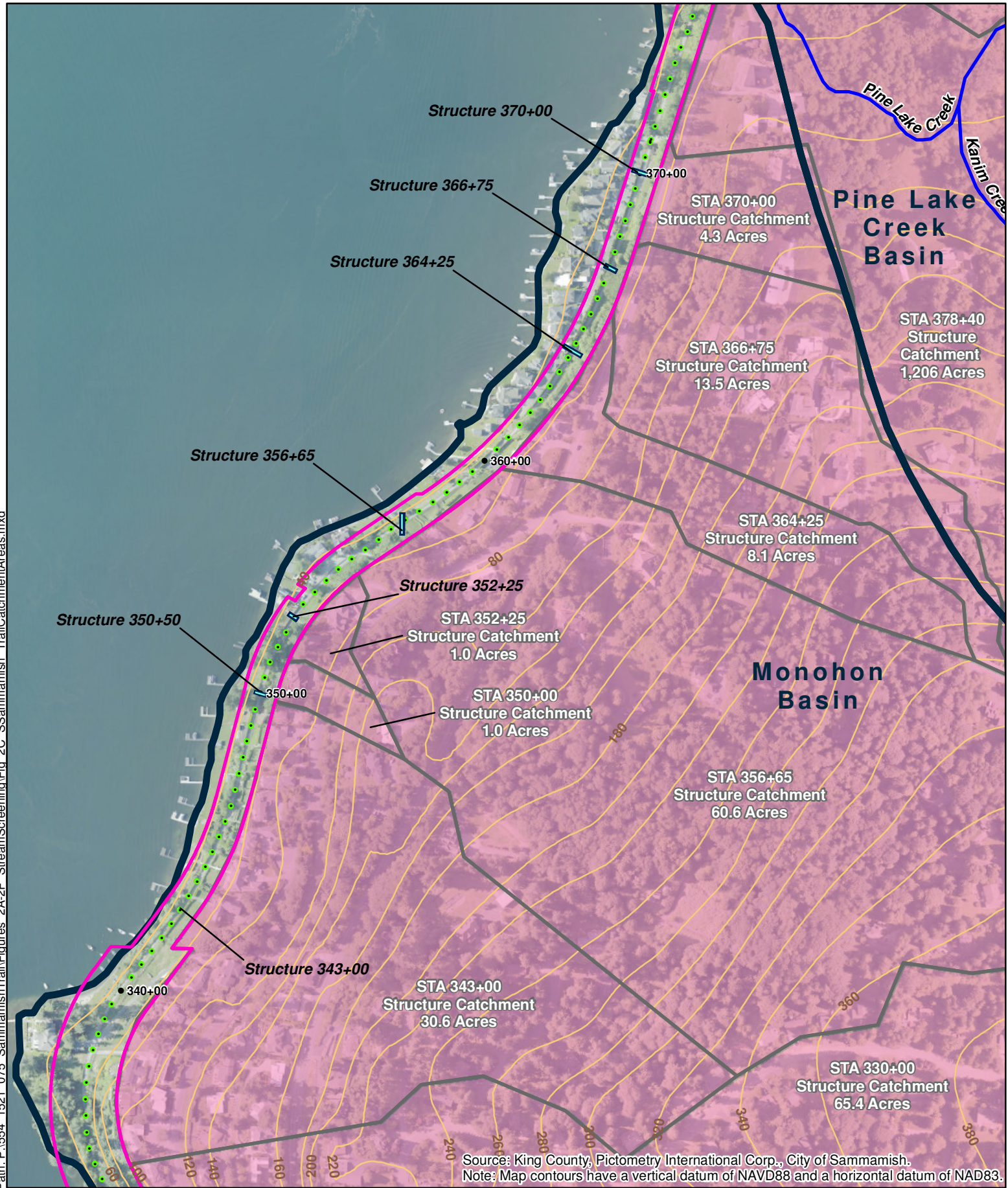
Source: King County, Pictometry International Corp., City of Sammamish.
 Note: Map contours have a vertical datum of NAVD88 and a horizontal datum of NAD83.

Parametrix

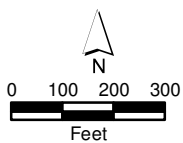


- █ South Sammamish Segment B Project Location
- █ Stream Crossing Field-Verified by Parametrix
- █ Stream Crossing Not Found Within Trail Corridor
- █ City of Sammamish Drainage Basin
- Catchment Area
- █ Contour - 20ft
- █ Drainage Structure
- Proposed Trail Stationing

Figure 2B
Trail Drainage Structure
Catchment Areas



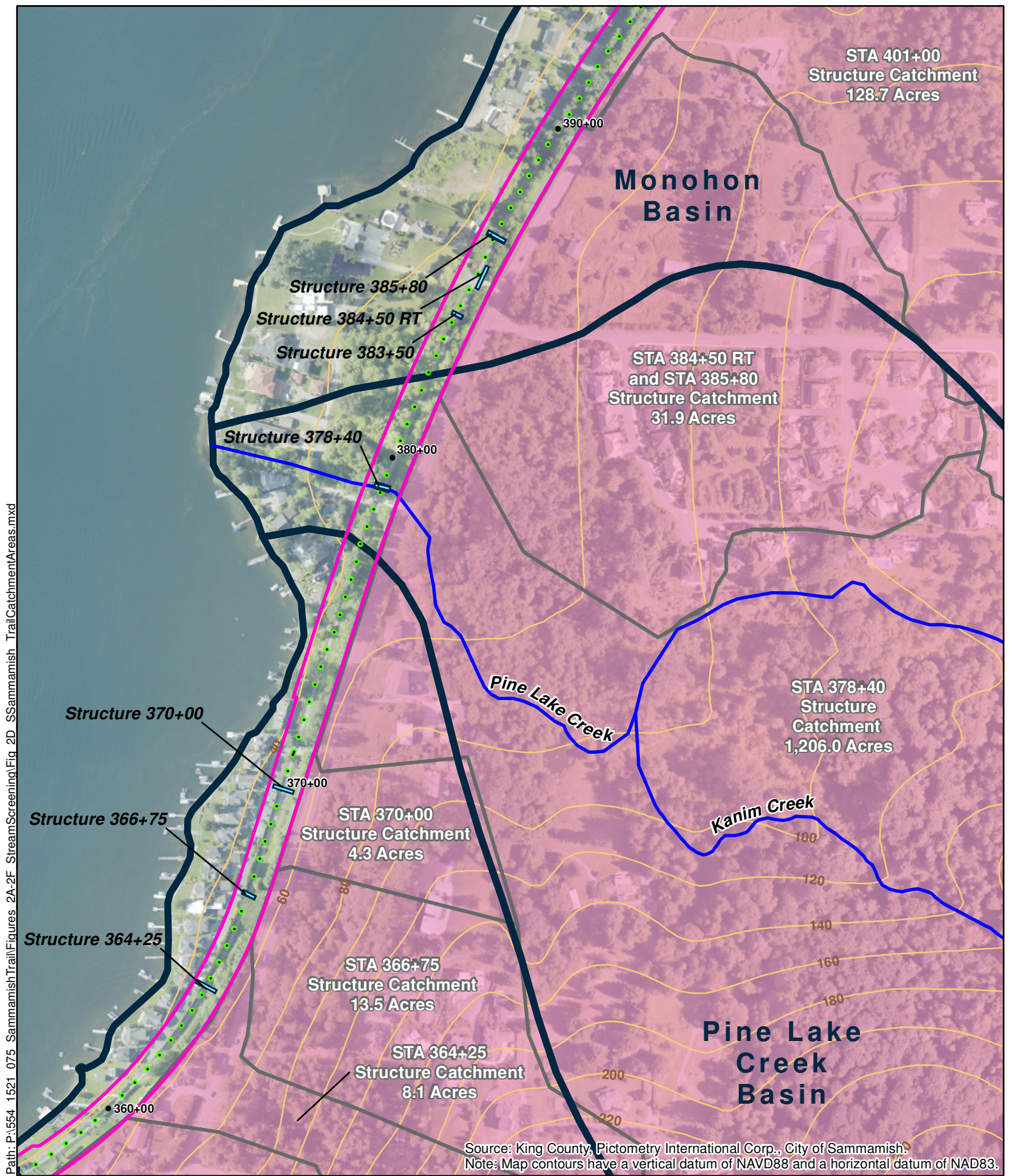
Parametrix



- ▭ South Sammamish Segment A Project Location
- ▬ Stream Crossing Field-Verified by Parametrix
- - - Stream Crossing Not Found Within Trail Corridor
- City of Sammamish Drainage Basin
- Catchment Area
- ▬ Contour - 20ft
- ▬ Drainage Structure



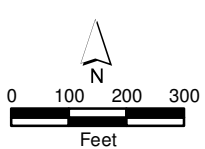
Figure 2C
Trail Drainage Structure
Catchment Areas



Path: P:\1554_1521_075_SammamishTrail\Figures_2A-2F_StreamScreening\Fig_2D_Sammamish_TrailCatchmentAreas.mxd

Source: King County, Pictometry International Corp., City of Sammamish.
 Note: Map contours have a vertical datum of NAVD88 and a horizontal datum of NAD83.

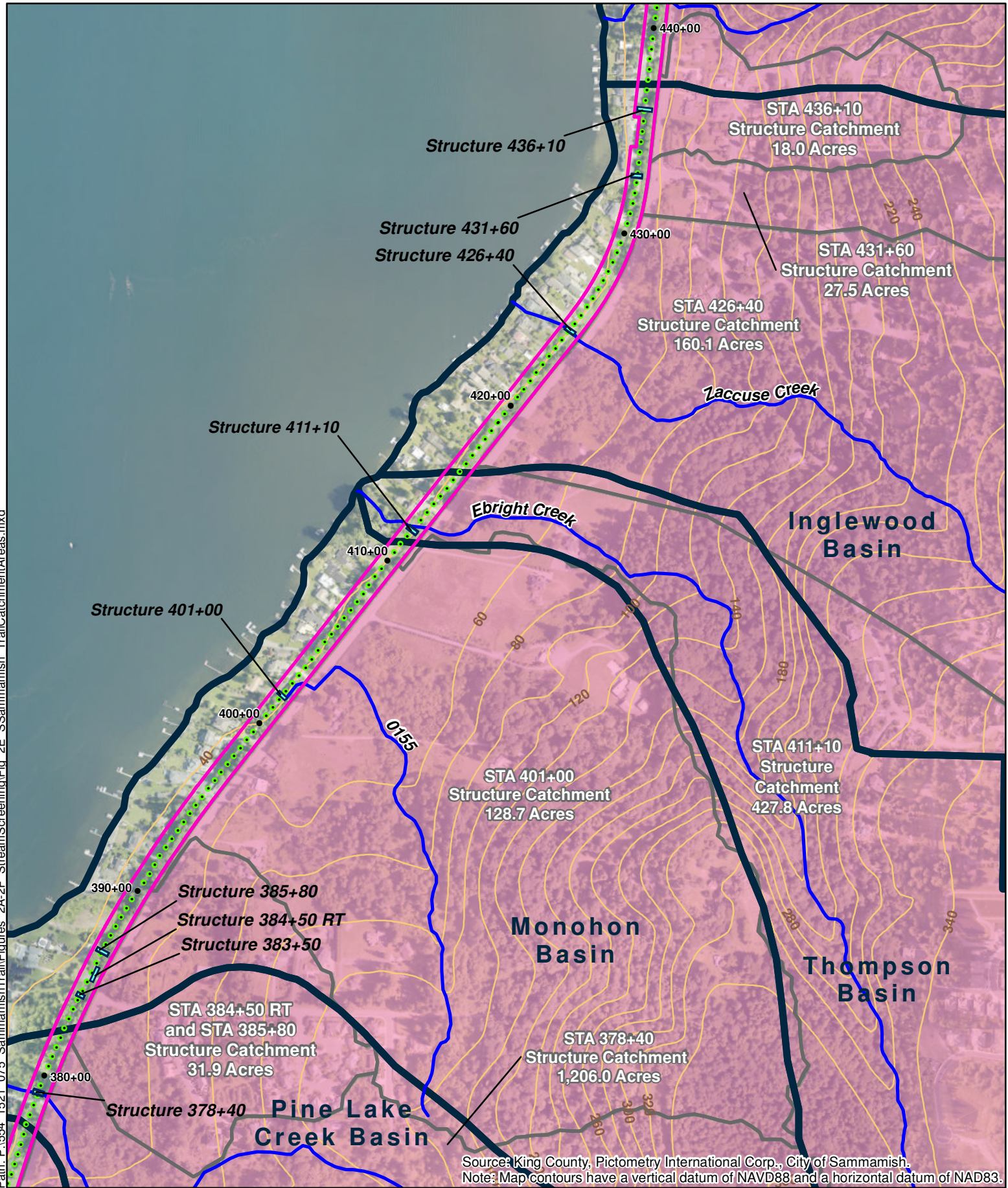
Parametrix



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- ▬ Contour - 20ft
- Drainage Structure
- ● ● ● ● Proposed Trail Stationing

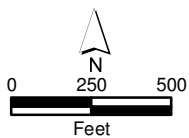
Figure 2D
Trail Drainage Structure
Catchment Areas

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Source: King County, Pictometry International Corp., City of Sammamish.
 Note: Map contours have a vertical datum of NAVD88 and a horizontal datum of NAD83.

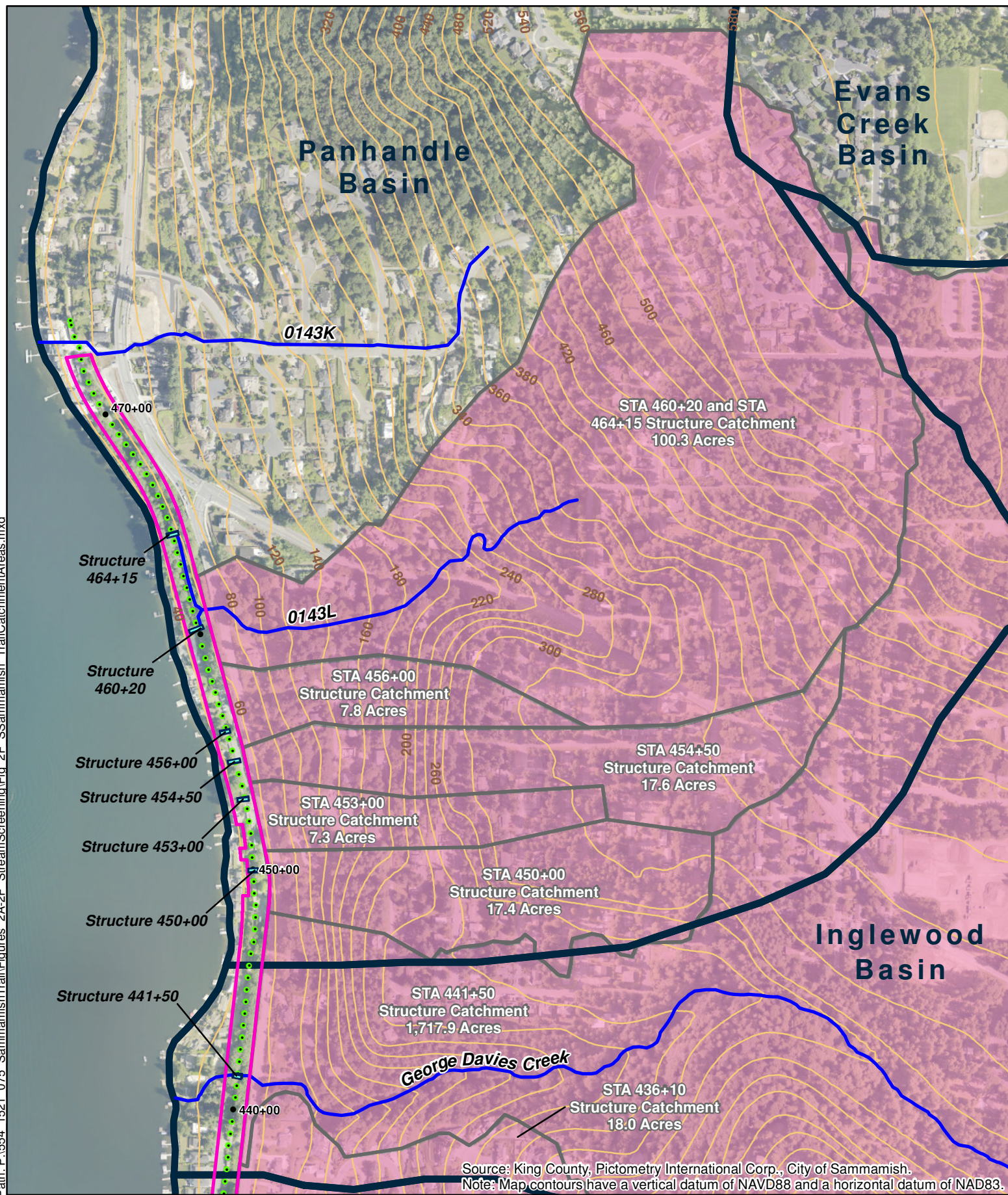
Parametrix



- ▭ South Sammamish Segment B Project Location
- ▬ Stream Crossing Field-Verified by Parametrix
- - - Stream Crossing Not Found Within Trail Corridor
- City of Sammamish Drainage Basin
- Catchment Area
- ▬ Contour - 20ft
- ▬ Drainage Structure
- 480+00
- 485+00
- Proposed Trail Stationing

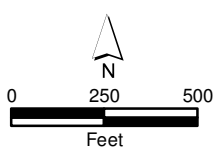
Figure 2E
Trail Drainage Structure
Catchment Areas

Path: P:\1554_1521_075_SammamishTrail\Figures_2A-2F_StreamScreening\Fig_2F_Sammamish_Trail\CatchmentAreas.mxd



Source: King County, Pictometry International Corp., City of Sammamish.
 Note: Map contours have a vertical datum of NAVD88 and a horizontal datum of NAD83.

Parametrix



- South Sammamish Segment B Project Location
- Stream Crossing Field-Verified by Parametrix
- Stream Crossing Not Found Within Trail Corridor
- City of Sammamish Drainage Basin
- Catchment Area
- Contour - 20ft
- Drainage Structure
- Proposed Trail Stationing

Figure 2F
Trail Drainage Structure
Catchment Areas

The next natural systems evaluation is the presence of the channel in three segments: upstream of the ELSP; between the ELSP and the trail; and between the trail and the lake. This is another indicator of the historic presence of natural or modified channels. In addition to the absence of a channel, a steep channel segment (generally over 16 percent) can effectively make a channel segment inaccessible. Slope was not used as a natural screen in this section but was evaluated for selected structures and screening later in this technical memorandum.

This screen generally indicates whether any potential improvements in the lower reaches, if present, could lead to a connection with upper reaches that may remain in an historic basin. The approximate total length of the drainage channel was measured from the lake to a “channel” upstream of the ELSP; if there is no channel, the length to the ELSP is used. Guidance documents, such as the WDFW Fish Passage Barrier Assessment Manual, uses 200 meters (about 650 feet) to indicate a ‘significant reach of habitat’. Using this approximate length as a screen, channels less than 500 feet in length from the lake to the absence of a channel and with no channel above the ELSP are removed from consideration for replacement. This screen is an indicator that there is virtually no potential for a habitat gain of over 500 feet of stream and often much less. Short reaches in this area are often indicators of local artificial drainage with limited potential that significant upstream natural systems existed before development or construction of the railroad or parkway. Table 2 shows the structure list, the approximate length of each channel segment, and the total length to “no channel”. Twenty structures fail this screen, four of which are in South Sammamish Segment A.

Table 2. Length of Channel Segments near Each Structure

Structure location station number	Channel upstream of ELSP?	Approximate length of segment upslope of ELSP (ft)	Approximate length of segment between ELST and ELSP (ft)	Approximate length of segment between Lake and the upstream side of ELST (ft)	Approximate length of reach from Lake Sammamish to no channel (ft)
218+45	YES	220	220	170	610
220+00RT ¹	YES	220	30	n/a	n/a
224+00	NO	120	250	100	470
229+85	YES	530	30	260	820
239+60	YES	5780	140	580	6500
241+15	YES	1250	30	580	1860
256+40	NO	n/a	290	120	410
270+00	NO	n/a	30	270	300
276+00	NO	n/a	40	260	300
290+05	NO	n/a	60	240	300
298+50	NO	n/a	n/a	130	130
308+10	NO	n/a	100	100	200
310+00	NO	n/a	n/a	110	110
315+90	NO	n/a	530	130	660
316+65	YES	910	360	140	1410
320+75	NO	n/a	n/a	n/a	n/a
324+75	NO	n/a	n/a	n/a	n/a
330+00	NO	n/a	n/a	70	70
343+00	NO	n/a	n/a	60	60
350+50	NO	n/a	n/a	80	80

Table 2. Length of Channel Segments near Each Structure (continued)

Structure location station number	Channel upstream of ELSP?	Approximate length of segment upslope of ELSP (ft)	Approximate length of segment between ELST and ELSP (ft)	Approximate length of segment between Lake and the upstream side of ELST (ft)	Approximate length of reach from Lake Sammamish to no channel (ft)
352+25	NO	n/a	n/a	60	60
356+65	YES	850	520	110	1480
364+25	YES	750	160	120	1030
366+75	YES	330	30	210	570
370+00	NO (FV)	n/a	n/a	180	180
378+40	YES	10330	30	490	10850
383+50	NO	n/a	30	600	630
384+50RT	NO (FV)	n/a	140	340	480
385+80	NO (FV)	n/a	100	290	390
401+00	YES	2550	130	290	2970
411+10	YES	11200	60	340	11600
426+40	YES	3320	40	330	3690
431+60	YES	1550	40	260	1850
436+10	NO	n/a	250	270	520
441+50	YES	17300	40	330	17670
450+00	NO (FV)	n/a	90	110	200
453+00	NO (FV)	n/a	30	90	120
454+50	YES	360	40	70	470
456+00	NO (FV)	n/a	20	80	100
460+20 ²	YES	1750	100	120	1970
464+15 ²	YES	1750	360	90	2200

FV=Field Verify

¹ This structure is in the same flow path as Structure 218+45, therefore the bottom reach is not included in the channel length

² Same upstream channel

Conditions for Restorable Habitat

The next evaluation considers if conditions are present under reasonable circumstances to restore passage to the trail and beyond. The primary consideration is the potential available length of restorable channel and catchment to provide suitable hydrologic conditions. The basis for the stream length limitation is the WDFW barrier assessment manual, as described above. The basis for the drainage catchment area is WAC 222-16-031, which indicates that a drainage areas must exceed 50 acres to be a Type 3 water, which is a segment of natural waters that has moderate to slight fish use. The next consideration is the location and available pathway for a restored stream channel that could lead to the trail structure. The lack of an existing stream channel or the absence of any drainage way are criteria to eliminate the structure from replacement consideration at this time. Table 3 shows the presence of a channel upstream of ELSP to which a restored system could be connected, length of a demonstrable drainage reach between the lake and ELSP or no channel (whichever is shorter), and catchment area. Channels shorter than 500 feet and with catchments under 50 acres were screened from further consideration and are shown in red.

Table 3. Length of Channel and Catchment Area Screening Data

Structure location station number	Channel upstream of ELSP?	Approximate length of reach from Lake Sammamish to no channel (ft)	Catchment area to trail (ac)
218+45	YES	610	31.8
220+00RT	YES	n/a	16.4
224+00	NO	470	1.8
229+85	YES	820	6.0
239+60	YES	6500	117.0
241+15	YES	1860 ¹	28.2
256+40	NO	410	42.0
270+00	NO (FV)	300	34.7
276+00	NO	300	76.2
290+05	NO	300	135.7
298+50	NO	130	0.8
308+10	NO	200	1.3
310+00	NO	110	3.9
315+90	NO	660	48.5
316+65	YES	1410	24.7
320+75	NO	n/a	n/a
324+75	NO	n/a	n/a
330+00	NO	70	65.4
343+00	NO	60	30.6
350+50	NO	80	1.0
352+25	NO	60	1.0
356+65	YES	1480	60.6
364+25	YES	1030	8.1
366+75	YES	570	13.5
370+00	NO	180	4.3
378+40	YES	10850	1206.0
383+50	NO	630	n/a
384+50RT	NO	480	31.9
385+80	NO	390	31.9
401+00	YES	2970	128.7
411+10	YES	11600	427.8
426+40	YES	3690	160.1
431+60	YES	1850	27.5
436+10	NO	520	18.0
441+50	YES	17670	1717.9
450+00	NO (FV)	200	17.4
453+00	NO (FV)	120	7.3
454+50	YES	470	17.6
456+00	NO (FV)	100	7.8
460+20	YES	1970	100.3
464+15	YES	2200	100.3

¹ Lower 580 feet is shared with 239+60

Table 4 lists existing reach conditions that have adequate available area for a meaningful and successful stream or natural systems restoration. For example, is the corridor between houses available for open channel construction or is there space for a meaningful channel and connected riparian area. Positive results in these areas would not represent proposals for the County to make these improvements, but rather identify areas where, if the County upgraded the structure under the ELST, others could come in and make improvements to create habitat. Structures in red are those where any of the built environment criteria are not suitable for restoration and there is no channel upstream of ELSP. Also, structures with gradient barriers (three structures were more closely evaluated for gradient steeper than 16 percent – 316+65, 356+65, and 431+60), or with an unsuitable section and less than 20 acre catchment were removed. 32 structures were removed using this screen, including six in South Sammamish Segment A.

Table 4. Structures Where Conditions are Suitable for Restoration

Structure location station number	Channel upstream of ELSP?	Built environment supports potential restoration upstream of ELSP?	Built environment supports potential restoration between ELST and ELSP?	Built environment supports potential restoration downstream of ELST?	Approximate length of reach from Lake Sammamish to no channel (ft)	Catchment area to trail (ac)
218+45	YES	YES	YES	YES	610	31.8
220+00RT	YES	YES	YES	YES	n/a	16.4
224+00	NO	NO	YES	NO (in pipe)	470	1.8
229+85	YES	YES	YES	NO (in pipe)	820	6.0
239+60	YES	YES	YES	YES	6500	117.0
241+15	YES	YES	YES	NO (not found)	1860	28.2
256+40	NO	NO	YES	NO (piped/conc channel)	410	42.0
270+00	NO (FV)	NO	NO	NO (not found)	300	34.7
276+00	NO	NO	NO (in pipe)	NO (in pipe)	300	76.2
290+05	NO	NO	NO	NO (not found)	300	135.7
298+50	NO	NO	NO	NO (in pipe)	130	0.8
308+10	NO	NO	NO (storm sewer)	YES	200	1.3
310+00	NO	NO	NO (in pipe)	NO (piped under house)	110	3.9
315+90	NO	NO	NO (not 2')	YES	660	48.2
316+65	YES	YES	NO (gradient 20%+)	YES	1410	24.7
320+75	NO	NO	NO	NO (no channel to lake)	n/a	n/a
324+75	NO	NO	NO	NO (no channel to lake)	n/a	n/a
330+00	NO	NO	NO (no outlet)	NO (no channel to lake)	70	65.4
343+00	NO	NO	NO (no outlet)	NO (no channel to lake)	60	30.6
350+50	NO	NO	NO (not 2')	YES	80	1.0

Table 4. Structures Where Conditions are Suitable for Restoration (continued)

Structure location station number	Channel upstream of ELSP?	Built environment supports potential restoration upstream of ELSP?	Built environment supports potential restoration between ELST and ELSP?	Built environment supports potential restoration downstream of ELST?	Approximate length of reach from Lake Sammamish to no channel (ft)	Catchment area to trail (ac)
352+25	NO	NO	NO (not 2') No (gradient 30%+)	YES	60	1.0
356+65	YES	YES	YES	YES	1480	60.6
364+25	YES	YES	YES	NO (piped)	1030	8.1
366+75	YES	YES	YES	NO (partial pipe)	570	13.5
370+00	NO	NO	YES	NO (piped)	180	4.3
378+40	YES	YES	YES	YES	10850	1206.0
383+50	NO	NO	YES	YES	630	n/a
384+50RT	NO	NO	YES	NO (partial pipe)	480	31.9
385+80	NO	NO	YES	NO (partial pipe)	390	31.9
401+00	YES	YES	YES	NO (piped)	2970	128.7
411+10	YES	YES	YES	YES	11600	427.8
426+40	YES	YES	YES	YES	3690	160.1
431+60	YES	YES (FV)	NO (gradient 19%+)	YES	1850	27.5
436+10	NO	NO	YES	NO (piped)	520	18.0
441+50	YES	YES	YES	YES	17670	1717.9
450+00	NO (FV)	NO	YES	NO (partial pipe)	200	17.4
453+00	NO (FV)	NO	NO (pipe)	YES	120	7.3
454+50	YES	YES	NO (pipe)	YES	470	17.6
456+00	NO (FV)	NO	YES	YES	100	7.8
460+20	YES	YES	NO (gradient 20%+)	NO (gradient)	1970	100.3
464+15	YES	YES	YES	YES	2200	100.3

Summary of Results

Most of the culverts in the screening process were removed due to multiple issues, which is reflective of the heavily modified conditions and the evidence that many of these drainage paths did not historically provide habitat upstream of the lake’s edge beyond the location of the parkway or railroad grade. A review summary of all of the screening steps is shown in Table 5. Structures in red do not pass that screen.

Table 5. Summary of Structure Screens

Structures in the South Sammamish Segment	Structures removed by the natural basin screen (Table 1)	Structures with no channel upstream of ELSP and less than 500 feet in length (Table 2)	Structures with catchments less than 50 acres and less than 500 feet of channel (Table 3)	Structures with poor suitability for restoration (Table 4)	Structures remaining	Stream name or identifier
218+45	218+45	218+45	218+45	218+45		
220+00RT	220+00RT	220+00RT ¹	220+00RT	220+00RT		
224+00	224+00	224+00	224+00	224+00		
229+85	229+85	229+85	229+85	229+85		
239+60	239+60	239+60	239+60	239+60	239+60	0163 N & S
241+15	241+15	241+15	241+15	241+15	241+15	0163 N & S
256+40	256+40	256+40	256+40	256+40		
270+00	270+00	270+00	270+00	270+00		
276+00	276+00	276+00	276+00	276+00		
290+05	290+05	290+05	290+05	290+05		
298+50	298+50	298+50	298+50	298+50		
308+10	308+10	308+10	308+10	308+10		
310+00	310+00	310+00	310+00	310+00		
315+90	315+90	315+90	315+90	315+90		
316+65	316+65	316+65	316+65	316+65		
320+75	320+75	320+75	320+75	320+75		
324+75	324+75	324+75	324+75	324+75		
330+00	330+00	330+00	330+00	330+00		
343+00	343+00	343+00	343+00	343+00		
350+50	350+50	350+50	350+50	350+50		
352+25	352+25	352+25	352+25	352+25		
356+65	356+65	356+65	356+65	356+65		
364+25	364+25	364+25	364+25	364+25		
366+75	366+75	366+75	366+75	366+75		
370+00	370+00	370+00	370+00	370+00		
378+40	378+40	378+40	378+40	378+40	378+40	Pine Lake Creek
383+50	383+50	383+50	383+50	383+50		
384+50RT	384+50RT	384+50RT	384+50RT	384+50RT		
385+80	385+80	385+80	385+80	385+80		
401+00	401+00	401+00	401+00	401+00	401+00	0155
411+10	411+10	411+10	411+10	411+10	411+10	Ebright Creek
426+40	426+40	426+40	426+40	426+40	426+40	Zaccuse Creek
431+60	431+60	431+60	431+60	431+60		
436+10	436+10	436+10	436+10	436+10		
441+50	441+50	441+50	441+50	441+50	441+50	George Davis Cr
450+00	450+00	450+00	450+00	450+00		
453+00	453+00	453+00	453+00	453+00		
454+50	454+50	454+50	454+50	454+50		
456+00	456+00	456+00	456+00	456+00		
460+20	460+20	460+20	460+20	460+20		
464+15	464+15	464+15	464+15	464+15	464+15	0143L

Eight structures pass all of the screens (see Table 5) and are to be further evaluated to confirm the replacement approach. The WDNR stream typing maps were reviewed as a cross reference of the screening process. The stream types for the structures passing the screens is shown on Table 6, which shows that six of the eight structures are Type F, one is Type N, and one is not typed or shown on the maps. There are no Type F streams in the Segment A corridor that are not included in this list.

Table 6. Summary of Structures and Proposed Status

Structures passing all screens	Stream name	WDNR stream typing	Proposal (reason)	Comments
239+60	0163S	Type F	Not replaced (no habitat gain without other replacements outside of trail corridor); additional culverts replaced at Zaccuse and Pine Lake Creeks	Channel combines immediately downstream of trail; barrier immediately upstream
241+15	0163N	Type N	Not replaced (no habitat gain without other replacements outside of trail corridor); additional culverts replaced at Zaccuse and Pine Lake Creeks	Channel combines immediately downstream of trail; channel in culvert immediately downstream of trail
378+40	Pine Lake Creek	Type F	Replace (pass screens, named, Type F); Additional structure to be replaced outside of trail corridor	Two culverts proposed will provide complementary benefits for comprehensive habitat gain
401+00	Stream 155	Type F	Replace (pass screens, named, Type F)	Downstream reach to lake is in a pipe that must be replaced to gain benefit
411+10	Ebright Creek	Type F	Replace (pass screens, named, Type F)	
426+40	Zaccuse Creek	Type F	Replace (pass screens, named, Type F); Additional structure to be replaced outside of trail corridor	Two culverts proposed will provide complementary benefits for comprehensive habitat gain
441+50	George Davis Creek	Type F	Replace (pass screens, named, Type F)	
464+15	Stream 143L	not typed	Replace (pass screens)	

The data in the screens provide a meaningful objective analysis of structure replacement needs and potential. This approach and the results support the County’s approach to removal of passage barriers in the South Sammamish Segment.