Appendix A: Project Planning Matrices

Table A-1: Problem Area Matrix

Table A-2: Project Opportunity Matrix

Table A-1 . Wilsonville Problem Area Matrix												
Problem Area Location ID	Location/Asset Description	Source	Problem Description	Deficiency Category[1]		Site Visit Conducted?	Workshop/Coordination Call Feedback (8-24-21 and 9-1-21)	Site Visit Outcome (9-27-21) (Green font reflects action items)	Project Planning[1]			
				Primary	Secondary				Hydraulic Model Expansion/ Update Need (Y/N)	Stream Assessment Location (Y/N)[2]	Project Need? (Y/N)[3]	Program Need?
1	Morey's Landing bubbler (AKA Willamette Way East bubbler)	Public Works Community Development	Localized flooding during high intense storm events. Existing bubbler meant to collect runoff from the streets and divert to grass easement area under the power line and to the river. The design (location) is flawed and the water flows into the yard of the homes that back up against the easement, requiring sandbags to redirect flow.	R/R		Y	Recent outfall projects on Belknap and Morey Lane. AKS study (2017) indicated current pipe size is not sufficient to redirect flow into pipe to SW Belnap Ct outfall. AKS study identified alternatives. Meetings have occurred with BPA related to locating a pond.	Any pond option on the BPA easement would require coordination and adequate BPA utility access. There is a high-pressured fuel line running N-S on the E edge of the easement that would need to be avoided. Infiltration rates anticipated to be high. Project development considerations: Need to understand infiltration rates for pond/gsi feasibility. Current sandbag system 'works' (UV resistant sandbags needed). Location of bubbler not ideal. Both pond/GSI and pipe upsizing in one project unlikely System modeling would be needed to assess flows and size detention.	Y	N	Y*	N
2	Frog Pond ditch and culvert under Boeckman Rd.	Public Works	Ongoing flooding issue at 6920 SW Boeckman Rd. House - foundation is only 2-3 in. higher than W Fork Meridian Creek. Possible culvert misalignment and minimal slope downstream of property.	R/R		Y	Area has presented an ongoing issue. Model extension is needed.	Existing culvert along Boeckman Road is directed toward the homeowner's garage, where peak flows come very close to the foundation. Project development considerations: Project needed to right size the culvert underneath Boeckman Rd (currently not in the model). A box culvert may be easier to maintain. Pipe the drainage along Boeckman Road beyond the property owner's house where the channel has additional vertical drop. Projects may be implemented as part of the Boeckman Road improvements	Y	Secondary	Y*	N
3	Pond F	Public Works	Possible design flaw and blockages impeding flow; potential maintenance issue.	R/R	MAINT	N		Not visited but discussed with PW staff. Pond is already included in model but scheduled for reconfiguration.	N	N	TBD	TBD
4	Library Pond	Public Works Community Development	Library Pond does not have flow control/orifice structure or emergency overflow type structure. Pond currently floods into Library parking lot and Memorial Dr near park entrance.	CAP		Y	City wants to include Library Pond expansion in fee in lieu program for Town Center redevelopment. Current configuration/ contributing drainage area in model overestimates flow contribution. Model updates needed to more accurately reflect existing drainage area to pond.	Flow from the pond is a ditch inlet that requires maintenance to keep clear from vegetation and debris (currently there is a temporary fence installed for this purpose). Project development considerations: Phase 1: retrofit the pond outlet structure to include an emergency overflow for consistency with current standard pond details. Clear vegetation and debris. Phase 2: construct flow control structure per standard details and pond outlet structure to accommodate per future growth. Include a dedicated maintenance access path. No as-builts/drainage report available to confirm existing stage-storage. Model updates required to refine the current contributing drainage area (hydrology) and evaluate capacity.	N	Primary	Y*	N

[1] Project planning outcome results are identified. TBD means that additional discussion may be warranted following modeling evaluation. Location IDs that are shaded in gray are not anticipated to require a project or program.
[2] Stream assessment locations identified as priority or secondary.
[3] Priority project location identified with a *

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				Primary	Secondary				Hydraulic Model Expansion/ Update Need (Y/N)	Stream Assessment Location (Y/N)[2]	Project Need? (Y/N)[3]	Program Need?
5	Memorial Lift Station - current location	Public Works	Ditch behind lift station occasionally overflows during heavy precipitation.	CAP		N	Lift station is being relocated to the east and should mitigate this issue.	Not visited.	N	N	N	N
6	Regional Parks 7 & 8; SW Coffee Lake Dr. Level Spreader	Public Works	Level spreader does not drain properly causing erosion issues	MAINT	E&S	N	Appears to be an operational issue only.	Not visited.	N	N	N	N
7	SW Montgomery Way	Public Works Community Development 2012 SMP	Channel and culvert issues are causing flooding. Future development (PDR1) is anticipated upstream of problem area.	CAP		N	City staff have not reported recent flooding issues here and don't consider it a project need any longer. 2012 MP identified a CIP (WD-1) for this location. Limited GIS information available to conduct modeling. City staff have not reported recent flooding issues here and don't consider it a project need any longer.	Not visited.	N	N	N	N
8	Commerce Circle near Delta Logics parking lot	Public Works Community Development	Improperly abandoned storm line on private property is causing flooding and a sink hole (safety concern).	R/R		Y	Contributing drainage area to pipeline is unclear.	Improperly abandoned storm line is not shown in the GIS. Pipe is on private property north of the street. Project/ program development considerations: Public Works would like a contracting mechanism to contract the investigation and proper abandonment of this pipe independent of the PW maintenance budget. Current sink hole is causing a safety concern. Additional as-built research is needed to identify lateral connections to the abandoned pipe.	N	N	N	Y
9	Miley Rd sinkhole	Public Works 2012 SMP	Collapsed mainline due to age and pipe corrosion has caused a sinkhole. Remaining pipe is failing and needs replacement.	R/R		Still Needed	Project location is in an extremely steep area. 2012 MP identified a CIP (SD9000 to SD9069) for this location. Location is already included in hydraulic model extents.	Not visited.	N	N	Y	TBD
10	Miley Rd outfall	Public Works 2012 SMP	Significant scouring into jurisdictional wetland.	E&S		Still Needed	Project location is in an extremely steep area. 2012 MP identified a CIP (SD9000 to SD9069) for this location. Location is already included in hydraulic model extents. Erosion issues are entering a jurisdictional wetland and thus replacement is beyond scope for maintenance.	Not visited.	N	N	Y*	N

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				Primary	Secondary				Hydraulic Model Expansion/ Update Need (Y/N)	Stream Assessment Location (Y/N)[2]	Project Need? (Y/N)[3]	Program Need?
11	Town Center Loop near Les Schwab Tire Shop	Public Works Community Development	Observed flooding along Town Center Loop W via the CBs that tie into current high flow bypass. Town Center redevelopment will impact high flow bypass for flows towards Library Pond.	CAP		Y	In 2015, ODOT installed a reducer on the 18" pipe that outfalls west before entering ODOT culvert under I-5.	ODOT reducer (12" as verified by PW 10-11-21) limits the existing 18" pipe that outfalls west to the ODOT culvert underneath I-5. Town Center redevelopment will remove the high flow bypass that currently sends flow south towards Library Pond. PW has observed flooding along Town Center Loop W via the CBs that tie into this current high flow bypass line. Project development considerations: Model development needed to determine when it floods, and project need for existing conditions. Future conditions will be driven by adherence to Town Center plan.	Y	N	Y	N
12	Rose Ln culvert	Public Works Community Development 2012 SMP	Culvert under Rose Lane floods road and neighboring yard/garage on downstream side. Drainage is very flat with several hard turns. Future development (PDR1) is anticipated upstream of problem area.	CAP	MAINT	Y	City has implemented programmatic activities to resolve the issues but is still a problem. 2012 MP identified a CIP (WD-2) for this location. Limited GIS information available to conduct modeling. Boeckman Road project may inform need.	Culvert underneath Rose Lane floods as vegetation on the upstream side blocks flow and drainage overtops the road and floods the neighbor's yard/garage on the downstream side. Drainage patterns here take several hard turns and is very flat. Project development considerations: Realign the existing culvert (at a diagonal) and/or install a secondary culvert south across Rose Lane to alleviate the US ponding that occurs in the adjacent field.	N	N	Y	N
13	SW Parkway Ave south of Costco	Public Works	N-S drainage swale south of Parkway has filled with sediment, surcharging the roadway drainage system, and resulting in ongoing maintenance. Ditch is owned and maintained by Sysco) but receives flows from both public and private sources. Upstream drainage from Costco includes a large underground detention system that does not function properly and holds water year-round. Related to Problem Area #30.	MAINT	CAP	Y	Ongoing maintenance issue. Grade of swale and channel is a concern. Ditch was recently dredged. Location is already included in hydraulic model extents.	Sysco ditch experiences high sedimentation rates due to minimal grade for the first section of the ditch. Sysco has plans to develop the lot to the west of the ditch, but timeline for this is unknown. Project development considerations: Since this is a complicated issue (Sysco owns ditch but receives drainage from others both public/private), City may install WQ manhole (s) to remove sediments from public runoff. This would isolate any additional sediment accumulated in Sysco ditch to private sources. Hydraulic model review is needed to confirm long stream profile for potential improvement opportunities. Public works confirmed 36" pipe from Costco to 40" pipe to Sysco ditch (may attribute to Costco backwater).	N	N	TBD	TBD
14	Culvert south of Day Rd.	Public Works	Culvert needs replacement. Conveyance and storage limitations exist south of Day Rd (limited areas, BPA towers, narrow channel, etc.). Related to Problem Area #15/26.	R/R		Y	Location is already included in hydraulic model extents. AKS Coffee Creek system evaluation included additional survey that needs to be incorporated into model. Need to evaluate area from larger perspective and investigate US/DS opportunities for improvement.	See Problem #15.	Y	Secondary	Y*	N

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15	South of Day Road ponds near power lines behind businesses	Public Works 2012 SMP	Without brush clearing, the ponds south of Day Road back up and flow onto the road. Conveyance and storage limitations S of Day Rd (limited areas, BPA towers, narrow channel, etc.). Related to Problem Area #14/26.	MAINT		Y	Location is already included in hydraulic model extents. 2012 MP identified a CIP (CLC-1) for this location. AKS Coffee Creek system evaluation included additional survey that needs to be incorporated into model. Need to evaluate area from larger perspective and investigate US/DS opportunities for improvement.	Area studied as part of AKS Coffee Creek Facility Study. Effort worked to identify infrastructure needs and alternatives). The 2012 MP also included several capital projects to address these issues. Project development considerations: AKS study did not directly incorporate survey into existing condition model (extra effort required to incorporate survey independently into the hydraulic model). AKS study does not alleviate flooding.	Y	Secondary	TBD	TBD
16	95th Ave north of Hillman Rd.	Public Works	Crushed storm pipe found during CCTV inspection.	R/R		N	Location is already included in hydraulic model extents. Per City (10-1-21), replacement being completed as CIP #7062 95th Avenue Storm Line Repair. North repair is replacement of 120 LF of existing 24" CMP with 24" PVC (Carte ID 2335). South Repair is replacement of 44 LF of 15" CMP with 15" PVC (Carte ID 2337).	Not visited.	N	N	N	N
17	Mont Blanc in Villebois	Public Works	Tree planted in front of inlet blocking drainage into swale	MAINT		N	Appears to be an operational issue.	Not visited.	N	N	N	N
18	Memorial Park drainage area behind the barn	Public Works	Same drainage ditch that causes issues with Memorial lift station (see Location ID5).	CAP		N	Lift station is being relocated to the east and should mitigate this issue.	Not visited.	N	N	N	N
19	NW intersection of Elligsen Road and SW Parkway Ave near 76 gas station	Public Works External Survey	During heavy precipitation the CB backs up and floods the road at the corner	CAP		N	Additional CBs were installed with roadway improvements at low points and has alleviated flooding issue.	Visited surrounding property area and confirmed no issue.	N	N	N	N
20	NE corner of Elligsen Road and SW Parkway Center	Public Works	Sediment from the agriculture area north of Elligsen Road impacts Pheasant Ridge RV Park detention pond.	MAINT		N	Appears to be an operational issue.	Not visited.	N	N	N	N
21	NW corner of Graham Oaks parking lot	Public Works	Erosion around outfall sends debris into creek.	E&S		N	Outfall included in model for capacity only, does not evaluate erosion. Public Works filled with CDF and is continuing to monitor for erosion.	Not visited.	N	N	N	N

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22	Converted bubbler River Fox Park & SW Preakness	Parks Department (via) Public Works	Piped collection system is outside of the ROW and pipe diameter is reduced. Leaf debris affects the manhole in front of 11591 SW Preakness limits flow to mainline to Willamette Way East causing flooding. "Bubbler" manhole at fenceline acts like a sump.	MAINT	CAP	Y	Manhole (Cartograph # 57) surcharges and water exits the system, overflowing to inlet Cart #1240. Issue is capacity and whether the manhole should be redesigned to actually be a bubbler and not a surcharged manhole.	Complicated SW configuration. Pipe size changes from 24" to 18" to 12". Based on conversations with the property owner at 11242 SW Champoeg Dr (adjacent to inlet grate in SW corner of park) no flooding occurs here. Project development considerations: May consider installation of a pipe to directly tie runoff that is coming from Preakness Dr. into the MH at the end of Champoeg Dr. Following site visit, PW confirmed with Parks that this is nonissue. Clearing grates of any leaf debris addresses the issue. Future CCTV at this location may be warranted to confirm configuration.	N	N	N	N
23	Cul-de-sacs west of Serenity Way	Public Works	Inlets at Pleasant (Cartograph #1750) and Serenity Ln. (Cartograph #1748) become covered with leaf debris causing cul-de-sacs to flood.	CAP		N	Installation of additional inlets near the intersection of Serenity Ln. may prevent ponding at the bottom of the cul-de-sac.	Not visited but confirmed that additional inlets can be included in a programmatic effort.	N	N	N	Y
24	Catch basins corner of Wilsonville Rd & Kinsman Rd	Public Works	Recurring flooding at catchbasins occurs after cleaning.	CAP	MAINT	Still Needed	Location is already included in hydraulic model extents.	Not visited.	N	N	TBD	TBD
25	SW Salish Ln at intersection with Parkway Ave	Public Works	Undersized catch basins cause flooding (ponding in SE corner by pond).	CAP		Y	Location is already included in hydraulic model extents, but with limited detail. As-builts provided from City reflect drainage ditches but no cross sections for ditches.	City pond at the Shrine Center receives a small amount of drainage and requires frequent maintenance. Project development considerations: Need improved access (for a vactor truck) to the WQ MH and pond maintenance (like Library Pond). Access should be from the Shrine Center parking lot. Refinement of the model extents not needed.	N	N	Y	TBD
26	Day Rd culvert at Tapman Creek near PGE substation	Public Works	Undersized culvert over capacity causing flooding. Conveyance and storage limitations S of Day Rd (limited areas, BPA towers, narrow channel, etc.). Related to Problem Areas #14/15.	CAP		Y	Location is already included in hydraulic model extents. Need to evaluate area from larger perspective and investigate US/DS opportunities for improvement.	See Problem #15.	N	Secondary	Y*	N
27	Storm basin SW Iron Horse St & SW Willow Creek Dr	Public Works	Reoccurring maintenance issues causing flooding; mix of private and City maintained structures	MAINT		N	Appears to be an operational issue.	Not visited.	N	N	N	N
28	SW Advance Rd btwn Stafford Rd & SW 63rd Ave	Public Works	Outfall blockage issues caused by vegetation. City cannot access to fix	MAINT		N	Appears to be an operational issue.	Not visited.	N	N	N	N

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29	SW Daybreak St & SW Morningside Ave	Public Works	Capacity issues with Renaissance detention pond. Possible elevation or directional issue with flow out of detention pond	CAP		N	Renaissance Pond is included in existing hydraulic model. City confirmed configuration and pond outlet to west.	Not visited.	N	N	TBD	N
30	Sysco drainage ditch south of Parkway Ave	Public Works Community Development	Historical flooding issues; can no longer be accessed due to newly constructed fence. Ditch is owned and maintained by Sysco) but receives flows from both public and private sources. Upstream drainage from Costco includes a large underground detention system that does not function properly and holds water year-round. Related to Problem Area #30.	CAP	MAINT	Y	Ongoing maintenance issue. Grade of swale and channel is a concern. Ditch was recently dredged. Location is already included in hydraulic model extents.	See Problem #13. Same issue.	N	N	Y	TBD
31	Off Canyon Creek Road; catch basin in a residential backyard	Public Works	When farmer plows the field east of area debris enters catch basin and causes backups.	MAINT		N	Appears to be an operational issue.	Not visited.	N	N	N	N
32	Drainage ditch west & south of Delta Logistics	Public Works 2012 SMP	Overflow floods parking lot/channel conveyance issues. Related to Problem Area#15.	CAP		Y	Location is already included in hydraulic model extents. 2012 MP identified a CIP (CLC-3) for this location. AKS Coffee Creek system evaluation included additional survey that needs to be incorporated into model. Need to evaluate area from larger perspective and investigate US/DS opportunities for improvement.	See Problem #15. Same issue.	Y	Secondary	Y*	N
33	Elligsen Rd and Parkway Center Dr near Jeep Dealership	Public Works	Bubbler does not operate as designed; runoff goes over road.	R/R		N	Bubbler location is mapped incorrectly (located on SW Canyon Creek Rd near Burns Way). Issue deemed to be not significant by COW staff.	Not visited.	N	N	N	N
34	95th Ave at Grace Chapel	Public Works Community Development	Outfall blockage in ODOT right of way.	MAINT		N	Appears to be an operational issue requiring coordination with ODOT.	Not visited.	N	N	N	N
35	Culverts under I-5	Public Works	End of design life and need to be replaced (already modeled). Various locations along Parkway Ave & Boones Ferry Rd.	R/R		Still Needed	Locations already included in hydraulic model extents. Requires coordination with ODOT.	Not visited.	N	N	TBD	TBD

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36	Culverts under Jobsey Ln. and Arrowhead Creek	Public Works 2012 SMP	Damaged and old culverts (already modeled), need to be replaced	R/R		Y	Locations already included in hydraulic model extents. 2012 MP identified a CIP (CLC-9) for this location.	Not visited.	N	N	Y	TBD
37	Boeckman Creek N of Colvin Ln.	Public Works	Erosion of streambank and migrating channel.	E&S		N	Potential stream survey evaluation area	Not visited.	N	Primary	Y	N
38	Villebois neighborhoods	Public Works	Ponding issues in front of mailboxes.	R/R		N	Staff is unaware of any ponding in this area. Existing modeling extents are adequate.	Not visited.	N	N	N	N
39	Villebois neighborhood	Public Works	Concerns about the various detention ponds and whether they are being maintained appropriately. Maintenance issues include Grahams Ferry Pond – potential design issues for the WQ manhole and adjacent outlets. Palermo (Pond F) - a large concrete pond off Grahams Ferry Road requires routine maintenance to prevent upstream tailwater issues.	MAINT		Still Needed	HOA is responsible for maintenance of ponds (currently overgrown with vegetation) and the City maintains the inlets and outlets. Grahams Ferry Pond has some design issues associated with the WQ manhole and adjacent inlets. Tooze Pond needs to be added to the hydraulic model (need stage-storage curve).	Not visited but discussed with PW. Pond maintenance is an ongoing issue. Recommend dedicated program to address and review of SOPs.	Y	N	TBD	Y
40	Citywide	Public Works	1996 flooding event	CAP		N	No additional information provided for specific areas/structures of concern.	Not visited.	N	N	N	N
41	Citywide	Public Works	2006 flooding event	CAP		N	No additional information provided for specific areas/structures of concern.	Not visited.	N	N	N	N
42	Citywide	Public Works	2015 flooding event	CAP		N	No additional information provided for specific areas/structures of concern.	Not visited.	N	N	N	N
43	Town Center Loop W - Shari's	External Survey	Drainage issues -Shari's parking lot.	CAP		N	Issue to be resolved with SW infrastructure proposed in Town Center Plan (2019).	Not visited.	N	N	Y	N
44	Town Center Loop W - Starbucks	External Survey	Drainage issues -Starbucks parking lot.	CAP		N	Issue to be resolved with SW infrastructure proposed in Town Center Plan (2019).	Not visited.	N	N	Y	N
45	Coffee Creek	External Survey	Lots of trash within creek at various locations (especially at choke points).	MAINT		N	Locations already included in hydraulic model extents, but need to verify configuration.	Not visited but location discussed with PW. Modeling refinements to incorporate the 30" and 36" lines from the Coca Cola Pond, starting at Seely Road to Coffee Creek.	Y	N	N	N
46	29851/29840 SW Camelot St	External Survey	Flooding from storm drain street grate. Grate clogs with debris .	MAINT		N	Appears to be an operational issue.		N	N	N	Y

Table A-2. Project Opportunity Matrix

Project Opportunity Location ID[5]	Previous Problem Area Location ID	Location/ Asset Description	Basin	Source	Problem Description	Deficiency Category[1]		Site Visit Conducted (Y/N)	Project Planning[2]					Project/Program Development			
						Primary	Secondary		Hydraulic Model Developed? (Y/N)	Modeled Capacity Deficiency (Y/N)	Stream Assessment IDd Need (Y/N)[3]	Water Quality Retrofit Opportunity (Y/N)	Project Development Considerations (per Workshop and City Discussions)	Costed Capital Project Need? (Y/N)[4]	Unfunded or Future Capital Project Need? (Y/N)[4]	Program Need? (Y/N)	Policy Need?
1	1	Morey's Landing bubbler (AKA Willamette Way East bubbler)	Willamette River	Staff Surveys	Localized flooding during high intense storm events. Existing bubbler meant to collect runoff from the streets and divert to grass area within the BPA power line easement and to the river. 2012 AKS study identified deficient pipe capacity, preventing flow from reaching SWM Belknap Court outfall. Water flows into yards adjacent to the easement, requiring sandbags to redirect flow.	R/R	WQ	Y	Y	Y	N	Y	• Project area is adjacent to high pressure fuel line. • Project will require continued coordination with BPA to locate water quality facility and maintain utility access. • Need to understand infiltration rates for retention/GSI feasibility. • Current sandbag system 'works' (UV resistant sandbags needed). Location of bubbler not ideal. • GSI and pipe upsizing in one project unlikely	Y- WR-1, Phase 1 and 2	--	--	--
2	2	Frog Pond ditch and culvert under Boeckman Rd.	Meridian Creek	Staff Surveys H&H Model	Ongoing flooding issue at 6920 SW Boeckman Rd. Culvert along Boeckman Road directs flows toward an existing garage. The foundation is only 2-3 inches higher than W Fork Meridian Creek. Possible culvert misalignment and minimal slope downstream of property.	R/R	CAP	Y	Y	Y	Y	N	• Project Fact Sheet and Cost Estimate prepared March 2022. • Project currently in design as part of the Boeckman Road improvements • Piped drainage system extended along Boeckman Road beyond the existing house, where the channel has additional vertical drop.	N	N	N	N
3	3, 39	Pond F and other ponds in Villebois	Coffee Lake Creek	Staff Surveys	Concerns whether various private detention ponds are being maintained appropriately. HOA is responsible for maintenance of ponds (currently overgrown with vegetation) and the city maintains the inlets and outlets. Maintenance issues include Grahams Ferry Pond – potential design issues for the WQ manhole and adjacent outlets. Palermo (Pond F) - a large concrete pond off Grahams Ferry Road requires routine maintenance to prevent upstream tailwater issue.	R/R	MAINT	Y	Y, except for Grahams Ferry Pond	N	N	Y	• H/H model updated to include relevant facilities. • Active maintenance implemented by HOA. • Workshop recommendation – Need program for restorative maintenance of ponds (especially private). Current PW staffing doesn't support private pond maintenance. • Policy recommendation – Implement an escalating, more robust enforcement protocol with provisions for City-initiated maintenance subject to private property reimbursement. • Per City (6/9/23) – Pond F swales above the level spreader have been cleaned out and are no longer causing issues.	N	N	Y- P-6	Y
4*	4	Library Pond	Boeckman Creek	Staff Surveys Retrofit Analysis H&H Model	Library Pond does not have flow control/orifice structure or emergency overflow type structure. Pond currently floods into Library parking lot and Memorial Dr near park entrance.	CAP	WQ	Y	Y	Y	N	Y	• Primary objective is to accommodate redevelopment of the Town Center; secondary is to accommodate Boeckman mitigation needs. • As-builts (stage-storage) incorporated into H&H evaluation.	Y – BC-1	--	--	Y

N/A = Not Applicable
Project Opportunities in gray have been removed from consideration for further project development.
[1] Categories include: MAINT=Maintenance; R/R=Repair and Replacement; CAP=Capacity Issue; E&S=Instream Erosion/Sediment Issue; INFRA=New infrastructure need per growth and development; WQ= Water Quality.
[2] Project planning outcome results are identified. TBD means that additional discussion may be warranted following modeling evaluation. Location IDs that are shaded in gray are not anticipated to require a project or program.
[3] Stream assessment locations identified as priority or secondary.
[4] Costed Project needs = Y were confirmed with City during on 3-15-23 and require a conceptual design, fact sheet and cost estimate. Unfunded Project needs will be documented in the SMP but will not have a conceptual design or cost associated. The resulting Project ID is listed for reference.
[5] Project Opportunity Locations affiliated with the Boeckman Road mitigation efforts are indicated with a *.

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						Primary	Secondary		Hydraulic Model Developed? (Y/N)	Modeled Capacity Deficiency (Y/N)	Stream Assessment IDd Need (Y/N)[3]	Water Quality Retrofit Opportunity (Y/N)	Project Development Considerations (per Workshop and City Discussions)	Costed Capital Project Need? (Y/N)[4]	Unfunded or Future Capital Project Need? (Y/N)[4]	Program Need? (Y/N)	Policy Need?
					Ongoing challenges with debris removal at existing ditch inlet (which serves as outlet from pond). City has considered expanding the pond as part of the fee in lieu program for Town Center redevelopment.								• BC to document findings specific to future policy requirements and cost improvements to the pond to adhere to current design criteria. • Policy recommendation –Require portions of redevelopment to install onsite treatment and flow control to ensure capacity in Library Pond as a fee-in-lieu opportunity.				
5	9, 10	Miley Rd sinkhole and outfall	Charbonneau	Staff Surveys 2012 SMP H&H Model	2012 MP CIP SD9000 to SD9069. Collapsed mainline due to age and pipe corrosion has caused a sinkhole at eastern edge of pipe alignment. Challenge is exacerbated by steep slopes. Remaining pipe along Miley Rd. is failing and needs replacement. Significant scouring into jurisdictional wetland. Upstream capacity deficiencies indicated by H/H modeling (preliminary flooding location #1).	R/R	CAP	Y	Y	Y	N	N	• Steep slopes will require geotechnical evaluation. • Erosion issues are entering the jurisdictional wetland, and beyond the scope of maintenance actions, such as adding riprap to dissipate energy at the outfall. • Upstream end is collapsed (replacement in kind) and upsizing with outfall. Alignment is under private retaining wall. • Modeled capacity deficiencies at the upstream portion of the alignment (due to hydrologic inputs)	Y – WR-2, Phase 1 and 2	--	--	--
6	11	Town Center Loop near Les Schwab Tire Shop	Boeckman Creek	Staff Surveys	Observed flooding along Town Center Loop W via the CBs that tie into current high flow bypass. Existing reducer (12" control on 18" pipe) was installed in 2015 to limit flow toward ODOT culvert under I-5. Restriction contributes to upstream problems through Town Center Loop. Town Center redevelopment will remove the high flow bypass for flows towards Library Pond.	CAP		Y	Y	N	N	N	• Model does not reflect flooding in this location. • Future conditions will be driven by adherence to Town Center Plan. • Discussion during 3-15 Wksp confirmed not an immediate need. • Policy recommendation – As a best practice, establish public/private partnerships in conjunction with road overlay efforts to replace damaged private stormwater pipe.	N	N	N	Y
7	12	Rose Ln culvert	Willamette River	Staff Surveys 2012 SMP	2012 MP identified a CIP WD-2 for this location. Culvert under Rose Lane floods road and neighboring yard/garage on downstream side. Drainage pattern is very flat with several hard turns. Future development (PDR1) is anticipated upstream of problem area.	CAP	MAINT	Y	N	N/A	N	N	• Realign the existing culvert (at a diagonal) and/or install a secondary culvert south across Rose Lane to alleviate the US ponding that occurs in the adjacent field. • Consider opportunity to construct project in conjunction with future upstream development (PDR1). • Discussion during 3-15 Wksp confirmed historic project need requiring cost estimate.	Y – WR-3	--	--	--
8	13, 30	SW Parkway Ave south of Costco	Boeckman Creek	Staff Surveys H&H Model	N-S drainage swale south of Parkway has flat grades and is routinely filled with sediment, surcharging the roadway drainage system, and resulting in an ongoing maintenance concern.	MAINT	CAP	Y	Y	Y	N	Y	• Public works confirmed 36" pipe from Costco to 40" pipe to Sysco ditch (may attribute to Costco backwater). • Sysco intends to expand its footprint at this location, so private development may alleviate immediate open channel issue.	N	Y	Y- P-1	--

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					Ditch is owned and maintained by private owner (Sysco) but receives flows from both public and private sources. Upstream drainage from Costco includes a large underground detention system that does not function properly and holds water year-round. Modeled results indicate flooding at US node of 30" culvert at N-S end of ditch.								• Future Project/ Program Recommendation - City may install WQ manhole(s) or other facilities to remove sediments from public runoff (Localized Drainage Improvements Program or Green Street/LID Retrofit). This would isolate any additional sediment accumulated in the ditch to private sources (could be done as part of a program activity).				
9	14, 15, 26, 32	Open channel system from Day Rd. to Ridder Rd	Coffee Lake Creek	Staff Surveys 2012 SMP H&H Model	Culvert needs replacement. Conveyance and storage limitations exist south of Day Rd (limited areas, BPA towers, narrow channel, etc.). Existing AKS design does not fully alleviate modeled flooding.	R/R		Y	Y	Y	N	Y	• AKS Coffee Creek system evaluation included additional survey that was incorporated into model as part of validation efforts. AKS evaluation did not include impoundment (incorporated into BC model) or updated hydrology. • Need to evaluate area from larger perspective and investigate US/DS opportunities for improvement. • Discussion during 3-15 Wksp indicated purchasing the adjacent (to the west) parcel for installation of the detention pond (AKS concept) is complicated by access road issues. • BC to confirm feasibility of improvements and 100-year WSE with respect to adjacent structures. City to confirm what level of future flooding is acceptable. • Policy recommendation – May be required to limit/ confirm adherence to City stormwater standards upstream (north) of Day Rd and establish similar standards for Tualatin discharge. • Planning Project – Conduct flow monitoring prior to Phase 2 initiation to confirm sizing needs.	Y – CLC-1, Phase 1 and 2 and City-1	--	Y- P-5	Y
10	24	Catch basins corner of Wilsonville Rd & Kinsman Rd	Coffee Lake Creek	Staff Surveys	Recurring flooding at catch basins occurs even after cleaning.	CAP	MAINT	N	Y	N	N	Y	• Reconstruction is occurring so this may not be a pressing issue; future deficiencies to be addressed as part of a program (Localized Drainage Improvements Program)	N	N	Y- P-1	N
11	25	SW Salish Ln at intersection with Parkway Ave	Coffee Lake Creek	Staff Surveys H&H Model	Undersized catch basins cause flooding (ponding in SE corner by pond). A city-owned pond at the Shrine Center receives a small amount of drainage and requires frequent maintenance. Model predicts flooding within the pond and outlet. Pond configuration is based on original model build from 2012 SMP (preliminary flooding location #10).	CAP		Y	Y	Y	N	N	• Need improved access for a vactor truck to access the WQ MH and pond for maintenance. Access should be from the Shrine Center parking lot. • Refinement of the model extents or pond configuration determined to not be needed. • Program Recommendation - Localized Drainage Improvements Program or Green Street/LID Retrofit.	N	Y	Y- P-1	N

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													• Other option would be documentation of an unfunded project for maintenance enhancement.				
12*	29	SW Daybreak St & SW Morningside Ave	Coffee Lake Creek	Staff Surveys	Capacity issues with Renaissance detention pond. Possible elevation or directional issue with flow out of detention pond. Opportunity to improve water quality treatment through retrofit and reconfiguration of existing pond property.	CAP		Y	N	N	N	Y	• Possible pond retrofit to increase storage capacity and improve water quality treatment. • Location is also affiliated with Boeckman Road mitigation alternative locations and Ash Meadows (Project Opportunity Location #26), but not a prioritized location. • Workshop recommendation – Need program for restorative maintenance of ponds (especially private). Current PW staffing doesn't support private pond maintenance. • Policy recommendation – Implement an escalating, more robust enforcement protocol with provisions for City-initiated maintenance subject to private property reimbursement.	N	N	Y- P-6	Y
13	35	Culverts under I-5	Coffee Lake Creek	Staff Surveys H/H Model	End of design life and need to be replaced. Various locations along Parkway Ave & Boones Ferry Rd (crossings from E-W).	R/R		N	Y	Y	N	N	• Project may be referred to ODOT; not one that the City would initiate. • Locations already included in hyd. model.	N	N	N	N
14	36	Culverts under Jobsey Ln. and Arrowhead Creek	Coffee Lake Creek	2012 SMP Stream Assessment	2012 MP identified CIP CLC-9 for this location. Damaged and old culverts (already modeled), need to be replaced	R/R	E&S	Y	Y	N	Y	N	• Locations already included in hydraulic model. • Combine with Project Opportunity #20.	Y – CLC-2	--	N	N
15	37	Boeckman Creek N of Colvin Ln.	Boeckman Creek	Staff Surveys 2012 SMP	2012 MP identified BC-8 (Canyon Creeks Estate Pipe Removal) for this location. Erosion of streambank and migrating channel reported in downstream portion of the project site.	E&S	WQ	Y	Y	N	N	N	• Consider more detailed stream survey evaluation to understand channel constraints and extents of potential planting. • Per meeting on 3-8, City confirmed ongoing issue. Refer to 2012 SMP.	Y – BC-4	--	N	N
16	43, 44	Town Center Loop W - Shari's and Starbucks	Boeckman Creek	External Survey	Drainage issues - Shari's and Starbucks parking lot (down the road from each other).	CAP		N	Y	N	N	TBD	• May be localized ponding addressed with addition of inlets (programmatic). • This issue was identified to be addressed through the Town Center Plan (2019). • Discussion during 3-15 Wksp confirmed not an immediate need. • Policy recommendation – As a best practice, establish public/private partnerships in conjunction with road overlay efforts to replace damaged private stormwater pipe.	N	N	N	Y
17		Boeckman Creek - Reach 1 (US of Willamette R.)	Boeckman Creek	Stream Assessment	Significant risk of continued channel incision and lateral erosion along the lowest reach of Boeckman Creek prior to confluence of the Willamette River. Several properties have experienced bank failures and loss of land, and an active	E&S		Y	Y	N	Y	Y	• Consider upstream opportunities to reconnect floodplain, allow high flows to expand laterally, and dissipate channel energy. • Boeckman Road mitigation efforts (in progress) include evaluation of the tributary channel to the	Y- City-4	Possible	N	N

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					landslide is impacting the backyard and deck of one of the properties.								main reach of Boeckman and potential modification to increase upstream retention. • Per 3-15 Wksp, efforts may include stabilizing the channel and apply grade control; geotechnical investigation; retaining/ crib wall or soldier pile. • June 2023 – Per City - location to part of ongoing monitoring project (planning project need)					
18		Meridian Creek in Landover Park - Reach 1 (US of Wilsonville Rd.)	Meridian Creek	Stream Assessment	Sediment-clogged culvert (30-inch) at the Meridian Creek Crossing at Wilsonville Road. Culvert is mostly obstructed and appears to cause ponding during storm runoff.	MAINT	E&S	Y	Y	N	Y	N	• Consider location of ponding and whether infrastructure is being impacted. • If ponding is isolated to park and not overtopping any roadways or impacting private property, then maybe this isn't a problem that needs to be fixed. It's effectively a detention pond. • Per Wksp 3-15, planning project need to monitor location and confirm worsening.	Y-City-2	N	Y-P-5	N	
19		Meridian Creek in Landover Park - Reach 2 (DS of Willow Creek Dr.)	Meridian Creek	Stream Assessment	Culvert outlet at upstream end of reach is clogged and backs up water underneath Willow Creek Dr. PVC SW outfall along reach is undermined (STA 1,100) and 6-foot section has washed out and moved downstream.	MAINT	E&S	Y	Y	N	Y	N	• Need in-water work permits to replace culvert. • Traffic impacts to Willow Creek Drive during culvert replacement. • Per Wksp 3-15, planning project need to monitor location and confirm worsening.	Y-City-2	N	Y-P-5	N	
20		Arrowhead Creek at Pedestrian Bridge (Reach 4)	Coffee Lake Creek	Stream Assessment	Culvert at upstream end of reach (at pedestrian crossing) is failing and should be considered for replacement.	R/R		Y	Y	N	Y	N	• Need in-water work permits to replace culvert. • See Project Opportunity #14.	Y – CLC-2	N	N	N	
21*		Memorial Park (Swale Retrofit, Pipe Upsizing, and Mitigation)	Boeckman Creek	Retrofit Analysis H/H Model	Swale at Memorial Dr. is not draining properly. Potential concept is to extend swale all the way along the road or relocate to the base of hill. Modeling evaluation indicates that the pipe system after convergence point at Memorial Drive has a constriction resulting in backwater and upstream system flooding (preliminary flooding location #5).	MAINT	CAP	Y	Y	Y	N	Y	• Opportunity to expand water quality treatment through retrofit of existing facility. • Location is also affiliated with Boeckman Road mitigation alternative location (raising of pedestrian trail to detain flow from entering Boeckman Creek). • Relocation of swale allows for offline facility construction. •	Y – BC-5	--	N	N	
22		Oulanka and Tivoli Parks	Coffee Lake Creek	Retrofit Analysis	6 swales haven't been maintained properly - 2 are City owned and 4 need to be retrofitted and taken over by City	MAINT	WQ	Y	N	N/A	N	Y	• Level spreaders aren't working well. • Opportunity to expand water quality treatment through retrofit of existing facility. • June 2023 – Per City – PW already fixed the swales. Instead, recommend unfunded project or program for restorative maintenance of facilities (especially private). Current PW staffing doesn't support private facility maintenance. • Policy recommendation – Implement an escalating, more robust enforcement protocol with provisions for City-initiated maintenance subject to private property reimbursement.	N	Y	Y-P-6	Y	

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23*		Creekside Apartments (Boeckman Creek at Wilsonville Rd.)	Boeckman Creek	Boeckman Road Mitigation Study Retrofit Analysis	City staff have identified a former irrigation pond near this apartment complex adjacent to Boeckman Creek. This location may have potential to provide additional storage or provide mitigation measures. Upstream of this location there is an existing outfall to Boeckman Creek that has known erosion issues per the 2012 SMP (BC-5).	CAP	WQ	Y	N	N/A	N	Y	• Opportunity to expand water quality treatment through retrofit of existing facility. • Boeckman Road mitigation efforts originally identified as a potential flow mitigation site but was not prioritized for alternative evaluation. • Will require private property partnership. • Policy recommendation – Implement an escalating, more robust enforcement protocol with provisions for City-initiated maintenance subject to private property reimbursement.	N	Y	N	Y
24*		Wiedeman Ditch/ Canyon Creek Park/BPA Easement	Boeckman Creek	Boeckman Road Mitigation Study 2012 SMP Retrofit Analysis	City staff identified potential project opportunity to construct a regional wetland or drainage facility at this location (would require BPA coordination). Facility would be able to manage runoff from Argyle Square, Sysco, and other future developments to help offset Boeckman Creek flows. This location is adjacent to previously identified erosion issues within Canyon Creek Estates (BC-8).	CAP	WQ	Y	N	N	N	Y	• Opportunity to expand water quality treatment and increase detention/retention through retrofit of existing facility. • Boeckman Road mitigation efforts evaluated storage capabilities in Wiedeman Ditch and Canyon Creek. This location is one of the preferred alternatives. • Will require coordination with BPA. • Potential mitigation opportunity for Sysco redevelopment (discussions in progress).	Y – BC-3, Phase 1 and 2	--	N	N
25*		Mentor Graphics/Siemens Ponds	Coffee Lake Creek	Boeckman Road Mitigation Study	Existing series of ponds located on Siemens property (8005 Boeckman Rd) currently only provide flow through storage. Ponds have potential to be modified to provide detention or reconfigured to divert less flow to Boeckman Creek during large storm events.	CAP		Y	Y	N	N	Y	• Opportunity to expand water quality treatment and increase detention/retention capacity through retrofit of existing facility. • Boeckman Road mitigation efforts included evaluation of potential bypass for low flow conditions and reroute from Boeckman to Coffee Creek watershed (in line with historic drainage patterns). See Project Opportunity #26. This location is one of the preferred alternatives.	Y – BC-2	--	N	N
26*		Mentor Graphics/Siemens Flow diversion structure and Ash Meadows Detention	Coffee Lake Creek	Boeckman Hydraulic Eval TM	Eliminate flow diversion structure on private property that diverts flows to Boeckman Creek during high flows (Project Opportunity Area 25). To account for additional flow returning to the Coffee Lake Creek drainage basin, utilize the Ash Meadows area to detain flows prior to entering the ODOT culvert underneath I-5. Utilize the volume of the natural depression near Ash Meadows to detain flows during large storm events.	CAP	WQ	Y	Y	N	N	N	• Boeckman Road mitigation efforts evaluated flow control potential at this location. This location is one of the preferred alternatives. • May require additional capital improvement projects downstream of Ash Meadows to ensure adequate conveyance capacity is available. • Will require coordination with ODOT.	Y – BC-2	--	N	N
27*		Boeckman Creek Instream flow mitigation and restoration	Boeckman Creek	Boeckman Hydraulic Eval TM	Within Boeckman Creek, several concepts have been identified to provide flow mitigation for projected increases in flow.	CAP	E&S	Y	Y	N	Y	Y	• Boeckman Road mitigation efforts indicated that instream improvements wouldn't provide the level of flow protection required.	Y- City-2	N	Y- P-5	N

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				Retrofit Analysis	Specific locations within Boeckman Creek have not been identified at this stage: • Beaver Analogs: Increase the depth and size of natural ponding within the creek. This would supplement the existing population of beavers and dams currently within Boeckman Creek. • Channel Improvements: Protect, harden, or slow flow in areas potentially impacted by the change in creek flows. May include the addition of large woody debris, large root wads, grade control structures or other appropriate measures to protect threatened stream banks."								• Program need - Instream restoration or vegetation enhancement. Project needs may stem from monitoring efforts.				
28		Charbonneau West - SW French Prairie Rd and SW Boones Bend Rd.	Charbonneau	2012 SMP	Stormwater system within the western portion of Charbonneau was identified in the 2012 SMP as a location that requires replacement	R/R	CAP	N	Y	Y	N	N	• Model indicates limited capacity deficiency at this location. • The 2012 SMP and subsequent Charbonneau Plan identified the piped infrastructure at this location in need of repair and replacement. • Per 3-15 Wksp, City confirmed need to cost out capital project for this area per the R/R Chabonneau Infrastructure Master Plan.	Y – WR-5	--	N	N
29		Charbonneau East-SW French Prairie Rd Outfall and SW Edgewater	Charbonneau	H/H Model 2012 SMP	Model predicts flooding at this outfall and along the SW Edgewater piped system. Predicted flooding along this system generally starts at the 10-yr design storm, while the most upstream pipe segments along SW Edgewater are predicted to start at the 2-yr design storm. Restriction is caused by undersized outfall (30") in comparison to upstream pipe segments (36"). This outfall pipe was replaced in 2018 during an emergency repair but was not upsized to 36" per the recommendation from the 2012 SMP.	CAP	R/R	N	Y	Y	N	N	• Model indicates limited capacity deficiency at this location. • Wallis Engineering is currently designing the portion of the system on Edgewater that contributes to this outfall. Per City (11-2-22), no capital project needed for Edgewater component.	N	N	Y- P-4	N
30		Charbonneau East-SW French Prairie Rd and SW Old Farm Rd piped system	Charbonneau	2012 SMP	Model predicts flooding throughout these piped systems starting at the 2-yr design storm due to insufficient capacity at the outfall pipe (Project Opportunity #29). Flooding at this location could impact the residential properties within Charbonneau.	R/R	CAP	Y	Y	Y	N	N	• Model indicates limited capacity deficiency at this location. • Alternatives evaluated include inline detention upstream along SW French Prairie Rd and/or SW Old Farm Rd and replacement of outfall. Due to space limitations a detention pipe within the roadway cannot provide adequate flow control. • Planning Project – Conduct flow monitoring prior to Phase 2 initiation to confirm sizing needs. • City to confirm how much modeled flooding is acceptable.	Y – WR-4, Phase 1 and 2 and City-1	--	N	N

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31		Parkway Ave./Metolius Ln.	Willamette River	H/H Model 2012 SMP	Model predicts flooding at several nodes along N-S run of pipe starting at the 10-yr design storm. Capacity is limited by the small diameter (21") pipes near the outfall which is causing a constriction. Flooding at this location could threaten the adjacent properties along SW Parkway Ave.	CAP		N	Y	Y	N	N	• Invert elevation in MH prior to outfall are misaligned, causing constriction. • Per 3-15 Wksp, PW Ops confirmed no immediate project need.	N	Y	N	N	
32		Garden Acres Rd./Peters Rd.	Coffee Lake Creek	H/H Model Retrofit Analysis	Model predicts flooding along N-S piped system along Garden Acres that crosses the RR tracks and outfalls to Coffee Creek wetlands. Model flooding starts at the 2-yr design storm. City concern with obtaining easement/ coordinating with railroad to upsize pipe. Flooding at this location during the 2-yr design storm is concerning as in the future the contributing drainage area will further develop which will exacerbate this issue.	CAP		Y	Y	Y	N	TBD	• Prior to outfall, there are several smaller size pipe constraints constricting flow and causing surcharge. • As-builts were received for the existing ponds (two private, one public) located near the outfall (at the location of several small diameter pipes) of the Garden Acres Rd./Peters Rd. piped system. • Potential pipe rerouting and new outfall was evaluated to divert flow away from the undersized storm piping along Peters Rd. and towards a separate outfall to Coffee Creek. Per meeting 3-29, not a preferred option because would require new outfall. • Expanded pond to help mitigate flow downstream.	Y – CLC-3	--	N	N	
33		Boberg Rd. and RR crossing	Coffee Lake Creek	H/H Model 2012 SMP	Model predicts flooding along N-S pipe prior to discharging into open channel starting at the 2-yr design storm. Predicted flooding also at two large diameter culverts flowing E-W underneath RR tracks. Flooding at this location could impact the industrial properties along Boberg Rd.	CAP		N	Y	Y	N	N	• May be addressed in conjunction with Opp Area #32.	---	N	N	N	
34		Barber St.	Coffee Lake Creek	H/H Model 2012 SMP	Model predicts flooding at several DS nodes prior to Coffee Creek outfall and at node near RR tracks starting at the 25-yr design storm. Backwater conditions from Coffee Creek may be contributing to downstream flooding.	CAP		N	Y	Y	N	N	• Per H/H results, immediate project need is unlikely.	N	Y	N	N	
35		Lower Boones Ferry Rd.	Willamette River	H/H Model	Model predicts flooding along piping that conveys private drainage (former Albertsons property) to Boones Ferry Rd starting at the 2-yr design storm. Flooding at this location could impact the commercial properties along SW Boones Ferry Rd.	CAP		N	Y	Y	N	Y	• Modeled flooding may be due in part to hydrology node placement. • Large parking lots in adjacent areas could be potential for retrofit with pervious pavements or stormwater planters for stormwater collection. • Will require coordination with private property owners. • Per Wksp 3-15, City is unaware of existing issue here.	N	Y	N	N	

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36	8	Commerce Circle near Delta Logics parking lot	Coffee Lake Creek	Staff Survey	Improperly abandoned storm line on private property is causing flooding and a sink hole (safety concern).	R/R		Y	N	--	N	N	• Discussion during Public Works during site visit concludes no project need. • Public Works would like a contracting mechanism to contract the investigation and proper abandonment of this pipe independent of the PW maintenance budget. • Additional as-built research is needed to identify lateral connections and drainage area to the abandoned pipe. • Program Recommendation - Localized Drainage Improvements Program or Repair and Replacement.	N	N	Y- P-1	N
37	23	Cul-de-sacs west of Serenity Way	Coffee Lake Creek	Staff Survey	Inlets at Pleasant (Cartograph #1750) and Serenity Ln. (Cartograph #1748) become covered with leaf debris causing cul-de-sacs to flood.	CAP		N	N	--	N	N	• Program Recommendation - Localized Drainage Improvements Program. Installation of additional inlets near the intersection of Serenity Ln. may prevent ponding at the bottom of the cul de sac.	N	N	Y- P-1	N
38	46	29851/29840 SW Camelot St	Coffee Lake Creek	External Survey	Flooding from storm drain street grate. Grate clogs with debris.	MAINT	WQ	N	N	--	N	N	• Appears to be an operational issue. • Program Recommendation - Localized Drainage Improvements Program.	N	N	Y- P-1	N
39		Green Streets/LID Facilities	N/A	Retrofit Analysis	Develop a program to install LID facilities in conjunction with planned roadway improvements. Potential locations as listed in the Retrofit Assessment include SW Camelot, SW Wilsonville Road, and SW Hillman.	R/R			N	--	N	Y	• Program Recommendation – Water Quality Retrofit Program.	N	N	Y- P-2	N
40		Porous Pavement Pilot Study	N/A	Retrofit Analysis	Evaluate feasibility of porous pavement for future paving projects.	R/R			N	--	N	Y	• Consider applicability as a planning project to do porous pavement overlays for water quality in conjunction with pavement restoration/ improvement needs.	Y- City-3	N	N	N
41		Gesellschaft Water Well Channel Restoration	Boeckman Creek	2012 SMP Retrofit Analysis	Erosion is occurring within the drainage channel that enters Boeckman Creek.	E&S		N	N	--	N	Y	• Determined to be a higher priority retrofit location per 2015 Retrofit Assessment. • Per Wksp 3-15, project per 2012 SMP needed for funding.	Y – BC-6	N	N	N
42		Ridder Road Wetland Restoration	Coffee Lake Creek	2012 SMP Retrofit Analysis	Current drainage channel is underutilized with invasive vegetation. Referenced as CLC-4 per 2012 SMP.	E&S	MAINT	N	N	--	N	Y	• Determined to be a low priority retrofit location per 2015 Retrofit Assessment. • Discussion needed during planning workshop to confirm that funded project is not warranted.	N	Y	N	N
43		Town Center Conveyance Piping	Boeckman Creek	Community Development Town Center Concept Plan	Public stormwater collection pipe (>15" diameter) per Town Center Concept Plan.	INFRA		Y	N	--	N	Y	• Conveyance sizing is based on no onsite controls. • Library Pond analysis will be used to support onsite (private) collection system requirements. • Additional assets/ re-piping is development driven. No defined project need, pending redevelopment.	N	Y	N	Y

Table A-2. Project Opportunity Matrix																		
Project Opportunity Location ID[5]	Previous Problem Area Location ID	Location/ Asset Description	Basin	Source	Problem Description	Deficiency Category[1]		Site Visit Conducted (Y/N)	Project Planning[2]					Project/Program Development			
						Primary	Secondary		Hydraulic Model Developed? (Y/N)	Modeled Capacity Deficiency (Y/N)	Stream Assessment IDd Need (Y/N)[3]	Water Quality Retrofit Opportunity (Y/N)	Project Development Considerations (per Workshop and City Discussions)	Costed Capital Project Need? (Y/N)[4]	Unfunded or Future Capital Project Need? (Y/N)[4]	Program Need? (Y/N)	Policy Need?
44		Frog Pond E and S Conveyance Piping	Newland Creek	Community Development Frog Pond East and South Master Plan	Public stormwater collection pipe and outfall along SW 60th Ave. (>15" diameter) per Frog Pond Master Plan.	INFRA		N	N	--	Y	Y	• Frog Pond E and S Master Plan complete in December 2022. • Additional stream assessment conducted in October 2023 baselined receiving water characteristics. • SMP incorporates trunk line and outfall associated with proposed system along SW 60th.	Y – NC-1	--	N	N
45		SW Miami	Willamette River	H/H Model	Model predicts flooding along 15" piping starting at the 25-yr design storm.	CAP		N	Y	Y	--	N	• City doesn't recall location as being an issue. Per City with validation exercise, no immediate project need.	N	Y	N	N
46		Canyon Creek Rd (near Xerox)	Boeckman Creek	H/H Model	Model predicts flooding at node that conveys private stormwater from Xerox to the E across Canyon Creek Rd. starting at the 10-yr design storm.	CAP		N	Y	Y	--	N	• City doesn't recall location as being an issue. Per City with validation exercise, no immediate project need.	N	Y	N	N
47		River Fox Park	Willamette River	H/H Model	Model predicted flooding in 12" pipe	CAP		Y	Y	Y	--	N	• City doesn't recall location as being an issue. Per City with validation exercise, no immediate project need.	N	Y	N	N

Appendix B: TM#3: Stormwater Modeling Methods, Assumptions, and Results

Technical Memorandum: Hydrologic and Hydraulic Modeling Methodology and Results

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Technical Memorandum

FINAL

Prepared for: City of Wilsonville

Project Title: Stormwater Master Plan

Project No.: 156157

Technical Memorandum #3

Subject: Hydrologic and Hydraulic Modeling Methodology and Results

Date: March 7, 2023 (Final)

To: Kerry Rappold, City of Wilsonville

From: Michael Glass, P.E.
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List of Abbreviations

BC	Brown and Caldwell
BRCP	Boeckman Road Corridor Project
CIP	capital improvement program
City	City of Wilsonville
CMP	corrugated metal pipe
COM	Commercial
CPs	capital projects
CWS	Clean Water Services
GIS	geographic information system
GOV	Government
HB	House Bill
H/H	hydrological and hydraulic
HGL	hydraulic grade line
IND	Industrial
INST	Institution
LID	low impact development
LIDAR	Light Detection and Ranging
NAVD88	North American Vertical Datum of 1988
NGVD29	National Geodetic Vertical Datum of 1929
NRCS	National Resource Conservation Service
ODOT	Oregon Department of Transportation
OS	Open Space
PDR	Planned Development Residential
PVC	polyvinyl chloride
PWS	Public Works Stadards
RA	Rural Agriculture
RCP	reinforced concrete pipe
SMP	Stormwater Master Plan
TM	Technical Memorandum
TMDL	total maximum daily load
TSS	total suspended solids
UGB	urban growth boundary
VAC	Vacant

Section 1: Introduction

The City of Wilsonville (City) is developing an updated Stormwater Master Plan (SMP) to improve the understanding of stormwater system characteristics and infrastructure in the city. The SMP will include a capital improvement program (CIP) reflecting prioritized capital projects (CPs) and programmatic activities to address conveyance, capacity, water quality, and natural resource enhancement for existing and future development.

To document efforts completed as part of the SMP update, a series of Technical Memorandums (TM) have been developed. Technical Memorandum #1 (TM#1): Stormwater Basis of Planning (2/18/22) documented data collection and compilation efforts, presents applicable regulatory and design criteria, identifies stormwater problem areas (informing hydrologic and hydraulic [H/H] model updates), as well as preliminary project and programmatic concepts. Technical Memorandum #2 (TM#2): Geomorphic Analysis (5/25/22) documented field stream assessments for select stream channels within the City and identifies areas for additional consideration as a capital project.

This Technical Memorandum #3 (TM#3) builds upon the previously completed TMs to document the methodology and results of the H/H model activities. Topics covered in TM#3 include:

- H/H model evaluation criteria.
- Hydrologic model updates, including development of revised input parameters.
- Hydraulic model updates and expansion efforts, including refinement of existing modeled elements and the inclusion of additional stormwater infrastructure.
- Model validation approach, objectives, and adjustments.
- H/H model results under applicable design storm events, including identification of capacity limitations to inform development of capital projects.
- Next steps, including the comprehensive summary of project opportunities to inform CP development.

Section 2: Design Storm and Model Evaluation Criteria

The City's 2012 SMP developed a city-wide H/H model using the Innovyze InfoSWMM model platform. BC reviewed the City's existing H/H model and initiated updates as described in Sections 2.2 and 5.4 of TM#1. In addition, Brown and Caldwell (BC) reviewed Section 3 of the City's Public Works Standards (PWS) to outline planning criteria and sizing/design criteria to assess the existing stormwater system for deficiencies. This review is detailed in Section 4 of TM#1.

Section 2.1 identifies design storms that will be simulated for the H/H model and how model results will be used to assess compliance with the Surface Water Design and Construction Standards outlined in Section 3 of the City's PWS, revised December 2015.

2.1 Design Storms

Design storms are precipitation patterns typically used to evaluate the capacity of storm drainage systems and to design capital improvements for the desired level of service.

Design storms used for this study include the 2-, 10-, 25-, and 100-year, 24-hour recurrence interval events. The rainfall distribution for these design storms is based on the standard National Resource Conservation Service (NRCS) Type IA storm, which is applicable to western Oregon, Washington, and northwestern California. Table 1 lists the design storm rainfall depths used in the hydrology model, as listed in the City's PWS.

Table 1. Design Storm Depths	
Design Storm Event	**Rainfall Depth (inches)**
2-year, 24-hour	2.5
10-year, 24-hour	3.45
25-year, 24-hour	3.9
100-year, 24-hour	4.5

2.2 Model Evaluation Criteria

Stormwater infrastructure within the H/H model will be evaluated for capacity per the design criteria established in the PWS. The PWS reflects design criteria for new infrastructure and will also be the basis for design of future CPs developed as part of this SMP. Key hydraulic design requirements for modeled elements are listed below:

- **Pipes and Open channels:** Sized to convey and contain the peak runoff from the 25-year design storm while also maintaining a minimum of 1 foot of freeboard between the hydraulic grade line (HGL) and the top of structure or ground surface.
- **Culverts:** Designed to safely pass the 100-year design storm flow and provide a minimum of 1 foot of freeboard between the HGL and the ground surface.
  - For new culverts 18 inches in diameter or less, the maximum allowable design storm event headwater elevation (measured from the inlet invert) shall not exceed two times the pipe diameter or three times the pipe diameter with a seepage collar, unless an exception is approved by the City.
  - For new culverts larger than 18 inches in diameter, the maximum allowable design storm event headwater elevation (measured from the inlet invert) shall not exceed 1.5 times the pipe diameter, unless an exception is approved by the City Engineer.

Specific to the identification and evaluation of conveyance capacity issues with existing City infrastructure, the model evaluation conducted in Section 7 identified capacity deficiencies up to the 25-year design storm event. Capacity deficiencies were defined based on predicted flooding which consisted of locations where the HGL exceeded the ground surface elevation. This approach allowed for deficiencies to be quickly identified throughout the system at a city-wide level. For capacity deficient locations where a CP is developed, recommended projects will follow the PWS to allow for the minimum of 1 foot of freeboard between the HGL and ground surface. For additional information on PWS design standards and criteria as it relates to this SMP, refer to TM#1 Section 4.

Section 3: Hydrologic Model Development

The hydrologic model developed for this SMP update utilizes InfoSWMM version 15.0 and the RUNOFF method, which is consistent with the original modeling approach for the 2012 SMP. The RUNOFF method is a simple yet well-established method for simulating subbasin hydrology that utilizes the Green-Ampt method for calculating infiltration.

The necessary parameters for the RUNOFF method when utilizing the Green-Ampt method for infiltration includes subbasin area, slope, width, impervious percentage, hydraulic conductivity, initial moisture deficit, and suction head. The hydrologic module in InfoSWMM converts rainfall into stormwater runoff based on design storm parameters (i.e., volume and intensity of rainfall) and the hydrologic input parameters listed above.

This section includes detailed descriptions of the methodology used in determining each of the hydrology model input parameters to update the original model.

3.1 Subbasin Delineation

The total contributing drainage area to City owned stormwater infrastructure is approximately 8,728 acres and extends beyond both the City limits and the urban growth boundary (UGB) in some locations. This total contributing drainage area represents the study area for the SMP and is organized by watershed or major basin. The study area is further subdivided into subbasins as shown on Figure A-1 of Attachment A. The receiving water body for all watersheds is the Willamette River.

The City's 2012 SMP developed subbasin delineations within each major basin for purposes of characterizing hydrology. BC reviewed this existing watershed and subbasin delineation and updated based on the following City provided information:

- Topographic Light Detection and Ranging (LiDAR) and contour data (2019)
- Stormwater infrastructure geographic information system (GIS) data (2021)
- Aerial Imagery (2021)

Where necessary, major basin boundaries were adjusted to accurately reflect that the entire drainage area was captured. However, most adjustments occurred on the subbasin level and typically involved the refinement of existing subbasin boundaries to better reflect newly developed areas or the subdivision of subbasins to depict drainage patterns more accurately.

From this revised subbasin delineation, ArcGIS Pro was used to calculate individual subbasin areas for use as a hydrologic input into the model. A summary of the subbasins by major basin is presented in Table 2. Please note Newland Creek (and its associated drainage area) is outside the designated study area and not included in Table 2.

Table 2. Subbasin Summary

Major Basin	Subbasins			Contributing Drainage Area (acres)
	Number	Average Area (acres)	Median Area (acres)	
Boeckman Creek	46	42.2	14.5	1,941
Charbonneau [a]	20	23.9	16.8	478
Coffee Creek/Tapman Creek	77	67.4	28.5	5,192
Mill Creek	3	47.0	49.0	141
Meridian Creek	7	67.2	40.8	470
Willamette River (direct)	25	20.2	14.6	505
Total	178	49.0	23.9	8,728

a. The Charbonneau basin discharges to the Willamette River (direct) but was classified as a separate major based due to its location south of the Willamette River versus north.

The largest basins within the study area are the Boeckman Creek and Coffee Creek/Tapman Creek watersheds. These watersheds represent over 80 percent of the contributing drainage area from which the City manages stormwater runoff.

Subbasin names throughout the watershed are consistent with those developed for the 2012 SMP. This naming convention includes a unique four-digit ID (e.g., 1100, etc.) to classify each individual subbasin. Per the 2012 SMP, deviations from this convention include several subbasins that are instead named in accordance with the detention facility they drain to (e.g., CANYON_N etc.).

Modification to subbasin naming for this SMP update only occurred when the original subbasin delineations were subdivided to provide a greater level of hydrologic detail. Split basins use “A” or “B” in the suffix to the original subbasin ID for identification purposes.

3.2 Subbasin Slope and Width

The RUNOFF method requires both subbasins slope and width parameters which are a function of the revised subbasin delineation discussed in Section 3.1. To approximate these two physical parameters for modeling purposes, the subbasin slope was first calculated based on the longest flow path line within each individual subbasin. Flow path lines were generated for each subbasin in ArcGIS Pro using automated spatial processing tools. These tools approximate the flow path line as the straight-line distance between the highest and lowest elevation points (based on LIDAR) in the subbasin. The auto generated flow path lines for each subbasin were then reviewed, and manually adjusted as necessary to correct instances where the flow path lines did not appear to represent reality. Examples of this includes flow path lines that did not follow the existing topography or followed a path outside of the subbasin due to an oddly shaped catchment or other nonstandard configuration. Subbasin slope was then calculated based on the flow path line length and upstream and downstream elevations. Subbasin width was then calculated for each subbasin by dividing the subbasin area by the flow path line length.

3.3 Infiltration Conditions and Soils

Soil classification and infiltration are important characteristics to consider when developing and evaluating runoff flow rates and volumes for subbasins. Soil classifications within the study area were identified using the NRCS Soil Survey. Soil information is based upon 2020 soil survey data in Clackamas and Washington County, Oregon. Soil texture class information for the study area is presented on Figure A-2 of Attachment A.

There are multiple methods that can be used to simulate infiltration associated with each soil type. For this project, the Green Ampt method was selected which is consistent with the 2012 SMP approach. The Green Ampt method was used due to its ability to be applied City-wide and for its use of parameters that can be sourced from available soil data without the need for field work.

The Green Ampt method requires the following input parameters for each soil texture classification:

- **Average Capillary Suction**. A measure of the water transport through soils due to surface tension acting in soil pores.
- **Initial Moisture Deficit**. The fractional difference between soil porosity and actual moisture content.
- **Saturated Hydraulic Conductivity**. A physical parameter reflective of the rate at which water moves through saturated soil.

All input parameters for soil texture classifications were based on the reference values in Table 6-1 of the City’s 2012 SMP and confirmed against published literature values. These values have been reproduced as Table 3.

Table 3. Soil Infiltration Parameters (Green Ampt Method)				
Soil Texture Class	Saturated Hydraulic Conductivity (inches/hour)	Initial Moisture Deficit (fraction)	Suction Head (inches)	Percent of Contributing Drainage Area (%)
Sand	4.74	0.41	1.93	0
Loamy Sand	1.18	0.39	2.40	0
Sandy Loam	0.43	0.37	4.33	1
Loam	0.13	0.35	3.50	12
Silt Loam	0.26	0.37	6.69	79
Sandy Clay Loam	0.06	0.26	8.66	0
Clay Loam	0.04	0.28	8.27	0
Silty Clay Loam	0.04	0.26	10.63	4
Sandy Clay Loam	0.02	0.21	9.45	0
Silty Clay Loam	0.02	0.23	11.42	0
Clay	0.01	0.21	12.60	4

An area-weighted average value was assigned to each subbasin for each input parameter based on the distribution of soil texture class within the subbasin. The average input parameters for each subbasin are listed in Attachment B, Table B-2.

3.4 Land-Use and Impervious Percentage

Area-weighted impervious percentages were assigned to each subbasin based on an associated percent imperviousness for each land-use coverage in the City. Land use coverage and percent imperviousness by land use were adjusted from values used in the 2012 SMP due to refined zoning categories (i.e., impacts of House bill [HB] 2001) and improved methodology for calculating impervious coverage.

Land-use categories and coverages (reflecting existing development conditions and future, full-build out development conductions) were developed with the City in October 2021 using City zoning, comprehensive plan designations, developable lands/open space coverage, floodplain and wetland area designations, and impervious area coverages. The methodology of developing representative, current percent impervious percentages for each land-use coverage for this study is summarized in Section 2.3.2 of TM#1. A summary of the updated land use categories and associated impervious percentages are shown in Table 4 below.

Table 4. Land-Use Categories		
SMP 2012 Categories	**SMP Category**	**Representative Impervious Percentage [a] (%)**
Agriculture	Rural Agriculture (RA)	15[b]
Commercial	Commercial/Government (COM/GOV)	82
Commercial-Villebois		
Industrial	Industrial (IND)	71
Residential	Planned Development Residential 1 (PDR1)	17
	Planned Development Residential 2 (PDR2)	33
Multi-Family Residential	Planned Development Residential 3 (PDR3)	43
	Planned Development Residential 4 (PDR4)	51
Residential–Villebois	Planned Development Residential 5 (PDR5)	52
Multi-Family Residential-Villebois	Planned Development Residential 6 (PDR6)	64
Open Space	Open Space (OS)	10
	Park	24
Vacant	Vacant (VAC)	3
NA	Institution (INST)	35
NA	Oregon Department of Transportation (ODOT)	48

NA: Category not used

a. Based on aerial imagery review and digitization of impervious surfaces conducted by the City.

b. Adjusted as part of the calibration process for the Boeckman Creek Hydraulic Evaluation TM (1/31/22). See Section 5.1 of the TM.

An area-weighted average impervious percentage by subbasin was calculated for both existing and future development conditions based on the contributing land use and associated land-use based impervious percentages. The future land use coverage assumes conversion of vacant lands that are developable to their underlying zoning or comprehensive plan designation. The existing and future impervious percentage for each subbasin is listed in Attachment B, Table B-2 and shown in Attachment A, Figures A-3, and A-4.

The revised hydrologic input parameters discussed in this section inform the amount of runoff generated and ultimately routed through the hydraulic model as discussed in Section 4.

Section 4: Hydraulic Model Development

The City's existing InfoSWMM H/H model was initially developed as part of the 2012 SMP effort with minor, localized revisions for the Elligsen Pump-to-Waste evaluation completed in 2019. This most recent version of the H/H model was provided to BC in March 2021 and additional hydraulic updates were made as necessary for this SMP effort. The following subsections provide a description of the key hydraulic inputs required for the model and a summary of the hydraulic updates completed for this SMP.

4.1 Hydraulic Input Parameters

The InfoSWMM hydraulic model includes a network of nodes connected by conduits to represent the City's stormwater system in the model environment. Hydraulic information required by the model is stored within each node or conduit dataset. Within each node or conduit element, various hydraulic information is stored to govern the calculations and flow routing performed by the model.

4.1.1 Node Data

Model nodes include structures such as manholes, outfalls, storage facilities and junctions. These elements are informed by the City's GIS. Model nodes also include other relevant connection points in the system not defined in the GIS such as connection points between continuous open channel segments. Key model node attributes are listed in Table 5.

Table 5. Model Node Attributes	
Attribute	Value
ID	The ID is maintained from the original 2012 SMP model. New nodes were assigned an ID based on the City's GIS attribute information.
Invert elevation	Invert elevation of the junction in feet (vertical datum NAVD88)[a]
Rim elevation	Elevation at the ground level in feet (vertical datum NAVD88)[a]
Storage Volume (if applicable)	Stage storage relationship (Depth vs. surface area)

a. Vertical datum of GIS data discussed in Section 4.2.1.

Storage nodes within the model allow for the simulation of ponds, underground detention, and other flow control facilities within the City's stormwater network. Each storage node is assigned a stage storage relationship (depth. vs. surface area) to represent the available volume of storage at a given water elevation. Table 6 lists the storage facilities included within the H/H model, including both those reflected in the 2012 SMP and those newly added or modified as part of this SMP update.

Table 6. Model Storage Nodes		
Storage Node ID	Description	SMP update status
POND_LIBRARY	Library Pond (Memorial Dr.)	Updated
POND_E1	Villebois–Palermo Park dry pond	No adjustment
POND_E2	Villebois–Palermo Park dry pond	No adjustment
POND_F	Villebois–Palermo Park dry pond	No adjustment
COCA-COLA_POND	Coca Cola Facility Pond (SW Kinsman Rd.)	No adjustment
RENAISSANCE_POND	Renaissance Development Pond (SW Canyon Creek Rd.)	No adjustment
STAFFORD_POND	Al Kader Shrine Center pond (SW Parkway Ave.)	No adjustment
WILSONVILLE_DIST_CTR_POND	Wilsonville Distribution Center pond (Boones Ferry Rd.)	No adjustment
TONKIN_NISSAN_POND	Tonkin Wilsonville Nissan Pond (SW 95th Ave.)	No adjustment
CANYON_CR_PH2_DET	Canyon Creek Business Park underground detention facility	No adjustment
CANYON_CR_ARCH_PIPE	Canyon Creek Business Park underground detention facility	No adjustment
POND_BOECKMAN	Area upstream of Boeckman Rd. flow control structure	Updated
SIEMENS_POND_B	Private pond on Mentor Graphics/Siemens property (Boeckman Rd.)	Added
SIEMENS_POND_C&D	Private ponds on Mentor Graphics/Siemens property (Boeckman Rd.)	Added
STAFFORD_MEADOWS_1_BASIN	Frog Pond West–Stafford Meadows pond (Boeckman Rd.)	Added
DAY_RD_IMPOUNDMENT	Impoundment south of Day Rd.	Added
TOOZE_POND	Villebois–Calais East (Tooze Rd.)	Added

4.1.2 Conduit Data

Key attributes for conduits (i.e., pipes, culverts, and open channels) include ID, length, invert elevations, slope, shape (i.e., circular, or open channel cross-section), inlet and outlet losses, and Manning's roughness coefficient. The existing model conduit ID and naming convention was maintained for this SMP update. In locations where new conduits were integrated into the model, an ID was assigned based on the City's GIS attribute information.

Manning's roughness coefficient "n" is dependent on the material of the conduit. Table 7 provides a list of the roughness values applied, which are consistent with the documentation for the 2012 H/H model.

Table 7. Model Conduit Roughness

	Manning's *"n"* Roughness Coefficient
Pipe Material and Open Channel	Polyvinyl chloride (PVC) Pipe: 0.011
	Reinforced Concrete Pipe (RCP): 0.013
	Concrete Pipe: 0.013
	Corrugated Metal Pipe (CMP): 0.024
	Open channels: 0.035

4.2 Hydraulic Updates

Hydraulic model updates completed for this SMP update include model expansion, primarily in new growth areas since the previous 2012 SMP was completed or in identified problem areas (see TM#1), and model updates to reflect revised pipe sizing/alignment in conjunction with completed capital projects. These areas were discussed in a System Status and Modeling Extents workshop with City Staff in August 2021 to identify/confirm the specific locations for hydraulic model updates and documented in TM#1. Hydraulic updates used the City's GIS data (provided June 2021) as the primary source information and supplemented by City provided as-built drawings and field verification where necessary. Additional hydraulic model refinement described outside of this section was completed as part of the model validation adjustments discussed in Section 5.3.

4.2.1 Vertical Datum Resolution

The original hydraulic model used inconsistent vertical datums to reflect elevations of hydraulic model elements. Based on discussions with the City, this inconsistency was determined to be due to the City switching standards from the National Geodetic Vertical Datum of 1929 (NGVD29) to the North American Vertical Datum of 1988 (NAVD88) sometime between 2006 and 2008.

To rectify this discrepancy, BC reviewed and adjusted all existing hydraulic model elevations to be consistent with the City's current standard of NAVD88. Details and assumptions related to the identification and correction of datums is included in TM#1, Section 2.1.2. With this effort complete, future hydraulic updates (Section 4.2.2) were able to be integrated into the model under a consistent datum.

4.2.2 Model Update and Area Expansion Locations

Hydraulic model updates were completed from May 2021 through May 2022 as additional data were received and concurrently with the problem area identification process (see TM#1 Section 5.1). This process supported the initial identification of stormwater problem areas for the City, as locations requiring modeling to validate an observed problem. Additionally, expanded modeling helps to identify new problem areas or predict future problem capacity deficiencies.

Table 8 summarizes the specific locations of hydraulic model updates that were integrated into the City's InfoSWMM model for this SMP update. Comprehensive locations of hydraulic model updates are shown in Attachment A, Figure A-5.

Table 8. Hydraulic Model Update Summary

Date Completed	Type of Revision	Rationale for Update	Location	Description
May 2021	Update	Topographic survey	Boeckman Creek	Integrated open channel cross-sections surveyed in the vicinity of Boeckman Rd. crossing. Revised stage storage relationship of Boeckman Pond based on survey information.
June 2021	Update	Constructed capital project	Charbonneau	Revised model to incorporate Charbonneau pipe upsizing associated with CP SD9022-9025 (Old Farm Rd. Phase I) and CP SD9014-9016, & SD9030 (French Prairie Drive Phase II).
June 2021	Update	Constructed capital project	Barber Street	Revised model to incorporate pipe upsizing along Barber St. associated with CP SD4208 and SD4209.
August 2021	Update	GIS discrepancy	ODOT yard west of I-5	Updated diameter of modeled culvert from 40-in to 42-in to match GIS data.
August 2021	Update	GIS discrepancy	Boones Ferry Rd.	No model adjustment needed north of 5th St. for existing 24-in pipe segment. City rectified GIS data to match the 24-in pipe shown in model. Model adjusted south of 5th St. to reflect pipe upsizing to 30-in shown in GIS.
August 2021	Update	GIS discrepancy	Wilsonville Rd.	No model adjustment needed. City rectified GIS data to match 30-in pipe shown in model.
August 2021	Update	GIS discrepancy	Graham Oaks Nature Park	Adjusted model to follow correct piping alignment shown in GIS.
August 2021	Update	GIS discrepancy	Boeckman Rd. (west of I-5)	Adjusted pipe diameter to 24-in to reflect latest GIS data.
August 2021	Update	GIS discrepancy	Hillman Ct.	No model adjustment needed. City rectified GIS data to match 24-in pipe shown in model.
October 2021	Update	Problem area and site visit	Kinsman Rd.	Model adjusted to incorporate field measurements (rim and measure-down elevations) collected by Public Works.
October 2021	Update	Problem area and site visit	Town Center Loop	Model adjusted to incorporate field measurement of ODOT reducer (12-in) collected by Public Works.
November 2021	Expansion	Problem area and site visit	Tooze Pond	Model expanded to include Tooze Pond detention facility. Stage-storage relationship estimated form City provided as-built drawings.
November 2021	Update	Problem area and site visit	Day Rd. to Ridder Rd.	Model updated with culvert information (diameter, length, inverts) surveyed in 2019 as part of the Coffee Creek Stormwater Facility Study. Surveyed open channel information not incorporated.
November 2021	Update	Boeckman Creek Hydraulic TM	Boeckman Road flow control structure	Integrated as-built information to update flow control structure elevations and the storage capacity of the pond upstream of the flow control structure.
November 2021	Update	Boeckman Creek Hydraulic TM	Mentor Graphics/Siemens	Model updated based on survey information collected as part of the Boeckman Road Improvement Hydraulic Evaluation. Survey information included geometry and elevations of the Boeckman Creek diversion structure and weirs. Onsite Siemens ponds added to the model based on as-built drawings.

Table 8. Hydraulic Model Update Summary				
Date Completed	Type of Revision	Rationale for Update	Location	Description
December 2021	Expansion	New growth	Garden Acres Rd.	Expand model to include piped stormwater infrastructure along Garden Acres Rd. to Coffee Creek outfall.
December 2021	Expansion	New growth	Villebois	Expand model to include additional large diameter (>18-in) pipe within the Villebois planning district.
December 2021	Expansion	Problem area and site visit	Willamette Way E	Expand model to include additional infrastructure associated with Belnap Court outfall and Bonneville Power Administration (BPA) easement outfall.
February 2022	Update/Expansion	Problem area and site visit	Meridian Creek at Boeckman Rd. (Frog Pond)	Revised Meridian Creek culvert information based on City provided as-built drawings. Expanded model to include the open channel and “Stafford Meadows 1 Basin” detention pond upstream of the culverts.
May 2022	Expansion	Problem area and site visit	Day Rd. impoundment	Impoundment south of Day Rd. added to model based on as-built information provided by the City.

Section 5: Model Validation

The updated H/H model went through a validation process from May to August 2022 with the objective to increase confidence in the updated model’s accuracy and results. Flow monitoring and model calibration was not specifically conducted as part of this SMP update. The validation process involved several successive steps, as described below, leading to refinement of model input data to ultimately support the use of the H/H model to identify and develop CPs under this SMP update. The validation process included discussion of intermediate modeling results with the City during regular project check in meetings, which informed additional hydraulic modeling updates where the incorporation of as-built information was necessary.

The model validation effort included the following key components:

- Citywide integration of the model calibration adjustments determined as part of the Boeckman Road Hydraulic Evaluation (1/31/22).
- Simulation of a validation storm event from January 2022 and comparison of model results with photographs and field measurements collected near Ridder Rd.
- Discussion of preliminary model flooding results with City staff to confirm validity of modeled flooding locations and the need for additional refinement of hydraulic model elements using newly provided as-built data.

5.1 Boeckman Road System Calibration

The Boeckman Road Hydraulic Evaluation (1/31/22) is a separate but concurrent study conducted as a precursor to the Boeckman Road Corridor Project (BRCP). This study utilizes the same, updated, citywide InfoSWMM H/H model as being updated for this SMP. The study calibrated the H/H model for the Boeckman Creek basin based on flow monitoring data collected at the Boeckman Road flow control structure from March to June 2021. This flow data represents drainage from approximately 1,400 acres of the study area, specifically the upper Boeckman Creek watershed that drains to the Boeckman Road flow control structure.

Calibration adjustments integrated into the H/H model are summarized in Table 9 below.

Table 9. Boeckman Rd. Hydraulic Evaluation Calibration Adjustment Summary	
Adjustment	Description
1. Baseflow addition	Added constant 0.4 cubic feet per second of inflow to the Boeckman Creek system and simulated the three preceding months of rainfall to replicate antecedent conditions.
2. Residential Agriculture (RA) Land Use Impervious Percentage	Revised the initial RA impervious percentage from 6 to 15 percent. This adjustment affected hydrology citywide.
3. Mentor Graphics/Siemens survey results (2022)	Updated model to better represent existing conditions of private stormwater infrastructure, which included the Boeckman Creek diversion structure and weirs.

These calibration adjustments result in model results that match (within 3 percent) the peak instream flow for the selected calibration storm (June 11-15, 2021). Since conveyance infrastructure is sized based on peak flows, matching peak flow was the primary objective for this calibration effort. Detailed results of this calibration process including assumptions and rationale are described in the Boeckman Creek Hydraulic Evaluation TM, dated 1/31/22.

The calibration adjustments were applied to the citywide H/H model as the initial validation step for this SMP update. The anticipated impact from these calibration adjustments is not expected to be substantial; however only adjustment #2 from Table 9 directly impacts basins outside of Boeckman Creek watershed. Residential agriculture (RA) land use only comprises a small portion of the study area (approximately 14 percent), and most of this area is outside of the city limits. As such, additional validation efforts beyond the Boeckman Road Hydraulic Evaluation calibration adjustments alone were needed to sufficiently validate the citywide model.

5.2 Model Validation

To further validate the City-wide model, a validation storm event from January 4 to 7, 2022, was selected by City staff for simulation in the H/H model. This event was identified based on reported flooding observed by Public Works staff near Day Road and Commerce Circle (NW portion of City limits). Available information for this storm event included anecdotal accounts of flooding, photographs, and water surface measurements. The 15-minute rainfall data was collected from a nearby rain gauge.

Public Works staff provided several photographs from January 6 (time unknown) to document the reported ponded water south of Day Road as shown in Figure 1.

Figure 1. Validation observations (south of Day Road)

To correlate observed standing water conditions with measured data, BC staff collected a water depth measurement downstream of the observed flooding per Figure 2 (left) on January 7, 2022 at 11 a.m.. This measurement was collected at one of the 48-inch culverts underneath Ridder Road. While this measurement was collected after the peak of the storm event, water levels within the culvert remained high, as the culvert was approximately 67 percent full as shown in Figure 2 (right) below.

Figure 2. Validation measurement location (48-in. culvert underneath Ridder Road)

Left: Location of culvert. Right: Depth of water in culvert.

Rainfall data for this validation storm event was obtained from a rain gauge owned and operated by Clean Water Services (CWS) located along 99W Pacific Hwy between King City and Sherwood near the Tualatin National Wildlife Refuge. The gauge is identified by CWS as "LTR" and is approximately 5.75 miles from the Boeckman Road and Boeckman Creek crossing. This rain gauge was also used for the model calibration effort conducted for the 2012 SMP. The validation storm event rainfall is plotted (15-minute increments) on Figure 3, and storm characteristics are summarized in Table 10.

Table 10. Validation Storm Event

Statistic	Storm 1
Start Date/Time	1/4/22, 12:00
End Date/Time	1/7/22, 12:00
Duration, hours	72
Total Rainfall, inches	1.76
Peak Intensity, inches/hour	0.28

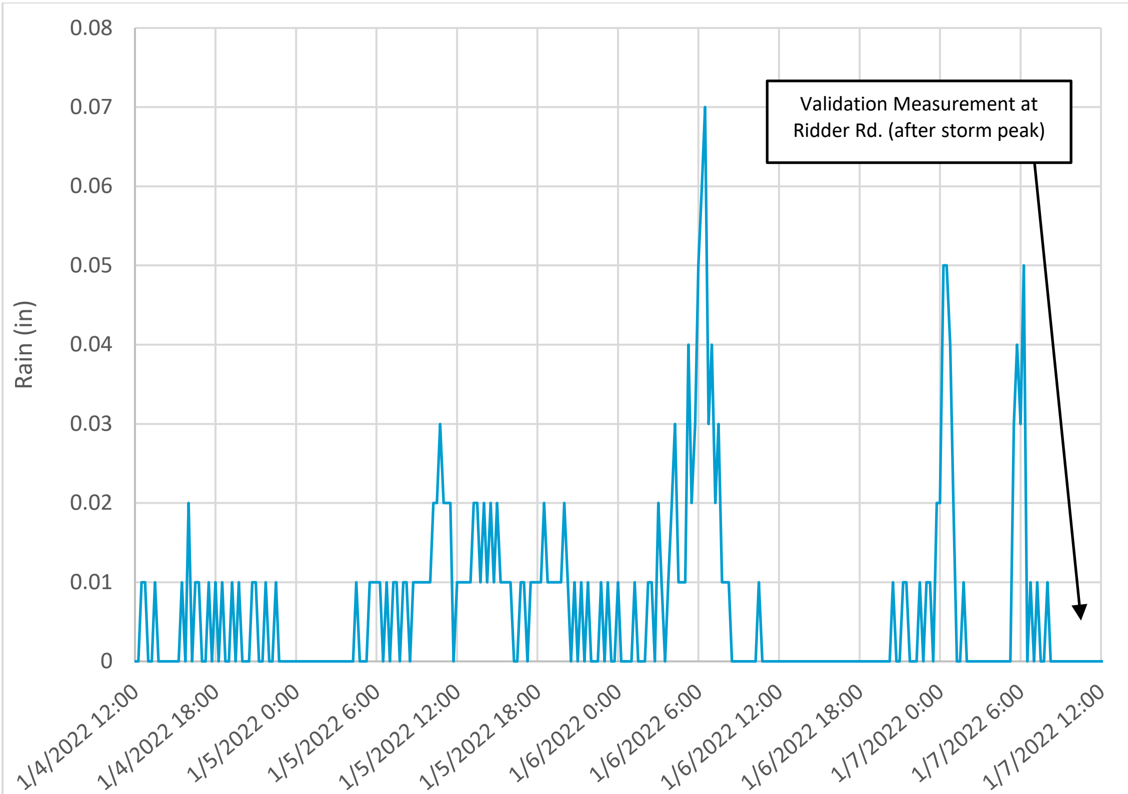


Figure 3. January 2022 validation storm event

5.2.1 Model Simulation

The validation storm was simulated in the H/H model to attempt to replicate the observed water surface elevations within the culverts at Ridder Road. The validation model simulation was unable to replicate observed conditions (i.e., standing water), indicating a discrepancy between the model results, City staff observations and BC measurements. The validation model results underpredicted the water depth measurements collected at the culverts underneath Ridder Road (Figure 2). While field measurements indicate that the culverts were approximately 67 percent full, the validation model predicted that the culverts would only be 11 percent full during that same period of the storm.

The discrepancy between the measured and simulated water surface elevation was attributed to the model not fully representing actual upstream hydraulic conditions from the culverts at Ridder Road. The modeled hydraulic reach between Day Road and Ridder Road includes simplified geometry to represent the open channel conveyance (trapezoidal cross-sections) and does not include the large wetland area north of Day Road nor the impoundment directly south of Day Road. In addition, it is suspected that during the storm event, the buildup of vegetation and sediment along this reach significantly contributed to backwater conditions and elevated water surface levels throughout the system.

5.2.2 Hydraulic Model Updates (Commerce Circle)

Adjustments to the system hydrology and hydrologic input parameters were briefly discussed with City staff but ultimately not made to resolve the large discrepancy in water surface elevations at the Ridder Road culverts. Rainfall patterns and storm volumes can vary significantly, and the rainfall gauge used to obtain the rainfall data is a relatively far distance from the validation location. Also, any adjustment to the hydrologic input parameters to increase flows at this location may have unintended consequences (i.e., impact CP sizing in other locations). The drainage area to the Ridder Road culverts is relatively small compared to the overall City's contributing drainage area. Therefore, it was decided that hydrologic adjustments associated with the model validation effort are not preferred and hydraulic model refinements should be made.

The hydraulic model between Day Road and Ridder Road was reviewed and updated based on available survey data within the general system area. Representative channel cross-sections were developed using the preliminary design information for AKS' 2019 Coffee Creek Stormwater Facility Study including the topographic data for the area collected by the survey team. This provided a more accurate representation of channel geometry in comparison to the conceptual trapezoidal channels included in the 2012 SMP model, although the change in the model results for the validation storm was marginal.

5.3 Preliminary Flooding Results and Additional Model Adjustments

With the large disparity in validation model results in the Day Road and Commerce Circle system (Section 5.2), it was decided jointly with the City to use a more comprehensive approach to qualify other flooding locations throughout the City.

Preliminary model results (reflecting validation adjustments described above) were discussed with the City in May 2022. This review focused on newly identified flooding locations (i.e., the 2012 SMP did not define a CP to address flooding in a specific location) throughout the City based on the 25-yr design storm (City's conveyance standard) under existing conditions. The preliminary flooding results were reviewed to identify and confirm deficiencies within the City's drainage network.

Locations with predicted flooding were cataloged in a summary table (Attachment B, Table B-2) and mapped (Attachment A, Figure A-6). City staff provided input on the preliminary modeled flooding locations as well as provided additional information (as-builts) to help refine the model prior to producing finalized results. City staff confirmed known flooding locations and locations where model flooding may not be indicative of a real-world issue.

In general, City staff agreed with the preliminary flooding results presented by the model. Preliminary flooding locations where City staff were not aware of issues were reviewed in detail to confirm their hydraulic configuration and whether the contributing drainage area and subbasin delineation was representative. For several locations where flooding had not been previously known by City staff, modeled flooding was resolved by further subdividing subbasins to simulate runoff entering the piped hydraulic system more accurately. It was decided jointly with the City that these adjustments were reasonable to resolve the issues and further effort should focus on the higher priority locations.

Additional locations (per Attachment A, Figure A-6) warranted hydraulic updates based on updated information provided by the City. These locations include:

- Location #2 Charbonneau SW French Prairie Rd. Outfall. Model revised based on as-built information to incorporate the outfall pipe lining completed as part of the emergency repair project in 2019.
- Location #6 Library Pond. Model revised to more accurately represent the pond's storage capacity based on a review of LiDAR and as-built information. The outlet pipe configuration was also modified to better reflect the ditch inlet and 18-inch outlet pipe per the as-built information.
- Location #11: Penske Truck Rental Property. Model revised to reflect updated culvert information underneath parking lot based on as-built drawings.
- Location #15: Wilsonville Distribution Center Pond: Model revised to reflect pond outlet structure based on as-built drawings.

Following hydraulic model adjustments, several locations are still predicted to flood despite City staff not being aware of any issues. These locations are outlined in Attachment B, Table B-1 as location IDs without narrative in the "City Validation Notes" column. Completion of the City-driven validation adjustments to the hydraulic model concluded the validation effort for the model. As previously discussed, traditional validation efforts for this H/H model were not feasible due to limited data. BC relied on feedback from City staff as part of this validation effort as it provided the most realistic path forward to continue with the capacity evaluation (Section 7) and advance CP development without requiring additional extensive data collection or flow monitoring.

Section 6: Future Flow Condition Modeling Analysis

During the model development process (Sections 3 and 4), BC evaluated different future flow assumption methodologies to determine impacts on runoff rates and ultimately CP sizing.

This analysis was initiated based on efforts to expedite design of a culvert replacement project at Meridian Creek at Boeckman Road (Problem Area #2) in February 2022. In this location, upstream development complies with current City stormwater design standards and incorporates various low impact development (LID) and flow control facilities and practices. As the sizing of CPs is typically independent of the presence of onsite facilities, the impact of onsite treatment and flow control on CP sizing was considered. While the immediate applicability of this effort was intended to inform this specific design effort (implemented and funded as part of the Boeckman Road Corridor Project), it was acknowledged that the future flow assumptions established here should apply to CPs developed as part of this SMP. This section documents the analysis for application to the SMP.

6.1 Background

The 2012 SMP developed CPs with a future flow condition that assumed each contributing subbasin would be fully built out to its zoning coverage. Future condition hydrology was developed from this future land use condition to size applicable stormwater infrastructure (i.e., pipes, culverts, ponds, etc.).

Since adoption of the 2012 SMP, the City revised their Stormwater and Surface Water Design and Construction Standards (2015). As part of this revision, developers are required to maintain pre-development runoff characteristics to minimize the effects of sediment transport and erosion, as described in Section 301.1.05 below:

> Stormwater management facilities shall be designed to maximize groundwater recharge through the process of infiltration of runoff into vegetated facilities and the use of what is referred to as Low Impact Development (LID) facilities and/or flow controls to address hydromodification.
>
> *Section 301.1.05, Wilsonville Stormwater and Surface Water Design and Construction Standards, 2015*

Compliance with this requirement provides a level of flow control for new development that was not accounted for in the 2012 SMP methodology for estimating future flows. If the same methodology is used, there is a potential to oversize CPs, as any upstream flow mitigation provided by LID facilities may reduce the peak flow to be managed by the constructed CP. The objective of this analysis was to evaluate whether implementation of onsite LID facilities should adjust the future flow methodology for CP development.

6.2 LID Facilities Modeling Approach

Evaluating the direct impact of future LID facilities associated with future development using the InfoSWMM H/H model is inherently difficult as the configuration and location of these facilities is unknown. InfoSWMM is capable of modeling specific LID facilities through its hydraulic module, but requires several known inputs such as invert elevations, depth/storage curves, outlet structure geometry, and specific locations within the drainage system to accurately retain and route flow.

Due to the absence of this information, the impact of future LID facilities was estimated through InfoSWMM's hydrologic module, specifically by adjusting the Sub-Area routing feature. The Sub-Area routing default within InfoSWMM routes all impervious and pervious area associated with a subbasin directly to the outlet (outlet routing). An optional configuration called percent routing, allows for a percentage of the impervious area within a subbasin to be routed over the pervious area within a subbasin prior to reaching the outlet. This is illustrated in Figure 4, originally published in the EPA Storm Water Management Model Reference Manual Volume I, Hydrology.

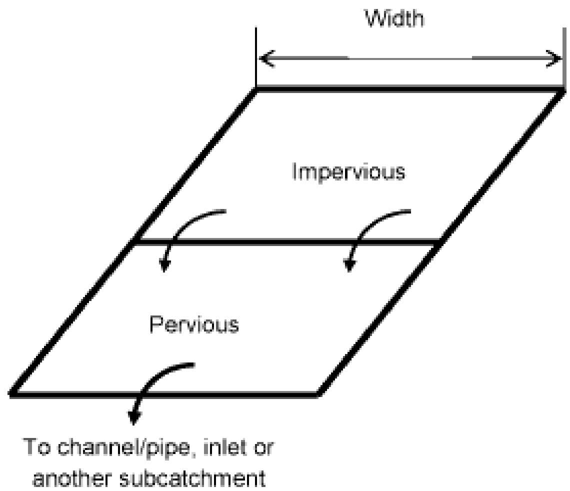


Figure 4. Percent routing diagram

Use of this percent routing feature within InfoSWMM is a simple routing mechanism. Available literature on this routing feature reflects its usage to approximate impacts of LID facilities within a subbasin, as it slows the timing of peak flow and allows for flow attenuation and additional infiltration.

The percent routed can range from 0 percent (direct outlet routing) to 100 percent (all runoff from impervious area routed to pervious area). To assess the sensitivity of the percent routing option on peak flows within the model, three different future alternative scenarios were simulated in addition to the traditional outlet routing model:

- PERV=75 percent
  - Routes 75 percent of impervious area over pervious area (less conservative)
- PERV=50 percent
  - Routes 50 percent of impervious area over pervious area
- PERV=25 percent
  - Routes 25 percent of impervious area over pervious area (more conservative)
- Outlet Routing
  - Impervious area and pervious area are routed directly to outlet (most conservative)

6.3 Results

The different future alternative scenarios were simulated for several design storms to assess relative impact on peak flows specific to the location of the Meridian Creek culvert replacement project. Results for the 10-yr design storm and the 100-yr design storm (culvert design standard) are shown below on Figures 5 and 6, respectively.

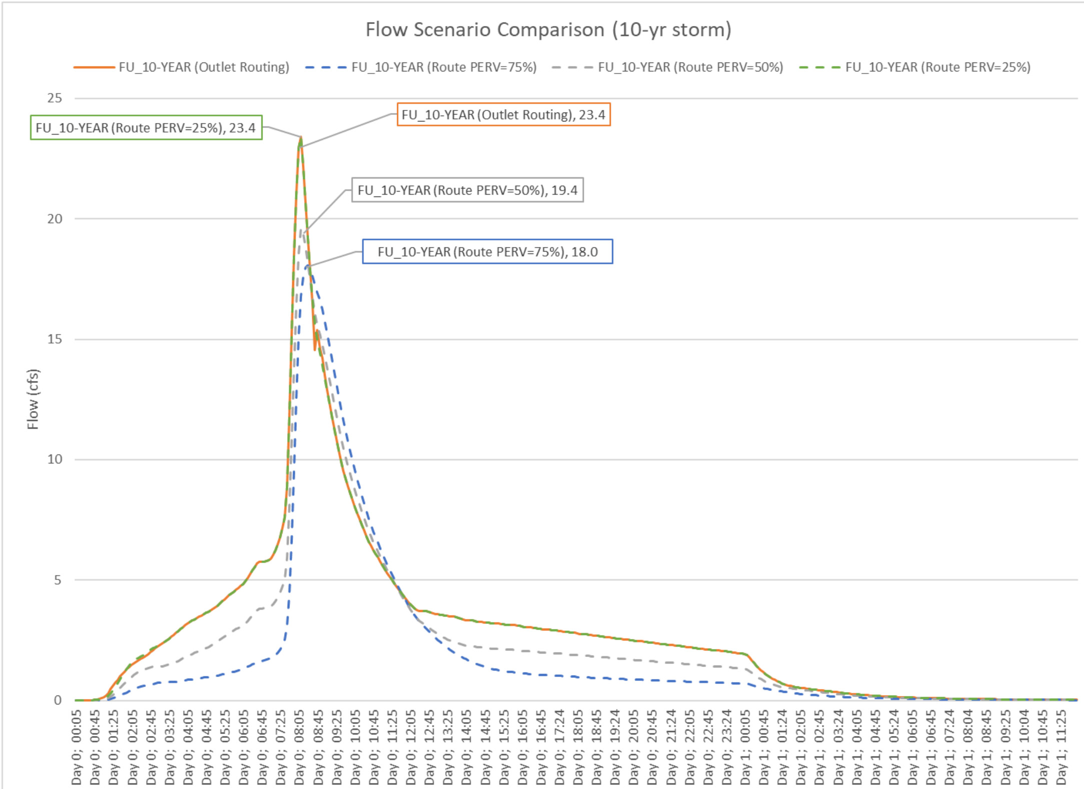


Figure 5. Meridian creek culvert–10-yr design storm

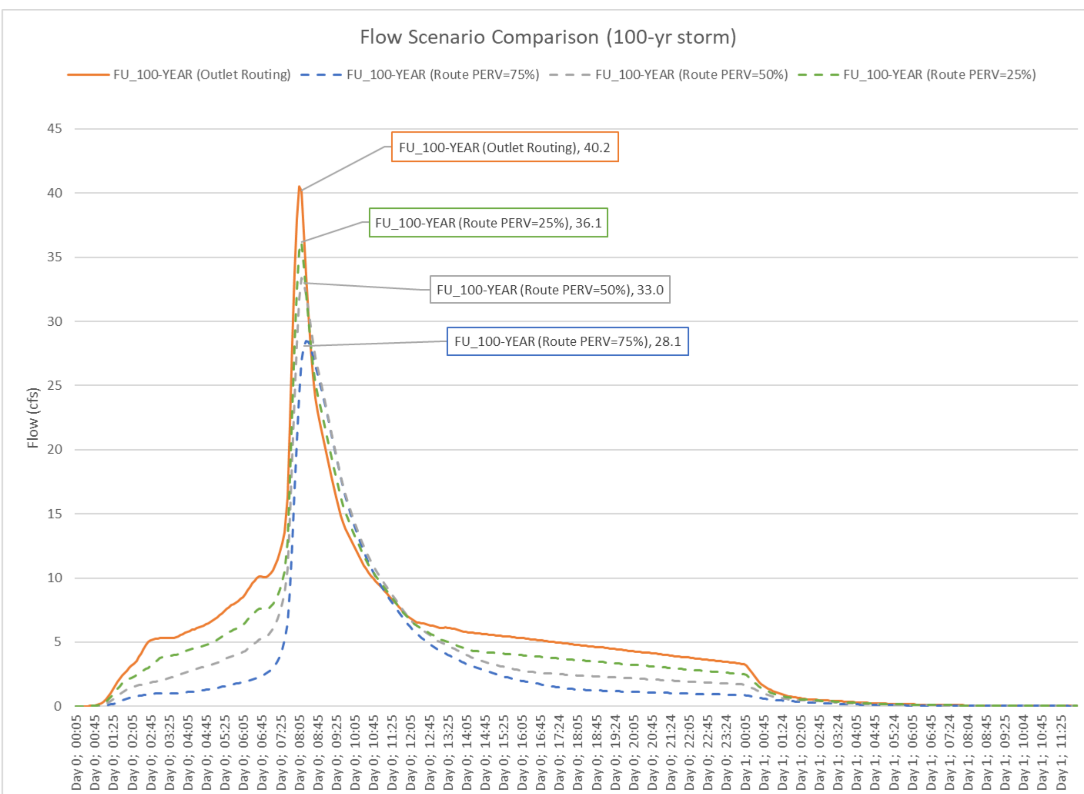


Figure 6. Meridian creek culvert–100-yr design storm

Based on these sensitivity model runs, the following conclusions regarding peak flow percent routing were reached:

- Increasing percent routing for a subbasin reduces anticipated peak flows.
- Percent routing has a greater impact on anticipated peak flows for larger design storms (i.e., 100-yr design storm)
- Percent routing has a greater impact on subbasins with lower impervious percentages (undeveloped/vacant lands).
- For smaller design storms (i.e., 10-yr design storm) the anticipated peak flow difference between outlet routing and PERV=25 percent is insignificant.

Based on these conclusions, and the desire to build some conservatism into the sizing for future CPs, it was decided jointly with the City to proceed with future condition modeling without subbasin percent routing. It was acknowledged that this approach may lead to the oversizing of some stormwater infrastructure; however, this would only be where the contributing drainage area is primarily undeveloped.

Section 7: H/H Model Evaluation and Results

Upon completion of the model validation effort (Section 5), detailed H/H model results were simulated for the 2-yr, 10-yr, 25-yr, and 100-yr design storm. H/H model inputs and results are summarized for the hydrologic and hydraulic models in Tables B-2 and B-3, of Attachment B, respectively. The following sections present the findings resulting from the model and how the model will inform CP development efforts.

7.1 Hydrologic Results

The hydrologic model results for all design storms show that future land use conditions (and associated increased imperviousness) result in increased peak flows compared to existing land use conditions. The increase in peak flows is most significant during the 2-year storm and gradually becomes less pronounced with larger storm events. Future land use conditions represent the development of developable (vacant) lands per their associated zoning category or adjusted zoning coverage for select, developed lands based on anticipated zoning in accordance with House Bill (HB) 2001.[1]

In general, most locations within the city limits are nearly fully developed; therefore, the increase in peak flow from these areas is expected to be relatively small. This is most evident in urbanized locations such as Charbonneau, Villebois, and along the I-5 corridor. Attachment A, Figure A-7 presents subbasins within the study area and their anticipated increase in peak flows (based on percentage) from existing to future land use conditions.

The largest anticipated increases in peak flow are primarily in the subbasins located outside of city limits, specifically within the upper reaches of the Coffee Lake Creek and Boeckman Creek watersheds. These locations are primarily undeveloped, but new development is pending and will increase the amount of impervious surface (runoff flow). As noted in Section 6, flow attenuation during new development is anticipated through implementation of the City's stormwater design standards, but for purposes of this SMP, CP sizing will be based on unmitigated flows.

Detailed hydrologic inputs and peak flow results for all subbasins and design storms are included in Attachment B, Table B-2.

[1] HB 2001 was passed by the 2019 Oregon State Legislature and requires Cities to allow for middle housing (e.g., duplexes) for properties zoned as single family residential.

7.2 Hydraulic Results

Hydraulic model results identify flooding locations with the intent to develop CPs to increase conveyance capacity and resolve flooding. For purposes of this evaluation, and as referenced in Section 2.2, flooding within the model was defined as locations where the hydraulic grade line exceeded the node rim elevation. Node flooding is a direct output from the model that can be used to efficiently identify capacity issues throughout the hydraulic system. Since the City's conveyance standard is the 25-yr design storm, this storm event was used as the benchmark to identify potential issues.

To assist in prioritizing locations by flooding severity, the 2-yr and 10-yr design storm flooding locations were also identified as shown in Attachment A, Figures A-8 and A-9. Using results from the three design storms, flooding locations were discussed with the City and cross-referenced with the Problem Area Matrix (Table A-1 of TM#1) to confirm the need to develop a CP for inclusion in the SMP.

As described in Attachment B, Table B-1, there are a total of 17 locations that continue to experience flooding in the existing condition. Of these, three locations were identified as key flooding locations based on discussions with the City. These locations are considered high priority for purposes of CP development and may require alternatives analysis to ensure that City objectives and preferences will be achieved. Description of these key flooding locations is provided below.

7.2.1 Charbonneau

Flooding is predicted within the SW French Prairie Rd. area of the Charbonneau District during rainfall events starting at the 2-yr design storm. Deficiencies (capacity and condition) in stormwater infrastructure within Charbonneau were previously identified in the 2012 SMP and subsequent Charbonneau Consolidated Improvement Plan (2014). Since the completion of those studies, some of the recommended pipe improvements have been completed and as-builts or revised GIS is integrated into the updated hydraulic model (see Table 8).

As part of the model validation exercise (Section 6), this area was reviewed in detail to investigate predicted flooding in the model since model results should incorporate completed pipe upsizing projects. Discussions with City staff led to an in-depth review of the as-builts for an emergency outfall repair project adjacent to 31233 SW Edgewater Pl. completed in 2019. Review of the as-builts indicated that the damaged section of the 30-inch corrugated metal pipe (CMP) was removed and replaced with a lined 30-inch CMP. The outfall pipe was not upsized to 36-inches as recommended by the 2012 SMP due to limitations associated with the emergency repair. While the lining of the pipe increases flow (reduces pipe roughness), the H/H model still indicates this section of pipe is a bottleneck in the system resulting in an elevated hydraulic grade line upstream of the outfall as shown on Figure 7 below.

To address predicted flooding, CP development at this location will evaluate options to incorporate detention into the upstream (non-replaced) portions of the collection system, to reduce peak flows downstream. Since available space is limited within the area, concepts that utilize a limited footprint such as detention pipes will be explored.

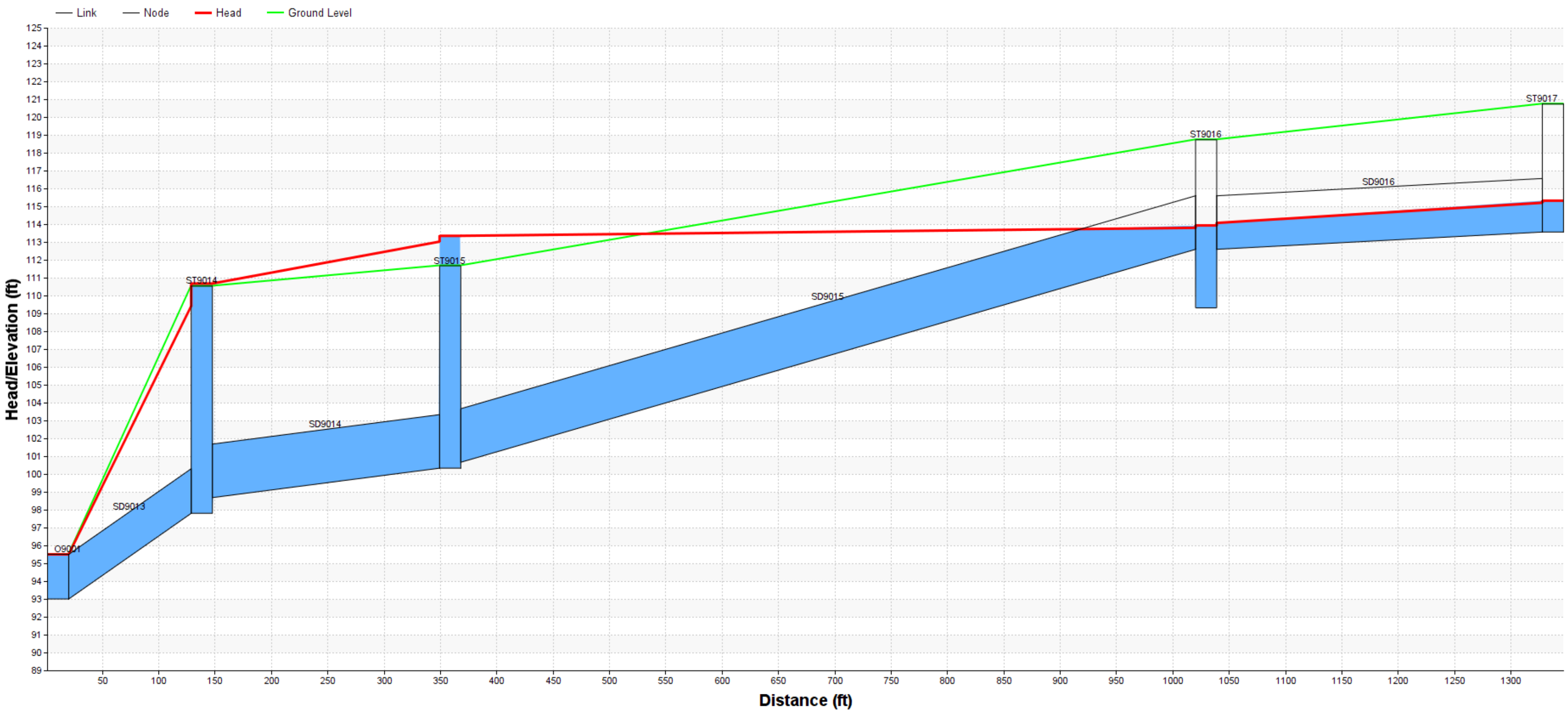


Figure 7. Charbonneau outfall–hydraulic grade line 25-yr design storm

7.2.2 SW Garden Acres Rd./Peters Rd.

Starting at the 2-yr design storm, flooding is anticipated along the stormwater collection system running north to south along SW Garden Acres Rd. and Peters Rd. The modeled capacity issue at this location is caused by a constriction due to undersized pipes (24-inch/27-inch) prior to the system discharging to the Coffee Lake Creek wetlands as shown on Figure 8 below. The upstream drainage area to this piped system is expected to develop into a high impervious land use type (industrial) and as such currently contains large diameter conveyance pipes (42-inch/48-inch). Future development will further exacerbate the predicted flooding at this location. This location is a known issue for the City, and a CP will be developed at this location to address the capacity issues.

Early discussions with the City have identified potential issues to upsize the undersized pipe, due to the fact the alignment transects the railroad right-of-way and discharges to a greenspace property owned by Metro. To avoid railway and Metro conflicts, the City has suggested retrofit of existing (private and public) ponds along the pipe alignment near the terminus of Peters Road to provide additional flow mitigation (discussed further in Section 8.1). In addition, alternative alignments may also be considered to divert runoff from the identified pipe constriction near the existing outfall. One possibility that could avoid the railroad right-of-way and Metro property would be to install new piping along SW Clutter Rd. to the west and along Grahams Ferry Rd. to the south to outfall into Coffee Lake Creek wetlands. This concept is preliminary and will need to be investigated and tested further with the City once CPs start to be developed.

7.2.3 Commerce Circle and Day Road

Starting at the 2-year design storm, model results indicate that the open channel to the west of Commerce Circle continues to be a flooding problem area. Banks of the open channel and the existing impoundment adjacent to Day Road are expected to overtop during larger storm events. These model results are consistent with the modeling/CP development for the 2012 SMP, and the follow up study “Coffee Creek Stormwater Facility Study” completed by AKS in 2019.

This location has several deficiencies within the waterway such as undersized culverts, heavy buildup of vegetation/debris, and segments with negative grade. Historically, this location has been particularly difficult to address due to space constraints, limited available grade, and the original drainage design allowing for the adjacent parking lots to flood to provide detention. This SMP update will build upon previous preliminary design concepts to develop a refined option for implementation.

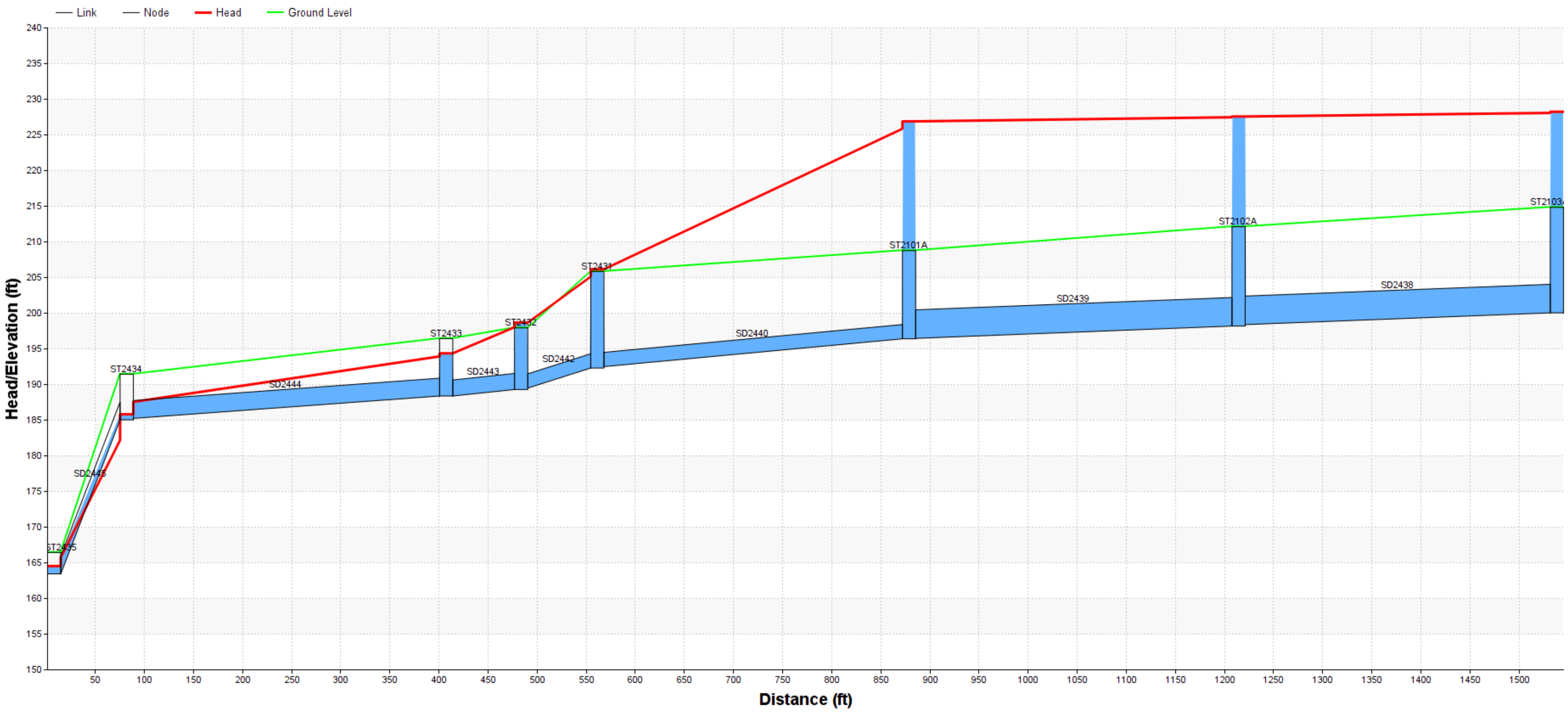


Figure 8. Peters Road–hydraulic grade line 25-yr design storm

Section 8: Retrofit Analysis

In conjunction with the H/H modeling evaluation of the City's stormwater system, BC initiated efforts to investigate additional project opportunity locations where the addition of new water quality and/or detention facilities or the reconfiguration of such facilities can provide regulatory or development benefit within the City.

To assist in this analysis, a working map was developed to facilitate the identification of potential retrofit locations. Key elements displayed on this figure included potential property (classified as vacant, parks, open space, or City owned), ponds (public and private), water quality projects from the 2012 SMP, best management practice drainage areas, and future transportation corridors. This retrofit figure is included in Attachment A, Figure A-10.

Based on review of the retrofit analysis figure and City staff preferences, the following objectives (strategies) were developed to guide the retrofit analysis:

1. Revisit priority (higher scoring) retrofit projects previously identified in the 2015 Retrofit Assessment to confirm continued relevance. These projects generally align with water quality-related projects per the 2012 SMP. This effort supports requirements of the 2021 National Pollutant Discharge Elimination System municipal separate storm sewer permit, which requires permittees to revisit the 2015 Retrofit Assessment and provide a status update.
2. Integrate water quality and/or flow control into existing project opportunity areas (where possible).
3. Retrofit underutilized facilities such as ponds or swales to enhance water quality and/or provide downstream flow mitigation.

Identification of new facilities to support anticipated development and growth was not considered a preferred retrofit strategy, given the fact that private development already has to adhere to the City's prescriptive stormwater design standards. These strategies helped to inform the retrofit projects and program discussed below.

8.1 Potential Retrofit Project Locations

Retrofit project locations were organized into two primary categories: previously identified locations and new opportunity locations. Applicable and relevant project opportunities are discussed in the following subsections to document potential locations for future CP development.

8.1.1 Previously Identified Opportunities

The 2012 SMP originally identified 14 restoration and 7 LID projects. These projects were reassessed and prioritized as part of the 2015 Retrofit Assessment.

For this SMP update, these projects were revisited to confirm implementation status and continued applicability in conjunction with current retrofit objectives. To track these projects and document discussions with City staff, Table 11 below was produced.

In this table, eight projects were removed (see gray shading) from consideration either due to them already being completed or no longer being feasible. Most projects were deemed still applicable and thus have been retained for inclusion in the overall project opportunity list.

Table 11. 2015 Retrofit Assessment Review and Status Confirmation														
Project ID[a]	Project Name	Constructed?	Overlaps with Existing Problem Area	Overall Score [a]	Scoring criteria (per 2015 Retrofit Assessment)							Implementation Timeframe	Notes
					Progress Toward TMDL WLA	Location	Temperature Control	Erosion Control	Integration	Impact Area	Funding Source		
					0–4	0–3	0–3	0–3	0–3	1–3	0/1	1–3	
LID3	SW Camelot Green Street Mid-block Curb Extension	No	Yes, 46	**16**	4	2	2	2	3	1	0	2	Reflect in Program
LID7	SW Wilsonville Road Stormwater Planters	No	No	**16**	4	2	2	2	3	1	0	2	Reflect in Program
CLC-10B	Coffee Creek Storm Projects	No	Yes	**16**	4	2	2	2	2	1	1	2	Not Applicable–reflects CLC-1. Project number is unique to the Retrofit Assessment source document.
BC-5	Boeckman Creek Outfall Realignment	No	No	**13**	2	0	0	3	3	2	1	2	Project involves realignment of an existing outfall into Boeckman Creek (330' N of Wilsonville Rd) that is causing erosion. Erosion issues not identified in 2021 stream assessment. Mid-term project need from source document of retrofit assessment. Project location may overlap with a Boeckman Road mitigation need (Creekside Woods Pond). Not considered a retrofit but keep as a Project Opportunity Area.
CLC-6	Coffee Lake Creek South Tributary Wetland Enlargement	No	No	**13**	2	2	3	2	0	3	0	1	Referenced as a long-term project need from source document of retrofit assessment. Project location overlaps with Siemens/Ash Meadows. Current METRO project may also negate the project need. Remove from Project Opportunity List.
BC-4	Gesellschaft Water Well Channel Restoration	No	No	**13**	2	0	1	3	2	1	1	3	Project may be constructed in conjunction with other infrastructure projects (Interceptor Trail). Not considered a retrofit but keep as a Project Opportunity Area.
LID2	SW Hillman Green Street Stormwater Curb Extension	No	No	**13**	4	3	2	2	0	1	0	1	Reflect in Program
BC-8	Canyon Creeks Estate Pipe Removal	No	Yes, 37	**12**	2	0	1	3	0	2	1	3	Short term/High priority CIP need per source document from retrofit assessment. Maintain as a retrofit project and keep as a Project Opportunity Area (combined with problem area).
CLC-3	Commerce Circle Channel Restoration	No	Yes, 15/32	**12**	0	0	3	1	3	2	1	2	Mid-term project need from source document of retrofit assessment. Maintain as a retrofit project and Project Opportunity Area (combined with problem area).
WD-4A	Willamette Way West Outfall Replacement	No	No	**11**	2	0	0	3	0	2	1	3	Project location is being monitored. No immediate project need. Remove as a Retrofit project and Project Opportunity Area.
WD-4B	Belknap Ct Outfall Protection	**Yes**	No	**11**	2	0	0	3	0	2	1	3	Complete. Remove from list.
WD-4C	Morey Ct West Outfall Protection	**Yes**	No	**11**	2	0	0	3	0	2	1	3	Complete. Remove from list.
BC-2	Boeckman Creek Outfall Rehabilitation	No	No	**9**	0	0	0	1	3	2	1	2	Project involves rehab of 5 existing outfalls between Wilsonville Rd and Boeckman Rd that have erosion issues. Erosion issues not identified in 2021 stream assessment. Mid-term project need from source document of retrofit assessment. Project location may overlap with other infrastructure projects. Not considered a retrofit but keep as a Project Opportunity Area.
BC-10	Memorial Park Stream and Wetland Enhancement	No	No	**9**	0	0	3	0	2	2	0	2	BC-10 enhances the existing stream channel that flows into Boeckman Creek to the N of Memorial Park baseball field (near sanitary lift station). This stream receives flow from the Memorial Drive Swales which are just upstream (Problem Area #52 & BC-9). Mid-term project need from source document of retrofit assessment. Project location overlaps with potential Boeckman Road flow mitigation site. Keep as a retrofit project and Project Opportunity Area.

Table 11. 2015 Retrofit Assessment Review and Status Confirmation

Project ID[a]	Project Name	Constructed?	Overlaps with Existing Problem Area	Overall Score [a]	Scoring criteria (per 2015 Retrofit Assessment)							Implementation Timeframe	Notes
					Progress Toward TMDL WLA	Location	Temperature Control	Erosion Control	Integration	Impact Area	Funding Source		
					0–4	0–3	0–3	0–3	0–3	1–3	0/1	1–3	
CLC-1	Detention/Wetland Facility Near Tributary to Basalt Creek	No	Yes, 15/32	**8**	2	1	0	2	0	1	1	1	Referenced as a long-term project need from source document of retrofit assessment but aligns with problem area. Maintain as a retrofit project and Project Opportunity Area (combined with problem area).
CLC-2	SW Parkway Avenue Stream Restoration	No	No	**8**	0	0	3	1	0	2	0	2	Project is no longer needed, given onsite improvements for capacity (La Quinta). Remove from retrofit assessment.
CLC-7	Coffee Lake Creek South Tributary Stream Restoration	No	No	**8**	0	0	3	1	0	3	0	1	Project is no longer needed as this location conflicts with proposed new Public Works building. Current METRO project may also negate the project need.
CLC-8	Coffee Lake Creek Restoration	No	No	**8**	0	0	3	1	0	3	0	1	Project is no longer needed. This location is associated with 5th and Kinsman Project–Road isn't going to come out so project no longer applicable. Also at the driveway for Wilsonville Concrete.
CLC-5	Coffee Lake Creek Stream and Riparian Enhancement	No	No	**7**	0	0	3	1	0	2	0	1	Referenced as a long-term project need from source document of retrofit assessment. Maintain as a retrofit project and Project Opportunity Area (combined with problem area).
CLC-4	Ridder Road Wetland Restoration	No	No	**7**	0	0	3	1	0	2	0	1	Referenced as a long-term project need from source document of retrofit assessment. Maintain as a retrofit project and Project Opportunity Area (combined with problem area).

a. *Overall score is based on a maximum 23 points possible.*

TMDL = total maximum daily load

WLA = waste load allocation

8.1.2 New Opportunities

In addition to the projects previously identified in the 2015 Retrofit Assessment, this SMP update identified several opportunities to integrate water quality and/or flow control into an existing project opportunity or retrofit an existing, underutilized facility. These opportunities and their preliminary retrofit concept are summarized in Table 12.

Table 12. New Retrofit Opportunities

Location	Retrofit Strategy	Retrofit Concept
Library Pond	Existing Project Opportunity	Install outlet structure to existing pond to provide flow control benefits. Drainage from Town Center is conveyed through this facility. Opportunity to implement a fee-and-lieu system for upstream redevelopment.
Tivoli and Oulanka Parks	Underutilized Facility	Combination of public and private swales at these locations. Swales have not been properly maintained and need retrofit.
Oregon Glass Pond	Underutilized Facility	Ponds near the outfall of the Ridder Rd./Peters Rd. piped stormwater system may be able to be reconfigured to provide a flow control benefit. Opportunity to help to mitigate the pipe capacity issues at this location.
Memorial Park Dr. Swales	Existing Project Opportunity and Underutilized Facility	Existing swale is not draining properly. Swale needs retrofit.
Canyon Creek Park	Existing Project Opportunity	Existing park property has potential to construct a regional facility. This facility could treat upstream runoff from Argyle Square, Sysco, and other future developments. Due to location within BPA easement, additional coordination would be required.

While these are the opportunities identified to date, additional opportunities may be identified in the future especially with the current design efforts associated with the BRCP. As part of the BRCP, mitigation opportunities associated with Boeckman Creek are currently being identified and evaluated for future project development. Any projects that result from the BRCP will be coordinated with projects developed as part of the SMP update. At this time, preferred mitigation opportunity locations have also been integrated into the larger project opportunity list for this SMP.

8.2 Potential Programs

To allow for the opportunistic integration of water quality in conjunction with transportation or other utility replacement projects, this retrofit assessment identified two potential programs that would provide a general funding mechanism to support retrofit strategies. These programs include the following:

- Green Street/LID Facilities–Allocate approximately $250,000/year to support green street and LID facility installations of facilities in conjunction with already planned utility work for select roadway improvements. This would allow for continued expansion of water quality treatment areas in areas without any existing treatment.
- Porous Pavement Pilot Study–Allocate approximately $25,000/year to install porous pavement overlays in conjunction with scheduled pavement replacement or restoration efforts. This would allow the City to begin to evaluate feasibility of adopting porous pavement for future paving projects in the City.

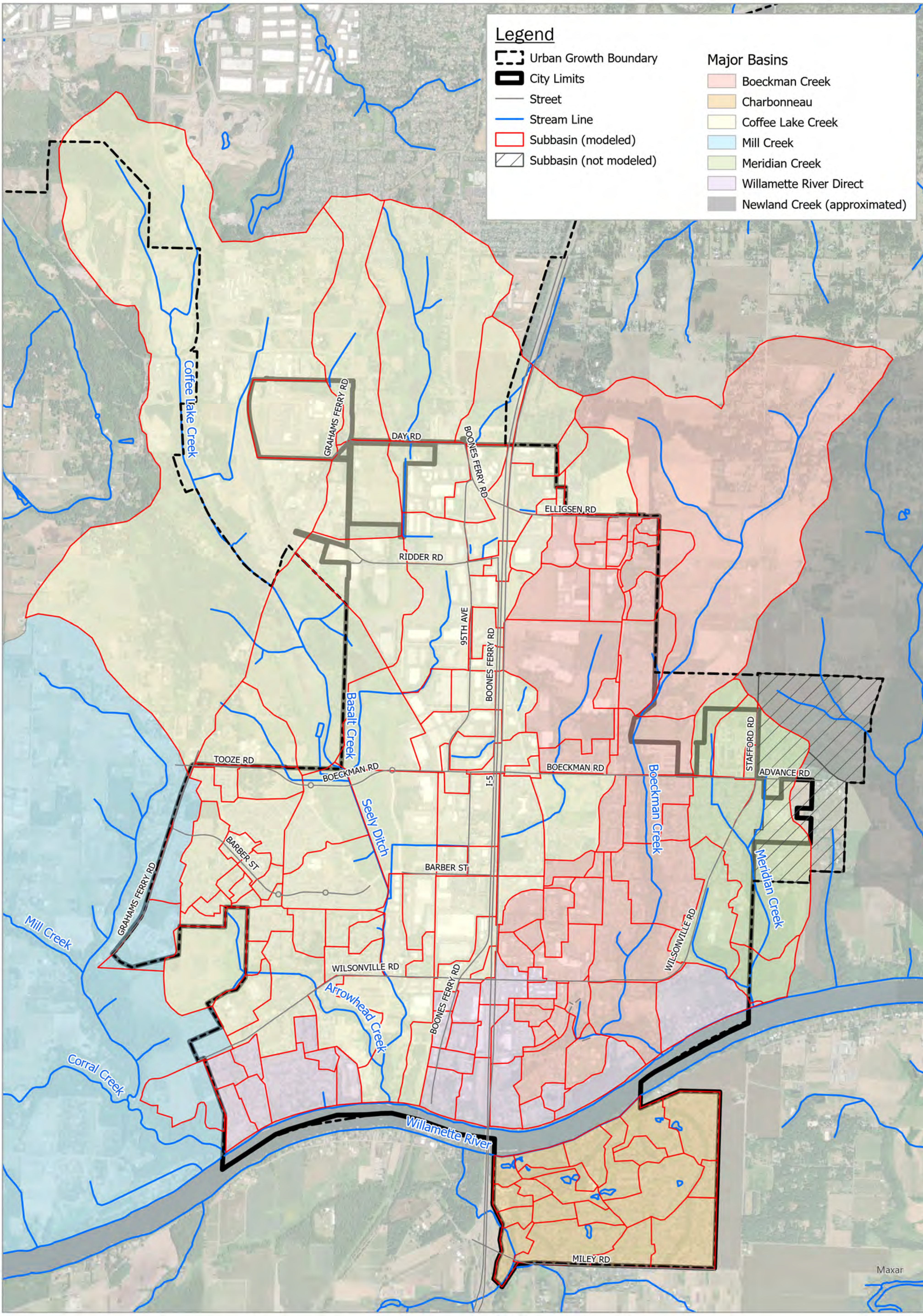
These programs will be considered in conjunction with other CP planning. Additional program opportunities have previously been identified as outlined in TM#1.

Section 9: Conclusions and Next Steps

Project identification and preliminary project concepts stemming from the H/H modeling (Section 7) and retrofit assessment (Section 8), as documented in this TM, have been integrated into a Project Opportunity Matrix (Attachment B, Table B-4). The Project Opportunity Matrix expands the Problem Area Matrix that was originally included as Table A-1 in TM#1. The Project Opportunity Matrix provides a comprehensive summary of project needs in the City and will be used to facilitate City discussions and identify preferred locations to develop CPs for the SMP update.

Following City review of this TM, BC will start evaluating priority flooding locations (see Attachment B, Table B-4) to assess alternatives and feasibility of preferred project concepts. Subsequent evaluation efforts will focus on other priority locations, as confirmed through the Capital Project Workshop (scheduled for February/March 2023). Refined project concepts and cost estimates will be developed for select (approximately 15) project opportunity locations, and results documented in the SMP in graphical and tabular format.

Attachment A: Figures



Brown AND Caldwell

City of Wilsonville/
Project # 156157

Stormwater Master Plan

Date: 3/3/2023

Notes:

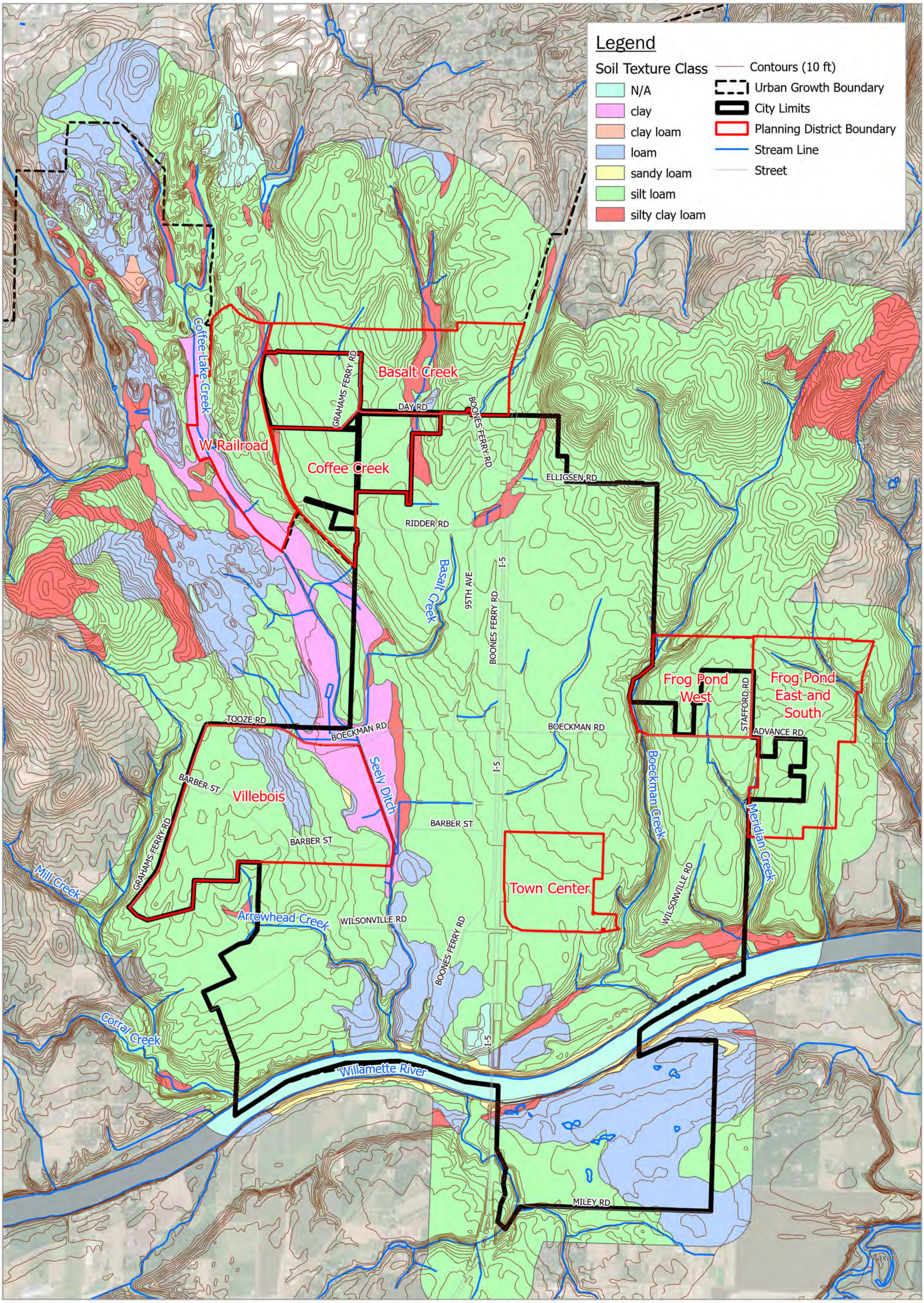
Drawn By: SWG
Checked By:

Spatial Reference:
Name: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl

N

0 1,250 2,500 5,000 Feet

Figure A-1: Subbasin Delineation



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Accessed By: SGILMARTIN at 03/07/2023

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Notes:

Drawn By: SWG
Checked By:

Spatial Reference:
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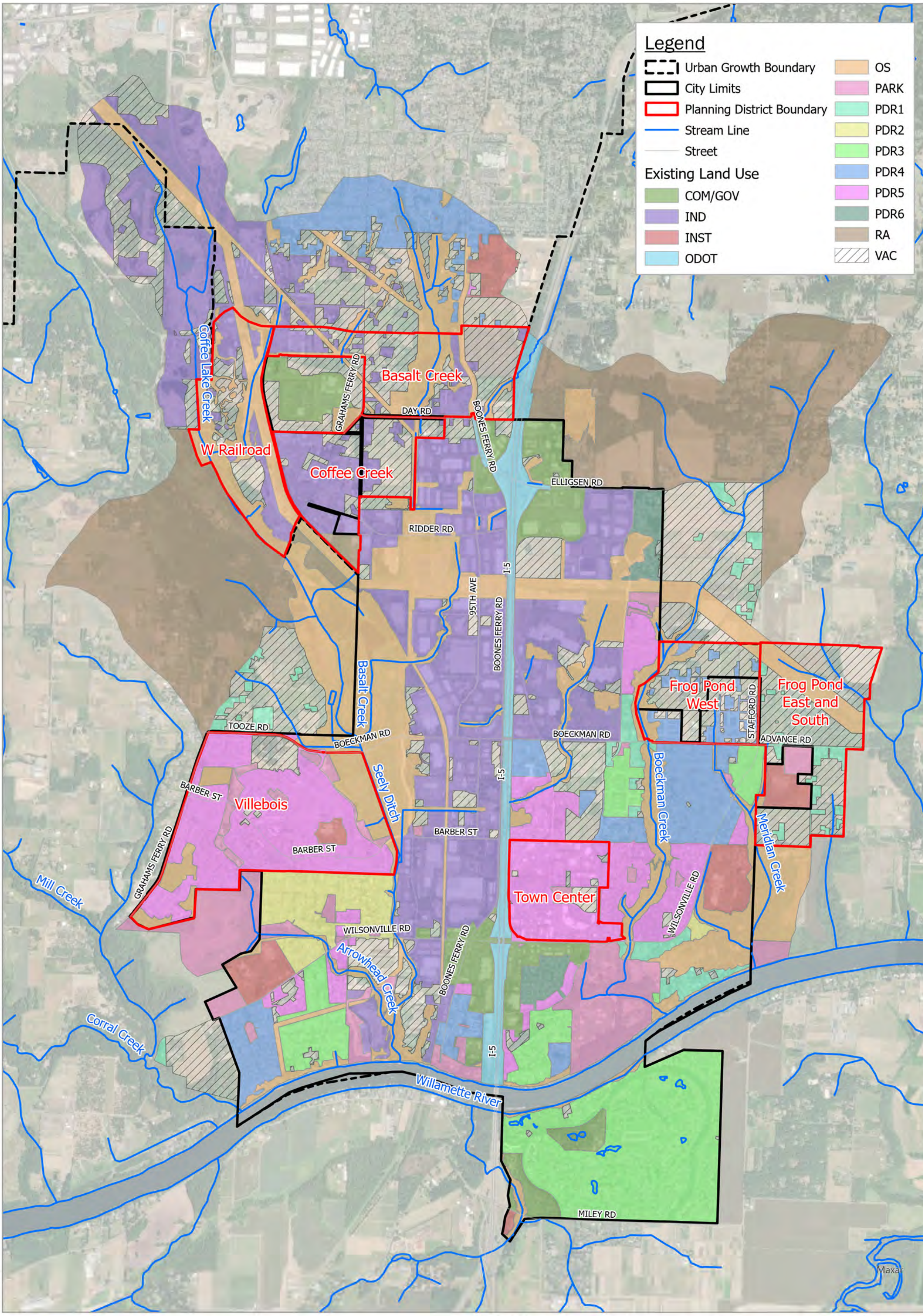
Figure A-2: Soils and Topography

Date: 3/7/2023



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Stormwater Master Plan

Notes:

Drawn By: SWG
Checked By:

Spatial Reference:
Name: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl

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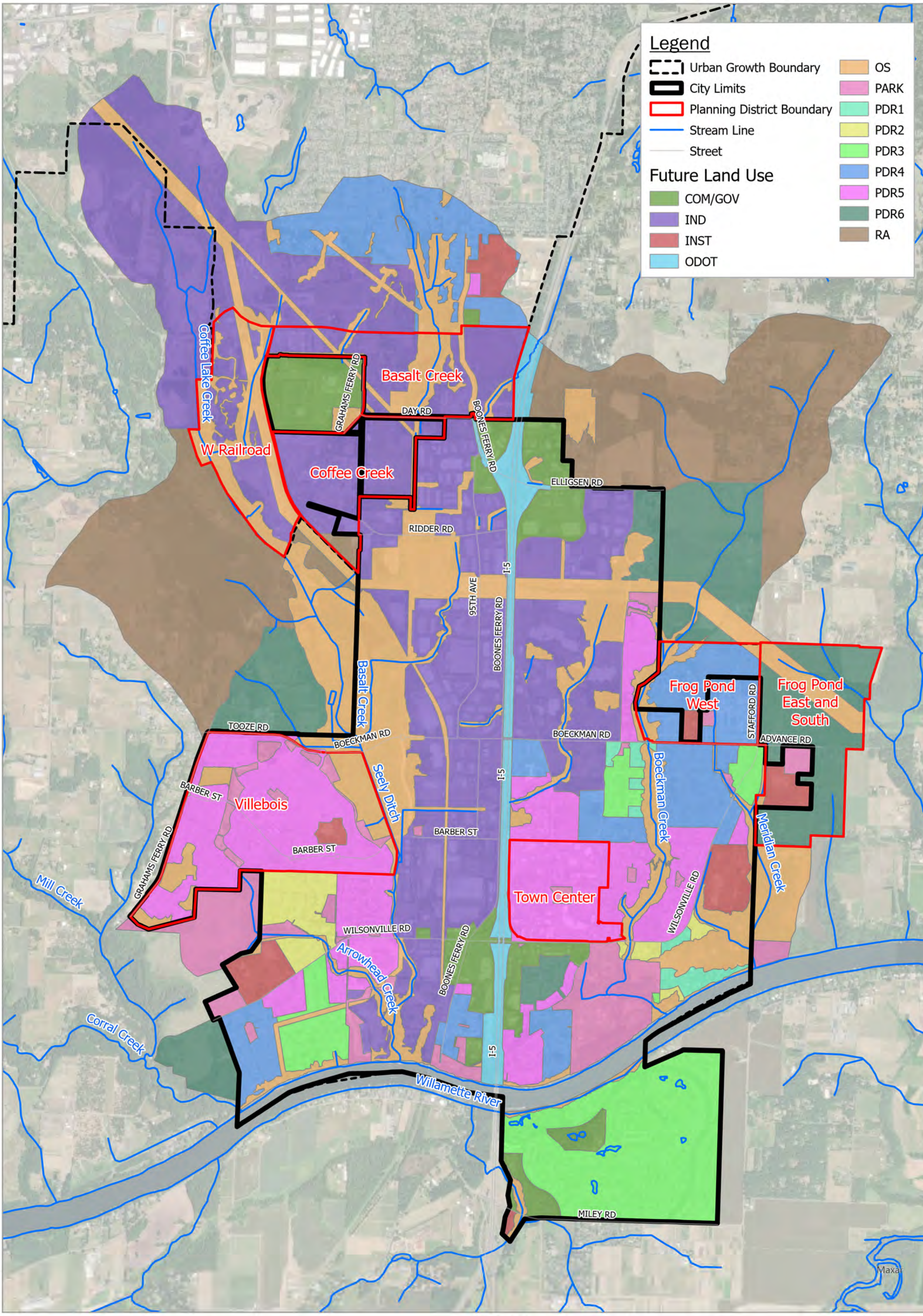
0 1,250 2,500 5,000 Feet

Figure A-3: Existing Land Use Condition

Date: 3/7/2023



Accessed By: SGILMARTIN at 03/07/2023

Path: W:\156157 - Wilsonville Stormwater Master Plan\GIS_Internal BC\APRX\TM3\Fig A-4_Future LU.aprx

City of Wilsonville/
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Stormwater Master Plan

Notes:

Drawn By: SWG
Checked By:

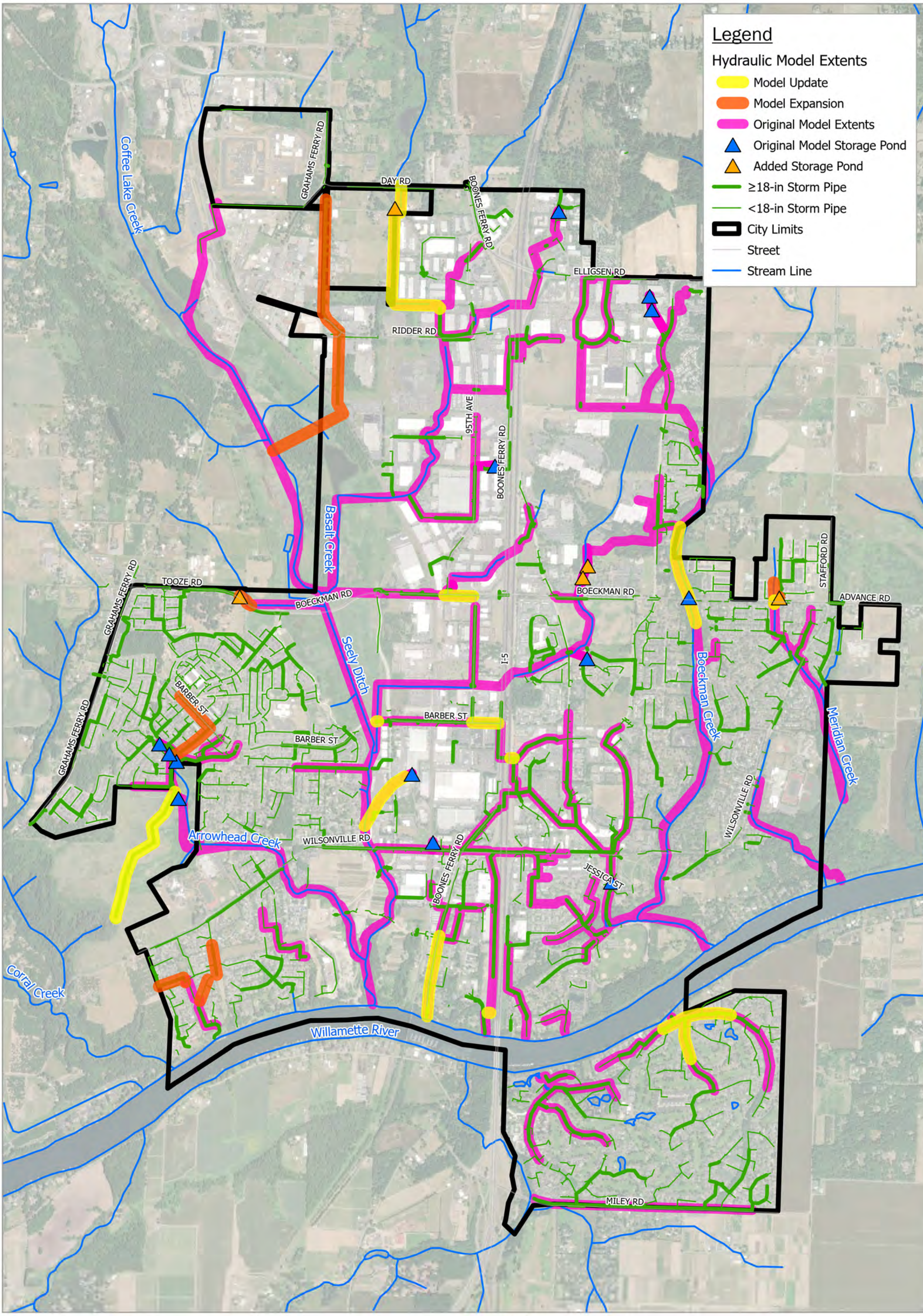
Spatial Reference:
Name: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl

N

0 1,250 2,500 5,000 Feet

Figure A-4: Future Land Use Condition

Date: 3/7/2023



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Date: 3/7/2023

Notes:

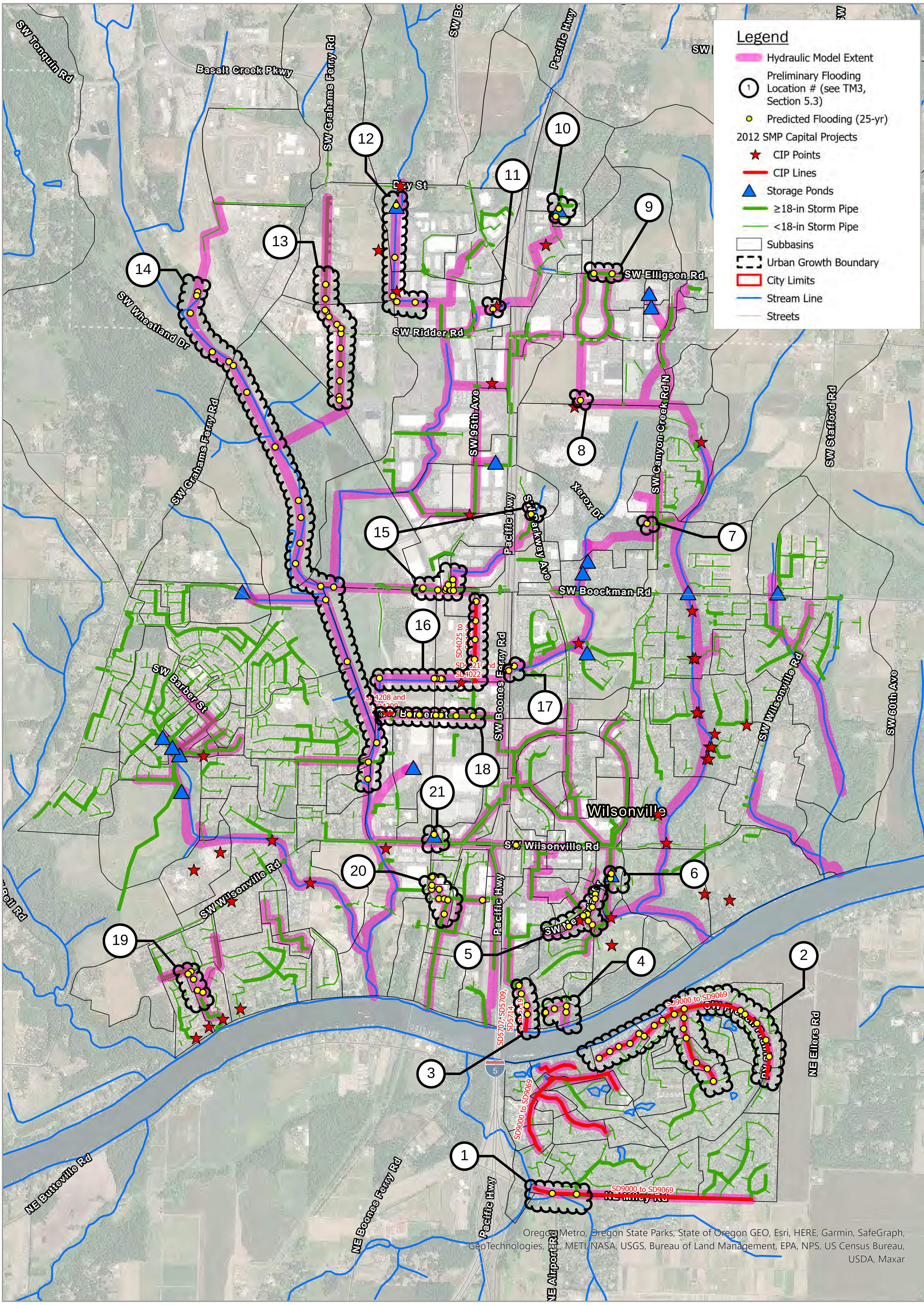
Drawn By: MRG
Checked By:

Spatial Reference:
Name: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl

N

0 1,000 2,000 4,000 Feet

Figure A-5. Hydraulic Model Overview



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Date: 3/7/2023

Notes:

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Spatial Reference:
Name: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl

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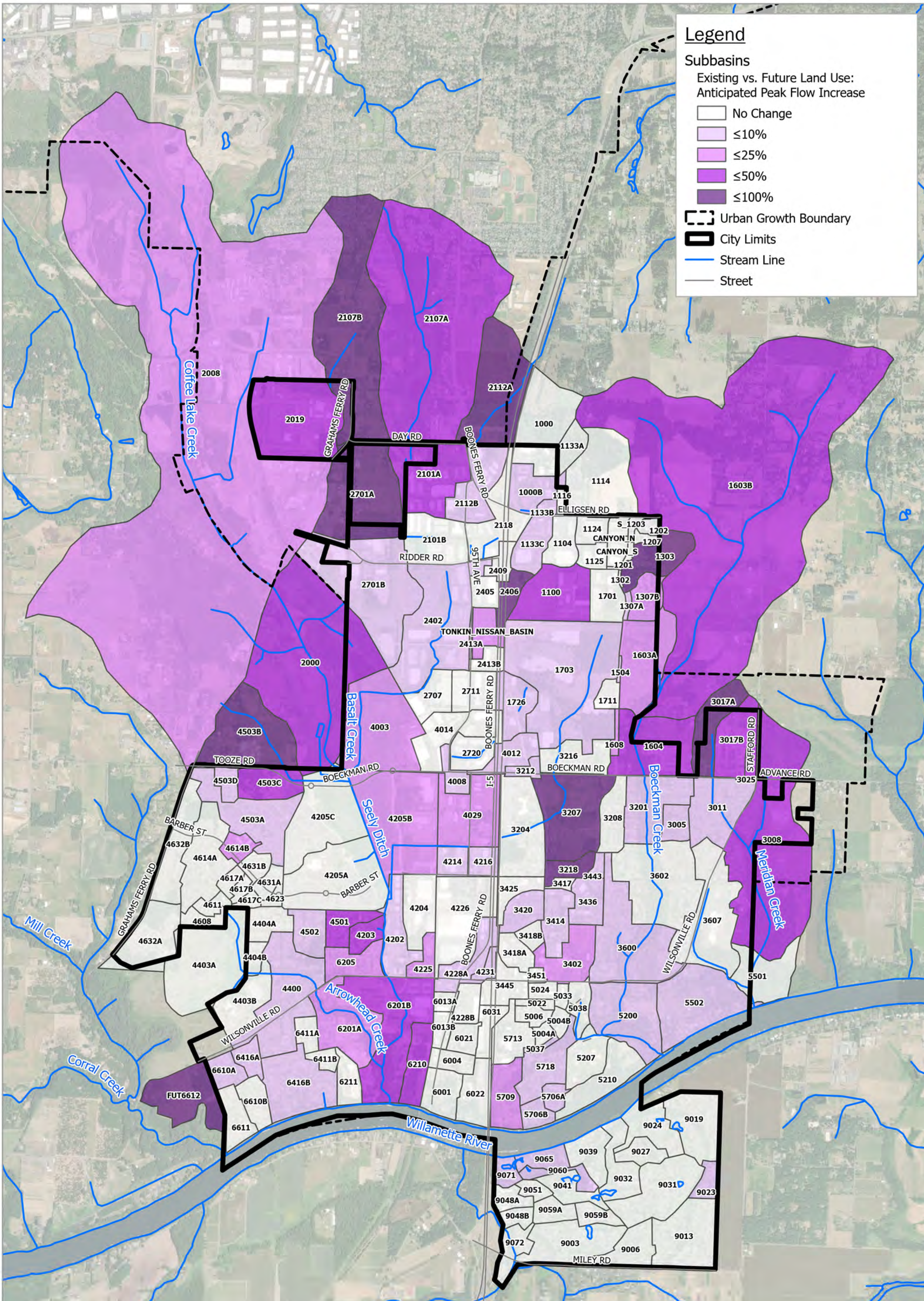
Figure A-6: Preliminary Flooding Results (25-yr design storm)



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Date: 3/7/2023

Notes:

Drawn By: SWG
Checked By:

Spatial Reference:
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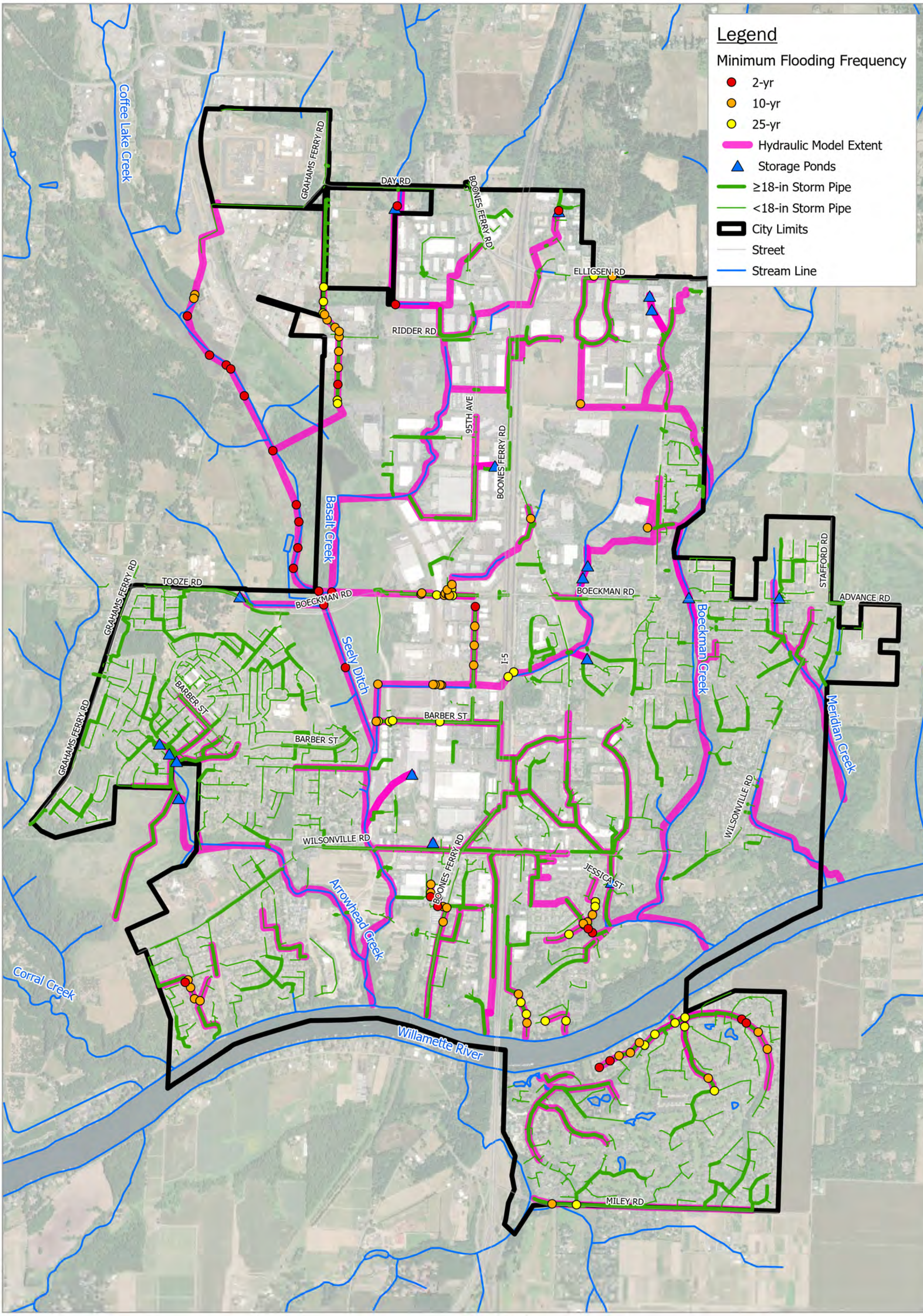
Figure A-7: Hydrologic Results: Subbasin Peak Flow Increase %



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City of Wilsonville/
Project # 156157

Stormwater Master Plan

Notes:

Drawn By: MRG
Checked By:

Spatial Reference:
Name: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl

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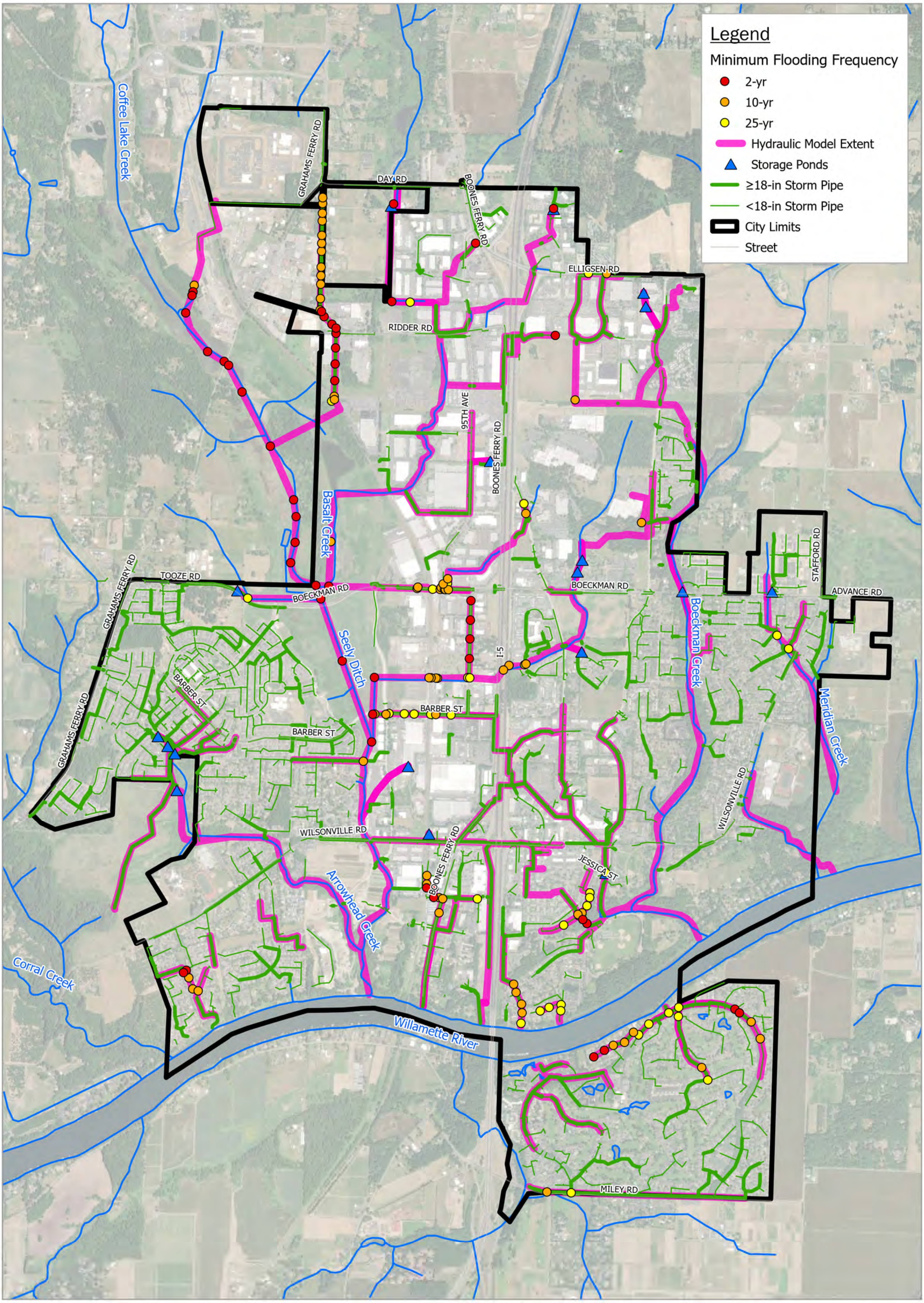
Feet

Figure A-8. Hydraulic Results: Existing Condition Flooding Locations

Date: 3/7/2023



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Stormwater Master Plan

Notes:

Drawn By: MRG
Checked By:

Spatial Reference:
Name: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl

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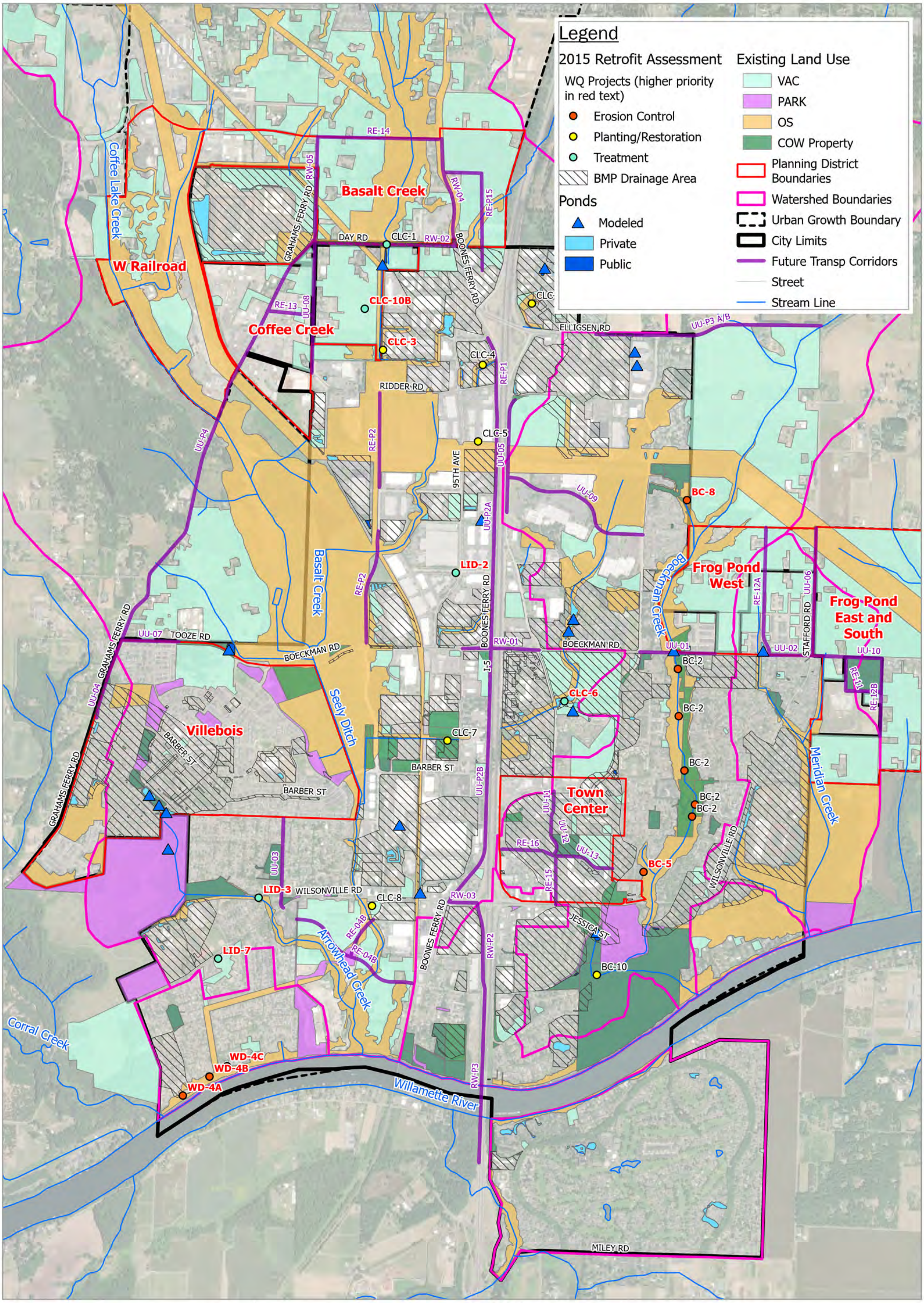
Figure A-9. Hydraulic Results: Future Condition Flooding Locations

Date: 3/7/2023



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City of Wilsonville/
Project # 156157

Stormwater Master Plan

Date: 3/7/2023

Notes:

Drawn By: SWG
Checked By:

Spatial Reference:
Name: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl

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0 1,000 2,000 4,000 Feet

Figure A-10. Retrofit Analysis

Path: W:\156157 - Wilsonville Stormwater Master Plan\GIS_Internal BC\APRX\TM3\Fig A-10_Retrofit Analysis.aprx

Accessed By: SGILMARTIN at 03/07/2023

Attachment B: Tables

Table B-1: Preliminary Flooding Results

Table B-2: Hydrologic Model Inputs and Results

Table B-3: Hydraulic Model Inputs and Results

Table B-4: Working Project Opportunity Matrix *(removed for the 2024 SMP deliverable, instead refer to Appendix A, Table A-2 of the SMP for the final Project Opportunity Matrix)*

Table B-1. Modeled Capacity Deficiencies

Flooding Location ID	Watershed	Location	Model Description/ Preliminary Flooding Results	Minimum Flooding Frequency (up to 25-yr design storm)	Modeling Notes	Model Adjustments per Validation	Associated Problem Area from TM#1 (2022)	Flooding predicted in 2012 SMP?	Associated CIP from 2012 SMP?	CIP from 2012 SMP Constructed? (Y/N)	Flooding Predicted following Model Validation?	Project Need per 2022 SMP	Notes
1	Charbonneau	Miley Rd.	Predicted flooding at 42" pipe segment upstream of Miley Rd. outfall.	10-yr	Rim elevations and inverts along pipe profile appears reasonable and match GIS data. No apparent issues.	None	10 (E&S)	Y	SD9000 to SD9069 (Charbonneau Pipe Replacement)	N	Y	Y	City confirmed project need at this location for inclusion in the SMP.
2	Charbonneau	French Prairie Rd. & Old Farm Rd.	Flooding indicated throughout these piped systems. Model contains some pipe replacement projects completed as CIPs from the Charbonneau Consolidated Improvement Plan (2014). Small portion of all improvements recommended per the plan.	2-yr	Issues previously identified/documented in 2012 SMP and Charbonneau Consolidated Improvement Plan. Capacity issue appears to be the outfall piping (30") acting as a constriction to the upstream piping that was upsized (36") as part of the CIP.	Model previously was updated to reflect the completed CIPs. Asbuilts of the emergency outfall repair were provided and reviewed by BC. Confirmed model assumption of 30" diameter of outfall. Updated model to include revised pipe slope and Manning's roughness for installation of CMP liner based on provided asbuilt information.	None	Y	SD9000 to SD9069 (Charbonneau Pipe Replacement)	Y (select phases completed)	Y	Y	Wallis Engineering is currently working on the design of pipe upsizing along SW French Prairie and SW Edgewater. City coordinated meeting between BC and Wallis with the goal to have the capacity deficiency identified by the SMP modeling effort (outfall pipe constriction) inform current design project. based on the capacity deficiency identified by the SMP modeling effort. This work is in progress and strategies are being discussed to provide flow detention to mitigate the model predicted flooding.
3	Willamette River	Parkway Ave./Metolius Ln.	Flooding at several nodes along N-S run of pipe. Constriction appears to be the small diameter pipe at the outfall and one conduit US.	10-yr	Invert elevations in MH prior to outfall are misaligned. Pipe sequence is 48">42">21">15" causing constriction. No GIS data available to verify the existing model data. Issue previously identified in previous MP.	None. Inverts and diameters appear odd but better information is not available in GIS to resolve. City would need to provide measurements or asbuilts to potentially update and fix model here.	None	Y	SD5707, SD5709, SD5714, and SD5719 (SW Parkway Pipes Replacement)	N	Y	?	
4	Willamette River	SW Miami	15" conveyance pipe with US node preliminary flooding results.	25-yr	Subbasin hydrology is inserted at most US node of each pipe segment to generate flow w/in all pipes. May not be fully representative of runoff received by US nodes in reality. There also is a pond that is not currently being modeled which may alleviate flooding to the system.	Original subbasin subdivided to try and address the suspected hydrology input issue. However flooding still predicted at this location.	None	N. However the drainage area to this location was revised from the original model.	None	N	Y	N	City does not recall issues at this location. Maintain this location as a flooding location however development of a project is not warranted.
5	Boeckman	Memorial Dr.	Piped system near Memorial Dr. swale predicts flooding.	2-yr	After convergence point at Memorial Dr. (ST5002) pipe sizes are 24">15">12">18">24" prior to outfall to Boeckman Creek causing the constriction and US flooding.	Asbuilts of the swale and piped system were provided and reviewed by BC. Asbuilts confirmed the model configuration, no adjustments required.	52 (swale issues)	Y	BC-9 (Memorial Drive Pathway and Storm Drain Repair)	Y	Y	Y	Based on confirmed pipe configuration and known issues at this location, project at this location is needed.
6	Boeckman	Library Pond	Preliminary Library Pond flooding, Depth >9' (pond max depth). and node DS of Library Pond outlet shows flooding	N/A	Unknown how previous model build accounted for amount of library pond storage or developed the outlet curve for flow leaving the pond. From site visit, outlet should just be a pipe w grate. Seems unlikely that pond would flood based on configuration.	Model updated per asbuilts to reflect pond outlet configuration	4 (CAP)	Y	None	N	N	Y	Project to be developed at this location to provide a flow control benefit for pond storage. Project need is primarily based on providing flow control for Town Center redevelopment and not for capacity (no issues observed by City).
7	Boeckman	Canyon Creek Rd (near Xerox)	Flooding at node that convey private SW (Xerox) to the S and then E across Canyon Creek Rd.	10-yr	Pipe sequence is 15">18">15">12">12" causing constriction at Canyon Creek Rd. Final 12" pipe is at 5%.	None. GIS information is the same as model. City would need to provide measurements or asbuilts to potentially update and fix model here.	None	Y	None		Y	N	City confirmed pipe configuration per as-built drawings. City does not recall this location as an issue and unlikely to be a project need.
8	Boeckman	Sysco Ditch	Flooding at US node of 30" culvert at end of N-S section of Sysco Ditch	10-yr	Issue (constriction) is at 30" culvert. Very steep slope @ 8.6%.	None. GIS information is the same as model. City would need to provide measurements or asbuilts to potentially update and fix model here.	30 (CAP and MAINT)	N	BC-1 (Wiedeman Road Regional SW Detention/Stream Enhancement)		Y	N	Very limited grade. Flooding shown at upstream end of culvert and impacts downstream Costco property. Sysco owns property to west of ditch. Ditch can be removed (manmade) and they are proposing. Does not warrant a City project need - up to Sysco to resolve.
9	Boeckman	Elligsen Rd	Flooding along US nodes of 18" SW piping	10-yr	Model set up seems reasonable. Large subbasins is inserted at US end which may be causing the flooding. Trailer Park pond on N side of Elligsen is not currently in the model	None. Flooding likely can be disregarded here, otherwise additional routing likely needed for model (pond and open channel for routing purposes)	20 (MAINT)	Y	None		Y	N	

Flooding Location ID	Watershed	Location	Model Description/ Preliminary Flooding Results	Minimum Flooding Frequency (up to 25-yr design storm)	Modeling Notes	Model Adjustments per Validation	Associated Problem Area from TM#1 (2022)	Flooding predicted in 2012 SMP?	Associated CIP from 2012 SMP?	CIP from 2012 SMP Constructed? (Y/N)	Flooding Predicted following Model Validation?	Project Need per 2022 SMP	Notes
10	Coffee Creek	Shrine Center Pond	Pond flooding (HGL>4.7' max pond depth) and DS node from pond outlet	2-yr	Unknown how previous model build accounted for amount of pond storage or developed the outlet curve for flow leaving the pond.	None. To fix, would need to throughly investigate asbuilts for this pond.	25 (MAINT Access)	Y	None		Y	Y (specfic to maintenance access only)	
11	Coffee Creek	NW of 95th Ave. and Ridder Rd. intersection	Preliminary flooding at US end of culvert that conveys flow E to W under a private parking lot (Penske Truck)	N/A	Rim elevation at US end of culvert appears low. GIS does not show culvert, so unable to verify inherited model data.	None. City would need to provide measurements or asbuilts to verify culvert data if desired.	None	N	CLC-4 (Ridder Rd Wetland Restoration). Proj is immediately US of culvert that floods		N	N	Culvert under parking lot - private (Penske property) and not in GIS. City not aware of issues at this location but provided as-built information. -BC incorporated revised culvert information into model from provided asbuilts. US end of culvert flooding resolved.
12	Coffee Creek	Commerce Circle Ditch	Flooding throughout N-S run of ditch and culverts to the W of Commerce Circle	2-yr	See old MP and AKS study for issues that have been well documented. Current model has updated culvert inverts from survey	None	14/15/26 (R/R, MAINT, CAP)	Y	CLC-1 (Detention/Wetland Facility near Tributary to Basalt Creek) and CLC-3 (Commerce Circle Channel Restoration)		Y	Y	Known important project area. Beaver dam, other unknowns may not be reflected in model and factor into current discrepancy in peak flow and WSE. Redevelopment application looking to build parking area west of channel and would have to span existing channel to other development area - no access from Day Road. -BC developed 4 representative cross-sections along the Commerce Circle Ditch based on AKS survey points. Model link geometry within this reach then revised accordingly. Note that survey data was unavailable for 1 model link and thus a revised cross-section was not developed for this section.
13	Coffee Creek	Garden Acres	N-S piped system along Garden Acres Rd. and Peters Rd. Outfalls to Coffee Creek wetlands.	2-yr	Prior to outfall there is several small diameter pipes (24") that cause constriction and elevated HGL that backs up system. Most other pipes in profile are large diameter (42"/36")	None. Model matches GIS info. City (Sean S.) provided as-builts of this outfall (1994) which showed this small diameter pipe near the outlet of piping run.	None	Not modeled	None		Y	Y	City not surprised by flooding here. This is a priority need in conjunction with build out of Coffee Creek area. Private development is currently having to overdetain. Higher priority need. Railroad and METRO coordination needed (outfalls to METRO property).
14	Coffee Creek	Coffee Creek Wetlands	Flooding throughout wetlands predicted	2-yr	Main issue is the generalization of cross-sections in the model(under represents the actual amount of storage in locations)	None	None	Y	None		Y	N	
15	Coffee Creek	Boeckman Corp. Center Pond	Flooding DS of flow control structure in model and at node near the US end. Flow control structure configuration rationale is unknown but appears to be the restriction	N/A	At very US end of this pipe segment there is a 30">12">24" which seems incorrect. GIS has same info	None. Would need to thouroughly look through asbuilts to modify how this flow control structure is modeled from scratch	None	Y	None		Y	N	US portion - on Parkway. No known issue DS portion - Car dealership - existing pond is mitigation for wetland. Flooding reported downstream of pond. City not aware of any flooding in area (may be an after effect of how pond was integrated into the model. - Based on asbuilt review, control structure configuration adjusted. Pond no longer floods during 25-yr storm event.
16	Coffee Creek	Boberg Rd. and RR crossing	Flooding along N-S pipe prior to discharging into ope channel. This was an area identified in original MP. Flooding also at two large diameter culverts (59" and 51"?!) flowing E-W underneath RR tracks	10-yr	Pipe profile looks reasonable. Previous CIP location. Culverts in model (in series) do not match configuration in GIS (parallel). GIS does not have diameters or inverts	None. Need more info about culverts to make updates	None	Y	SD4025-SD4029 (Boberg Rd Pipe Replacement)		Y	?	
17	Coffee Creek	I-5 Culverts	Flooding at culverts crossing I-5 from E to W	25-yr	Profile looks reasonable. Culvert size (36") can not be verified as that info is not in the GIS data.	None. City would need to provide measurements or asbuilts to verify culvert data if desired.	35 (R&R)	N	None		Y	N	City thinks that flooding at this location is accurate. Maintain as a flooding location, however a project that upsizes ODOT culverts is unlikely.
18	Coffee Creek	Barber St	Flooding indicated at several DS nodes prior to outfall and at node near RR tracks	25-yr	DS flooding along this segment appears to be from backwatering of Coffee Creek (see location #14). Profile appears reasonable and matches the GIS data.	None	None	Y	SD4208 and SD4209 (Barber Street Pipe Replacement). -	N	Y	Unlikely	
19	Willamette River	River Fox Park (site visit	Flooding predicted within 12" pipes	2-yr	Profile looks reasonable and matches the GIS data.	None	22 (MAINT and CAP)	N	None	N/A	Y	Y	

Flooding Location ID	Watershed	Location	Model Description/ Preliminary Flooding Results	Minimum Flooding Frequency (up to 25-yr design storm)	Modeling Notes	Model Adjustments per Validation	Associated Problem Area from TM#1 (2022)	Flooding predicted in 2012 SMP?	Associated CIP from 2012 SMP?	CIP from 2012 SMP Constructed? (Y/N)	Flooding Predicted following Model Validation?	Project Need per 2022 SMP	Notes
20	Willamette River	Lower Boones Ferry	Flooding along 18" Piped segment on private property.	2-yr	Hydrology is input at most US node to generate flow through all pipes, not reflective of reality for US node flooding.	Split subbasin at this location with assumption that they have the same hydrology characteristics. Model still indicates flooding during the 25-yr event.	None	Y	None	N/A	Y	?	
21	Coffee Creek	Wilsonville Distr Center Pond	Model predicts pond flooding	N/A	Unknown how previous model build accounted for amount of pond storage or developed the outlet curve for flow leaving the pond.	None. To fix, would need to throughly investigate asbuilts for this pond.	None	N. However the original model is configured incorrectly such that flow is not actually routed through the pond.	None	N/A	N	?	

Table B-2. Hydrologic Model Inputs and Results																	
Subbasin Name	Inlet Node	Area (Ac)	Impervious Area (%)		Average Subbasin Slope (ft/ft)	Subbasin Width (ft)	Green-Ampt Infiltration Parameters			Maximum Flow (cfs) for Design Storm							
			Existing Land Use	Future Land Use			Average Capillary Suction (in)	Initial Moisture Deficit (frac.)	Saturated Hydraulic Conductivity (in/hr)	2-yr storm event		10-yr storm event		25-yr storm event		100yr storm event	
										Existing Land Use	Future Land Use	Existing Land Use	Future Land Use	Existing Land Use	Future Land Use	Existing Land Use	Future Land Use
1000	STAFFORD_POND	69.13	33.7	33.7	11.2	1616	6.85	0.36	0.25	14.3	14.3	23.9	23.9	29.8	29.8	38.7	38.7
1000B	ST1000	28.49	59.7	62.4	3.8	673	7.26	0.35	0.23	9.9	10.3	15.0	15.6	17.8	18.4	21.7	22.3
1100	ST1100	55.81	29.9	52.1	1.5	1516	6.69	0.37	0.26	9.8	16.6	15.2	24.7	18.2	29.1	22.8	35.2
1104	ST1104	21.55	82.2	82.2	1.7	625	6.69	0.37	0.26	9.8	9.8	14.3	14.3	16.6	16.6	19.6	19.6
1114	ST1114	74.81	15.3	15.3	7.8	1303	6.69	0.37	0.26	7.1	7.1	12.8	12.8	16.5	16.5	22.5	22.5
1116	ST1116	3.25	82.2	82.2	4.6	209	6.69	0.37	0.26	1.6	1.6	2.4	2.4	2.8	2.8	3.3	3.3
1124	ST1124	14.02	70.8	70.8	4.9	601	6.69	0.37	0.26	5.9	5.9	8.9	8.9	10.5	10.5	12.6	12.6
1125	ST1125	10.91	71.6	71.6	4.5	649	6.69	0.37	0.26	4.7	4.7	7.1	7.1	8.4	8.4	10.1	10.1
1133A	ST1002	14.12	10.0	10.0	11.9	412	6.69	0.37	0.26	1.0	1.0	2.5	2.5	3.5	3.5	5.1	5.1
1133B	ST1000	4.26	74.4	79.8	3.6	370	6.69	0.37	0.26	1.9	2.1	2.9	3.1	3.4	3.6	4.1	4.3
1133C	ST1132	25.05	74.2	80.6	2.1	766	6.69	0.37	0.26	10.5	11.3	15.5	16.7	18.1	19.4	21.6	22.9
1201	ST1201	2.75	66.1	66.1	5.6	151	6.69	0.37	0.26	1.1	1.1	1.7	1.7	2.0	2.0	2.4	2.4
1202	PST1202	4.78	64.1	64.1	11.9	588	6.69	0.37	0.26	2.0	2.0	3.2	3.2	3.8	3.8	4.6	4.6
1207	PST1207	4.10	64.1	64.1	14.5	392	6.69	0.37	0.26	1.7	1.7	2.7	2.7	3.2	3.2	3.9	3.9
1302	ST1302	0.70	39.5	39.5	1.8	68	6.69	0.37	0.26	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5
1303	ST1303	35.38	19.2	51.4	5.6	841	6.69	0.37	0.26	4.2	10.7	7.4	16.3	9.4	19.5	12.6	23.9
1307A	ST1307	2.27	36.0	47.3	5.4	733	6.69	0.37	0.26	0.7	0.8	1.3	1.4	1.6	1.7	2.0	2.1
1307B	ST1402	20.17	36.0	47.3	5.4	733	6.69	0.37	0.26	4.4	5.8	7.3	9.1	9.1	11.0	11.7	13.8
1504	ST1504	1.09	37.0	43.6	2.8	82	6.69	0.37	0.26	0.3	0.3	0.4	0.5	0.6	0.6	0.7	0.8
1603A	ST1404A	63.03	30.0	37.1	3.8	1121	6.69	0.37	0.26	11.2	13.7	17.2	20.8	20.8	24.8	26.0	30.6
1603B	ST1603	809.84	12.6	26.7	3.5	3376	7.01	0.36	0.24	58.3	112.1	87.9	166.3	104.4	194.8	129.7	235.6
1604	POND_BOECKMAN	69.37	19.4	40.0	5.6	1559	6.69	0.37	0.26	8.3	16.5	14.3	25.7	18.2	31.0	24.4	38.7
1608	ST1608	3.82	49.3	62.5	4.1	209	6.69	0.37	0.26	1.1	1.4	1.9	2.2	2.3	2.7	2.8	3.2
1701	ST1701	25.65	40.7	40.7	2.2	907	6.69	0.37	0.26	6.2	6.2	9.6	9.6	11.6	11.6	14.4	14.4
1703	ST1703	171.87	41.3	46.8	1.5	2258	6.69	0.37	0.26	38.3	42.6	56.6	62.9	66.3	73.5	79.7	88.2
1711	ST1711	9.40	69.5	69.5	3.6	531	6.69	0.37	0.26	3.9	3.9	5.9	5.9	7.0	7.0	8.4	8.4
1726	ST1726	29.64	54.6	60.0	1.1	721	6.69	0.37	0.26	8.9	9.7	13.2	14.4	15.5	16.8	18.6	20.1
2000	ST2000	250.97	9.7	21.1	1.3	2548	8.82	0.30	0.14	16.6	32.0	30.9	52.7	30.4	55.3	30.9	59.8
2008	ST2008	1550.87	31.4	42.1	0.9	4917	6.57	0.34	0.19	194.4	238.8	292.4	358.6	343.9	421.2	415.2	507.8
2019	ST2019	102.09	48.4	76.9	3.6	2343	6.75	0.36	0.26	28.8	44.3	43.6	65.1	51.8	75.9	63.4	90.1
2101A	ST2120	69.86	43.0	62.5	2.9	1499	7.45	0.35	0.22	17.8	25.0	27.4	37.5	33.2	44.5	41.3	54.0
2101B	ST2101	44.71	50.7	50.7	1.4	1656	6.74	0.36	0.26	13.2	13.2	19.9	19.9	23.6	23.6	28.8	28.8
2107A	ST2123	359.21	24.0	41.2	1.2	2353	7.15	0.35	0.23	44.8	68.9	66.6	102.5	78.3	120.0	95.0	144.3
2107B	ST2123	178.65	22.1	55.4	1.9	1285	6.69	0.37	0.26	21.8	46.4	32.3	68.6	37.9	80.0	45.9	95.5
2112A	ST2112	88.70	15.9	56.5	2.9	1214	6.69	0.37	0.26	8.4	27.3	13.4	40.3	16.4	47.1	21.1	56.5
2112B	ST2112	43.89	62.6	71.3	2.9	854	6.69	0.37	0.26	15.4	17.3	22.7	25.4	26.6	29.7	31.9	35.4
2118	ST2118	42.69	52.3	52.3	2.0	571	7.85	0.34	0.19	12.1	12.1	18.4	18.4	21.8	21.8	26.6	26.6
2402	ST2402	112.36	39.2	41.2	1.6	1188	6.69	0.37	0.26	23.3	24.3	34.4	35.9	40.3	42.0	48.4	50.4

Table B-2. Hydrologic Model Inputs and Results																	
Subbasin Name	Inlet Node	Area (Ac)	Impervious Area (%)		Average Subbasin Slope (ft/ft)	Subbasin Width (ft)	Green-Ampt Infiltration Parameters			Maximum Flow (cfs) for Design Storm							
			Existing Land Use	Future Land Use			Average Capillary Suction (in)	Initial Moisture Deficit (frac.)	Saturated Hydraulic Conductivity (in/hr)	2-yr storm event		10-yr storm event		25-yr storm event		100yr storm event	
										Existing Land Use	Future Land Use	Existing Land Use	Future Land Use	Existing Land Use	Future Land Use	Existing Land Use	Future Land Use
2405	ST2405	13.00	63.9	63.9	1.4	785	6.69	0.37	0.26	4.9	4.9	7.4	7.4	8.8	8.8	10.6	10.6
2406	ST2406	15.27	22.0	56.6	2.0	463	6.69	0.37	0.26	2.0	5.0	3.3	7.5	4.2	8.8	5.4	10.7
2409	ST2409	11.04	57.3	57.4	1.2	422	7.23	0.35	0.23	3.7	3.7	5.6	5.6	6.6	6.6	8.1	8.1
2413A	ST2413	2.04	46.8	50.2	1.1	73	6.69	0.37	0.26	0.6	0.6	0.8	0.9	1.0	1.0	1.2	1.3
2413B	ST2410	10.32	66.1	66.4	1.6	444	6.69	0.37	0.26	4.0	4.0	5.9	5.9	6.9	7.0	8.3	8.4
2701A	ST2119A	102.46	28.7	67.3	1.6	2586	6.69	0.37	0.26	17.4	38.2	26.8	56.4	32.3	65.9	40.4	78.7
2701B	ST2105A	128.40	39.2	41.1	1.8	2063	6.69	0.37	0.26	28.3	29.6	42.1	43.9	49.5	51.6	60.1	62.5
2707	ST2707	23.67	64.1	64.1	2.3	650	6.69	0.37	0.26	8.7	8.7	12.9	12.9	15.1	15.1	18.1	18.1
2711	ST2711	26.66	70.9	70.9	2.2	755	6.69	0.37	0.26	10.7	10.7	15.8	15.8	18.5	18.5	22.1	22.1
2720	ST2720	24.22	57.1	57.1	2.2	484	6.69	0.37	0.26	7.7	7.7	11.4	11.4	13.4	13.4	16.1	16.1
3005	ST3005	14.54	50.8	51.3	2.8	598	6.69	0.37	0.26	4.4	4.4	6.8	6.9	8.2	8.2	10.1	10.1
3008	ST3008	213.73	16.8	38.0	2.4	1453	6.69	0.37	0.26	20.4	41.6	30.5	61.4	36.1	71.7	44.2	85.9
3011	ST3011	51.74	45.7	46.3	2.8	2046	6.69	0.37	0.26	14.1	14.3	22.0	22.3	26.6	26.8	33.0	33.3
3017A	9067	36.66	10.9	46.6	1.5	600	6.69	0.37	0.26	2.4	9.3	4.0	13.8	4.9	16.2	6.5	19.4
3017B	STAFFORD_MEADOWS_1_BASIN	38.68	27.2	51.3	1.4	774	6.69	0.37	0.26	6.1	10.9	9.3	16.2	11.1	19.0	13.7	22.8
3025	ST3024	5.99	31.7	51.0	2.5	378	6.69	0.37	0.26	1.2	1.9	2.0	2.9	2.6	3.6	3.4	4.4
3201	ST3201	51.42	29.7	30.3	4.5	918	6.69	0.37	0.26	9.1	9.2	14.1	14.4	17.1	17.4	21.5	21.8
3204	ST3204	64.53	46.3	46.3	2.0	1078	6.69	0.37	0.26	16.7	16.7	24.7	24.7	29.1	29.1	35.1	35.1
3207	ST3207	78.25	17.7	56.7	2.1	1728	6.69	0.37	0.26	8.4	25.0	13.6	37.1	16.9	43.6	22.0	52.5
3208	RENAISSANCE_POND	25.07	41.1	41.2	0.9	587	6.69	0.37	0.26	5.8	5.8	8.6	8.6	10.1	10.1	12.2	12.2
3212	ST3212	7.21	62.2	66.8	2.1	366	6.69	0.37	0.26	2.7	2.8	4.0	4.3	4.8	5.0	5.8	6.1
3216	ST3208	30.40	62.0	62.0	2.0	881	6.69	0.37	0.26	10.8	10.8	16.0	16.0	18.8	18.8	22.6	22.6
3218	ST3218	14.44	19.6	51.8	1.8	415	6.69	0.37	0.26	1.7	4.3	2.8	6.5	3.5	7.6	4.6	9.3
3402	ST3402	34.92	41.4	52.6	1.4	1087	6.69	0.37	0.26	8.4	10.5	12.8	15.7	15.2	18.6	18.7	22.5
3414	ST3414	25.72	43.5	46.7	1.6	652	6.69	0.37	0.26	6.4	6.9	9.7	10.3	11.4	12.1	13.9	14.8
3417	ST3417	3.75	52.0	52.2	2.4	230	6.69	0.37	0.26	1.2	1.2	1.9	1.9	2.2	2.3	2.8	2.8
3418A	ST3421	14.99	51.6	52.0	0.6	631	6.69	0.37	0.26	5.6	5.7	8.9	8.9	10.4	10.4	12.2	12.3
3418B	ST3418	8.22	52.2	52.2	0.5	456	6.69	0.37	0.26	2.5	2.5	3.7	3.7	4.4	4.4	5.3	5.3
3420	ST3420	20.12	51.0	52.2	3.2	1215	6.69	0.37	0.26	6.2	6.4	10.0	10.2	12.1	12.3	15.0	15.2
3425	ST3425	15.60	51.2	51.3	1.2	378	6.69	0.37	0.26	4.5	4.5	6.6	6.6	7.8	7.8	9.4	9.4
3436	ST3436	22.08	48.4	52.2	1.8	734	6.69	0.37	0.26	6.2	6.7	9.4	10.1	11.2	11.9	13.7	14.5
3443	ST3443	4.70	49.2	51.3	2.3	314	6.69	0.37	0.26	1.4	1.5	2.2	2.3	2.7	2.8	3.4	3.5
3445	ST3445	23.46	63.5	63.5	2.6	930	6.69	0.37	0.26	8.7	8.7	13.2	13.2	15.5	15.5	18.8	18.8
3451	ST3451	3.55	56.1	56.1	0.9	289	6.69	0.37	0.26	1.2	1.2	1.8	1.8	2.2	2.2	2.7	2.7
3600	ST3600	91.20	41.5	43.1	3.7	1193	6.69	0.37	0.26	21.5	22.2	32.0	33.1	37.7	38.9	45.8	47.2
3602	ST3602	90.57	39.7	39.9	5.8	1918	6.69	0.37	0.26	21.4	21.5	33.1	33.3	40.0	40.1	49.9	50.0
3607	ST3606	82.77	36.5	36.5	2.9	916	6.70	0.37	0.26	16.9	16.9	25.0	25.1	29.4	29.5	35.6	35.7
4003	ST4003	95.74	18.9	22.1	1.7	1565	8.66	0.31	0.17	11.5	13.2	19.6	21.9	24.8	27.5	32.5	35.6

Table B-2. Hydrologic Model Inputs and Results																			
Subbasin Name	Inlet Node	Area (Ac)	Impervious Area (%)		Average Subbasin Slope (ft/ft)	Subbasin Width (ft)	Green-Ampt Infiltration Parameters			Maximum Flow (cfs) for Design Storm							
			Existing Land Use	Future Land Use			Average Capillary Suction (in)	Initial Moisture Deficit (frac.)	Saturated Hydraulic Conductivity (in/hr)	2-yr storm event		10-yr storm event		25-yr storm event		100yr storm event	
										Existing Land Use	Future Land Use	Existing Land Use	Future Land Use	Existing Land Use	Future Land Use	Existing Land Use	Future Land Use
4008	ST4008	12.06	67.5	70.9	3.3	714	6.69	0.37	0.26	4.9	5.1	7.4	7.7	8.8	9.1	10.6	10.9
4012	ST4012	22.39	59.4	66.3	2.0	626	6.69	0.37	0.26	7.6	8.4	11.3	12.4	13.3	14.6	16.0	17.5
4014	ST4014	41.33	66.2	66.2	2.7	710	6.69	0.37	0.26	14.9	14.9	22.0	22.0	25.7	25.7	30.8	30.8
4029	ST4029	59.74	51.7	64.5	2.7	1218	6.69	0.37	0.26	17.6	21.5	26.2	31.8	30.9	37.2	37.4	44.6
4202	ST4202	34.53	63.0	64.3	1.0	936	6.59	0.33	0.16	12.3	12.5	19.0	19.3	22.6	22.9	25.2	25.6
4203	ST4203	13.49	31.3	48.5	1.5	630	7.57	0.34	0.22	2.6	4.0	4.4	6.2	5.5	7.5	7.2	9.4
4204	COCA-COLA_POND	32.66	68.5	68.5	0.5	726	5.91	0.36	0.23	11.1	11.1	16.5	16.5	19.3	19.3	23.1	23.1
4205A	ST4205	89.30	40.5	40.5	3.2	1666	7.97	0.33	0.20	21.6	21.6	33.6	33.6	40.9	40.9	51.3	51.3
4205B	ST4205	113.36	28.3	34.3	1.3	2147	9.25	0.30	0.14	20.3	23.9	34.4	39.4	35.4	41.2	37.5	44.3
4205C	ST4000	79.50	29.0	29.0	3.2	1548	9.46	0.28	0.11	17.5	17.5	20.2	20.2	24.4	24.4	30.6	30.6
4214	ST4214	13.80	61.0	68.2	1.9	778	6.69	0.37	0.26	5.0	5.6	7.6	8.4	9.1	9.9	11.0	11.8
4216	ST4216	13.42	61.5	66.8	2.5	563	6.69	0.37	0.26	4.9	5.3	7.4	7.9	8.7	9.3	10.6	11.2
4225	ST4225	11.73	54.8	66.6	0.8	449	6.69	0.37	0.26	3.7	4.4	5.4	6.4	6.4	7.5	7.7	9.0
4226	WILSONVILLE_DIST_CTR_POND	65.84	68.0	68.0	1.0	1069	6.69	0.37	0.26	22.3	22.3	32.9	32.9	38.3	38.3	45.7	45.7
4228A	ST4228	28.98	72.6	74.3	1.4	623	6.69	0.37	0.26	11.2	11.4	16.4	16.8	19.2	19.5	22.8	23.2
4228B	ST6007	14.64	82.2	82.2	1.1	522	6.27	0.36	0.24	6.6	6.6	9.8	9.8	11.3	11.3	13.4	13.4
4231	ST4231	6.30	56.3	57.4	3.9	511	6.69	0.37	0.26	2.2	2.2	3.5	3.6	4.3	4.3	5.2	5.3
4400	ST4400	84.63	33.9	37.5	2.9	1896	6.69	0.37	0.26	16.9	18.6	26.1	28.5	31.4	34.1	39.2	42.2
4403A	ST4403	93.84	23.5	23.5	2.0	1987	6.88	0.36	0.25	13.2	13.2	20.7	20.7	25.2	25.2	32.1	32.1
4403B	ST4402	34.38	31.5	31.5	0.7	841	6.69	0.37	0.26	6.2	6.2	9.3	9.3	11.0	11.0	13.4	13.4
4404A	ST4639	19.90	32.9	32.9	2.6	672	6.69	0.37	0.26	3.9	3.9	6.3	6.3	7.7	7.7	9.8	9.8
4404B	ST4404	8.40	32.9	32.9	2.6	672	6.69	0.37	0.26	1.7	1.7	3.1	3.1	4.0	4.0	5.2	5.2
4501	ST4501	18.45	34.0	52.1	1.8	420	6.78	0.36	0.26	3.7	5.4	5.6	8.1	6.6	9.5	8.2	11.5
4502	ST4502	22.56	31.8	32.3	4.2	1035	6.69	0.37	0.26	4.4	4.5	7.6	7.7	9.6	9.7	12.5	12.6
4503A	ST4503	58.83	46.4	49.1	2.6	745	5.59	0.36	0.21	15.2	15.9	22.8	23.9	27.1	28.4	33.1	34.6
4503B	ST4503	81.06	6.2	64.1	3.9	1499	5.80	0.36	0.22	3.7	29.6	8.2	44.3	11.7	52.4	17.7	63.4
4503C	ST4503	30.20	13.8	39.1	5.7	899	5.86	0.33	0.14	4.2	8.5	9.9	15.3	8.3	15.0	8.8	16.5
4503D	TOOZE_POND	12.16	49.2	51.8	3.2	450	4.99	0.36	0.19	3.7	3.9	6.1	6.3	7.5	7.7	9.3	9.5
4608	ST4608	10.25	51.9	51.9	1.6	280	6.69	0.37	0.26	3.0	3.0	4.5	4.5	5.3	5.3	6.5	6.5
4611	POND_E2	7.97	47.5	47.5	2.7	475	6.69	0.37	0.26	2.3	2.3	3.7	3.7	4.5	4.5	5.6	5.6
4614A	POND_E1	53.36	42.8	42.9	1.6	1058	6.69	0.37	0.26	12.9	12.9	19.2	19.2	22.6	22.6	27.4	27.4
4614B	ST4829	11.09	45.2	52.2	2.2	662	6.69	0.37	0.26	3.0	3.5	4.9	5.5	5.9	6.6	7.4	8.1
4617A	ST4610	6.68	52.1	52.1	1.6	378	6.69	0.37	0.26	2.1	2.1	3.2	3.2	3.8	3.8	4.7	4.7
4617B	ST4803	5.35	52.2	52.2	2.1	268	6.69	0.37	0.26	1.7	1.7	2.6	2.6	3.1	3.1	3.8	3.8
4617C	ST4617	4.89	52.2	52.2	2.2	310	6.69	0.37	0.26	1.5	1.5	2.4	2.4	2.9	2.9	3.6	3.6
4623	ST4623	4.26	52.2	52.2	1.2	453	6.69	0.37	0.26	1.4	1.4	2.2	2.2	2.6	2.6	3.3	3.3
4631A	ST4631	9.68	52.2	52.2	0.8	535	6.66	0.37	0.26	3.0	3.0	4.5	4.5	5.3	5.3	6.5	6.5
4631B	ST4806	10.14	52.2	52.2	2.4	615	6.66	0.37	0.26	3.2	3.2	5.0	5.0	6.1	6.1	7.5	7.5

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			Existing Land Use	Future Land Use			Average Capillary Suction (in)	Initial Moisture Deficit (frac.)	Saturated Hydraulic Conductivity (in/hr)	2-yr storm event		10-yr storm event		25-yr storm event		100yr storm event		
										Existing Land Use	Future Land Use	Existing Land Use	Future Land Use	Existing Land Use	Future Land Use	Existing Land Use	Future Land Use	
4632A	O4632A	49.06	31.8	31.8	1.7	814	6.69	0.37	0.26	8.9	8.9	13.4	13.4	15.8	15.8	19.4	19.4	
4632B	O4632B	41.58	43.7	43.7	1.2	674	6.69	0.37	0.26	9.9	9.9	14.6	14.6	17.1	17.1	20.5	20.5	
5004A	ST5004	5.30	59.7	59.7	3.1	360	5.50	0.36	0.21	2.0	2.0	3.2	3.2	3.9	3.9	4.7	4.7	
5004B	ST5028	6.65	54.3	54.3	4.2	380	6.69	0.37	0.26	2.2	2.2	3.5	3.5	4.2	4.2	5.2	5.2	
5006	ST5006	9.00	64.1	64.1	1.1	589	6.69	0.37	0.26	3.4	3.4	5.1	5.1	6.0	6.0	7.3	7.3	
5022	ST5022	4.80	70.7	70.7	0.9	304	6.69	0.37	0.26	2.0	2.0	2.9	2.9	3.4	3.4	4.1	4.1	
5024	ST5024	7.31	78.8	78.8	1.2	645	6.69	0.37	0.26	3.4	3.4	5.1	5.1	5.9	5.9	7.0	7.0	
5033	ST5033	4.32	71.8	71.8	3.3	476	6.69	0.37	0.26	1.9	1.9	2.9	2.9	3.4	3.4	4.2	4.2	
5037	ST5037	2.66	49.2	50.3	3.5	135	4.36	0.35	0.16	0.9	0.9	1.5	1.5	1.8	1.9	2.0	2.0	
5038	ST5038	15.24	43.6	43.6	7.1	553	6.69	0.37	0.26	4.0	4.0	6.6	6.6	8.1	8.1	10.2	10.2	
5200	ST5200	64.84	21.6	23.9	4.8	1222	6.75	0.36	0.26	8.5	9.3	13.9	15.1	17.2	18.6	22.4	23.9	
5207	ST5207	26.98	23.7	23.7	2.5	1176	6.91	0.36	0.24	4.0	4.0	7.2	7.2	9.1	9.1	12.4	12.4	
5210	O5210	37.10	23.5	23.5	10.3	3038	6.21	0.37	0.29	5.3	5.3	12.9	12.9	17.2	17.2	23.0	23.0	
5501	ST5501	40.80	14.3	14.3	8.6	1077	7.94	0.33	0.19	4.6	4.6	10.2	10.2	14.2	14.2	19.9	19.9	
5502	O5502	75.65	12.7	13.9	7.8	1936	7.24	0.34	0.24	6.5	7.0	13.7	14.4	18.5	19.3	27.1	27.9	
5706A	ST5703	8.78	43.6	47.1	3.6	607	5.51	0.36	0.24	2.4	2.6	4.1	4.3	5.1	5.3	6.5	6.7	
5706B	ST5706	11.41	43.6	47.1	3.6	607	5.51	0.36	0.24	3.1	3.3	5.1	5.4	6.3	6.6	8.0	8.3	
5709	ST5709	29.34	43.9	53.0	6.1	642	5.20	0.36	0.22	7.8	9.3	12.3	14.4	15.1	17.3	18.9	21.4	
5713	ST5713	25.39	71.0	71.0	2.9	985	6.30	0.36	0.24	10.6	10.6	15.9	15.9	18.7	18.7	22.4	22.4	
5718	ST5718	34.38	39.0	46.2	7.6	1251	6.12	0.34	0.16	9.6	11.0	17.7	19.3	21.9	23.6	23.1	25.2	
6001	ST6001	24.29	39.6	39.6	10.7	1121	5.08	0.36	0.19	6.8	6.8	12.5	12.5	15.8	15.8	19.6	19.6	
6004	ST6003	13.42	53.7	53.7	1.6	528	5.03	0.36	0.19	4.4	4.4	6.9	6.9	8.3	8.3	10.2	10.2	
6013A	ST6013	6.55	73.9	73.9	1.3	1183	4.91	0.36	0.19	3.1	3.1	4.9	4.9	5.7	5.7	6.7	6.7	
6013B	ST6007	9.69	73.9	73.9	1.3	1183	4.91	0.36	0.19	4.5	4.5	7.0	7.0	8.2	8.2	9.7	9.7	
6021	ST6021	12.43	68.8	68.8	1.0	513	3.99	0.35	0.15	4.9	4.9	7.8	7.8	8.9	8.9	10.4	10.4	
6022	ST6022	27.99	51.1	51.1	6.8	687	5.56	0.37	0.30	8.4	8.4	12.6	12.6	15.1	15.1	18.3	18.3	
6031	ST6031	14.40	65.2	65.2	1.9	429	6.61	0.37	0.26	5.3	5.3	7.9	7.9	9.3	9.3	11.1	11.1	
6201A	ST6412	56.66	34.1	42.4	1.9	885	5.81	0.36	0.22	11.1	13.5	16.9	20.3	20.2	24.2	25.1	29.6	
6201B	ST6201	97.87	25.0	49.0	3.0	1101	4.90	0.36	0.19	14.6	26.4	23.2	40.1	28.4	47.8	36.2	58.4	
6205	ST6205	25.21	37.1	49.6	2.3	757	6.71	0.36	0.25	5.6	7.3	8.7	11.1	10.5	13.3	13.2	16.3	
6210	O6210	26.56	23.8	51.5	4.4	551	4.29	0.35	0.17	4.2	8.4	7.8	13.4	10.1	16.2	12.0	19.0	
6211	O6211	16.53	37.7	37.7	10.1	587	4.46	0.35	0.17	4.5	4.5	8.3	8.3	10.4	10.4	12.2	12.2	
6411A	ST6411	10.69	40.1	40.1	2.4	565	6.37	0.36	0.25	2.6	2.6	4.3	4.3	5.3	5.3	6.7	6.7	
6411B	ST6405	7.47	40.1	40.1	2.4	565	6.37	0.36	0.25	1.9	1.9	3.2	3.2	4.0	4.0	5.1	5.1	
6416A	ST6653	11.82	48.7	49.7	1.7	435	6.68	0.37	0.26	3.4	3.4	5.1	5.2	6.1	6.2	7.5	7.6	
6416B	O6416	59.26	34.8	36.5	5.6	1204	6.68	0.37	0.26	12.3	12.9	19.3	20.0	23.3	24.2	29.4	30.4	
6610A	ST6610	15.48	44.9	46.9	2.6	789	6.69	0.37	0.26	4.2	4.4	6.7	6.9	8.1	8.4	10.2	10.5	
6610B	ST6605	18.06	43.6	43.6	7.3	525	6.69	0.37	0.26	4.8	4.8	7.6	7.6	9.2	9.2	11.6	11.6	

Table B-2. Hydrologic Model Inputs and Results																	
Subbasin Name	Inlet Node	Area (Ac)	Impervious Area (%)		Average Subbasin Slope (ft/ft)	Subbasin Width (ft)	Green-Ampt Infiltration Parameters			Maximum Flow (cfs) for Design Storm							
										2-yr storm event		10-yr storm event		25-yr storm event		100yr storm event	
			Existing Land Use	Future Land Use			Average Capillary Suction (in)	Initial Moisture Deficit (frac.)	Saturated Hydraulic Conductivity (in/hr)	Existing Land Use	Future Land Use	Existing Land Use	Future Land Use	Existing Land Use	Future Land Use	Existing Land Use	Future Land Use
6611	O6611	20.49	44.0	44.1	6.3	530	6.69	0.37	0.26	5.4	5.4	8.4	8.5	10.2	10.2	12.7	12.7
9003	ST9003	52.84	50.4	50.4	1.6	900	6.35	0.36	0.25	14.6	14.6	21.6	21.6	25.3	25.3	30.5	30.5
9006	ST9006	26.30	43.4	43.4	1.8	752	4.66	0.35	0.18	7.0	7.0	11.2	11.2	13.7	13.7	17.0	17.0
9013	ST9013	58.92	43.4	43.4	0.7	1462	4.40	0.35	0.17	14.7	14.7	22.9	22.9	27.6	27.6	32.4	32.4
9019	ST9019	46.34	43.4	43.4	2.0	995	3.51	0.35	0.13	12.2	12.2	18.9	18.9	20.6	20.6	25.2	25.2
9023	ST9023	11.00	42.7	43.4	1.5	481	4.61	0.35	0.18	3.0	3.0	4.9	5.0	6.1	6.1	7.6	7.7
9024	ST9024	30.75	41.9	41.9	4.5	727	3.57	0.35	0.16	8.3	8.3	13.8	13.8	17.3	17.3	19.0	19.0
9027	ST9027	14.17	43.4	43.4	3.2	799	3.50	0.35	0.13	4.3	4.3	7.3	7.3	7.7	7.7	9.7	9.7
9031	ST9031	56.63	43.4	43.4	1.3	1438	3.51	0.35	0.13	14.8	14.8	22.9	22.9	25.0	25.0	30.5	30.5
9032	ST9032	29.13	42.7	42.7	3.9	608	3.72	0.35	0.16	7.8	7.8	12.7	12.7	15.9	15.9	17.4	17.4
9039	ST9039	24.37	51.0	51.0	5.4	777	3.58	0.35	0.16	8.1	8.1	13.4	13.4	16.6	16.6	18.3	18.3
9041	ST9066	19.00	64.7	64.7	1.2	395	4.18	0.35	0.16	6.7	6.7	10.2	10.2	12.2	12.2	13.8	13.8
9048A	ST9044	11.52	53.9	53.9	2.6	1140	6.62	0.37	0.26	3.8	3.8	6.3	6.3	7.6	7.6	9.4	9.4
9048B	ST9048	8.86	53.9	53.9	2.6	1140	6.62	0.37	0.26	3.0	3.0	5.0	5.0	6.1	6.1	7.4	7.4
9051	ST9051	7.62	43.3	43.4	1.8	365	3.82	0.35	0.14	2.2	2.2	3.6	3.6	4.0	4.0	4.6	4.6
9059A	ST9053	13.59	43.4	43.4	1.4	582	6.15	0.36	0.24	3.5	3.5	5.5	5.5	6.6	6.6	8.3	8.3
9059B	ST9059	11.82	43.4	43.4	1.4	582	6.15	0.36	0.24	3.1	3.1	4.9	4.9	5.9	5.9	7.4	7.4
9060	ST9060	11.18	63.9	64.7	1.8	230	3.50	0.35	0.13	4.0	4.1	6.1	6.2	6.8	6.9	8.1	8.2
9065	ST9065	14.62	35.3	39.3	10.5	997	4.96	0.33	0.12	4.2	4.5	7.6	7.9	8.2	8.6	10.6	11.0
9071	O9071	10.19	39.8	40.4	8.5	743	5.61	0.33	0.14	3.6	3.7	6.5	6.6	6.6	6.6	7.2	7.2
9072	O9072	19.38	43.9	43.9	4.1	1126	6.69	0.37	0.26	5.2	5.2	8.7	8.7	10.7	10.7	13.5	13.5
CANYON_N	CANYON_CR_PH2_DET	7.24	70.4	70.4	9.3	367	6.69	0.37	0.26	3.1	3.1	4.8	4.8	5.6	5.6	6.8	6.8
CANYON_S	CANYON_CR_ARCH_PIPE	7.74	70.9	70.9	3.9	469	6.69	0.37	0.26	3.3	3.3	5.0	5.0	5.9	5.9	7.1	7.1
FUT6612	O6612	50.30	3.7	64.1	5.1	1383	6.69	0.37	0.26	1.5	18.9	4.7	28.4	7.1	33.5	11.4	40.4
S_1203	1203	3.59	64.8	64.8	5.5	126	6.69	0.37	0.26	1.4	1.4	2.1	2.1	2.5	2.5	3.0	3.0
TONKIN_NISSAN_BASIN	TONKIN_NISSAN_POND	17.83	37.3	43.5	0.9	638	6.69	0.37	0.26	3.9	4.5	5.9	6.7	7.0	8.0	8.7	9.8

Table B-3. Hydaulic Model Inputs and Results																				
Conduit			Conduit Atributes								Existing Land Use Conditions					Future Land Use Conditions				
			Shape	Diameter (ft)/ Max Width (ft)	Depth (ft)	Length (ft)	Invert Elevation (ft)		Slope (%)	Manning's Roughness	Peak Flow (cfs)				When Hydraulically Deficient	Peak Flow (cfs)				When Hydraulically Deficient
ID	US Node	DS Node					US	DS			2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	
ST1202	1203	ST1202	CIRCULAR	1.5	-	262	276.62	265.7	3.87	0.013	5.0	8.0	9.5	11.5	NF	5.0	8.0	9.5	11.5	NF
17559	3316	ST3017	CIRCULAR	1.5	-	77	212.75	211.2	2.08	0.024	3.2	5.0	6.0	6.8	NF	6.9	8.1	8.6	9.5	100-yr, 24-hr
17558	3316	ST3017	CIRCULAR	1.5	-	77	212.75	211.2	2.08	0.024	3.2	5.0	6.0	6.8	NF	6.9	8.1	8.6	9.5	100-yr, 24-hr
SD6629	6652	ST6618	CIRCULAR	0.83	-	106.2	161.33	160.0	1.04	0.013	0.0	0.0	0.0	0.3	NF	0.0	0.0	0.0	1.8	NF
STAFFORD_MEADOWS_CHANNEL	9067	3316	STAFFORD_CHANNEL	88	3	410	214.8	212.8	0.50	0.035	2.4	3.8	4.8	6.3	NF	9.2	13.6	15.8	19.1	NF
SD2151	DAY_RD_IMPOUNDMENT	ST2107	CIRCULAR	2	-	192.4	227.55	227.5	0.07	0.01	17.4	16.7	16.4	16.4	2-yr, 24-hr	16.8	16.7	16.7	16.9	2-yr, 24-hr
SD5218	POND_LIBRARY	ST5215	CIRCULAR	1.5	-	69	140.76	136.0	4.08	0.013	19.3	22.2	22.2	22.2	100-yr, 24-hr	21.9	22.2	22.2	22.1	25-yr, 24-hr
PST1204	PST1202	PST1204	CIRCULAR	1	-	84.3	331.58	329.2	2.59	0.011	2.0	3.2	3.8	4.6	NF	2.0	3.2	3.8	4.6	NF
PST1205	PST1204	PST1205	CIRCULAR	1	-	129.3	329.2	314.6	11.16	0.011	2.0	3.2	3.8	4.6	NF	2.0	3.2	3.8	4.6	NF
PST1206	PST1205	PST1206	CIRCULAR	1	-	189.2	314.58	309.5	2.59	0.011	2.0	3.2	3.8	4.6	NF	2.0	3.2	3.8	4.6	NF
PST1207	PST1206	PST1207	CIRCULAR	1	-	121.8	309.49	307.0	1.91	0.011	2.0	3.2	3.8	4.6	NF	2.0	3.2	3.8	4.6	NF
PST1208	PST1207	PST1208	CIRCULAR	1	-	61.1	306.97	292.8	8.21	0.011	3.6	5.9	7.0	8.5	NF	3.6	5.9	7.0	8.7	NF
PST1209	PST1208	PST1209	CIRCULAR	1	-	116.5	292.77	278.1	14.30	0.011	3.6	5.9	7.0	8.5	NF	3.6	5.9	7.0	8.5	NF
1203	PST1209	1203	CIRCULAR	1	-	23.3	278.08	276.6	1.50	0.011	3.6	5.9	7.0	8.5	NF	3.6	5.9	7.0	8.5	NF
SD1740	SIEMENS_POND_C&D	ST3208	CIRCULAR	2.5	-	77	208.45	207.0	1.95	0.013	2.8	6.1	8.3	11.8	NF	3.5	7.5	10.1	14.3	NF
SD1000	ST1000	ST1129	CIRCULAR	2.5	-	142.7	257.9	253.5	3.12	0.013	18.9	25.5	28.9	33.7	NF	19.5	26.2	29.7	34.6	NF
SD1001	ST1001	ST1000	CIRCULAR	1.5	-	900	270.05	257.9	1.24	0.013	7.2	8.3	7.9	8.1	NF	7.2	7.8	7.8	8.1	NF
SD1002	ST1002	ST1001	CIRCULAR	1.25	-	540	277.75	270.1	1.38	0.013	7.2	8.4	8.7	8.3	25-yr, 24-hr	7.2	8.1	8.1	8.2	25-yr, 24-hr
SD1100	ST1100	ST1700	CIRCULAR	2.5	-	72	241.73	239.2	3.59	0.013	36.2	49.6	57.9	72.9	10-yr, 24-hr	39.6	57.3	68.1	80.4	10-yr, 24-hr
SD1101	ST1101	ST1100	SYSCO	21	3.8	1170	244.65	241.7	0.25	0.035	28.5	43.6	48.3	52.6	NF	28.5	40.9	43.8	51.9	100-yr, 24-hr
SD1102	ST1102	ST1101	CIRCULAR	3.5	-	58	244.82	244.7	0.29	0.011	28.9	44.2	52.2	63.0	NF	28.9	44.1	52.0	63.0	NF
SD1103	ST1103	ST1102	CIRCULAR	3.5	-	77	245.25	244.8	0.30	0.011	28.9	44.2	52.2	63.0	NF	28.9	44.1	52.0	63.0	NF
SD1104	ST1104	ST1103	CIRCULAR	3	-	31	245.61	245.3	0.52	0.011	18.4	28.5	34.0	41.4	NF	18.4	28.5	34.0	41.5	NF
SD1105	ST1105	ST1104	CIRCULAR	2.5	-	150	250.61	245.6	3.20	0.011	8.7	14.6	18.1	22.8	NF	8.7	14.6	18.1	22.8	NF
SD1106	ST1106	ST1105	CIRCULAR	2.5	-	332.6	253.77	250.6	0.89	0.011	8.7	14.6	18.1	22.8	NF	8.7	14.6	18.1	22.8	NF
SD1107	ST1107	ST1106	CIRCULAR	2.5	-	170.5	255.79	253.8	1.07	0.011	8.7	14.6	18.2	22.8	NF	8.7	14.6	18.2	22.8	NF
SD1108	ST1108	ST1107	CIRCULAR	2.5	-	180	257.5	255.8	0.89	0.011	8.7	14.6	18.1	22.8	NF	8.7	14.6	18.1	22.8	NF
SD1109	ST1109	ST1108	CIRCULAR	2.5	-	273.1	261.49	257.5	1.39	0.011	8.7	14.6	18.2	22.9	NF	8.7	14.6	18.2	22.9	NF
SD1110	ST1110	ST1109	CIRCULAR	2.5	-	218.1	266.69	261.5	2.29	0.011	8.7	14.6	18.1	22.8	NF	8.7	14.6	18.1	22.8	NF
SD1111	ST1111	ST1110	CIRCULAR	2	-	112.9	267.03	266.7	0.30	0.013	7.1	12.4	15.7	20.4	NF	7.1	12.4	15.7	20.4	NF
SD1112	ST1112	ST1111	CIRCULAR	1.5	-	100	271.56	267.0	4.53	0.013	7.1	12.4	15.7	20.4	NF	7.1	12.4	15.7	20.4	NF
SD1113	ST1113	ST1112	CIRCULAR	1.5	-	67.4	272.22	271.6	0.68	0.013	7.1	12.4	15.7	20.4	25-yr, 24-hr	7.1	12.4	15.7	20.4	25-yr, 24-hr
SD1114	ST1114	ST1113	CIRCULAR	1.5	-	379.5	276.02	272.2	0.92	0.013	7.1	12.4	15.7	20.8	10-yr, 24-hr	7.1	12.4	15.7	20.8	10-yr, 24-hr
SD1115	ST1115	ST1110	CIRCULAR	2.5	-	47	268.44	266.7	2.32	0.012	1.6	2.4	2.8	3.3	NF	1.6	2.4	2.8	3.3	NF
SD1116	ST1116	ST1115	CIRCULAR	2.25	-	79	270.48	268.4	2.58	0.013	1.6	2.4	2.8	3.3	NF	1.6	2.4	2.8	3.3	NF
SD1117	ST1117	ST1103	CIRCULAR	2.75	-	238.4	246.52	245.3	0.31	0.013	10.6	15.9	18.4	22.0	NF	10.6	15.8	18.2	21.9	NF
SD1118	ST1118	ST1117	CIRCULAR	2.75	-	350.9	247.64	246.5	0.32	0.013	10.6	15.9	18.5	22.0	NF	10.6	15.9	18.3	21.9	NF
SD1119	ST1119	ST1118	CIRCULAR	2.75	-	293.1	262.81	247.6	5.18	0.013	5.9	8.9	10.5	11.8	NF	5.9	8.9	10.5	11.9	NF
SD1120	ST1120	ST1119	CIRCULAR	1.5	-	309	267.58	262.8	1.48	0.013	5.9	8.9	10.5	11.8	NF	5.9	8.9	10.5	11.9	NF
SD1121	ST1121	ST1120	CIRCULAR	1.5	-	277.3	271.88	267.6	1.44	0.013	5.9	8.9	10.5	12.4	NF	5.9	8.9	10.5	12.4	NF
SD1122	ST1122	ST1121	CIRCULAR	1.5	-	277.7	273.75	271.9	0.67	0.013	5.9	8.9	10.5	12.2	NF	5.9	8.9	10.5	12.2	NF
SD1123	ST1123	ST1122	CIRCULAR	1.25	-	105.6	276.24	273.8	2.12	0.013	5.9	8.9	10.5	12.2	100-yr, 24-hr	5.9	8.9	10.5	12.2	100-yr, 24-hr
SD1124	ST1124	ST1123	CIRCULAR	1.25	-	257.5	284.48	276.2	3.20	0.013	5.9	8.9	10.5	12.3	100-yr, 24-hr	5.9	8.9	10.5	12.3	100-yr, 24-hr
SD1125	ST1125	ST1118	CIRCULAR	1.75	-	193.8	251.13	247.6	1.28	0.013	4.7	7.1	8.4	10.1	NF	4.7	7.1	8.5	10.2	NF
SD1127	ST1126	ST1701	CANYON_CR	22	4	1500	246.95	237.5	0.63	0.035	12.5	19.9	24.0	31.1	NF	19.0	28.9	34.1	42.3	NF
SD1128	ST1128	ST2118	CIRCULAR	2.5	-	307.2	244.51	241.5	0.86	0.013	18.8	28.7	28.9	33.3	NF	19.3	28.8	29.4	34.1	NF
SD1129	ST1129	ST1128	BASALT_CR9	11	2	530	253.45	244.5	0.75	0.035	18.8	33.6	33.6	33.7	NF	19.3	38.5	38.5	34.3	NF
SD2411	ST1130	ST2407	CIRCULAR	2	-	727	240.02	236.7	0.43	0.024	8.7	9.4	9.8	10.4	NF	8.8	9.5	9.8	10.5	NF
SD2410	ST1130	ST2409	CIRCULAR	2	-	263.6	240.02	240.3	0.59	0.024	1.6	5.8	8.0	10.6	NF	2.1	6.2	8.2	10.8	NF
SD1130	ST1131	ST1130	CIRCULAR	2.75	-	105.9	242.76	240.0	0.32	0.024	10.5	15.4	18.0	21.5	NF	11.0	15.9	18.3	22.0	NF
SD1131	ST1132	ST1131	CIRCULAR	2.75	-	399.7	244.2	242.8	0.31	0.024	10.5	15.5	18.0	21.5	NF	11.0	15.9	18.3	22.0	NF

Table B-3. Hydaulic Model Inputs and Results																					
Conduit			Conduit Atributes								Existing Land Use Conditions					Future Land Use Conditions					
			Shape	Diameter (ft)/ Max Width (ft)	Depth (ft)	Length (ft)	Invert Elevation (ft)		Slope (%)	Manning's Roughness	Peak Flow (cfs)				When Hydraulically Deficient	Peak Flow (cfs)				When Hydraulically Deficient	
ID	US Node	DS Node					US	DS			2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		
SD1132	ST1133	ST1132	CIRCULAR	1.25	-	282.4	247.5	244.2	0.64	0.013	0.0	0.0	0.0	0.1	NF	11.0	15.9	18.3	22.0	2-yr, 24-hr	
SD1302	ST1200	ST1302	CIRCULAR	2.25	-	75	257.59	256.1	1.64	0.013	8.4	12.8	14.9	19.1	NF	8.4	12.8	14.9	19.1	NF	
SD1200	ST1201	ST1200	CIRCULAR	2.25	-	180	260.31	257.6	1.46	0.013	8.5	12.8	14.9	19.1	NF	8.5	12.8	14.9	19.1	NF	
SD1201	ST1202	ST1201	CIRCULAR	2	-	251.1	265.7	260.3	2.05	0.013	5.0	8.0	9.5	11.5	NF	5.0	8.0	9.5	11.5	NF	
SD1126	ST1300	ST1126	CIRCULAR	3	-	68	247.22	247.0	0.40	0.013	8.6	13.1	15.3	19.5	NF	8.6	13.1	15.3	19.5	NF	
SD1300	ST1301	ST1300	CIRCULAR	3	-	121	248.45	247.2	0.55	0.013	8.6	13.1	15.3	19.5	NF	8.6	13.1	15.3	19.5	NF	
SD1301	ST1302	ST1301	CIRCULAR	2.5	-	323	256.11	248.5	2.18	0.013	8.6	13.1	15.3	19.5	NF	8.6	13.1	15.3	19.5	NF	
SD1303	ST1303	ST1126	CIRCULAR	1	-	90	250.55	247.0	1.33	0.011	1.4	2.8	3.6	4.3	NF	3.9	5.6	6.6	8.0	100-yr, 24-hr	
SD1304	ST1303	ST1126	CIRCULAR	1	-	90	250.55	247.0	1.44	0.011	0.1	1.3	2.2	4.0	NF	3.1	5.4	6.4	7.9	100-yr, 24-hr	
SD1305	ST1303	ST1126	CIRCULAR	1	-	90	250.55	247.0	0.44	0.011	2.7	3.2	3.5	4.3	NF	3.8	5.4	6.4	7.9	100-yr, 24-hr	
SD1401	ST1304	ST1400	CIRCULAR	1.5	-	93.8	240.49	238.7	1.03	0.013	0.6	1.3	1.6	2.0	NF	0.8	1.4	1.7	2.1	NF	
SD1306	ST1305	ST1304	CIRCULAR	1	-	310.8	242.46	240.5	0.60	0.013	0.6	1.3	1.6	2.0	NF	0.8	1.4	1.7	2.1	NF	
SD1307	ST1306	ST1305	CIRCULAR	1.25	-	159	244.66	242.5	0.82	0.013	0.6	1.3	1.6	2.0	NF	0.8	1.4	1.7	2.1	NF	
SD1308	ST1307	ST1306	CIRCULAR	1.25	-	147.8	246.73	244.7	1.33	0.013	0.7	1.3	1.6	2.0	NF	0.8	1.4	1.7	2.1	NF	
SD1400	ST1400	ST1401	CIRCULAR	1.5	-	10	238.7	235.4	0.80	0.013	0.6	1.3	1.6	2.0	NF	0.8	1.4	1.7	2.1	NF	
SD1402	ST1401	ST1402	CIRCULAR	4	-	68	235.43	235.4	0.49	0.013	43.7	58.1	65.6	73.7	NF	50.9	65.0	71.1	79.1	NF	
SD1403	ST1402	ST1403	BOECKMAN_CR	37	9	970	235.43	197.5	3.92	0.035	45.9	61.7	69.6	78.5	NF	53.5	68.8	75.5	83.9	NF	
SD1404	ST1403	ST1404A	CIRCULAR	4	-	45	197.45	195.5	4.45	0.013	45.4	61.6	69.3	78.1	NF	53.1	68.6	75.2	83.6	NF	
SD1405A	ST1404A	ST1404B	BOECKMAN_CR	37	9	1285	195.45	160.9	2.69	0.035	50.8	70.3	79.8	91.8	NF	59.7	78.6	88.7	102.5	NF	
SD1405B	ST1404B	ST1603	BOECKMAN_CR	37	9	500	160.9	147.5	2.69	0.035	50.8	70.3	79.7	91.8	NF	59.7	78.6	88.4	102.2	NF	
SD1602	ST1500	ST1600	CIRCULAR	2.5	-	221.5	203.36	194.6	2.06	0.011	0.3	0.4	1.5	3.1	NF	0.3	0.5	1.6	3.2	NF	
SD1500	ST1501	ST1500	CIRCULAR	1.5	-	153	212.81	203.4	5.47	0.013	0.3	0.4	0.5	0.7	NF	0.3	0.5	0.6	0.8	NF	
SD1502	ST1502	ST1501	CIRCULAR	1.5	-	300.9	220.39	212.8	2.49	0.013	0.3	0.4	0.5	0.7	NF	0.3	0.5	0.6	0.8	NF	
SD1503	ST1503	ST1502	CIRCULAR	1.25	-	276	227.5	220.4	2.49	0.013	0.3	0.4	0.5	0.7	NF	0.3	0.5	0.6	0.8	NF	
SD1504	ST1504	ST1503	CIRCULAR	1.25	-	54	228.96	227.5	2.52	0.013	0.3	0.4	0.6	0.7	NF	0.3	0.5	0.6	0.8	NF	
SD1603	ST1600	ST1601	CIRCULAR	4	-	157.6	194.55	180.0	9.11	0.013	29.8	37.4	42.0	50.0	NF	31.3	39.9	44.8	56.1	NF	
SD1604	ST1601	ST1602	CIRCULAR	4	-	169	180.04	156.6	14.03	0.013	29.8	37.4	42.0	50.2	NF	31.3	39.9	44.8	56.5	NF	
SD1605	ST1602	ST1603	MENTOR_GRAPHICS	13	1	350	156.56	147.5	2.60	0.035	29.8	37.4	41.9	49.2	NF	31.3	39.9	44.8	54.5	NF	
SD1607	ST1603	POND_BOECKMAN	BOECKMAN_CR_B	141.6	15.3	100	147.45	131.5	16.21	0.035	130.5	186.1	216.4	529.5	NF	196.0	278.7	707.7	651.9	NF	
SD3200	ST1605	ST3200	CIRCULAR	5	-	300	131.45	127.6	1.29	0.024	124.0	161.8	210.5	289.9	25-yr, 24-hr	166.9	247.4	304.8	303.6	10-yr, 24-hr	
SD1600	ST1608	ST1600	CIRCULAR	1.25	-	251	212.8	194.6	5.11	0.013	1.1	1.9	2.3	2.8	NF	1.4	2.2	2.7	3.2	NF	
16687	ST1640	3316	CIRCULAR	1.5	-	125	214.82	212.8	1.54	0.011	3.7	4.9	5.3	5.9	NF	5.3	6.4	6.9	7.5	NF	
SD1700	ST1700	ST1701	SYSCO-2	70	3	900	239.15	237.5	0.19	0.035	35.7	49.0	52.8	62.3	NF	39.3	52.2	59.7	70.3	NF	
SD1701	ST1701	ST1702	SYSCO-3	24	5	350	237.45	236.2	0.35	0.035	43.5	57.9	65.4	73.8	NF	50.7	64.7	70.7	79.3	NF	
SD1702	ST1702	ST1401	CIRCULAR	4	-	95	236.23	235.4	0.49	0.013	43.4	57.7	65.2	73.4	100-yr, 24-hr	50.6	64.6	70.7	78.7	100-yr, 24-hr	
SD1703	ST1703	ST1704	CIRCULAR	4	-	56	208.45	210.4	0.18	0.013	24.9	30.8	34.7	40.2	NF	26.1	34.0	37.8	44.4	NF	
SD1704	ST1704	ST1705	CIRCULAR	4	-	312	210.35	209.4	0.32	0.013	24.8	30.8	34.6	40.1	NF	26.1	33.5	37.7	43.7	NF	
SD1705	ST1705	ST1706	CIRCULAR	4	-	276.9	209.35	208.3	0.40	0.013	24.8	30.8	34.6	40.1	NF	26.1	33.5	37.7	43.7	NF	
SD1706	ST1706	ST1707	CIRCULAR	4	-	263.6	208.25	207.7	0.20	0.013	24.8	30.8	34.6	40.1	NF	26.0	33.4	37.6	43.7	NF	
SD1707	ST1707	ST1708	CIRCULAR	4	-	142.8	207.72	207.4	0.23	0.013	24.8	30.8	34.6	40.1	NF	26.0	33.4	37.6	43.7	NF	
SD1708	ST1708	ST1709	CIRCULAR	4	-	434.9	207.39	206.0	0.32	0.013	24.7	30.8	34.5	40.4	NF	26.0	33.4	37.6	44.4	NF	
SD1709	ST1709	ST1710	CIRCULAR	4	-	277	205.99	200.6	1.93	0.013	24.8	30.8	34.6	42.4	NF	26.0	33.4	37.7	48.2	NF	
SD1716	ST1710	ST1600	CIRCULAR	4	-	75	200.64	194.6	8.15	0.013	28.6	35.7	39.8	48.2	NF	29.8	38.1	42.9	54.5	NF	
SD1710	ST1711	ST1712	CIRCULAR	1.25	-	310	217.25	215.0	0.71	0.013	3.9	5.9	7.1	8.4	100-yr, 24-hr	3.9	5.9	7.2	8.5	100-yr, 24-hr	
SD1711	ST1712	ST1713	CIRCULAR	1.5	-	270	215.04	208.6	2.14	0.013	3.9	5.8	7.1	8.4	NF	3.9	5.8	7.2	8.4	NF	
SD1715	ST1713	ST1500	CIRCULAR	1.5	-	128	208.58	203.4	9.93	0.013	0.0	0.0	1.0	2.5	NF	0.0	0.0	1.0	2.5	NF	
SD1712	ST1713	ST1714	CIRCULAR	1.25	-	250.1	208.58	208.6	-0.28	0.013	3.9	5.3	6.2	6.5	NF	3.9	5.3	6.2	6.5	NF	
SD1713	ST1714	ST1715	CIRCULAR	1	-	135	208.58	205.7	2.17	0.013	3.8	5.2	5.9	5.9	10-yr, 24-hr	3.8	5.3	5.9	5.9	10-yr, 24-hr	
SD1714	ST1715	ST1710	CIRCULAR	1	-	20	205.65	200.6	25.88	0.013	3.8	5.2	5.9	5.9	NF	3.8	5.3	5.9	5.9	NF	
SD2722	ST1717	ST2720	CIRCULAR	2	-	500	209.05	205.5	0.72	0.013	8.6	12.6	13.8	16.9	100-yr, 24-hr	9.3	13.0	14.5	17.2	100-yr, 24-hr	
SD1717	ST1718	ST1717	TRAPEZOIDAL	30	2	50	209.45	209.1	0.80	0.035	8.7	12.9	13.8	17.4	100-yr, 24-hr	9.4	13.4	14.5	18.3	100-yr, 24-hr	

Table B-3. Hydaulic Model Inputs and Results

Conduit			Conduit Atributes								Existing Land Use Conditions					Future Land Use Conditions				
			Shape	Diameter (ft)/ Max Width (ft)	Depth (ft)	Length (ft)	Invert Elevation (ft)		Slope (%)	Manning's Roughness	Peak Flow (cfs)				When Hydraulically Deficient	Peak Flow (cfs)				When Hydraulically Deficient
ID	US Node	DS Node					US	DS			2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	
SD1718	ST1719	ST1718	CIRCULAR	3.5	-	107	210.45	209.5	0.93	0.024	8.8	13.1	15.0	17.7	NF	9.5	14.2	15.9	18.9	NF
SD1719	ST1720	ST1719	ARCH	2.92	2	100	211.35	210.5	0.90	0.024	8.8	13.1	15.3	18.1	NF	9.5	14.2	16.1	18.9	NF
SD1720	ST1721	ST1720	CIRCULAR	2	-	282.2	216.15	211.4	1.70	0.013	8.8	13.1	15.3	18.1	NF	9.5	14.2	16.5	18.9	NF
SD1721	ST1722	ST1721	CIRCULAR	1.5	-	38.9	216.83	216.2	0.98	0.013	8.8	13.1	15.3	18.1	NF	9.5	14.2	16.5	19.3	NF
SD1722	ST1723	ST1722	CIRCULAR	2	-	90	217.26	216.8	0.32	0.013	8.8	13.1	15.4	18.1	NF	9.5	14.2	16.5	19.3	100-yr, 24-hr
SD1723	ST1724	ST1723	CIRCULAR	1	-	40.9	217.39	217.3	0.05	0.011	8.8	13.1	15.3	18.1	25-yr, 24-hr	9.6	14.2	16.5	19.4	10-yr, 24-hr
SD1724	ST1725	ST1724	CIRCULAR	2.5	-	208	218.26	217.4	0.36	0.013	8.8	13.2	15.5	18.3	100-yr, 24-hr	9.6	14.4	16.6	19.7	100-yr, 24-hr
SD1725	ST1726	ST1725	CIRCULAR	2.5	-	34	218.56	218.3	0.56	0.013	8.9	13.2	15.5	18.6	NF	9.7	14.4	16.8	20.0	100-yr, 24-hr
SD2000	ST2000	ST4002	PRISON_OFFSITE6	33	3.5	820	139.95	139.5	0.06	0.035	127.8	162.0	174.8	191.0	2-yr, 24-hr	160.7	199.6	206.0	225.9	2-yr, 24-hr
SD2001	ST2001	ST2000	PRISON_OFFSITE6	33	3.5	331.9	140.15	140.0	0.06	0.035	157.8	187.7	190.6	190.8	2-yr, 24-hr	150.7	191.5	196.6	216.5	2-yr, 24-hr
SD2002	ST2002	ST2001	PRISON_OFFSITE5	40	3.5	630.6	140.45	140.2	0.05	0.035	143.6	179.7	178.7	184.3	2-yr, 24-hr	172.0	182.4	191.0	215.3	2-yr, 24-hr
SD2003	ST2003	ST2002	PRISON_OFFSITE4	19	3.5	359.2	140.95	140.5	0.14	0.035	166.1	167.6	177.3	181.0	2-yr, 24-hr	174.5	177.2	189.9	214.5	2-yr, 24-hr
SD2004	ST2004	ST2003	PRISON_OFFSITE4	19	3.5	1208.4	142.45	141.0	0.12	0.035	135.7	141.5	156.5	179.6	2-yr, 24-hr	145.3	175.5	189.3	214.1	2-yr, 24-hr
SD2005	ST2005	ST2004	PRISON_OFFSITE3	48	3	1322.9	142.95	142.5	0.04	0.035	121.1	143.8	156.6	177.1	2-yr, 24-hr	138.2	171.1	186.8	207.0	2-yr, 24-hr
SD2006	ST2006	ST2005	PRISON_OFFSITE2	23.4	2.3	705.4	143.85	143.0	0.13	0.035	132.5	173.0	192.3	219.2	2-yr, 24-hr	159.1	208.4	231.2	260.1	2-yr, 24-hr
SD2007	ST2007	ST2006	PRISON_OFFSITE2	23.4	2.3	46.3	143.95	143.9	0.22	0.035	137.8	182.4	203.7	232.9	2-yr, 24-hr	166.8	220.2	245.4	280.0	2-yr, 24-hr
SD2008	ST2008	ST2007	PRISON_OFFSITE2	23.4	2.3	195.6	144.15	144.0	0.10	0.035	140.3	187.1	209.8	241.4	2-yr, 24-hr	170.1	226.5	253.7	290.8	2-yr, 24-hr
SD2009	ST2009	ST2008	PRISON_OFFSITE2	23.4	2.3	1744.5	145.45	144.2	0.10	0.035	17.3	34.6	42.9	55.8	2-yr, 24-hr	19.8	39.8	54.8	73.7	2-yr, 24-hr
SD2010	ST2010	ST2009	PRISON_OFFSITE	20	4	108	150.46	145.5	4.18	0.035	29.5	78.9	115.0	90.8	10-yr, 24-hr	101.0	72.6	64.2	81.2	2-yr, 24-hr
SD2011	ST2011	ST2010	RECT_CLOSED	6	3	32	153.13	150.5	8.37	0.013	45.5	112.8	114.3	109.3	10-yr, 24-hr	110.2	115.1	81.6	86.6	2-yr, 24-hr
SD2012	ST2012	ST2011	PRISON_OFFSITE	20	4	89	160.54	153.1	8.35	0.035	28.7	54.1	57.9	62.4	100-yr, 24-hr	51.8	64.2	75.1	93.3	10-yr, 24-hr
SD2013	ST2013	ST2012	PRISON_OFFSITE	20	4	361	170.14	160.5	2.66	0.035	28.8	43.2	51.0	62.4	NF	43.8	64.2	77.1	89.5	100-yr, 24-hr
SD2014	ST2014	ST2013	RECT_CLOSED	6	3	32	170.46	170.1	1.00	0.013	28.8	43.1	51.0	62.5	NF	43.8	64.2	75.2	89.5	100-yr, 24-hr
SD2015	ST2015	ST2014	PRISON_OFFSITE	20	4	587	178.35	170.5	1.34	0.035	28.8	43.2	51.2	62.7	NF	43.9	64.5	75.6	89.8	NF
SD2016	ST2016	ST2015	CIRCULAR	3.5	-	279	187.75	178.4	3.37	0.013	28.8	43.3	51.4	62.9	NF	44.0	64.6	75.8	90.0	NF
SD2017	ST2017	ST2016	CIRCULAR	3.5	-	401	199.05	187.8	2.79	0.013	28.8	43.3	51.4	62.8	NF	44.0	64.6	75.8	90.0	NF
SD2018	ST2018	ST2017	CIRCULAR	3.5	-	551	201.95	199.1	0.50	0.013	28.8	43.4	51.4	62.9	NF	44.0	64.7	75.9	90.1	NF
SD2019	ST2019	ST2018	CIRCULAR	3.5	-	69	202.45	202.0	0.49	0.013	28.8	43.6	51.8	63.4	NF	44.2	65.1	75.9	90.1	NF
SD2403B	ST2100	ST2403	CIRCULAR	4	-	79.9	222.7	222.1	1.29	0.013	50.8	63.0	67.7	73.4	NF	58.7	69.1	72.9	77.5	NF
SD2403	ST2100	ST2403	CIRCULAR	4	-	80.8	222.7	222.1	0.84	0.013	46.1	59.5	64.6	70.1	NF	55.0	66.1	69.7	75.5	NF
SD2100	ST2101	ST2100	CIRCULAR	3	-	602.1	224.96	222.7	0.31	0.013	34.0	41.9	44.3	46.6	NF	42.8	48.0	49.3	51.2	NF
SD2101	ST2101	ST2100	CIRCULAR	3	-	603.7	224.96	222.7	0.28	0.013	33.9	41.8	44.2	46.5	NF	43.2	47.9	49.2	51.2	NF
SD2440	ST2101A	ST2431	CIRCULAR	2	-	327.1	196.41	192.3	1.19	0.013	37.9	47.3	51.3	56.2	2-yr, 24-hr	47.3	55.7	59.5	65.2	2-yr, 24-hr
SD2102	ST2102	ST2101	COMMERCE_CIR_DITCH	140.2	7.4	493.4	226.88	225.0	0.37	0.035	37.9	44.8	46.6	48.6	NF	45.0	48.8	49.9	50.3	NF
SD2439	ST2102A	ST2101A	CIRCULAR	4	-	346.6	198.2	196.4	0.50	0.013	38.8	54.5	55.8	70.9	10-yr, 24-hr	54.2	65.0	60.2	65.8	2-yr, 24-hr
SD2103	ST2103	ST2102	CIRCULAR	4	-	30	226.56	226.9	-1.07	0.024	37.9	42.6	44.4	46.1	NF	42.8	46.0	46.9	47.2	25-yr, 24-hr
SD2438	ST2103A	ST2102A	CIRCULAR	4	-	334.3	200.05	198.2	0.49	0.013	39.4	57.1	61.3	71.7	10-yr, 24-hr	57.6	62.7	63.5	69.7	2-yr, 24-hr
SD2104	ST2104	ST2103	BASALT_CR5_UPDATE	91.5	4	367.5	225.75	226.6	-0.22	0.035	38.1	43.3	44.2	45.0	2-yr, 24-hr	43.1	44.5	44.9	45.1	2-yr, 24-hr
SD2437	ST2104A	ST2103A	CIRCULAR	4	-	302.8	203.63	200.1	1.12	0.013	43.4	57.9	66.1	73.3	10-yr, 24-hr	59.9	69.9	71.2	75.6	2-yr, 24-hr
SD2105	ST2105	ST2104	CIRCULAR	4	-	96.7	226.41	225.8	0.68	0.024	39.7	44.1	45.9	47.4	NF	43.4	46.6	47.6	48.5	NF
SD2167	ST2105A	ST2104A	CIRCULAR	4	-	109.2	204.37	203.6	0.49	0.013	45.1	60.2	70.5	79.7	10-yr, 24-hr	63.2	76.4	77.6	80.1	2-yr, 24-hr
SD2106	ST2106	ST2105	COMMERCE_CIR_DITCH	42.1	9.8	754	226.75	226.4	0.05	0.035	41.0	44.6	46.7	48.8	NF	43.7	48.0	49.4	50.9	NF
SD2164	ST2106A	ST2105A	CIRCULAR	3.5	-	117.7	205.46	204.4	0.50	0.013	18.3	22.6	23.5	26.7	10-yr, 24-hr	35.8	43.4	44.2	43.4	2-yr, 24-hr
SD2107	ST2107	ST2120	COMMERCE_CIR_DITCH	26.4	7.4	965	227.47	226.7	0.08	0.035	28.8	28.8	29.1	29.5	NF	29.7	29.7	29.7	29.9	NF
SD2163	ST2107A	ST2106A	CIRCULAR	3.5	-	227.5	206.8	205.5	0.50	0.013	18.0	24.5	27.2	32.0	10-yr, 24-hr	42.2	48.6	48.5	50.6	2-yr, 24-hr
SD2108	ST2108	ST2101	BASALT_CR	24	5	300	228.84	225.0	1.27	0.035	22.8	34.0	40.2	50.4	NF	41.8	63.5	73.7	81.8	NF
17184	ST2108A	ST2107A	CIRCULAR	3.5	-	119.8	207.59	206.8	0.49	0.013	18.1	24.9	31.6	40.8	25-yr, 24-hr	41.9	48.0	48.4	48.5	2-yr, 24-hr
SD2109	ST2109	ST2108	BASALT_CR7	48	4	500	229.63	228.8	0.16	0.035	23.0	34.2	40.4	51.2	NF	42.1	63.9	74.2	85.8	NF
17195	ST2109A	ST2186	CIRCULAR	3.5	-	236.9	209.13	208.0	0.48	0.013	18.2	24.5	34.7	40.4	25-yr, 24-hr	40.5	47.4	47.7	47.6	10-yr, 24-hr
SD2110	ST2110	ST2109	CIRCULAR	3	-	70	230.56	229.6	1.33	0.013	23.0	34.4	40.6	52.0	NF	42.2	64.1	74.4	86.0	NF
17194	ST2110A	ST2109A	CIRCULAR	3.5	-	299.2	212.26	209.1	0.98	0.013	18.4	25.8	34.7	40.4	25-yr, 24-hr	40.3	47.4	47.6	47.9	10-yr, 24-hr

Table B-3. Hydaulic Model Inputs and Results

Conduit ID	Conduit US Node	Conduit DS Node	Shape	Diameter (ft)/ Max Width (ft)	Depth (ft)	Length (ft)	Invert Elevation (ft) US	Invert Elevation (ft) DS	Slope (%)	Manning's Roughness	Existing Peak Flow (cfs) 2-yr, 24-hr	Existing Peak Flow (cfs) 10-yr, 24-hr	Existing Peak Flow (cfs) 25-yr, 24-hr	Existing Peak Flow (cfs) 100-yr, 24-hr	Existing When Hydraulically Deficient	Future Peak Flow (cfs) 2-yr, 24-hr	Future Peak Flow (cfs) 10-yr, 24-hr	Future Peak Flow (cfs) 25-yr, 24-hr	Future Peak Flow (cfs) 100-yr, 24-hr	Future When Hydraulically Deficient
SD2111	ST2111	ST2110	BASALT_CR6	48	2	330	236.05	230.6	1.66	0.035	23.7	35.9	42.8	51.9	NF	44.3	64.1	74.4	86.0	NF
17203	ST2111A	ST2110A	CIRCULAR	3	-	177.8	214.19	212.3	0.80	0.013	17.4	26.8	34.5	40.4	100-yr, 24-hr	40.1	47.3	47.6	47.9	10-yr, 24-hr
SD2112	ST2112	ST2111	CIRCULAR	2	-	279.3	240.69	236.1	1.45	0.013	23.7	36.1	43.0	52.0	100-yr, 24-hr	44.4	64.2	74.5	88.8	10-yr, 24-hr
17201	ST2112A	ST2111A	CIRCULAR	3	-	178.4	215.82	214.2	0.80	0.013	17.4	28.7	34.3	40.5	100-yr, 24-hr	39.9	47.3	47.5	49.2	10-yr, 24-hr
SD2113	ST2113	ST2100	CIRCULAR	4	-	235.4	224.98	222.7	0.65	0.013	29.8	40.8	44.7	51.1	NF	30.2	41.0	45.2	51.6	NF
17269	ST2113A	ST2112A	CIRCULAR	3	-	329.5	218.27	215.8	0.68	0.013	17.4	27.5	34.2	40.5	100-yr, 24-hr	39.7	47.3	47.5	52.9	10-yr, 24-hr
SD2114	ST2114	ST2113	CIRCULAR	4	-	282.9	227.4	225.0	0.82	0.013	29.8	40.8	44.7	51.2	NF	30.3	41.1	45.2	51.8	NF
17271	ST2114A	ST2113A	CIRCULAR	3	-	166	219.51	218.3	0.63	0.013	17.4	27.0	34.0	40.4	100-yr, 24-hr	39.5	47.2	50.3	57.1	10-yr, 24-hr
SD2115	ST2115	ST2114	CIRCULAR	4	-	242	229.45	227.4	0.82	0.013	29.8	40.8	44.7	51.2	NF	30.3	41.0	45.2	51.7	NF
17280	ST2115A	ST2114A	CIRCULAR	3	-	166.1	220.95	219.5	0.75	0.013	17.4	27.6	33.7	40.4	100-yr, 24-hr	39.2	48.0	52.8	60.2	10-yr, 24-hr
SD2116	ST2116	ST2115	BASALT_CR11	16	4	150	233.95	229.5	3.00	0.035	29.8	40.8	44.7	51.2	NF	30.3	41.1	45.2	51.8	NF
17282	ST2116A	ST2115A	CIRCULAR	2.5	-	300.4	224.4	221.0	0.98	0.013	17.4	28.8	33.5	40.2	100-yr, 24-hr	39.0	50.1	55.9	64.5	10-yr, 24-hr
SD2117	ST2117	ST2116	CIRCULAR	3	-	288	235.45	234.0	0.69	0.013	29.8	40.8	44.7	51.2	100-yr, 24-hr	30.3	41.1	45.2	51.8	100-yr, 24-hr
17285	ST2117A	ST2116A	CIRCULAR	2.5	-	159.9	226.55	224.4	1.22	0.013	17.4	26.7	33.2	40.2	NF	38.8	52.1	59.0	68.8	10-yr, 24-hr
SD2118	ST2118	ST2117	BASALT_CR10	44	4	380	241.45	235.5	1.45	0.035	30.8	45.2	50.3	59.7	NF	31.3	44.7	51.0	60.3	NF
17290	ST2118A	ST2117A	CIRCULAR	2.5	-	202.4	229.21	226.6	1.22	0.013	17.4	26.7	34.1	40.2	NF	38.5	53.8	61.8	72.8	10-yr, 24-hr
17291	ST2119A	ST2118A	CIRCULAR	2.5	-	120	230.56	229.2	0.96	0.013	17.4	26.7	32.4	40.2	100-yr, 24-hr	38.2	55.5	64.5	76.8	10-yr, 24-hr
SD2120	ST2120	ST2106	CIRCULAR	4	-	62	226.67	226.8	-0.13	0.024	41.8	45.3	47.2	49.5	NF	44.2	48.7	50.5	52.2	NF
SD2121	ST2121	ST2107	ARCH	3	1.67	53.8	228.59	227.5	2.10	0.024	14.1	13.5	13.2	13.3	NF	13.6	13.5	13.5	13.6	NF
DAY_RD_BYPASS_CHANNEL	ST2122	DAY_RD_IMPOUNDMENT	TRAPEZOIDAL	17	3	20	226.18	227.6	0.01	0.035	54.6	89.7	108.5	135.0	NF	105.6	163.5	193.1	233.5	NF
SD2122	ST2122	ST2121	COMMERCE_CIR_DITCH	20.9	3.7	583	226.18	228.6	-0.41	0.024	19.2	15.8	14.1	14.1	NF	14.4	14.1	14.1	14.4	NF
SD2123	ST2123	ST2122	CIRCULAR	3	-	43	226.37	226.2	0.44	0.024	66.6	98.9	116.2	140.8	NF	115.3	171.1	200.0	239.7	100-yr, 24-hr
17196	ST2186	ST2108A	CIRCULAR	3.5	-	42.6	207.99	207.6	0.47	0.013	17.6	24.7	34.8	40.4	25-yr, 24-hr	41.0	47.5	48.0	47.8	10-yr, 24-hr
SD2706	ST2400	ST2706	BASALT_CR3	42	5	1130	214.45	175.5	3.45	0.035	133.9	178.5	197.6	223.3	NF	155.1	196.9	214.7	238.8	NF
SD2400	ST2401	ST2400	BASALT_CR3	42	5	90	214.9	214.5	0.50	0.035	134.0	178.5	197.7	223.4	NF	155.1	197.0	214.8	238.9	NF
SD2401	ST2402	ST2401	BASALT_CR3	42	5	1110	220.95	214.9	0.55	0.035	134.3	178.7	197.9	223.6	NF	155.3	197.2	215.0	239.1	NF
SD2402	ST2403	ST2402	BASALT_CR8	38	5	1000	222.09	221.0	0.10	0.035	96.3	121.7	131.5	142.6	NF	113.1	134.4	141.9	152.3	NF
SD2404	ST2404	ST2402	BASALT_CR2	30	5	400	228.12	221.0	1.67	0.035	19.9	29.9	35.2	42.8	NF	23.1	33.6	39.0	47.1	NF
SD2405	ST2405	ST2404	CIRCULAR	4.5	-	250	228.12	228.1	0.00	0.013	19.9	29.9	35.2	42.9	NF	23.1	33.6	39.1	47.1	NF
SD2406	ST2406	ST2405	BASALT_CR	24	5	450	229.5	228.1	0.31	0.035	15.5	23.4	27.6	33.5	NF	18.7	27.2	31.5	38.0	NF
SD2407	ST2407	ST2406	CIRCULAR	3.5	-	677	236.7	229.5	1.06	0.011	13.8	20.6	24.1	28.9	NF	14.1	20.6	23.8	28.6	NF
SD2408	ST2408	ST2407	CIRCULAR	3	-	131	238.66	236.7	1.18	0.011	5.1	11.2	14.3	18.6	NF	5.4	11.2	14.1	18.3	NF
SD2409	ST2409	ST2408	CIRCULAR	3	-	242.8	240.25	238.7	0.54	0.013	5.1	11.2	14.3	18.6	NF	5.4	11.2	14.1	18.3	NF
SD2716	ST2410	ST2715	CIRCULAR	1.5	-	253	214.7	210.3	1.42	0.013	5.0	7.6	9.1	11.4	NF	5.1	8.1	9.7	11.9	NF
SD2412	ST2411	ST2410	CIRCULAR	1.25	-	284	217.44	214.7	0.84	0.013	0.6	0.8	1.0	1.2	NF	0.6	0.9	1.0	1.3	NF
SD2413	ST2412	ST2411	CIRCULAR	1.25	-	415.1	221.01	217.4	0.85	0.013	0.6	0.8	1.0	1.2	NF	0.6	0.9	1.0	1.3	NF
SD2414	ST2413	ST2412	CIRCULAR	1.25	-	318.4	223.72	221.0	0.82	0.013	0.6	0.8	1.0	1.2	NF	0.6	0.9	1.0	1.3	NF
SD2442	ST2431	ST2432	CIRCULAR	2	-	69	192.31	189.3	4.08	0.013	37.9	47.3	51.3	56.2	100-yr, 24-hr	47.3	55.7	59.5	65.2	10-yr, 24-hr
SD2443	ST2432	ST2433	CIRCULAR	2.25	-	67.6	189.3	188.4	1.35	0.013	37.9	47.3	51.3	56.2	100-yr, 24-hr	47.3	55.7	59.5	65.2	10-yr, 24-hr
SD2444	ST2433	ST2434	CIRCULAR	2.5	-	335.6	188.39	185.1	0.94	0.013	37.9	47.3	51.3	56.2	NF	47.3	55.7	59.5	65.2	25-yr, 24-hr
SD2445	ST2434	ST2435	CIRCULAR	2.5	-	65	185.05	163.5	35.23	0.013	37.9	47.3	51.3	56.2	NF	47.3	55.7	59.5	65.2	NF
SD2446	ST2435	ST2004	PRISON_OFFSITE3	48	3	2000	163.45	142.5	1.05	0.035	37.4	47.1	51.2	56.2	NF	47.1	55.7	59.5	65.2	NF
SD2700	ST2700	ST4003	COFFEE_CR2	80	3.5	900	143.45	140.0	0.39	0.035	147.8	203.5	204.0	224.2	NF	170.4	192.2	226.7	298.4	10-yr, 24-hr
SD2701	ST2701	ST2700	COFFEE_CR2	80	3.5	1000	147.95	143.5	0.45	0.035	149.7	205.8	230.9	261.4	NF	172.0	223.8	248.1	278.0	NF
SD2702	ST2702	ST2701	COFFEE_CR2	80	3.5	1100	169.45	148.0	1.95	0.035	151.0	207.1	232.5	263.4	NF	173.3	225.7	250.1	280.6	NF
SD2703	ST2703	ST2702	COFFEE_CR	40	5	50	173.45	169.5	8.03	0.035	151.3	207.3	232.7	263.6	NF	173.5	225.9	250.4	281.0	NF
SD2704	ST2705	ST2703	BASALT_CR4	44	4	350	173.95	173.5	0.14	0.035	151.3	207.3	232.7	263.6	NF	173.5	225.9	250.4	281.0	NF
SD2705	ST2706	ST2705	BASALT_CR3	42	5	170	175.45	174.0	0.88	0.035	133.6	178.3	197.4	223.1	NF	154.9	196.7	214.5	238.6	NF
SD2707	ST2707	ST2705	CIRCULAR	2.5	-	48	178.69	174.0	6.79	0.013	24.2	35.8	40.7	47.6	NF	24.4	36.2	41.3	48.2	NF
SD2708	ST2708	ST2707	CIRCULAR	2.5	-	452	182.05	178.7	0.70	0.013	15.6	22.9	26.0	29.3	NF	15.7	23.3	26.6	30.1	NF
SD2709	ST2709	ST2708	CIRCULAR	2	-	274	188.85	182.1	2.30	0.013	15.6	23.1	26.3	29.5	NF	15.7	23.5	27.0	33.6	NF

Table B-3. Hydaulic Model Inputs and Results

Conduit			Conduit Atributes								Existing Land Use Conditions					Future Land Use Conditions				
			Shape	Diameter (ft)/ Max Width (ft)	Depth (ft)	Length (ft)	Invert Elevation (ft)		Slope (%)	Manning's Roughness	Peak Flow (cfs)				When Hydraulically Deficient	Peak Flow (cfs)				When Hydraulically Deficient
ID	US Node	DS Node					US	DS			2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	
SD2710	ST2710	ST2709	CIRCULAR	2	-	400	195.05	188.9	1.50	0.013	15.6	23.1	27.4	32.1	100-yr, 24-hr	15.7	23.5	30.2	32.2	100-yr, 24-hr
SD2711	ST2711	ST2710	CIRCULAR	2	-	400	200.45	195.1	1.30	0.013	15.6	23.1	27.3	32.7	100-yr, 24-hr	15.7	23.5	28.4	32.9	100-yr, 24-hr
SD2712	ST2712	ST2711	CIRCULAR	3	-	106.1	203.05	200.5	2.45	0.013	5.0	7.6	11.8	30.3	100-yr, 24-hr	5.1	8.0	13.4	29.9	100-yr, 24-hr
SD2713	ST2713	ST2712	CIRCULAR	2	-	247.2	205.72	203.1	0.76	0.013	5.0	7.6	9.1	14.3	NF	5.1	8.0	9.8	15.7	100-yr, 24-hr
SD2714	ST2714	ST2713	CIRCULAR	2	-	174.8	206.95	205.7	0.70	0.013	5.0	7.6	9.1	13.8	NF	5.1	8.0	9.7	16.9	100-yr, 24-hr
SD2715	ST2715	ST2714	CIRCULAR	1.75	-	293	210.3	207.0	1.04	0.013	5.0	7.6	9.1	11.7	NF	5.1	8.0	9.7	13.8	NF
SD2717	ST2716	ST4015	CIRCULAR	2.5	-	84.3	171.46	169.9	1.74	0.024	12.5	23.4	25.0	26.7	25-yr, 24-hr	13.7	24.1	25.5	26.9	25-yr, 24-hr
SD2718	ST2717B	ST2716	CIRCULAR	2.5	-	75	172.13	171.5	0.89	0.024	12.5	23.4	25.0	26.6	25-yr, 24-hr	13.8	24.1	25.5	26.8	25-yr, 24-hr
SD2719	ST2718	ST2717	COFFEE_CR	40	5	680	186.45	172.1	2.11	0.035	15.3	22.5	25.5	30.3	NF	15.9	23.0	26.1	31.0	NF
SD2720	ST2719	ST2718	ARCH	4.5	2.25	76	188.2	186.5	2.30	0.024	15.3	22.6	25.6	30.3	NF	16.0	23.1	26.2	31.0	NF
SD2721	ST2720	ST2719	COFFEE_CR	40	5	640	205.45	188.2	2.70	0.035	15.9	23.7	26.6	31.5	NF	16.6	24.0	27.3	32.8	NF
SD3000	ST3001	ST3201	CIRCULAR	1.25	-	111.7	171.92	113.5	25.67	0.011	4.4	6.8	8.1	10.0	NF	4.4	6.9	8.2	10.1	NF
SD3001	ST3002	ST3001	CIRCULAR	1.25	-	71.5	180.31	171.9	11.82	0.011	4.4	6.8	8.1	10.0	NF	4.4	6.9	8.2	10.1	NF
SD3002	ST3003	ST3002	CIRCULAR	1.25	-	116.4	188.52	180.3	7.07	0.011	4.4	6.8	8.1	10.2	NF	4.4	6.9	8.2	10.2	NF
SD3003	ST3004	ST3003	CIRCULAR	1.25	-	35	190.86	188.5	4.58	0.011	4.4	6.8	8.1	11.4	NF	4.4	6.9	8.2	10.6	NF
SD3004	ST3005	ST3004	CIRCULAR	1.25	-	293	195.52	190.9	1.53	0.011	4.4	6.8	8.1	10.7	NF	4.5	6.9	8.2	10.6	NF
SD3006	ST3007	O3000	N_FORK_MERIDIAN_CR	22	4	5350	153.45	58.5	1.78	0.035	36.1	52.3	59.8	71.2	NF	61.6	85.8	98.4	120.8	NF
SD3007	ST3008	ST3007	N_FORK_MERIDIAN_CR	22	4	500	169.45	153.5	2.20	0.035	38.0	54.6	62.6	73.6	NF	63.6	88.7	101.6	123.8	NF
SD3008	ST3009	ST3008	N_FORK_MERIDIAN_CR	22	4	750	185.82	169.5	2.18	0.035	18.4	26.6	29.2	35.4	NF	24.5	30.8	34.9	46.1	NF
SD3009	ST3010	ST3009	CIRCULAR	2	-	63.8	190	185.8	6.57	0.011	18.4	26.6	29.2	40.5	NF	24.5	30.9	34.9	54.0	100-yr, 24-hr
SD3010	ST3011	ST3010	CIRCULAR	2	-	198	191.45	190.0	0.73	0.011	18.4	26.6	29.2	36.8	NF	24.5	30.9	34.9	49.3	100-yr, 24-hr
SD3011	ST3012	ST3011	N_FORK_MERIDIAN_CR	22	4	260	192.03	191.5	0.22	0.035	6.9	11.2	13.6	25.3	NF	14.6	18.0	19.5	37.2	100-yr, 24-hr
SD3012	ST3013	ST3012	CIRCULAR	3	-	101.9	198.56	192.0	6.42	0.013	6.4	9.9	11.9	25.2	NF	13.7	16.1	17.2	36.7	NF
SD3013	ST3014	ST3013	CIRCULAR	3	-	27.7	200.02	198.6	4.55	0.011	6.4	9.9	11.9	29.3	NF	13.7	16.1	17.2	36.7	NF
SD3014	ST3015	ST3014	CIRCULAR	3	-	116.1	204.42	200.0	3.79	0.013	6.4	9.9	11.9	17.3	NF	13.7	16.1	17.2	36.7	NF
SD3015	ST3016	ST3015	CIRCULAR	3	-	31.7	206.09	204.4	4.32	0.013	6.4	9.9	11.9	13.6	NF	13.7	16.1	17.2	53.3	NF
SD3016	ST3017	ST3016	N_FORK_MERIDIAN_CR	22	4	600	211.15	206.1	0.84	0.035	6.5	10.1	12.0	13.7	NF	13.7	16.1	17.2	18.9	NF
SD3017	ST3018	ST3011	CIRCULAR	2	-	158.4	203.41	191.5	3.18	0.011	1.2	2.0	2.5	3.3	NF	1.8	2.9	3.5	15.6	NF
SD3018	ST3019	ST3018	CIRCULAR	2	-	61.4	204.08	203.4	1.01	0.011	1.2	2.0	2.5	3.3	NF	1.8	2.9	3.5	7.0	NF
SD3019	ST3020	ST3019	CIRCULAR	2	-	266.8	205.51	204.1	0.50	0.011	1.2	2.0	2.5	3.3	NF	1.8	2.9	3.5	5.0	NF
SD3020	ST3021	ST3020	CIRCULAR	1.5	-	56.5	209.33	205.5	4.48	0.011	1.2	2.0	2.5	3.3	NF	1.8	2.9	3.5	4.4	NF
SD3021	ST3022	ST3021	CIRCULAR	1.5	-	203.2	210.35	209.3	0.40	0.011	1.2	2.0	2.5	3.3	NF	1.8	2.9	3.5	4.4	NF
SD3022	ST3023	ST3022	CIRCULAR	1.25	-	38.7	211.86	210.4	0.41	0.011	1.2	2.0	2.6	3.4	NF	1.9	2.9	3.5	4.4	NF
SD3023	ST3024	ST3023	CIRCULAR	1.25	-	220.6	212.84	211.9	0.40	0.011	1.2	2.0	2.6	3.4	NF	1.9	2.9	3.5	4.4	NF
SD3201	ST3200	ST3201	BOECKMAN_CR_D	123.6	15.8	1100	127.59	113.5	1.29	0.035	124.0	161.8	188.4	281.1	NF	166.9	227.1	280.9	280.9	NF
SD3202	ST3201	ST3202	BOECKMAN_CR2	40	10	1100	113.45	111.5	0.18	0.035	132.6	172.7	195.5	285.6	NF	173.4	232.9	284.6	284.8	NF
SD3603	ST3202	ST3603	BOECKMAN_CR2	40	10	900	111.45	105.5	0.67	0.035	132.4	172.6	195.3	285.4	NF	173.3	232.1	284.5	284.8	NF
SD3203	ST3203	ST4025	CIRCULAR	3	-	100	177.45	177.0	0.50	0.013	39.1	51.4	56.3	70.1	25-yr, 24-hr	50.1	61.4	76.5	95.2	10-yr, 24-hr
SD3204	ST3204	ST3203	S_COFFEE_CR3	29	2	250	181.45	177.5	1.60	0.035	39.1	51.4	57.6	102.9	NF	50.1	94.4	109.5	118.2	25-yr, 24-hr
SD3220	ST3205	ST3204	CIRCULAR	3	-	100	183.45	181.5	2.00	0.024	15.6	23.8	27.0	24.4	100-yr, 24-hr	26.4	25.2	53.8	28.2	10-yr, 24-hr
SD3225	ST3205	ST3204	CIRCULAR	3	-	100	183.45	181.5	2.00	0.024	7.8	11.9	13.5	48.8	100-yr, 24-hr	13.2	50.4	26.9	56.4	10-yr, 24-hr
SD3221	ST3206	ST3205	S_COFFEE_CR2	30	2	750	190.73	183.5	0.97	0.035	23.6	36.1	43.2	54.5	NF	39.7	58.5	68.6	77.4	NF
SD3205	ST3207	ST3206	CIRCULAR	3	-	90.5	192.45	190.7	1.90	0.013	15.1	13.0	15.4	18.5	NF	25.6	19.7	22.4	58.5	NF
SD3206	ST3207	ST3206	CIRCULAR	2	-	90.6	192.45	190.7	0.79	0.013	8.6	23.2	28.0	36.1	NF	14.2	39.0	46.4	29.8	NF
SD3207	ST3208	ST3207	S_COFFEE_CR	16	2	1400	206.95	192.5	1.04	0.035	14.5	21.7	25.9	32.4	NF	14.8	22.4	27.0	34.7	NF
SD3208	ST3209	ST3208	CIRCULAR	1.5	-	204.1	210.24	207.0	1.20	0.013	2.7	4.0	4.8	5.8	NF	2.8	4.3	5.0	6.1	NF
SD3209	ST3210	ST3209	CIRCULAR	1.5	-	218.1	212.35	210.2	0.88	0.013	2.7	4.0	4.8	5.8	NF	2.8	4.3	5.0	6.1	NF
SD3210	ST3211	ST3210	CIRCULAR	1.5	-	50	213.1	212.4	1.30	0.013	2.7	4.0	4.8	5.8	NF	2.8	4.3	5.0	6.1	NF
SD3211	ST3212	ST3211	CIRCULAR	1.5	-	38	213.53	213.1	0.66	0.013	2.7	4.0	4.8	5.8	NF	2.8	4.3	5.0	6.1	NF
SD3418	ST3217	ST3417	CIRCULAR	1.25	-	279.3	188.65	186.5	0.70	0.013	1.7	2.8	3.5	4.5	NF	4.3	6.5	7.6	9.3	NF
SD3216	ST3218	ST3217	CIRCULAR	1.25	-	242.9	192.02	188.7	1.37	0.013	1.7	2.8	3.5	4.6	NF	4.3	6.5	7.6	9.3	NF

Table B-3. Hydaulic Model Inputs and Results																				
Conduit			Conduit Atributes								Existing Land Use Conditions					Future Land Use Conditions				
			Shape	Diameter (ft)/ Max Width (ft)	Depth (ft)	Length (ft)	Invert Elevation (ft)		Slope (%)	Manning's Roughness	Peak Flow (cfs)				When Hydraulically Deficient	Peak Flow (cfs)				When Hydraulically Deficient
ID	US Node	DS Node					US	DS			2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	
SD3400	ST3400	ST5039	CIRCULAR	4	-	88	158.96	155.2	0.48	0.013	35.1	54.3	64.4	79.2	NF	39.7	60.7	71.5	87.7	NF
SD3401	ST3401	ST3400	CIRCULAR	3.5	-	17.3	159.33	159.0	2.14	0.013	27.6	42.8	50.7	62.4	NF	31.6	48.5	56.9	73.2	NF
SD3402	ST3402	ST3401	CIRCULAR	3.5	-	187.4	160.35	159.3	0.54	0.013	27.6	42.9	50.7	62.4	NF	31.6	48.5	56.9	70.5	NF
SD3403	ST3403	ST3402	CIRCULAR	3.5	-	400	162.32	160.4	0.44	0.013	19.3	30.7	36.5	45.3	NF	21.4	33.6	40.0	49.5	NF
SD3404	ST3404	ST3403	CIRCULAR	3	-	365	165.43	162.3	0.81	0.011	19.4	30.8	36.5	45.2	NF	21.5	33.6	39.8	50.7	NF
SD3405	ST3405	ST3404	CIRCULAR	2	-	410	170.29	165.4	0.89	0.011	7.6	11.4	13.5	16.4	NF	8.9	13.2	15.5	19.1	NF
SD3406	ST3406	ST3405	CIRCULAR	2	-	11.7	171.08	170.3	6.34	0.013	7.6	11.4	13.5	16.5	NF	8.9	13.2	15.5	18.7	NF
SD3407	ST3407	ST3406	CIRCULAR	2	-	143	171.45	171.1	0.12	0.013	7.6	11.4	13.5	16.5	NF	8.9	13.2	15.5	18.7	NF
SD3408	ST3408	ST3407	CIRCULAR	2	-	163	171.85	171.5	0.12	0.013	7.6	11.4	13.5	16.5	NF	8.9	13.2	15.5	18.7	NF
SD3409	ST3409	ST3408	CIRCULAR	2	-	77	172.15	171.9	0.13	0.013	7.6	11.4	13.5	16.5	NF	8.9	13.2	15.5	18.7	NF
SD3410	ST3410	ST3409	CIRCULAR	2	-	145	174.88	172.2	1.75	0.011	7.6	11.4	13.5	16.5	NF	9.0	13.2	15.5	18.7	NF
SD3411	ST3411	ST3410	CIRCULAR	2	-	60	175.55	174.9	0.78	0.011	7.6	11.4	13.5	16.5	NF	9.0	13.2	15.6	18.7	NF
SD3412	ST3412	ST3411	CIRCULAR	2	-	27.1	175.43	175.6	-0.81	0.011	7.6	11.4	13.5	16.5	NF	9.0	13.2	15.6	18.7	NF
SD3413	ST3413	ST3412	CIRCULAR	2.5	-	145	176.1	175.4	0.46	0.013	7.6	11.4	13.5	16.5	NF	9.0	13.2	15.6	18.8	NF
SD3414	ST3414	ST3413	CIRCULAR	2.5	-	20	176.25	176.1	0.75	0.013	7.6	11.4	13.5	16.5	NF	9.0	13.3	15.6	18.8	NF
SD3415	ST3415	ST3414	CIRCULAR	1.5	-	268	178.63	176.3	0.73	0.013	1.2	1.8	2.2	2.8	NF	2.1	3.0	3.5	4.4	NF
SD3416	ST3416	ST3415	CIRCULAR	1.25	-	254	182.49	178.6	1.41	0.013	1.2	1.8	2.2	2.7	NF	2.1	3.0	3.5	4.1	NF
SD3417	ST3417	ST3416	CIRCULAR	1	-	230.5	186.51	182.5	1.61	0.013	1.2	1.8	2.2	2.7	NF	2.1	3.0	3.5	4.1	NF
SD3433	ST3417	ST3430	CIRCULAR	1.25	-	216.6	186.51	180.4	2.76	0.013	1.7	2.8	3.5	4.6	NF	3.4	5.3	6.4	8.0	NF
SD3419	ST3418	ST3404	CIRCULAR	3	-	591	168.26	165.4	0.47	0.013	11.8	19.5	22.9	29.8	NF	12.6	20.3	24.3	31.5	NF
SD3420	ST3419	ST3418	CIRCULAR	3	-	429.1	169.25	168.3	0.23	0.013	9.4	15.9	18.8	24.1	NF	10.2	16.8	20.2	26.0	NF
SD3421	ST3420	ST3419	CIRCULAR	3	-	258	169.73	169.3	0.15	0.013	9.4	15.9	18.8	24.2	NF	10.2	16.8	20.3	26.0	NF
SD3422	ST3421	ST3420	CIRCULAR	1.75	-	247.8	170.98	169.7	0.50	0.013	3.2	6.2	7.0	9.3	NF	3.9	6.9	8.4	10.8	NF
SD3423	ST3421	ST4236	CIRCULAR	1.5	-	638	170.98	166.9	0.65	0.013	2.7	5.5	7.5	8.1	NF	3.2	6.6	7.8	8.5	NF
SD3424	ST3422	ST3421	CIRCULAR	1.75	-	59	170.81	171.0	-0.29	0.013	0.4	2.9	4.4	5.5	NF	1.6	4.8	5.9	7.6	NF
SD3425	ST3423	ST3422	CIRCULAR	1.75	-	195	171.05	170.8	0.19	0.013	0.4	2.9	4.3	5.5	NF	1.6	4.8	5.9	7.6	NF
SD3426	ST3424	ST3423	CIRCULAR	1.75	-	74.2	171.12	171.1	0.09	0.013	0.4	2.9	4.3	5.5	NF	1.6	4.8	5.8	7.6	NF
SD3427	ST3425	ST3424	CIRCULAR	1.75	-	479.2	169.61	171.1	0.18	0.013	0.4	2.9	4.4	5.5	NF	1.7	4.9	5.8	9.3	100-yr, 24-hr
SD3428	ST3426	ST3425	CIRCULAR	1.75	-	85.1	169.79	169.6	0.21	0.013	1.7	2.8	3.5	4.9	NF	3.4	5.2	6.3	8.0	100-yr, 24-hr
SD3429	ST3427	ST3426	CIRCULAR	1.5	-	297.3	173.44	169.8	1.20	0.013	1.7	2.8	3.5	4.9	NF	3.4	5.2	6.8	8.0	100-yr, 24-hr
SD3430	ST3428	ST3427	CIRCULAR	1.5	-	434.9	178.86	173.4	1.21	0.013	1.7	2.8	3.5	4.5	NF	3.4	5.2	6.3	8.3	NF
SD3431	ST3429	ST3428	CIRCULAR	1.5	-	171.5	179.89	178.9	0.59	0.013	1.7	2.8	3.5	4.5	NF	3.4	5.2	6.3	8.0	NF
SD3432	ST3430	ST3429	CIRCULAR	1.5	-	65.7	180.41	179.9	0.65	0.013	1.7	2.8	3.5	4.6	NF	3.4	5.3	6.4	8.0	NF
SD3434	ST3431	ST3400	CIRCULAR	3.5	-	51.4	160.46	159.0	0.90	0.013	7.6	11.5	13.7	16.9	NF	8.1	12.3	14.5	18.6	NF
SD3435	ST3432	ST3431	CIRCULAR	2.5	-	257.6	163.39	160.5	1.04	0.011	7.6	11.5	13.7	16.9	NF	8.1	12.3	14.5	17.8	NF
SD3436	ST3433	ST3432	CIRCULAR	2.5	-	287.9	166.73	163.4	1.09	0.011	7.6	11.5	13.7	16.9	NF	8.1	12.3	14.6	17.8	NF
SD3437	ST3434	ST3433	CIRCULAR	2.5	-	262.1	169.86	166.7	1.12	0.011	7.6	11.6	13.8	16.9	NF	8.1	12.3	14.6	17.9	NF
SD3438	ST3435	ST3434	CIRCULAR	2.25	-	318.2	174.35	169.9	1.34	0.011	7.6	11.6	13.8	17.0	NF	8.1	12.3	14.6	17.9	NF
SD3439	ST3436	ST3435	CIRCULAR	2.25	-	442.3	180.59	174.4	1.40	0.011	7.6	11.6	13.8	17.0	NF	8.1	12.3	14.6	17.9	NF
SD3440	ST3437	ST3436	CIRCULAR	1.75	-	240	186.74	180.6	2.50	0.013	1.4	2.2	2.7	3.4	NF	1.5	2.3	2.8	3.5	NF
SD3441	ST3438	ST3437	CIRCULAR	1.75	-	240	189.99	186.7	1.26	0.013	1.4	2.2	2.7	3.4	NF	1.5	2.3	2.8	3.5	NF
SD3442	ST3439	ST3438	CIRCULAR	1.75	-	240	191.55	190.0	0.56	0.013	1.4	2.2	2.7	3.4	NF	1.5	2.3	2.8	3.5	NF
SD3443	ST3440	ST3439	CIRCULAR	1.75	-	240	193.2	191.6	0.58	0.013	1.4	2.2	2.7	3.4	NF	1.5	2.3	2.8	3.5	NF
SD3444	ST3441	ST3440	CIRCULAR	1.75	-	194.9	195.11	193.2	0.88	0.013	1.4	2.2	2.7	3.4	NF	1.5	2.3	2.8	3.5	NF
SD3445	ST3442	ST3441	CIRCULAR	1.75	-	120	197.05	195.1	1.62	0.013	1.4	2.2	2.7	3.4	NF	1.5	2.3	2.8	3.5	NF
SD3446	ST3443	ST3442	CIRCULAR	1.75	-	177	198.16	197.1	0.54	0.013	1.4	2.2	2.7	3.4	NF	1.5	2.3	2.8	3.5	NF
SD3447	ST3444	ST6036	CIRCULAR	2	-	230	150.86	142.2	3.65	0.013	14.1	21.2	24.5	29.1	NF	14.1	21.2	24.1	29.0	NF
SD3448	ST3445	ST3444	CIRCULAR	1.5	-	66	156.67	150.9	7.70	0.013	14.1	21.2	27.1	32.0	25-yr, 24-hr	14.1	21.2	27.3	31.9	25-yr, 24-hr
SD3449	ST3446	ST3445	CIRCULAR	1.5	-	173.9	166.18	156.7	4.71	0.013	5.4	8.1	9.4	10.9	NF	5.4	8.1	9.4	10.9	NF
SD3450	ST3447	ST3446	CIRCULAR	1.5	-	29.7	166.66	166.2	1.62	0.013	5.4	8.1	9.3	10.2	NF	5.4	8.1	9.3	10.2	NF
SD3451	ST3448	ST3447	CIRCULAR	1.5	-	198.7	168.66	166.7	1.06	0.013	5.4	8.1	9.3	10.2	NF	5.4	8.1	9.3	10.2	NF

Table B-3. Hydaulic Model Inputs and Results

Conduit			Conduit Atributes								Existing Land Use Conditions					Future Land Use Conditions				
			Shape	Diameter (ft)/ Max Width (ft)	Depth (ft)	Length (ft)	Invert Elevation (ft)		Slope (%)	Manning's Roughness	Peak Flow (cfs)				When Hydraulically Deficient	Peak Flow (cfs)				When Hydraulically Deficient
ID	US Node	DS Node					US	DS			2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	
SD3452	ST3449	ST3448	CIRCULAR	1.5	-	214.2	171.41	168.7	1.20	0.013	1.2	1.8	2.2	2.7	NF	1.2	1.8	2.2	2.7	NF
SD3453	ST3450	ST3449	CIRCULAR	1.25	-	178.4	175.05	171.4	2.20	0.013	1.2	1.8	2.2	2.7	NF	1.2	1.8	2.2	2.7	NF
SD3454	ST3451	ST3450	CIRCULAR	1.25	-	268.6	175.8	175.1	0.28	0.013	1.2	1.8	2.2	2.7	NF	1.2	1.8	2.2	2.7	NF
SD5204	ST3600	ST5203	BOECKMAN_CR_WILSC	42.5	5.5	49	95.2	94.5	1.53	0.035	158.4	210.4	236.5	299.5	NF	194.7	256.7	297.1	299.4	NF
SD3601	ST3602	ST3600	BOECKMAN_CR2	40	10	1250	103.45	95.2	0.66	0.035	144.2	190.0	212.1	292.0	NF	182.6	244.0	290.5	290.8	NF
SD3602	ST3603	ST3602	BOECKMAN_CR2	40	10	600	105.45	103.5	0.33	0.035	132.1	172.5	195.1	285.4	NF	173.2	231.5	284.5	284.8	NF
SD5503	ST3605	ST5501	S_FORK_MERIDIAN_CR	22	4	1250	167.45	111.5	4.48	0.035	16.7	24.7	29.1	35.3	NF	16.7	24.8	29.1	35.3	NF
SD3605	ST3606	ST3605	S_FORK_MERIDIAN_CR	22	4	530	184.96	167.5	3.31	0.035	16.8	25.0	29.3	35.5	NF	16.8	25.0	29.4	35.6	NF
SD4206	ST4000	ST4205	SEALY_DITCH	80	3.5	1450	138.45	138.0	0.03	0.035	238.1	298.7	322.9	432.6	2-yr, 24-hr	347.9	459.9	437.7	382.8	2-yr, 24-hr
SD4000	ST4001	ST4000	SEALY_DITCH	80	3.5	1600	138.95	138.5	0.03	0.035	231.5	286.9	307.7	330.4	2-yr, 24-hr	291.9	318.2	340.1	370.9	2-yr, 24-hr
SD4001	ST4002	ST4001	SEALY_DITCH	80	3.5	400	139.45	139.0	0.13	0.035	240.2	269.7	286.4	320.0	2-yr, 24-hr	272.0	306.5	325.4	345.5	2-yr, 24-hr
SD4002	ST4003	ST4002	COFFEE_CR2	80	3.5	150	139.95	139.5	0.33	0.035	158.6	212.3	215.6	236.8	2-yr, 24-hr	173.2	204.2	227.8	264.8	2-yr, 24-hr
SD4003	ST4004	ST4003	COFFEE_CR2	80	3.5	1400	149.66	140.0	0.69	0.035	29.5	50.8	54.5	58.5	NF	31.1	51.5	54.8	58.8	NF
SD4004	ST4005	ST4004	CIRCULAR	3	-	75	150.66	149.7	1.33	0.024	30.5	51.7	55.3	59.1	100-yr, 24-hr	32.0	52.4	55.6	59.3	100-yr, 24-hr
SD4005	ST4006	ST4005	CIRCULAR	3	-	300	154.66	150.7	1.33	0.024	30.5	51.7	55.3	59.1	10-yr, 24-hr	32.0	52.4	55.6	59.3	10-yr, 24-hr
SD4006	ST4007	ST4006	CIRCULAR	2.5	-	390	167.15	154.7	3.08	0.024	19.0	33.6	34.2	35.1	25-yr, 24-hr	21.3	34.0	34.6	35.3	25-yr, 24-hr
SD4007	ST4008	ST4007	CIRCULAR	2.5	-	146	168.68	167.2	1.05	0.024	19.0	33.0	33.8	34.8	10-yr, 24-hr	21.3	33.5	34.1	35.3	10-yr, 24-hr
SD4008	ST4009	ST4008	CIRCULAR	2	-	88.5	172.51	168.7	3.27	0.024	7.6	11.6	12.4	14.7	10-yr, 24-hr	8.4	12.4	13.7	15.9	10-yr, 24-hr
SD4009	ST4010	ST4009	CIRCULAR	2	-	21.1	172.71	172.5	0.95	0.024	7.6	11.3	12.4	14.7	25-yr, 24-hr	8.4	12.2	13.7	16.0	10-yr, 24-hr
SD4010	ST4011	ST4010	CIRCULAR	2	-	58.9	176.05	172.7	5.59	0.024	7.6	11.2	12.5	14.8	25-yr, 24-hr	8.4	12.0	13.7	16.0	10-yr, 24-hr
SD4011	ST4012	ST4011	CIRCULAR	2	-	429.3	185.15	176.1	2.12	0.024	7.6	11.6	13.3	15.2	100-yr, 24-hr	8.4	12.7	14.4	16.5	100-yr, 24-hr
SD4012	ST4013	ST4006	CIRCULAR	3	-	29.7	156.9	154.7	5.87	0.013	14.9	21.5	25.4	30.2	10-yr, 24-hr	14.9	21.6	25.4	30.2	10-yr, 24-hr
SD4013	ST4014	ST4013	CIRCULAR	3	-	195	159.2	156.9	0.92	0.013	14.9	22.7	25.7	30.5	100-yr, 24-hr	14.9	22.0	25.7	30.5	100-yr, 24-hr
SD4014	ST4015	ST4008	CIRCULAR	2.5	-	44.1	169.86	168.7	1.00	0.024	12.5	23.5	25.0	26.8	10-yr, 24-hr	13.8	24.2	25.6	27.0	10-yr, 24-hr
SD4015	ST4016	ST4206	S_COFFEE_CR5	16	2	700	143.95	141.7	0.29	0.035	47.7	59.0	62.8	69.7	10-yr, 24-hr	58.3	65.8	70.8	75.5	2-yr, 24-hr
SD4016	ST4017	ST4016	S_COFFEE_CR6	10	2	1150	150.25	144.0	0.55	0.035	48.5	65.6	65.8	73.3	10-yr, 24-hr	62.9	68.1	74.8	78.7	10-yr, 24-hr
SD4017	ST4018	ST4017	CIRCULAR	4.92	-	40	151.01	150.3	1.90	0.013	55.0	69.3	70.4	80.9	10-yr, 24-hr	63.7	73.8	81.3	84.7	10-yr, 24-hr
SD4018	ST4019	ST4018	S_COFFEE_CR4	9	2	90	152.72	151.0	1.90	0.035	54.9	69.6	70.8	82.0	10-yr, 24-hr	64.2	74.3	82.5	85.5	10-yr, 24-hr
SD4019	ST4020	ST4019	CIRCULAR	4.25	-	35	153.4	152.7	1.94	0.013	55.3	69.9	73.8	83.2	10-yr, 24-hr	64.7	75.2	83.7	86.3	10-yr, 24-hr
SD4020	ST4021	ST4020	S_COFFEE_CR4	9	2	580	164.48	153.4	1.91	0.035	54.5	73.8	75.3	91.8	100-yr, 24-hr	67.8	78.9	92.7	94.6	25-yr, 24-hr
SD4021	ST4022	ST4021	CIRCULAR	3.5	-	30	165.05	164.5	1.90	0.013	38.7	64.1	68.6	70.9	100-yr, 24-hr	50.1	70.4	73.0	74.8	25-yr, 24-hr
SD4022	ST4023	ST4022	CIRCULAR	3.5	-	30	165.63	165.1	1.90	0.013	38.7	67.4	72.0	73.5	100-yr, 24-hr	50.1	73.6	76.9	77.5	25-yr, 24-hr
SD4023	ST4024	ST4023	S_COFFEE_CR	16	2	540	175.95	165.6	1.91	0.035	39.1	51.4	56.3	69.2	NF	50.1	60.6	74.6	93.9	100-yr, 24-hr
SD4024	ST4025	ST4024	CIRCULAR	3	-	200	176.95	176.0	0.50	0.013	39.1	51.4	56.3	70.3	25-yr, 24-hr	50.1	60.7	76.9	95.5	10-yr, 24-hr
SD4025	ST4026	ST4021	CIRCULAR	1.75	-	400	168.35	164.5	0.83	0.013	15.9	20.7	22.4	24.8	10-yr, 24-hr	19.1	22.8	24.1	27.7	2-yr, 24-hr
SD4026	ST4027	ST4026	CIRCULAR	1.75	-	410	173.35	168.4	1.20	0.013	15.9	22.1	22.8	25.9	10-yr, 24-hr	19.4	23.2	25.5	28.7	2-yr, 24-hr
SD4027	ST4028	ST4027	CIRCULAR	1.75	-	390	175.76	173.4	0.59	0.013	16.1	21.0	23.7	27.4	10-yr, 24-hr	19.7	24.3	27.2	30.8	2-yr, 24-hr
SD4028	ST4029	ST4028	CIRCULAR	1.5	-	401.5	178.5	175.8	0.66	0.024	16.1	22.3	25.4	29.9	2-yr, 24-hr	18.9	26.2	29.7	34.5	2-yr, 24-hr
SD4200	ST4200	ST6205	RECT_CLOSED	24	7	75	135.3	135.0	0.47	0.013	298.6	357.8	386.5	416.9	NF	311.2	383.8	417.8	456.5	NF
SD4201	ST4201	ST4200	COFFEE_CR3	27	4	520	135.95	135.3	0.13	0.035	298.5	357.8	386.4	430.5	100-yr, 24-hr	311.2	423.0	417.8	456.5	10-yr, 24-hr
SD4202	ST4202	ST4201	COFFEE_CR3	27	4	500	136.95	136.0	0.20	0.035	298.5	357.8	386.4	441.2	100-yr, 24-hr	311.4	448.2	451.5	456.5	10-yr, 24-hr
SD4203	ST4203	ST4202	COFFEE_CR3	27	4	300	137.15	137.0	0.07	0.035	292.6	351.6	380.3	471.9	100-yr, 24-hr	319.3	494.6	471.4	451.4	10-yr, 24-hr
SD4204	ST4204	ST4203	COFFEE_CR3	27	4	250	137.45	137.2	0.12	0.035	291.6	350.4	379.2	507.8	100-yr, 24-hr	377.4	504.2	488.8	450.1	2-yr, 24-hr
SD4205	ST4205	ST4204	COFFEE_CR3	27	4	540	137.95	137.5	0.09	0.035	288.8	347.5	376.1	466.2	100-yr, 24-hr	414.9	469.4	461.7	446.9	2-yr, 24-hr
SD4207	ST4206	ST4205	S_COFFEE_CR7	12	2	400	141.67	138.0	0.99	0.035	55.0	66.5	69.7	97.9	10-yr, 24-hr	73.2	94.5	98.2	82.1	2-yr, 24-hr
SD4208	ST4207	ST4206	CIRCULAR	3.5	-	41.4	142.21	141.7	1.30	0.024	15.1	20.0	23.6	26.7	25-yr, 24-hr	16.0	23.9	24.6	24.9	10-yr, 24-hr
SD4209	ST4208	ST4207	CIRCULAR	3.5	-	233.4	142.32	142.2	0.05	0.024	15.4	20.4	23.3	26.5	25-yr, 24-hr	16.4	23.2	24.3	24.8	10-yr, 24-hr
SD4210	ST4209	ST4208	CIRCULAR	2.25	-	65.9	142.77	142.3	0.64	0.013	15.4	20.6	23.1	25.8	100-yr, 24-hr	16.6	22.4	24.1	25.1	25-yr, 24-hr
SD4211	ST4210	ST4209	CIRCULAR	2.25	-	319.3	144.47	142.8	0.50	0.013	15.5	20.6	23.1	25.5	100-yr, 24-hr	16.6	22.5	24.1	25.3	25-yr, 24-hr
SD4212	ST4211	ST4210	CIRCULAR	2.25	-	204	145.39	144.5	0.40	0.013	15.5	20.6	23.1	27.7	100-yr, 24-hr	16.8	22.5	23.6	26.7	25-yr, 24-hr
SD4213	ST4212	ST4211	CIRCULAR	2	-	290	147.56	145.4	0.65	0.013	15.5	20.6	23.1	26.1	NF	16.9	22.5	23.7	26.1	100-yr, 24-hr

Table B-3. Hydaulic Model Inputs and Results																				
Conduit			Conduit Atributes								Existing Land Use Conditions					Future Land Use Conditions				
			Shape	Diameter (ft)/ Max Width (ft)	Depth (ft)	Length (ft)	Invert Elevation (ft)		Slope (%)	Manning's Roughness	Peak Flow (cfs)				When Hydraulically Deficient	Peak Flow (cfs)				When Hydraulically Deficient
ID	US Node	DS Node					US	DS			2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	
SD4214	ST4213	ST4212	CIRCULAR	2	-	57	148.95	147.6	1.91	0.013	15.5	20.6	23.1	26.3	100-yr, 24-hr	16.9	22.5	26.7	26.5	25-yr, 24-hr
SD4215	ST4214	ST4213	CIRCULAR	2	-	103.6	149.03	149.0	0.08	0.013	15.5	20.6	23.1	25.9	25-yr, 24-hr	16.9	22.5	25.5	26.9	10-yr, 24-hr
SD4216	ST4215	ST4214	CIRCULAR	2	-	317	151.3	149.0	0.72	0.013	10.5	13.6	14.9	17.9	100-yr, 24-hr	11.4	14.6	17.1	17.1	25-yr, 24-hr
SD4217	ST4216	ST4215	CIRCULAR	2	-	349.1	155.45	151.3	1.16	0.013	10.5	13.6	15.0	20.0	100-yr, 24-hr	11.3	14.6	20.1	20.0	25-yr, 24-hr
SD4218	ST4217	ST4216	CIRCULAR	2	-	265.9	159.75	155.5	1.47	0.011	5.7	6.4	8.0	16.1	100-yr, 24-hr	6.1	7.4	14.0	14.0	100-yr, 24-hr
SD4219	ST4218	ST4217	CIRCULAR	2	-	288.1	163.05	159.8	1.11	0.011	5.7	6.4	6.8	11.5	NF	6.1	6.8	8.4	10.6	NF
SD4220	ST4219	ST4218	CIRCULAR	1.5	-	39.1	164.14	163.1	1.38	0.011	5.7	6.4	6.7	8.3	NF	6.1	6.8	7.6	11.1	NF
SD4221	ST4220	ST4219	CIRCULAR	2	-	355	164.8	164.1	0.14	0.013	5.7	6.4	6.7	8.0	NF	6.1	6.8	7.6	9.3	100-yr, 24-hr
SD4222	ST4221	ST4220	CIRCULAR	2	-	355.8	165.89	164.8	0.29	0.013	5.7	6.4	6.7	7.9	NF	6.1	6.8	7.7	11.4	100-yr, 24-hr
SD6207	ST4223	ST6205	CIRCULAR	4	-	82.2	138.64	135.0	0.18	0.013	33.7	54.1	60.3	65.3	NF	35.1	56.3	62.1	66.8	NF
SD4224	ST4224	ST4223	CIRCULAR	4	-	371.1	139.59	138.6	0.20	0.013	33.7	54.1	60.4	65.3	NF	35.1	56.3	62.1	66.8	NF
SD4225	ST4225	ST4224	CIRCULAR	4	-	365	140.31	139.6	0.20	0.013	33.7	54.2	60.4	65.3	NF	35.1	56.4	62.2	66.9	NF
SD4226	ST4226	ST4225	CIRCULAR	4	-	398.1	141.53	140.3	0.30	0.013	30.5	49.3	54.6	58.4	NF	31.3	50.5	55.2	58.8	NF
SD4227	ST4227	ST4226	CIRCULAR	3	-	361	143.64	141.5	0.58	0.013	15.8	24.8	29.9	34.6	NF	16.5	26.3	30.8	35.1	NF
SD4228	ST4228	ST4227	CIRCULAR	3	-	268.4	145.19	143.6	0.57	0.013	15.8	24.8	30.5	34.8	NF	16.5	26.3	31.4	35.1	NF
SD4229	ST4229	ST4228	CIRCULAR	3	-	68.6	145.77	145.2	0.85	0.024	2.2	3.5	4.4	5.1	NF	2.2	3.6	4.5	5.3	NF
SD4230	ST4230	ST4229	CIRCULAR	2.5	-	244	147	145.8	0.45	0.013	2.2	3.5	4.3	5.2	NF	2.2	3.6	4.3	5.3	NF
SD4231	ST4231	ST4230	CIRCULAR	2.5	-	246.4	147.7	147.0	0.28	0.013	2.2	3.5	4.3	5.2	NF	2.2	3.6	4.3	5.5	NF
SD4232	ST4232	ST4228	CIRCULAR	2.5	-	173.8	146.98	145.2	0.60	0.013	2.7	5.4	7.4	8.1	NF	3.2	6.6	7.6	8.5	NF
SD4233	ST4233	ST4232	CIRCULAR	1.75	-	471.6	151.25	147.0	0.76	0.013	2.7	5.4	7.4	8.1	NF	3.2	6.6	7.6	8.5	NF
SD4234	ST4234	ST4233	CIRCULAR	1.5	-	426	159.45	151.3	1.88	0.013	2.7	5.4	7.4	8.1	NF	3.2	6.6	7.7	8.5	NF
SD4235	ST4235	ST4234	CIRCULAR	1.5	-	27.5	164.24	159.5	1.49	0.013	2.7	5.5	7.5	8.1	NF	3.2	6.6	7.7	8.5	NF
SD4236	ST4236	ST4235	CIRCULAR	1.5	-	110.9	166.85	164.2	2.21	0.013	2.7	5.5	7.5	8.1	NF	3.2	6.6	7.8	8.5	NF
SD4241	ST4241	ST4242	CIRCULAR	2.5	-	80.5	143.45	142.1	1.74	0.013	0.6	0.7	0.9	1.3	NF	0.6	0.7	0.9	1.3	NF
SD4242	ST4242	ST4202	CIRCULAR	2.5	-	564	142.05	137.0	0.90	0.013	0.6	0.7	0.9	4.0	NF	0.6	3.1	2.7	1.3	NF
SD6413	ST4400	ST6413	CIRCULAR	4	-	100	161.45	159.5	2.00	0.013	52.4	71.8	80.9	92.7	NF	53.9	74.2	82.4	94.3	NF
SD4400	ST4401	ST4400	ARROWHEAD_CR2	28	6	400	163.45	161.5	0.50	0.035	32.7	47.0	55.5	65.6	NF	32.8	47.1	55.7	65.9	NF
SD4401	ST4402	ST4401	ARROWHEAD_CR	32	4	800	169.67	163.5	0.78	0.035	33.2	47.8	56.3	75.3	NF	33.2	47.8	56.5	76.0	NF
SD4402	ST4403	ST4402	ARROWHEAD_CR	32	4	100	170.45	169.7	0.78	0.035	25.4	35.8	42.1	58.0	NF	25.5	35.9	42.5	58.5	NF
SD4403	ST4404	ST4402	CIRCULAR	1.25	-	355	178.69	169.7	2.23	0.013	1.7	3.1	3.9	5.2	NF	1.7	3.1	3.9	5.2	NF
SD4500	ST4500	ST4204	CIRCULAR	2	-	421	143.57	137.5	1.44	0.013	8.1	13.0	15.9	21.2	NF	9.9	16.6	20.4	24.1	100-yr, 24-hr
SD4501	ST4501	ST4500	CIRCULAR	2	-	561	149.45	143.6	0.99	0.013	8.1	13.0	16.0	20.7	NF	9.9	15.6	18.9	24.4	NF
SD4502	ST4502	ST4501	CIRCULAR	1.5	-	473.6	167.3	149.5	2.81	0.013	4.4	7.6	9.5	12.5	NF	4.5	7.7	9.6	12.9	NF
SD4503	ST4503	ST4001	SEALY_CR	58	2	400	146.55	139.0	1.90	0.035	33.9	53.4	65.1	82.2	100-yr, 24-hr	63.2	94.0	110.8	133.4	25-yr, 24-hr
SD4600	ST4601	ST4600	CIRCULAR	2	-	57.2	195.67	190.2	0.49	0.013	3.0	4.1	4.6	5.8	NF	3.0	4.3	4.7	5.8	NF
SD4601	ST4602	ST4601	CIRCULAR	2	-	101.1	195.67	195.7	0.01	0.013	3.0	4.1	4.6	5.8	NF	3.0	4.1	4.7	5.8	NF
SD4602	ST4603	ST4602	CIRCULAR	2	-	135	195.87	195.7	0.15	0.013	3.0	4.3	4.6	5.8	NF	3.0	4.2	4.7	5.8	NF
SD4603	ST4604	ST4603	CIRCULAR	2	-	265.6	197.91	195.9	0.29	0.011	3.0	4.6	5.0	5.8	NF	3.0	4.5	5.0	5.8	NF
SD4604	ST4605	ST4604	CIRCULAR	2	-	165.8	198.78	197.9	0.40	0.011	3.0	4.5	5.3	6.1	NF	3.0	4.5	5.3	6.0	NF
SD4605	ST4606	ST4605	CIRCULAR	2	-	352.4	200.59	198.8	0.43	0.011	3.0	4.5	5.3	6.6	NF	3.0	4.5	5.3	6.6	NF
SD4606	ST4607	ST4606	CIRCULAR	1.5	-	58.5	201.4	200.6	1.04	0.011	3.0	4.5	5.3	6.4	NF	3.0	4.5	5.3	6.4	NF
SD4607	ST4608	ST4607	CIRCULAR	1.5	-	186.5	202.57	201.4	0.41	0.011	3.0	4.5	5.3	6.4	NF	3.0	4.5	5.3	6.4	NF
SD4612	ST4609	ST4614	CIRCULAR	2.5	-	36	196.32	196.0	0.28	0.01	7.1	8.3	8.5	11.2	NF	7.1	8.2	8.5	11.2	NF
SD4609	ST4610	ST4609	CIRCULAR	2.5	-	86	196.84	196.3	0.08	0.011	6.6	7.8	8.1	10.5	NF	6.6	7.8	8.0	10.5	NF
SD4610	ST4611	ST4610	CIRCULAR	2.5	-	125	197.42	196.8	0.16	0.011	4.8	5.8	6.7	9.2	NF	4.8	5.8	6.7	9.2	NF
SD4611	ST4612	ST4611	CIRCULAR	2.5	-	102	198.17	197.4	0.34	0.011	4.8	5.8	6.7	9.2	NF	4.8	5.8	6.7	9.2	NF
SD4613	ST4613	ST4609	CIRCULAR	1.5	-	42	197.53	196.3	0.50	0.01	0.5	0.6	0.6	0.8	NF	0.5	0.6	0.6	0.8	NF
SD4608	ST4614	ST4600	CIRCULAR	3	-	36	195.97	190.2	0.92	0.011	15.0	20.3	23.1	28.9	NF	15.5	20.8	24.0	29.7	NF
SD4614	ST4615	ST4600	CIRCULAR	2.5	-	103.5	195.7	190.2	0.38	0.013	5.8	8.1	9.5	12.6	NF	5.8	8.0	9.5	12.7	NF
SD4615	ST4616	ST4615	CIRCULAR	2.5	-	58.3	196.06	195.7	0.27	0.013	5.8	8.2	9.5	12.6	NF	5.8	8.1	9.5	12.8	NF
SD4616	ST4617	ST4616	CIRCULAR	2.5	-	151.3	196.68	196.1	0.28	0.013	5.8	8.5	9.5	12.6	NF	5.8	8.4	9.5	12.7	NF

Table B-3. Hydaulic Model Inputs and Results																				
Conduit			Conduit Atributes								Existing Land Use Conditions					Future Land Use Conditions				
			Shape	Diameter (ft)/ Max Width (ft)	Depth (ft)	Length (ft)	Invert Elevation (ft)		Slope (%)	Manning's Roughness	Peak Flow (cfs)				When Hydraulically Deficient	Peak Flow (cfs)				When Hydraulically Deficient
ID	US Node	DS Node					US	DS			2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	
SD4617	ST4618	ST4617	CIRCULAR	2.5	-	191.5	197.23	196.7	0.18	0.013	4.3	6.4	7.1	9.2	NF	4.3	6.4	7.0	9.2	NF
SD4618	ST4619	ST4618	CIRCULAR	2	-	134.6	198.35	197.2	0.68	0.011	1.4	2.2	2.5	3.2	NF	1.4	2.2	2.5	3.3	NF
SD4619	ST4620	ST4619	CIRCULAR	1.5	-	355.3	199.97	198.4	0.40	0.011	1.4	2.2	2.6	3.3	NF	1.4	2.2	2.7	3.3	NF
SD4620	ST4621	ST4620	CIRCULAR	1.5	-	142	200.83	200.0	0.46	0.011	1.4	2.2	2.6	3.3	NF	1.4	2.2	2.6	3.3	NF
SD4621	ST4622	ST4621	CIRCULAR	1.5	-	94.8	201.43	200.8	0.42	0.011	1.4	2.2	2.6	3.3	NF	1.4	2.2	2.6	3.3	NF
SD4622	ST4623	ST4622	CIRCULAR	1.5	-	106.3	202.53	201.4	0.85	0.011	1.4	2.2	2.6	3.3	NF	1.4	2.2	2.6	3.3	NF
SD4623	ST4624	ST4618	CIRCULAR	2	-	52.2	197.64	197.2	0.40	0.011	3.0	4.4	5.1	6.1	NF	3.0	4.4	5.1	6.2	NF
SD4624	ST4625	ST4624	CIRCULAR	2	-	47.6	198.06	197.6	0.46	0.011	3.0	4.4	5.2	6.1	NF	3.0	4.4	5.1	6.2	NF
SD4625	ST4626	ST4625	CIRCULAR	2	-	69.4	198.46	198.1	0.29	0.011	3.0	4.4	5.3	6.1	NF	3.0	4.4	5.2	6.2	NF
SD4626	ST4627	ST4626	CIRCULAR	2	-	58.4	198.89	198.5	0.39	0.011	3.0	4.4	5.3	6.2	NF	3.0	4.4	5.3	6.2	NF
SD4627	ST4628	ST4627	CIRCULAR	2	-	118.1	199.56	198.9	0.40	0.011	3.0	4.4	5.3	6.3	NF	3.0	4.4	5.3	6.3	NF
SD4628	ST4629	ST4628	CIRCULAR	1.5	-	44.5	200.15	199.6	0.88	0.011	3.0	4.4	5.3	6.5	NF	3.0	4.4	5.3	6.5	NF
SD4629	ST4630	ST4629	CIRCULAR	1.5	-	104.2	200.85	200.2	0.48	0.011	3.0	4.5	5.3	6.4	NF	3.0	4.5	5.3	6.4	NF
SD4630	ST4631	ST4630	CIRCULAR	1.5	-	95.2	201.33	200.9	0.29	0.011	3.0	4.5	5.3	6.5	NF	3.0	4.5	5.3	6.5	NF
SD4641	ST4633	ST4634	CIRCULAR	2.5	-	18.1	190.22	190.2	0.39	0.013	10.4	18.4	24.7	35.2	NF	10.5	18.9	25.5	36.5	NF
SD4633	ST4634	ST4635	CIRCULAR	2.5	-	100.3	190.15	189.3	0.54	0.013	10.4	18.4	24.7	35.2	NF	10.6	18.9	25.5	36.5	NF
SD4634	ST4635	ST4636	CIRCULAR	2.5	-	259.5	189.31	187.4	0.62	0.013	10.7	18.4	24.7	35.2	NF	11.6	18.9	25.5	36.5	NF
SD4635	ST4636	ST4637	CIRCULAR	3	-	262.3	187.4	189.4	-0.76	0.013	10.5	18.4	24.7	35.2	NF	10.6	18.9	25.5	36.5	NF
SD4637	ST4638	ST4639	CIRCULAR	2.5	-	85.7	189.38	188.4	1.10	0.013	9.6	17.1	18.4	19.8	NF	9.7	17.3	18.5	19.9	NF
SD4638	ST4639	ST4403	ARROWHEAD_CR	32	4	1200	188.44	170.5	1.50	0.035	12.5	20.1	23.3	27.8	NF	12.5	20.4	23.6	28.0	NF
SD4640	ST4640	O-SDDI	CIRCULAR	3	-	3151.9	189.38	168.1	0.68	0.013	0.9	1.3	6.1	15.2	NF	0.9	1.6	6.8	16.3	NF
3594	ST4656	ST4767	CIRCULAR	2.5	-	67.9	200.74	197.9	3.89	0.013	7.9	12.3	15.1	18.5	NF	8.3	12.9	16.0	19.3	NF
SD4654	ST4767	ST4614	CIRCULAR	2.5	-	59	197.9	196.0	3.27	0.013	7.9	12.3	14.9	18.4	NF	8.3	12.9	15.8	19.1	NF
949	ST4768	ST4656	CIRCULAR	2.5	-	55.2	201.23	200.7	0.62	0.013	7.9	12.3	14.8	18.5	NF	8.3	12.9	15.5	19.3	NF
950	ST4802	ST4768	CIRCULAR	2.5	-	109.6	202.54	201.2	1.01	0.013	7.9	12.3	14.8	18.5	NF	8.3	12.9	15.5	19.3	NF
SD4741	ST4803	ST4802	CIRCULAR	2.5	-	129.9	203.75	202.5	0.39	0.013	7.9	12.3	14.8	18.5	NF	8.3	12.9	15.5	19.3	NF
SD4830	ST4804	ST4803	CIRCULAR	2.5	-	268.2	205.38	203.8	0.53	0.013	6.2	9.8	11.8	14.8	NF	6.7	10.4	12.5	15.5	NF
SD4742	ST4805	ST4804	CIRCULAR	2.5	-	149.4	206.36	205.4	0.52	0.013	6.2	9.8	11.9	14.8	NF	6.7	10.4	12.5	15.5	NF
SD4789	ST4806	ST4805	CIRCULAR	2.5	-	116.6	207.03	206.4	0.40	0.013	6.2	9.8	11.9	14.8	NF	6.7	10.4	12.5	15.6	NF
SD4790	ST4828	ST4806	CIRCULAR	2	-	335.2	208.63	207.0	0.42	0.013	3.0	4.8	5.9	7.4	NF	3.5	5.4	6.5	8.1	NF
SD4752	ST4829	ST4828	CIRCULAR	2	-	335.2	211.99	208.6	1.00	0.013	3.0	4.9	5.9	7.4	NF	3.5	5.5	6.6	8.1	NF
SD5000	ST5000	ST5209	CIRCULAR	1	-	56	108.6	90.9	32.36	0.024	11.4	14.0	14.6	15.3	2-yr, 24-hr	11.4	14.0	14.6	15.3	2-yr, 24-hr
SD5001	ST5001	ST5000	CIRCULAR	1.25	-	120	124.12	108.6	12.89	0.024	11.4	14.3	14.7	15.3	10-yr, 24-hr	11.5	14.4	14.7	15.3	10-yr, 24-hr
SD5002	ST5002	ST5001	CIRCULAR	2	-	113	138.96	124.1	14.63	0.024	11.4	17.8	19.5	20.2	10-yr, 24-hr	11.5	17.8	19.5	20.2	10-yr, 24-hr
SD5003	ST5003	ST5002	CIRCULAR	1.5	-	34	145.4	139.0	2.44	0.024	6.5	10.0	11.3	13.3	10-yr, 24-hr	6.5	10.0	11.3	13.3	10-yr, 24-hr
SD5004	ST5004	ST5003	CIRCULAR	1.5	-	154.8	158.38	145.4	8.41	0.011	6.5	9.9	11.7	14.9	NF	6.5	9.9	11.7	14.9	NF
SD5005	ST5005	ST5004	CIRCULAR	1.5	-	129	161.19	158.4	2.02	0.011	4.5	6.7	7.9	10.2	NF	4.5	6.7	7.9	10.2	NF
SD5006	ST5006	ST5005	CIRCULAR	1.5	-	319.1	163.74	161.2	0.74	0.011	4.5	6.7	7.9	10.2	NF	4.5	6.7	7.9	10.2	NF
SD5007	ST5007	ST5006	CIRCULAR	1.25	-	84.1	164.9	163.7	0.43	0.011	1.2	1.7	2.0	3.1	NF	1.2	1.7	2.0	3.0	NF
SD5008	ST5008	ST5007	CIRCULAR	1.25	-	82.4	165.39	164.9	0.59	0.011	1.2	1.7	2.0	3.4	NF	1.2	1.7	2.0	3.4	NF
SD5009	ST5009	ST5008	CIRCULAR	1.25	-	100	165.88	165.4	0.49	0.011	1.2	1.7	2.0	3.4	NF	1.2	1.7	2.0	3.4	NF
SD5010	ST5010	ST5009	CIRCULAR	1.25	-	100	166.39	165.9	0.51	0.011	1.2	1.7	2.0	3.4	NF	1.2	1.7	2.0	3.4	NF
SD5011	ST5011	ST5010	CIRCULAR	1	-	100	166.89	166.4	0.50	0.011	1.2	1.7	2.0	3.2	NF	1.2	1.7	2.0	3.2	NF
SD5012	ST5012	ST5011	CIRCULAR	1	-	100	167.39	166.9	0.50	0.011	1.2	1.7	2.0	3.2	NF	1.2	1.7	2.0	3.2	NF
SD5013	ST5013	ST5012	CIRCULAR	1	-	100	167.89	167.4	0.50	0.011	1.2	1.7	2.0	3.2	NF	1.2	1.7	2.0	3.2	NF
SD5014	ST5014	ST5013	CIRCULAR	1	-	70.5	168.05	167.9	0.23	0.011	1.2	1.7	2.0	3.2	NF	1.2	1.7	2.0	3.2	NF
SD5015	ST5015	ST5014	CIRCULAR	1.5	-	292.7	169.56	168.1	0.43	0.011	1.2	1.7	2.0	3.5	NF	1.2	1.7	2.0	3.5	NF
SD5016	ST5016	ST5015	CIRCULAR	1.5	-	248.9	170.98	169.6	0.49	0.011	1.2	1.7	2.0	3.7	NF	1.2	1.7	2.0	3.7	NF
SD5017	ST5017	ST5016	CIRCULAR	1.5	-	132.4	171.76	171.0	0.44	0.011	1.2	1.7	2.0	3.6	NF	1.2	1.7	2.0	3.6	NF
SD5018	ST5017	ST5018	CIRCULAR	1.5	-	169.7	171.76	171.1	0.23	0.011	0.8	1.2	1.5	1.8	NF	0.8	1.2	1.5	1.8	NF
SD5019	ST5018	ST5019	CIRCULAR	1.5	-	167.1	171.09	170.0	0.45	0.011	0.8	1.2	1.5	2.0	NF	0.8	1.2	1.5	2.0	NF

Table B-3. Hydaulic Model Inputs and Results																				
Conduit			Conduit Atributes								Existing Land Use Conditions					Future Land Use Conditions				
			Shape	Diameter (ft)/ Max Width (ft)	Depth (ft)	Length (ft)	Invert Elevation (ft)		Slope (%)	Manning's Roughness	Peak Flow (cfs)				When Hydraulically Deficient	Peak Flow (cfs)				When Hydraulically Deficient
ID	US Node	DS Node					US	DS			2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	
SD5020	ST5019	ST5020	CIRCULAR	1.5	-	109.3	170	169.4	0.38	0.011	4.2	6.3	7.2	7.6	NF	4.2	6.3	7.2	7.6	NF
SD5021	ST5020	ST3448	CIRCULAR	1.5	-	87.6	169.38	168.7	0.59	0.011	4.2	6.3	7.1	7.6	NF	4.2	6.3	7.1	7.6	NF
SD5022	ST5021	ST5017	CIRCULAR	1.25	-	100	172.92	171.8	0.96	0.011	2.0	2.9	3.4	4.1	NF	2.0	2.9	3.4	4.1	NF
SD5023	ST5022	ST5021	CIRCULAR	1.25	-	100	173.42	172.9	0.50	0.011	2.0	2.9	3.4	4.1	NF	2.0	2.9	3.4	4.1	NF
SD5024	ST5023	ST5019	CIRCULAR	1.5	-	154.3	171.31	170.0	0.63	0.011	3.4	5.1	5.9	7.0	NF	3.4	5.1	5.9	7.0	NF
SD5025	ST5024	ST5023	CIRCULAR	1.25	-	159.8	172.11	171.3	0.38	0.011	3.4	5.1	5.9	7.0	NF	3.4	5.1	5.9	7.0	NF
SD5026	ST5025	ST5002	CIRCULAR	2	-	88	145.03	139.0	0.92	0.024	4.1	6.5	6.9	7.6	10-yr, 24-hr	4.1	6.5	6.9	7.6	10-yr, 24-hr
SD5027	ST5026	ST5025	CIRCULAR	2	-	181	146.43	145.0	0.66	0.024	4.1	6.8	8.7	9.0	25-yr, 24-hr	4.1	6.8	7.7	9.0	25-yr, 24-hr
SD5028	ST5027	ST5026	CIRCULAR	1.25	-	180	152.77	146.4	3.36	0.024	4.1	6.6	7.3	7.9	25-yr, 24-hr	4.1	6.6	7.1	7.9	25-yr, 24-hr
SD5029	ST5028	ST5027	CIRCULAR	1.25	-	97	157.4	152.8	4.53	0.024	4.1	6.7	7.3	8.3	25-yr, 24-hr	4.1	6.6	7.2	8.3	25-yr, 24-hr
SD5030	ST5029	ST5028	CIRCULAR	1.25	-	27	157.89	157.4	1.37	0.024	1.9	3.0	4.1	4.9	100-yr, 24-hr	1.9	3.0	4.0	4.8	100-yr, 24-hr
SD5031	ST5030	ST5029	CIRCULAR	1.25	-	38.1	159.14	157.9	1.60	0.011	1.9	3.9	4.0	4.8	100-yr, 24-hr	1.9	3.8	4.0	4.8	100-yr, 24-hr
SD5032	ST5031	ST5030	CIRCULAR	1.25	-	88.3	160.04	159.1	0.79	0.011	1.9	3.3	3.9	4.8	NF	1.9	3.3	3.9	4.7	NF
SD5033	ST5032	ST5031	CIRCULAR	1.25	-	47.8	160.69	160.0	0.94	0.011	1.9	2.9	4.1	4.7	NF	1.9	2.9	4.1	4.7	NF
SD5034	ST5033	ST5032	CIRCULAR	1.25	-	372.1	164.77	160.7	1.04	0.011	1.9	2.9	3.8	4.7	100-yr, 24-hr	1.9	2.9	3.7	4.7	100-yr, 24-hr
SD5035	ST5034	ST5002	CIRCULAR	1.25	-	372	152.22	139.0	2.00	0.024	0.9	1.5	2.6	3.0	25-yr, 24-hr	0.9	1.5	2.6	3.0	25-yr, 24-hr
SD5036	ST5035	ST5034	CIRCULAR	1.25	-	179	161.98	152.2	5.21	0.024	0.9	1.5	1.8	2.0	NF	0.9	1.5	1.8	2.0	NF
SD5037	ST5036	ST5035	CIRCULAR	1.25	-	119	167.87	162.0	4.74	0.024	0.9	1.5	1.8	2.0	NF	0.9	1.5	1.8	2.0	NF
SD5038	ST5037	ST5036	CIRCULAR	1.25	-	188	169.38	167.9	0.69	0.024	0.9	1.5	1.8	2.0	NF	0.9	1.5	1.8	2.0	NF
SD5219	ST5038	POND_LIBRARY	CIRCULAR	4	-	190	143.45	140.8	1.11	0.013	38.9	59.9	71.1	88.2	NF	43.5	66.0	78.4	96.6	NF
SD5039	ST5039	ST5038	CIRCULAR	4	-	308.1	155.16	143.5	0.92	0.013	35.1	54.3	64.4	79.2	NF	39.7	60.7	71.4	87.5	NF
SD5200	ST5200	ST5204	BOECKMAN_CR2	40	10	1200	78.85	71.7	0.60	0.035	199.1	271.7	306.4	352.8	NF	234.8	306.3	337.9	380.4	NF
SD5201	ST5201	ST5200	BOECKMAN_CR2	40	10	930	94.45	78.9	1.68	0.035	158.2	210.3	236.4	299.5	NF	194.6	256.4	297.1	299.1	NF
SD5202	ST5202	ST5201	KOLBE_BRIDGE	55	11	70	92.45	94.5	-2.86	0.035	158.2	210.3	236.4	299.5	NF	194.6	256.4	297.1	299.2	NF
SD5203	ST5203	ST5202	BOECKMAN_CR2	40	10	430	94.45	92.5	0.47	0.035	158.3	210.3	236.4	299.5	NF	194.6	256.6	297.1	299.3	NF
SD5205	ST5204	ST5205	MEMORIAL_PARK_BRID	88	20	55	71.7	71.7	0.02	0.035	198.5	271.3	305.9	351.5	NF	234.6	304.8	336.3	379.1	NF
SD5206	ST5205	O5200	BOECKMAN_CR2	40	10	1500	71.69	63.5	0.55	0.035	198.3	271.1	305.7	350.9	NF	234.5	304.2	335.7	378.7	NF
SD5207	ST5206	ST5200	BOECKMAN_CR	37	9	500	83.65	78.9	0.96	0.035	40.9	57.6	64.5	69.5	NF	43.2	59.3	66.3	71.8	NF
SD5208	ST5207	ST5206	BOECKMAN_CR	37	9	150	85.1	83.7	0.97	0.035	24.7	38.1	45.0	49.8	NF	26.2	39.8	46.7	52.0	NF
SD5210	ST5208	ST5207	CIRCULAR	2	-	201	87.14	85.1	1.02	0.024	11.4	14.0	14.6	15.3	NF	11.4	14.0	14.6	15.3	NF
SD5211	ST5209	ST5208	CIRCULAR	1.5	-	50	90.89	87.1	6.65	0.024	11.4	14.0	14.6	15.3	NF	11.5	14.0	14.6	15.3	NF
SD5212	ST5210	ST5206	CIRCULAR	1.75	-	164.3	102.15	83.7	5.61	0.024	19.3	20.0	21.9	21.9	NF	19.8	20.2	21.7	21.8	NF
SD5213	ST5211	ST5210	CIRCULAR	1.75	-	125	109.15	102.2	5.61	0.024	19.3	20.1	20.8	21.0	NF	20.0	20.2	21.0	20.8	NF
SD5214	ST5212	ST5211	CIRCULAR	1.75	-	105.4	115.05	109.2	5.61	0.024	19.3	20.1	20.8	21.1	NF	20.0	20.2	20.8	20.8	NF
SD5215	ST5213	ST5212	CIRCULAR	1.75	-	123.2	121.95	115.1	5.61	0.024	19.3	20.2	20.7	21.4	NF	20.0	20.2	20.7	20.7	NF
SD5216	ST5214	ST5213	CIRCULAR	1.75	-	108.9	128.05	122.0	5.61	0.024	19.3	20.8	20.9	21.6	NF	20.9	20.9	20.9	20.8	NF
SD5217	ST5215	ST5214	CIRCULAR	1.75	-	141.1	135.95	128.1	5.61	0.024	19.3	20.8	20.9	21.6	NF	20.8	20.9	20.9	20.8	NF
SD5501	ST5500	O5500	S_FORK_MERIDIAN_CR	22	4	282.7	71.45	63.5	2.83	0.035	20.7	34.1	42.2	54.1	NF	20.7	34.1	42.3	54.2	NF
SD5502	ST5501	ST5500	S_FORK_MERIDIAN_CR	22	4	1130	111.45	71.5	3.54	0.035	20.8	34.3	42.5	54.4	NF	20.8	34.3	42.5	54.4	NF
SD5701	ST5701	O5701	CIRCULAR	1.25	-	79.1	84.07	72.0	15.48	0.024	5.5	9.2	10.9	12.8	NF	5.9	9.7	11.2	13.4	NF
SD5702	ST5702	ST5701	CIRCULAR	1.25	-	158	86.6	84.1	1.60	0.013	5.5	9.2	10.9	13.1	25-yr, 24-hr	5.9	9.8	11.2	13.3	25-yr, 24-hr
SD5703	ST5703	ST5702	CIRCULAR	1.25	-	126	89.82	86.6	2.40	0.013	5.5	9.2	10.9	12.9	100-yr, 24-hr	5.9	9.8	11.3	13.0	100-yr, 24-hr
SD5704	ST5704	ST5703	CIRCULAR	1	-	103	95.76	89.8	4.68	0.013	3.1	5.1	6.1	7.1	100-yr, 24-hr	3.3	5.4	6.4	7.3	100-yr, 24-hr
SD5705	ST5705	ST5704	CIRCULAR	1.25	-	160	96.61	95.8	0.40	0.013	3.1	5.1	6.1	7.1	100-yr, 24-hr	3.3	5.4	6.4	7.2	25-yr, 24-hr
SD5706	ST5706	ST5705	CIRCULAR	1.25	-	199.8	97.61	96.6	0.40	0.013	3.1	5.1	6.1	7.6	25-yr, 24-hr	3.3	5.4	7.0	7.9	25-yr, 24-hr
SD5719	ST5707	ST5719	CIRCULAR	3.5	-	260	100.45	99.0	0.56	0.013	18.4	24.0	25.9	28.7	25-yr, 24-hr	19.8	24.6	27.1	29.6	10-yr, 24-hr
SD5708	ST5708	ST5707	CIRCULAR	4	-	270	101.32	100.5	0.32	0.013	18.4	24.6	28.6	33.5	25-yr, 24-hr	19.9	25.1	31.0	35.0	10-yr, 24-hr
SD5709	ST5709	ST5708	CIRCULAR	3.5	-	165	102.47	101.3	0.70	0.013	18.4	26.5	29.9	37.5	10-yr, 24-hr	19.9	27.5	33.7	39.5	10-yr, 24-hr
SD5710	ST5710	ST5709	CIRCULAR	4	-	246	107.43	102.5	1.79	0.011	10.6	18.1	19.9	24.2	NF	10.6	15.7	20.0	23.7	NF
SD5711	ST5711	ST5710	CIRCULAR	4	-	224.6	121.09	107.4	6.00	0.011	10.6	17.4	19.9	22.4	NF	10.6	17.4	19.4	22.4	NF
SD5712	ST5712	ST5711	CIRCULAR	4	-	314	137.34	121.1	5.15	0.011	10.6	15.9	18.7	22.4	NF	10.6	15.9	18.7	22.4	NF

Table B-3. Hydaulic Model Inputs and Results

Conduit			Conduit Atributes								Existing Land Use Conditions					Future Land Use Conditions				
			Shape	Diameter (ft)/ Max Width (ft)	Depth (ft)	Length (ft)	Invert Elevation (ft)		Slope (%)	Manning's Roughness	Peak Flow (cfs)				When Hydraulically Deficient	Peak Flow (cfs)				When Hydraulically Deficient
ID	US Node	DS Node					US	DS			2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	
SD5713	ST5713	ST5712	CIRCULAR	4	-	358.4	150.79	137.3	3.73	0.011	10.6	15.9	18.7	22.4	NF	10.6	15.9	18.7	22.4	NF
SD5714	ST5714	O5702	CIRCULAR	1.25	-	67	88.49	62.5	44.03	0.024	18.4	22.5	24.4	26.5	100-yr, 24-hr	19.7	22.9	25.0	26.9	100-yr, 24-hr
SD5209	ST5715	ST5207	BOECKMAN_CR	37	9	267	90	85.1	0.92	0.035	9.4	17.4	21.8	22.9	NF	10.9	19.1	23.5	25.0	NF
SD5715	ST5716	ST5715	CIRCULAR	2.5	-	198	90.69	90.0	0.35	0.013	9.5	17.6	21.9	23.1	NF	10.9	19.2	23.6	25.2	NF
SD5716	ST5717	ST5716	CIRCULAR	2.5	-	131	91.23	90.7	0.26	0.013	9.5	17.6	21.9	23.1	NF	10.9	19.3	23.6	25.2	NF
SD5717	ST5718	ST5717	CIRCULAR	2.5	-	123	91.7	91.2	0.22	0.013	9.6	17.6	21.9	23.1	NF	11.0	19.3	23.6	25.2	NF
SD5707	ST5719	ST5714	CIRCULAR	1.75	-	108	99	88.5	10.99	0.024	18.4	22.5	24.4	26.6	10-yr, 24-hr	19.7	22.9	25.1	27.0	10-yr, 24-hr
SD6000	ST6000	O6000	CIRCULAR	2.5	-	466.3	117.95	60.5	11.84	0.013	29.7	43.8	51.2	60.3	NF	29.7	43.8	51.2	60.3	NF
SD6001	ST6001	ST6000	CIRCULAR	2.5	-	182.4	122.86	118.0	4.23	0.013	29.8	43.9	51.3	60.3	NF	29.8	43.9	51.3	60.3	NF
SD6002	ST6002	ST6001	CIRCULAR	2.5	-	632.1	135.95	122.9	1.54	0.013	23.1	31.7	36.0	41.9	NF	23.1	31.7	36.1	41.9	NF
SD6003	ST6003	ST6002	CIRCULAR	2.5	-	167.5	137.28	136.0	0.79	0.013	23.1	31.8	36.1	41.5	NF	23.1	31.8	36.2	41.5	NF
SD6004	ST6004	ST6003	CIRCULAR	2.5	-	196.6	138.85	137.3	0.80	0.013	18.8	25.8	28.3	32.2	NF	18.8	25.8	28.3	32.2	NF
SD6005	ST6005	ST6004	CIRCULAR	2.5	-	68	139.17	138.9	0.47	0.013	14.0	18.2	20.0	22.6	NF	14.0	18.2	20.0	22.6	NF
SD6006	ST6006	ST6005	CIRCULAR	1.5	-	297.9	141.48	139.2	0.87	0.013	14.0	18.1	20.0	22.6	10-yr, 24-hr	14.0	18.1	20.0	22.6	10-yr, 24-hr
SD6007	ST6007	ST6006	CIRCULAR	2	-	302	142.11	141.5	0.21	0.013	14.0	18.5	20.4	23.3	10-yr, 24-hr	14.0	18.5	20.4	23.3	10-yr, 24-hr
SD6008	ST6008	ST6007	CIRCULAR	2	-	79	142.55	142.1	0.30	0.013	3.7	6.7	6.8	6.9	10-yr, 24-hr	3.7	6.5	6.8	6.9	10-yr, 24-hr
SD6009	ST6009	ST6008	CIRCULAR	2	-	112	142.9	142.6	0.31	0.013	3.7	6.2	6.1	6.2	10-yr, 24-hr	3.7	6.2	6.2	6.2	10-yr, 24-hr
SD6010	ST6010	ST6009	CIRCULAR	1.5	-	197	143.59	142.9	0.30	0.013	3.7	5.6	5.3	5.3	10-yr, 24-hr	3.7	5.6	5.4	5.3	10-yr, 24-hr
SD6011	ST6011	ST6010	CIRCULAR	1.5	-	154	144.25	143.6	0.30	0.013	3.5	4.8	4.8	5.4	10-yr, 24-hr	3.8	4.8	4.8	5.2	10-yr, 24-hr
SD6012	ST6012	ST6011	CIRCULAR	1.5	-	79	144.69	144.3	0.30	0.013	3.6	5.5	6.3	6.0	10-yr, 24-hr	4.0	5.4	5.8	6.3	10-yr, 24-hr
SD6013	ST6013	ST6012	CIRCULAR	1.5	-	177	145.43	144.7	0.31	0.013	3.5	6.2	5.5	7.5	10-yr, 24-hr	3.7	5.3	6.9	6.9	10-yr, 24-hr
SD6014	ST6014	ST6004	CIRCULAR	1.75	-	303.3	141.45	138.9	0.82	0.013	4.9	7.7	8.7	9.7	NF	4.9	7.7	8.7	9.7	NF
SD6015	ST6015	ST6014	CIRCULAR	1.5	-	290	143.21	141.5	0.52	0.013	4.9	7.7	8.8	9.7	NF	4.9	7.7	8.8	9.7	NF
SD6016	ST6016	ST6015	CIRCULAR	1.5	-	251	144.97	143.2	0.70	0.013	4.9	7.7	8.8	9.7	NF	4.9	7.7	8.8	9.7	NF
SD6017	ST6017	ST6016	CIRCULAR	1.5	-	89	145.42	145.0	0.51	0.013	4.9	7.8	8.8	9.7	NF	4.9	7.8	8.8	9.7	NF
SD6018	ST6018	ST6017	CIRCULAR	1.5	-	60	145.99	145.4	0.95	0.013	4.9	7.8	8.8	9.7	100-yr, 24-hr	4.9	7.8	8.8	9.7	100-yr, 24-hr
SD6019	ST6019	ST6018	CIRCULAR	1.5	-	160	147.08	146.0	0.68	0.013	4.9	7.8	8.8	9.8	100-yr, 24-hr	4.9	7.8	8.8	9.8	100-yr, 24-hr
SD6020	ST6020	ST6019	CIRCULAR	1.5	-	177	147.97	147.1	0.50	0.013	4.9	7.8	8.8	10.0	100-yr, 24-hr	4.9	7.8	8.8	10.0	100-yr, 24-hr
SD6021	ST6021	ST6020	CIRCULAR	1.25	-	114	148.43	148.0	0.18	0.013	4.9	7.8	8.8	10.3	25-yr, 24-hr	4.9	7.8	8.8	10.3	25-yr, 24-hr
SD6022	ST6022	O6001	I5	16	2	300	108.45	73.5	11.75	0.035	26.3	39.3	45.8	54.5	NF	26.3	39.3	45.9	54.4	NF
SD6023	ST6023	ST6022	I5	16	2	80	111.36	108.5	3.64	0.035	19.2	28.5	32.0	38.0	NF	19.2	28.5	32.0	37.9	NF
SD6024	ST6024	ST6023	CIRCULAR	3.5	-	50	120.41	111.4	18.40	0.013	19.2	28.5	32.0	38.0	NF	19.2	28.5	32.0	37.9	NF
SD6025	ST6025	ST6024	I5	16	2	20	123.14	120.4	13.78	0.035	19.2	28.5	32.0	38.0	NF	19.2	28.5	32.0	37.9	NF
SD6026	ST6026	ST6025	I5	16	2	700	132.99	123.1	1.41	0.035	19.2	28.5	32.0	38.0	NF	19.2	28.5	32.0	37.9	NF
SD6027	ST6027	ST6026	CIRCULAR	3.5	-	33	133.08	133.0	0.27	0.013	19.3	28.5	32.0	38.0	NF	19.3	28.5	32.0	38.0	NF
SD6028	ST6028	ST6027	CIRCULAR	3.5	-	394	134.09	133.1	0.26	0.013	19.3	28.5	32.0	38.1	NF	19.3	28.5	32.0	38.0	NF
SD6029	ST6029	ST6028	CIRCULAR	3.5	-	394	135.08	134.1	0.25	0.013	19.3	28.6	32.1	38.1	NF	19.3	28.6	32.1	38.1	NF
SD6030	ST6030	ST6029	CIRCULAR	3.5	-	394	136.06	135.1	0.25	0.013	19.3	28.7	32.1	38.3	NF	19.3	28.7	32.2	38.2	NF
SD6031	ST6031	ST6030	CIRCULAR	3.5	-	394	137.05	136.1	0.25	0.013	19.4	28.7	32.1	38.4	NF	19.4	28.7	32.2	38.4	NF
SD6032	ST6032	ST6031	CIRCULAR	3.5	-	394	138.03	137.1	0.25	0.013	14.1	21.1	23.4	27.6	NF	14.1	21.1	23.1	27.5	NF
SD6033	ST6033	ST6032	CIRCULAR	3.5	-	246	138.62	138.0	0.24	0.013	14.1	21.1	23.5	27.7	NF	14.1	21.1	23.3	27.6	NF
SD6034	ST6034	ST6033	CIRCULAR	3.5	-	254.4	139.24	138.6	0.24	0.013	14.1	21.2	23.8	27.8	NF	14.1	21.2	23.4	27.6	NF
SD6035	ST6035	ST6034	CIRCULAR	3	-	131	139.88	139.2	0.49	0.013	14.1	21.2	24.1	27.9	NF	14.1	21.2	23.5	27.7	NF
SD6036	ST6036	ST6035	CIRCULAR	2.25	-	131	142.21	139.9	1.40	0.013	14.1	21.2	24.3	28.0	NF	14.1	21.2	23.6	27.8	NF
SD6200	ST6200	O6200	COFFEE_CR4	27	4	650	79.45	62.2	2.66	0.035	370.6	484.3	525.3	529.3	NF	427.5	479.5	515.4	633.0	NF
SD6201	ST6201	ST6200	COFFEE_CR4	27	4	420	88.45	79.5	2.14	0.035	370.7	484.3	525.4	529.3	NF	427.6	479.7	515.6	633.1	NF
SD6202	ST6202	ST6201	ARROWHEAD_CR2	28	6	850	125.45	88.5	4.36	0.035	60.8	86.5	97.5	111.9	NF	64.3	92.2	102.9	117.2	NF
SD6203	ST6203	ST6202	ARROWHEAD_CR2	28	6	900	143.45	125.5	2.00	0.035	61.2	86.7	97.5	111.9	NF	64.5	92.4	103.0	117.3	NF
SD6205	ST6204	ST6201	COFFEE_CR4	27	4	900	123.95	88.5	3.95	0.035	323.6	384.7	413.8	443.0	NF	347.4	399.3	437.7	479.8	NF
SD6206	ST6205	ST6204	COFFEE_CR4	27	4	1300	134.95	124.0	0.85	0.035	323.6	384.7	413.8	443.1	NF	347.5	399.3	437.7	479.8	NF
SD6400	ST6400	O6400	CIRCULAR	2.5	-	10	146.95	145.0	20.41	0.011	4.5	7.3	9.0	11.5	NF	4.5	7.3	9.0	11.5	NF

Table B-3. Hydaulic Model Inputs and Results																			
Conduit			Conduit Atributes								Existing Land Use Conditions					Future Land Use Conditions			
			Shape	Diameter (ft)/ Max Width (ft)	Depth (ft)	Length (ft)	Invert Elevation (ft)		Slope (%)	Manning's Roughness	Peak Flow (cfs)				When Hydraulically Deficient	Peak Flow (cfs)				When Hydraulically Deficient
ID	US Node	DS Node					US	DS			2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	
SD6401	ST6401	ST6400	CIRCULAR	2.5	-	109	148.55	147.0	0.59	0.013	4.5	7.3	9.0	11.5	NF	4.5	7.3	9.0	11.5	NF
SD6402	ST6402	ST6401	CIRCULAR	2.5	-	229.6	149.5	148.6	0.25	0.013	4.5	7.3	9.0	11.6	NF	4.5	7.3	9.0	11.6	NF
SD6403	ST6403	ST6402	CIRCULAR	2.5	-	217.4	150.99	149.5	0.46	0.011	4.5	7.3	9.0	11.6	NF	4.5	7.3	9.0	11.6	NF
SD6404	ST6404	ST6403	CIRCULAR	2.5	-	207	151.76	151.0	0.33	0.011	4.5	7.4	9.1	11.6	NF	4.5	7.4	9.1	11.6	NF
SD6405	ST6405	ST6404	CIRCULAR	2	-	75.4	152.6	151.8	0.85	0.011	4.5	7.4	9.1	11.6	NF	4.5	7.4	9.1	11.6	NF
SD6406	ST6406	ST6405	CIRCULAR	2	-	89	153.47	152.6	0.98	0.011	2.6	4.2	5.2	6.6	NF	2.6	4.2	5.2	6.6	NF
SD6407	ST6407	ST6406	CIRCULAR	2	-	172.2	155.78	153.5	1.34	0.011	2.6	4.2	5.2	6.6	NF	2.6	4.2	5.2	6.6	NF
SD6408	ST6408	ST6407	CIRCULAR	1.5	-	109.3	158.01	155.8	1.47	0.011	2.6	4.2	5.2	6.6	NF	2.6	4.2	5.2	6.6	NF
SD6409	ST6409	ST6408	CIRCULAR	1.5	-	45.3	158.66	158.0	1.35	0.011	2.6	4.2	5.2	6.6	NF	2.6	4.2	5.2	6.6	NF
SD6410	ST6410	ST6409	CIRCULAR	1.25	-	219.7	161.47	158.7	1.17	0.011	2.6	4.2	5.2	6.6	NF	2.6	4.2	5.2	6.6	NF
SD6411	ST6411	ST6410	CIRCULAR	1.25	-	346	164.48	161.5	0.81	0.011	2.6	4.3	5.2	6.6	NF	2.6	4.3	5.2	6.6	NF
SD6204	ST6412	ST6203	CIRCULAR	4	-	70	149.45	143.5	8.60	0.013	61.4	86.8	97.5	111.9	NF	64.6	92.5	103.0	117.3	NF
SD6414	ST6413	ST6414	ARROWHEAD_CR2	28	6	50	159.45	158.7	1.56	0.035	51.8	71.4	80.6	92.6	NF	53.1	73.8	82.6	94.2	NF
SD6415	ST6414	ST6415	CIRCULAR	3.5	-	100	158.67	157.1	1.56	0.024	51.2	71.3	80.0	92.6	NF	52.2	73.6	82.2	94.2	NF
SD6412	ST6415	ST6412	ARROWHEAD_CR2	28	6	490	157.1	149.5	1.56	0.035	50.9	71.2	80.0	92.6	NF	51.8	73.6	82.2	94.2	NF
SD6601	ST6601	O6600	CIRCULAR	1.5	-	37.1	100.63	97.1	9.58	0.013	8.9	12.4	14.4	17.3	NF	9.1	12.5	14.5	17.4	NF
SD6602	ST6602	ST6601	CIRCULAR	1.5	-	53.4	114.29	100.6	26.04	0.013	8.9	12.4	14.4	17.3	NF	9.1	12.5	14.5	17.4	NF
SD6603	ST6603	ST6602	CIRCULAR	1.5	-	149.2	129.78	114.3	10.30	0.013	8.9	12.4	14.4	17.3	NF	9.1	12.5	14.5	17.4	NF
SD6604	ST6604	ST6603	CIRCULAR	1.75	-	233.4	139.31	129.8	4.00	0.013	8.9	12.4	14.4	17.3	NF	9.1	12.5	14.5	17.4	NF
SD6605	ST6605	ST6604	CIRCULAR	1.75	-	178.1	147.4	139.3	4.43	0.013	8.9	12.4	14.4	17.3	NF	9.1	12.5	14.5	17.4	NF
SD6606	ST6606	ST6605	CIRCULAR	0.83	-	144.2	150.98	147.4	2.35	0.013	4.2	5.3	5.9	6.8	10-yr, 24-hr	4.3	5.4	6.0	6.9	10-yr, 24-hr
SD6607	ST6607	ST6606	CIRCULAR	1	-	120.7	153.15	151.0	1.62	0.013	4.2	5.4	6.1	7.1	10-yr, 24-hr	4.3	5.5	6.3	7.3	10-yr, 24-hr
SD6608	ST6608	ST6607	CIRCULAR	1	-	245	156.07	153.2	1.10	0.013	4.2	5.7	6.4	7.6	10-yr, 24-hr	4.3	5.8	6.6	7.8	10-yr, 24-hr
SD6609	ST6609	ST6608	CIRCULAR	1	-	165.6	158.29	156.1	1.08	0.013	4.2	6.0	7.1	8.6	10-yr, 24-hr	4.3	6.2	7.3	8.8	10-yr, 24-hr
SD6610	ST6610	ST6609	CIRCULAR	1	-	77	159.64	158.3	1.40	0.013	4.2	6.4	7.7	9.6	10-yr, 24-hr	4.4	6.7	8.0	9.8	10-yr, 24-hr
SD6630	ST6618	ST6619	CIRCULAR	0.83	-	117.9	160.03	155.8	3.32	0.013	0.0	0.0	0.1	0.4	NF	0.0	0.0	0.2	1.9	NF
SD6632	ST6619	ST6606	CIRCULAR	0.83	-	348.8	155.79	151.0	1.35	0.013	0.0	1.1	1.2	1.5	NF	0.0	1.2	1.2	1.5	100-yr, 24-hr
SD6616	ST6653	ST6654	CIRCULAR	1.5	-	210.7	171.05	167.7	1.57	0.013	3.4	5.1	6.1	7.5	NF	3.4	5.2	6.2	7.6	NF
SD6617	ST6654	ST6655	CIRCULAR	1.5	-	197	167.65	161.9	2.89	0.013	3.4	5.1	6.1	7.5	NF	3.4	5.2	6.2	7.6	NF
SD6619	ST6655	STD6604	CIRCULAR	2	-	213.9	161.85	161.0	0.42	0.013	3.4	5.1	6.1	7.4	NF	3.4	5.2	6.2	7.6	NF
SD9000	ST9001	O9000	CIRCULAR	3	-	74	100.78	100.6	0.24	0.024	34.8	51.9	62.5	71.6	NF	34.8	51.9	62.5	70.7	NF
SD9001	ST9002	ST9001	CIRCULAR	3.5	-	317	101.89	100.8	0.32	0.024	34.8	51.9	62.5	71.6	10-yr, 24-hr	34.8	51.9	62.5	70.7	10-yr, 24-hr
SD9002	ST9003	ST9002	CIRCULAR	3.5	-	504.5	109.78	101.9	1.54	0.024	35.2	55.0	65.2	72.1	25-yr, 24-hr	35.2	55.0	65.2	71.1	25-yr, 24-hr
SD9003	ST9004	ST9003	CIRCULAR	3	-	436.8	119.75	109.8	2.17	0.013	21.1	33.2	40.0	45.9	NF	21.1	33.2	40.0	46.4	NF
SD9004	ST9005	ST9004	CIRCULAR	3	-	498	126.25	119.8	1.29	0.013	21.1	33.2	40.4	45.9	NF	21.1	33.2	40.4	46.6	NF
SD9005	ST9006	ST9005	CIRCULAR	3	-	460	127.45	126.3	0.24	0.013	21.1	33.2	40.5	53.2	NF	21.1	33.2	40.5	53.4	100-yr, 24-hr
SD9006	ST9007	ST9006	CIRCULAR	3	-	402.2	139.5	127.5	2.97	0.013	14.5	22.7	27.3	31.7	NF	14.5	22.7	27.3	31.9	NF
SD9007	ST9008	ST9007	CIRCULAR	3	-	283.7	141.13	139.5	0.57	0.013	14.5	22.7	27.3	31.7	NF	14.5	22.7	27.3	31.7	NF
SD9008	ST9009	ST9008	CIRCULAR	3	-	86.3	141.35	141.1	0.26	0.013	14.6	22.7	27.3	31.7	NF	14.6	22.7	27.3	31.7	NF
SD9009	ST9010	ST9009	CIRCULAR	3	-	379.9	143.25	141.4	0.50	0.013	14.6	22.7	27.4	31.7	NF	14.6	22.7	27.4	31.7	NF
SD9010	ST9011	ST9010	CIRCULAR	3	-	432.6	144.96	143.3	0.40	0.013	14.6	22.8	27.5	31.9	NF	14.6	22.8	27.5	31.9	NF
SD9011	ST9012	ST9011	CIRCULAR	2	-	315	147.48	145.0	0.27	0.013	14.7	22.9	27.6	31.9	NF	14.7	22.9	27.6	31.9	NF
SD9012	ST9013	ST9012	CIRCULAR	2	-	332	148.38	147.5	0.27	0.013	14.7	22.9	27.6	31.9	100-yr, 24-hr	14.7	22.9	27.6	31.9	100-yr, 24-hr
SD9013	ST9014	O9001	CIRCULAR	2.5	-	117	97.82	93.0	4.11	0.018	54.8	83.2	88.4	94.1	100-yr, 24-hr	54.8	83.2	88.1	94.2	100-yr, 24-hr
SD9014	ST9015	ST9014	CIRCULAR	3	-	217	100.35	97.8	0.76	0.011	40.2	62.1	64.8	70.3	25-yr, 24-hr	40.3	62.2	64.5	70.4	25-yr, 24-hr
SD9015	ST9016	ST9015	CIRCULAR	3	-	701.7	109.33	100.4	1.70	0.011	14.4	19.6	22.5	27.6	NF	14.5	19.7	22.3	27.6	NF
SD9016	ST9017	ST9016	CIRCULAR	3	-	311	113.58	109.3	0.31	0.011	14.5	19.6	21.2	24.0	NF	14.5	19.7	21.2	24.0	NF
SD9017	ST9018	ST9017	CIRCULAR	1.75	-	240	115.7	113.6	0.84	0.024	14.5	19.7	21.2	23.7	2-yr, 24-hr	14.5	19.7	21.2	23.7	2-yr, 24-hr
SD9060	ST9019	ST9018	CIRCULAR	1.75	-	121.7	116.62	115.7	0.67	0.024	14.8	20.0	21.5	24.5	2-yr, 24-hr	14.8	20.0	21.5	24.6	2-yr, 24-hr
SD9018	ST9020	ST9019	CIRCULAR	1.5	-	309	118.6	116.6	0.56	0.013	3.9	6.1	6.3	7.4	10-yr, 24-hr	3.8	6.2	6.4	7.5	10-yr, 24-hr
SD9019	ST9021	ST9020	CIRCULAR	1.25	-	395	130.67	118.6	2.99	0.013	2.9	5.3	5.6	6.5	10-yr, 24-hr	3.0	5.4	5.7	6.5	10-yr, 24-hr

Table B-3. Hydaulic Model Inputs and Results																				
Conduit			Conduit Atributes								Existing Land Use Conditions					Future Land Use Conditions				
			Shape	Diameter (ft)/ Max Width (ft)	Depth (ft)	Length (ft)	Invert Elevation (ft)		Slope (%)	Manning's Roughness	Peak Flow (cfs)				When Hydraulically Deficient	Peak Flow (cfs)				When Hydraulically Deficient
ID	US Node	DS Node					US	DS			2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	
SD9020	ST9022	ST9021	CIRCULAR	1.25	-	351	140.33	130.7	2.72	0.013	2.9	4.9	6.2	8.0	25-yr, 24-hr	3.0	4.9	6.3	8.0	25-yr, 24-hr
SD9021	ST9023	ST9022	CIRCULAR	1.25	-	453.5	145.89	140.3	1.20	0.013	3.0	4.9	6.2	7.9	100-yr, 24-hr	3.0	4.9	6.3	7.9	100-yr, 24-hr
SD9022	ST9024	ST9015	CIRCULAR	3	-	159.4	103.27	100.4	1.51	0.011	27.0	43.2	46.6	50.3	25-yr, 24-hr	27.0	43.5	46.4	62.5	25-yr, 24-hr
SD9023	ST9025	ST9024	CIRCULAR	3	-	238.4	106.07	103.3	1.17	0.011	18.8	29.5	30.4	34.5	100-yr, 24-hr	18.8	29.7	32.9	45.9	100-yr, 24-hr
SD9024	ST9026	ST9025	CIRCULAR	2.5	-	175.8	110.34	106.1	2.39	0.011	18.9	29.2	30.2	34.5	100-yr, 24-hr	18.9	29.4	32.9	38.3	25-yr, 24-hr
SD9025	ST9027	ST9026	CIRCULAR	2.5	-	271.6	117.35	110.3	2.58	0.011	18.9	29.1	30.2	35.0	NF	18.9	29.1	32.8	34.8	NF
SD9026	ST9028	ST9027	CIRCULAR	2	-	142	121.35	117.4	2.75	0.024	14.7	21.9	23.1	25.7	100-yr, 24-hr	14.7	21.9	23.0	25.7	100-yr, 24-hr
SD9027	ST9029	ST9028	CIRCULAR	2	-	160	125.35	121.4	2.44	0.024	14.7	21.9	23.1	25.9	100-yr, 24-hr	14.7	21.9	23.0	25.8	100-yr, 24-hr
SD9028	ST9030	ST9029	CIRCULAR	2	-	258	131.45	125.4	2.33	0.024	14.7	21.9	23.1	26.5	10-yr, 24-hr	14.7	21.9	23.0	26.4	10-yr, 24-hr
SD9029	ST9031	ST9030	CIRCULAR	2.5	-	296	135.35	131.5	1.28	0.024	14.7	22.9	27.0	28.8	25-yr, 24-hr	14.7	22.9	26.9	28.8	25-yr, 24-hr
SD9030	ST9032	ST9014	CIRCULAR	3	-	263.3	102.61	97.8	1.49	0.011	15.4	22.3	25.1	27.5	100-yr, 24-hr	15.4	22.3	25.1	30.4	100-yr, 24-hr
SD9031	ST9033	ST9032	CIRCULAR	1.75	-	202.4	103.63	102.6	0.45	0.024	7.7	10.9	13.1	16.7	100-yr, 24-hr	7.7	10.9	13.1	17.2	100-yr, 24-hr
SD9032	ST9034	ST9033	CIRCULAR	1.75	-	306.4	105.2	103.6	0.48	0.024	7.7	10.9	13.1	13.6	25-yr, 24-hr	7.7	10.9	13.1	14.9	25-yr, 24-hr
SD9033	ST9035	ST9034	CIRCULAR	1.5	-	118.7	107.06	105.2	0.40	0.013	7.7	10.9	12.8	12.6	25-yr, 24-hr	7.7	10.9	12.8	12.7	10-yr, 24-hr
SD9034	ST9036	ST9035	CIRCULAR	1.5	-	276	108.14	107.1	0.39	0.013	7.7	10.9	12.1	12.5	10-yr, 24-hr	7.7	10.9	12.1	12.5	10-yr, 24-hr
SD9035	ST9037	ST9036	CIRCULAR	1.5	-	242	108.87	108.1	0.39	0.013	7.7	10.6	12.5	13.5	10-yr, 24-hr	7.7	10.6	12.5	13.5	10-yr, 24-hr
SD9036	ST9038	ST9037	CIRCULAR	1.25	-	212.2	109.62	108.9	0.22	0.013	7.7	11.2	13.5	14.7	2-yr, 24-hr	7.7	11.2	13.5	14.7	2-yr, 24-hr
SD9037	ST9039	ST9038	CIRCULAR	1.25	-	260.1	110.29	109.6	0.22	0.013	7.9	12.4	15.1	16.6	2-yr, 24-hr	7.9	12.4	15.1	16.6	2-yr, 24-hr
SD9058	ST9040	ST9041	CIRCULAR	2.5	-	203	111.71	108.3	1.51	0.013	15.5	24.9	29.8	37.0	NF	15.5	24.9	29.8	37.0	NF
SD9057	ST9041	ST9068	CIRCULAR	2.5	-	275	108.31	104.0	1.21	0.013	15.5	24.9	29.7	37.0	NF	15.5	24.9	29.7	37.0	NF
SD9038	ST9042	ST9040	CIRCULAR	2	-	294.3	114.63	111.7	0.98	0.013	6.8	11.2	13.6	16.8	NF	6.8	11.2	13.6	16.8	NF
SD9053	ST9043	ST9066	CIRCULAR	1.5	-	961	122.65	108.0	1.51	0.013	4.0	6.0	6.7	8.0	NF	4.0	6.1	6.8	8.1	NF
SD9045	ST9044	ST9042	CIRCULAR	2	-	250	116.13	114.6	0.60	0.013	6.8	11.2	13.6	16.8	NF	6.8	11.2	13.6	16.8	NF
SD9054	ST9045	ST9044	CIRCULAR	1.5	-	249.8	117.91	116.1	0.51	0.013	3.0	4.9	6.1	7.5	NF	3.0	4.9	6.1	7.5	NF
SD9056	ST9046	ST9045	CIRCULAR	1.5	-	150	118.6	117.9	0.33	0.013	3.0	5.0	6.1	7.4	NF	3.0	5.0	6.1	7.4	NF
SD9055	ST9047	ST9046	CIRCULAR	1.25	-	168.6	120.31	118.6	0.87	0.013	3.0	5.0	6.1	7.4	NF	3.0	5.0	6.1	7.4	NF
SD9046	ST9048	ST9047	CIRCULAR	1.25	-	148.2	121.19	120.3	0.59	0.013	3.0	5.0	6.1	7.4	NF	3.0	5.0	6.1	7.4	NF
SD9047	ST9049	ST9040	CIRCULAR	2.25	-	217.2	114.26	111.7	1.06	0.013	8.8	13.8	16.2	20.2	NF	8.8	13.8	16.2	20.2	NF
SD9048	ST9050	ST9049	CIRCULAR	2	-	200.7	115.86	114.3	0.80	0.013	8.8	13.8	16.2	20.3	NF	8.8	13.8	16.2	20.3	NF
SD9049	ST9051	ST9050	CIRCULAR	2	-	118	116.69	115.9	0.70	0.013	8.8	13.8	16.2	20.3	NF	8.8	13.8	16.2	20.3	NF
SD9050	ST9052	ST9051	CIRCULAR	1.75	-	208	118.6	116.7	0.80	0.013	6.6	10.2	12.3	15.7	NF	6.6	10.2	12.3	15.7	NF
SD9044	ST9053	ST9052	CIRCULAR	1.75	-	143	119.74	118.6	0.80	0.013	6.6	10.2	12.3	15.7	NF	6.6	10.2	12.3	15.7	NF
SD9051	ST9054	ST9053	CIRCULAR	1.75	-	157	120.84	119.7	0.70	0.013	3.1	4.8	5.8	7.4	NF	3.1	4.8	5.8	7.4	NF
SD9040	ST9055	ST9054	CIRCULAR	1.75	-	180	121.74	120.8	0.50	0.013	3.1	4.8	5.8	7.4	NF	3.1	4.8	5.8	7.4	NF
SD9043	ST9056	ST9055	CIRCULAR	1.5	-	125	122.87	121.7	0.70	0.013	3.1	4.8	5.8	7.4	NF	3.1	4.8	5.8	7.4	NF
SD9041	ST9057	ST9056	CIRCULAR	1.5	-	150	123.62	122.9	0.50	0.013	3.1	4.8	5.8	7.4	NF	3.1	4.8	5.8	7.4	NF
SD9042	ST9058	ST9057	CIRCULAR	1.5	-	150	124.37	123.6	0.50	0.013	3.1	4.8	5.9	7.4	NF	3.1	4.8	5.9	7.4	NF
SD9039	ST9059	ST9058	CIRCULAR	1.25	-	135	125.5	124.4	0.65	0.013	3.1	4.8	5.9	7.4	NF	3.1	4.8	5.9	7.4	NF
SD9059	ST9060	ST9061	CIRCULAR	1.25	-	248.8	129.87	124.3	2.25	0.013	4.0	6.1	6.8	8.1	NF	4.1	6.2	6.8	8.2	NF
SD9052	ST9061	ST9043	CIRCULAR	1.25	-	65.9	124.27	122.7	2.26	0.024	4.0	6.1	6.8	8.1	NF	4.1	6.2	6.8	8.1	NF
SD9061	ST9062	ST9063	CIRCULAR	1.5	-	265.8	97.57	95.7	0.70	0.011	4.2	7.5	8.1	10.6	NF	4.5	7.8	8.5	11.0	NF
SD9067	ST9063	ST9069	CIRCULAR	1.5	-	128	95.65	94.8	0.75	0.011	4.1	7.5	8.0	10.6	NF	4.5	7.8	8.5	11.1	NF
SD9062	ST9064	ST9062	CIRCULAR	1.5	-	138.1	99.06	97.6	1.08	0.011	4.2	7.6	8.2	10.6	NF	4.5	7.9	8.5	11.0	NF
SD9063	ST9065	ST9064	CIRCULAR	1.25	-	98.2	99.89	99.1	0.54	0.011	4.2	7.6	8.2	10.6	NF	4.5	7.9	8.6	11.0	NF
SD9064	ST9066	ST9067	CIRCULAR	2.5	-	205	107.95	103.8	2.00	0.013	10.7	16.2	18.8	21.7	NF	10.7	16.3	18.9	21.8	NF
SD9065	ST9067	09003	CIRCULAR	3	-	145	103.75	100.0	2.60	0.013	26.2	40.9	48.4	58.6	NF	26.2	40.9	48.5	58.7	NF
SD9066	ST9068	ST9067	CIRCULAR	3	-	10	103.95	103.8	2.00	0.013	15.5	24.9	29.7	37.0	NF	15.5	24.9	29.7	37.0	NF
SD9068	ST9069	ST9070	CIRCULAR	1.5	-	110	94.81	92.8	1.44	0.011	4.1	7.5	8.0	10.6	NF	4.5	7.8	8.5	11.0	NF
SD9069	ST9070	09002	CIRCULAR	1.5	-	30	92.83	92.9	-0.27	0.011	4.1	7.5	8.0	10.6	NF	4.4	7.8	8.5	11.0	NF
1207	STD3400	ST4221	CIRCULAR	1.5	-	290.7	169.61	165.9	1.11	0.013	5.7	6.4	6.7	7.9	NF	6.1	6.8	7.7	9.7	NF
SD4592	TOOZE_POND	ST4503	CIRCULAR	2	-	264	147.24	146.6	0.26	0.013	3.6	5.8	7.0	8.7	NF	3.8	6.0	7.3	9.0	NF

Table B-3. Hydaulic Model Inputs and Results																				
Conduit			Conduit Atributes							Existing Land Use Conditions					Future Land Use Conditions					
			Shape	Diameter (ft)/ Max Width (ft)	Depth (ft)	Length (ft)	Invert Elevation (ft)		Slope (%)	Manning's Roughness	Peak Flow (cfs)				When Hydraulically Deficient	Peak Flow (cfs)				When Hydraulically Deficient
ID	US Node	DS Node					US	DS			2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr		2-yr, 24-hr	10-yr, 24-hr	25-yr, 24-hr	100-yr, 24-hr	
1323	WILSONVILLE_DIST_CTR_POND	ST4226	CIRCULAR	1	-	38	146.45	141.5	1.32	0.013	1.8	2.7	3.5	22.9	100-yr, 24-hr	1.8	2.7	3.5	22.9	100-yr, 24-hr
4826	WILSONVILLE_DIST_CTR_POND	ST4226	CIRCULAR	1.5	-	30	146.45	141.5	22.88	0.024	14.9	22.9	22.3	4.4	100-yr, 24-hr	14.9	22.9	22.3	4.4	100-yr, 24-hr

NF = No Flooding

Appendix C: TM #2: Stream Assessment

Technical Memorandum: Geomorphic Reconnaissance of Parts of Boeckman, Meridian, Arrowhead, Newland and Kruse Creeks

TECHNICAL MEMORANDUM - FINAL UPDATED

To: Angela Wieland, Brown and Caldwell

From: Waterways Consulting, Inc.

Date: January 30, 2024

Re: Geomorphic Reconnaissance of Parts of Boeckman, Meridian, Arrowhead Creeks, Newland, and Kruse Creeks

Introduction

Brown and Caldwell (BC) was hired by the City of Wilsonville (COW) to prepare an updated Stormwater Master Plan that will develop an integrated and long-term approach for managing stormwater in the city. Wilsonville is one of Oregon's fastest growing cities, and its rapid growth has necessitated updates to previous Stormwater Master Plans (URS, 2012) to reflect changes in land use and improvements to stormwater management practices.

As part of this process BC requested that Waterways Consulting, Inc. (Waterways) conduct geomorphic stream assessments of a subset of stream segments within and adjacent to the City of Wilsonville to inform the updated Stormwater Master Plan. The assessments are meant to improve the understanding of stream processes in the selected reaches and to identify infrastructure risks associated with changes in creek hydrology as the city develops. The assessment was conducted in two phases with an initial phase that included evaluations of portions of Boeckman, Meridian and Arrowhead Creeks. The second phase, conducted in Fall 2023, included evaluations of portions of Newland Creek and an unnamed tributary to the Willamette River, referred to as Kruse Creek in this report.

Boeckman, Meridian, Arrowhead creeks (tributary to Coffee Lake Creek), Newland, and Kruse Creeks are small tributaries of the Willamette River flowing in narrow canyons bordered by thick deposits of fine-grained sediment deposited by the Missoula Floods. These creeks flow in confined valleys with steep, landslide-prone valley walls. In some areas, residential development encroaches to the edge of the adjacent terraces[1], while in other areas, including the assessed portions of Arrowhead Creek, Newland Creek, and Kruse Creek, the adjacent land use is agricultural, rural residential, or industrial. Large portions of the watersheds upstream of the assessment reaches have, are in the process of, or will be converted from open space to suburban residential neighborhoods. These land use changes have, and will continue to have, the potential to impact the morphology of these streams as the channels respond to changes in flow, direct modifications, and changes in sediment supply. This assessment focuses on evaluating the current condition of the channels within the study reach, identifies any ongoing infrastructure concerns associated with past hydromodification impacts, and evaluates the susceptibility of the streams to future hydromodification impacts.

[1] This assessment focuses only on stream-based hazards and concerns and does not address landslide risks on the valley walls.

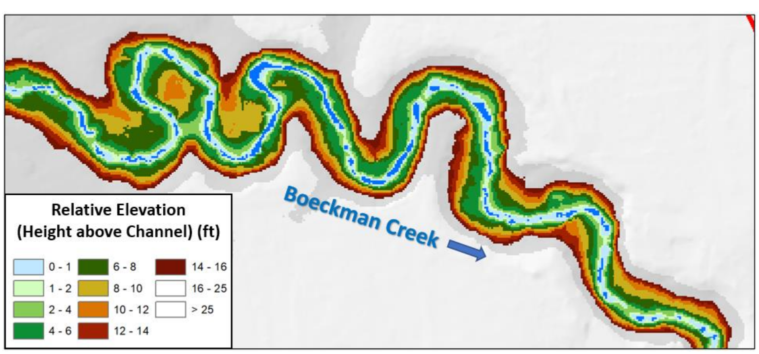
Approach

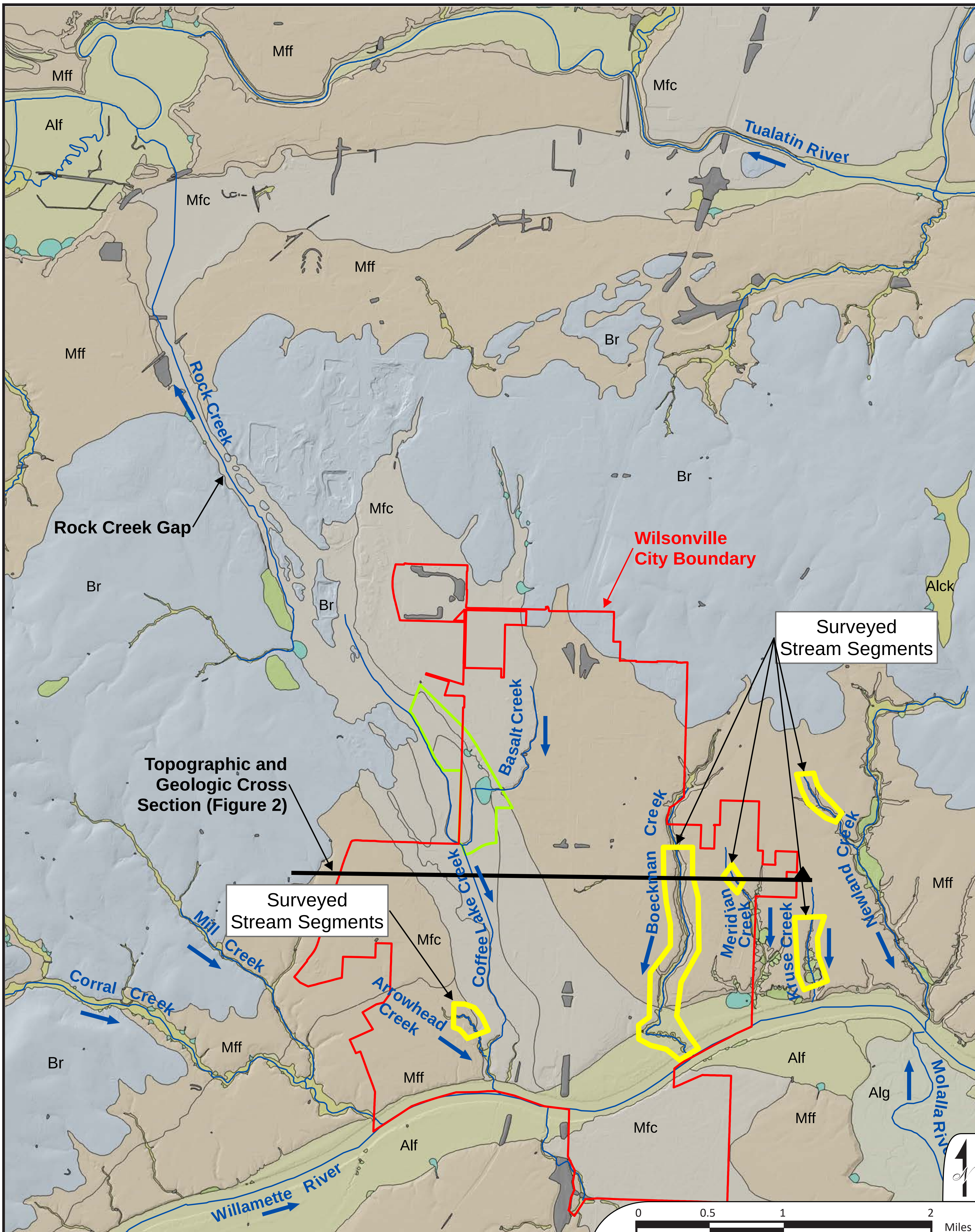
The purpose of the assessment is to understand and map the dominant geomorphic processes in the assessment reaches and identify any infrastructure-related issues that should be considered within the context of the updated Stormwater Master Plan. A key component of the assessment is the understanding that the reaches may be impacted by further hydromodification in the near future as a result of new upstream residential development or changes in other land use, such as agriculture or road development. Future efforts will include using the assessment information to identify potential Capital Improvement Projects (CIPs) or stream restoration actions that would address the identified risks to infrastructure or improve the resiliency of the stream corridor to impacts associated with hydromodification.

The assessments consisted of reconnaissance-level field observations supported by desktop mapping and analysis. The field protocols involved an experienced geomorphologist walking a designated stream reach twice in one day, starting and ending at the same location. In the first pass, the geomorphologist traversed the channel by wading, mapping and collecting georeferenced photographs of individual point features of interest, such as beaver dams, bridges, culverts, exposed pipes, affected roads and trails, headcuts, bedrock outcrops, heavily eroding banks, etc. The locations of these point-scale features were recorded in a tabular format and later digitized (these point-scale observations are presented in the tables in **Appendix A** of this report). During the first pass, the geomorphologist subdivided the stream into mappable "subreaches," typically several hundreds to thousands of feet long, within which geomorphic conditions are relatively consistent and could be characterized. The second pass consisted of walking back through the reach and evaluating the subreaches' key geomorphic features, conditions, infrastructure risks, restoration opportunities, etc. The reach-scale observations were recorded in a matrix-based field form specifically developed for this project. Subreach summary tables for the surveyed reaches are provided later in this report.

The desktop component of this assessment included compilation and analysis of geospatial data, including infrastructure data, topographic data, and geologic information. Waterways used the 2014 LiDAR data to create "Relative Elevation Models" (REMs) for each of the creeks within the assessment area. An REM is a topographic model created from a LiDAR elevation surface that shows the height of the ground surface relative to the adjacent streambed, which is helpful for identifying and interpreting geomorphic surfaces relative to the stream (e.g., **Figure 1**). The REMs for the creeks are provided as .tif files in a digital appendix to this report (**Appendix B**). In addition, as part of the desktop portion of the assessment Waterways created and analyzed topographic and geologic cross sections and stream longitudinal profiles and produced a set of field maps identifying streams and stormwater infrastructure identified during the field component. The field maps are provided as **Appendix C**.

Figure 1. *Example of Relative Elevation Model of Part of Lower Boeckman Creek*





Legend

- City Limits
- Stream Centerline
- Coffee Lake Wetlands (City of Wilsonville)

Surficial Geology (from compilation by Ma et al., 2012)

- Af - Artificial Fill
- Alck - Creek Alluvium
- Alf - Fine Alluvium
- Alg - Coarse Alluvium
- Br - Columbia River Basalts
- Df - Debris Flow Fans
- Ls - Large Landslides
- Mfc - Missoula Flood Coarse Bedload Deposits
- Mff - Missoula Fine Flood Deposits

Ma, L., Madin, I.P., Duplantis, S., and K.J. Williams. 2012. LiDAR- Based Surficial Geologic Map and Database of the Greater Portland Area, Clackamas, Columbia, Marion, Multnomah, Washington, and Yamhill Counties, Oregon, and Clark County, Washington. State of Oregon Department of Geology and Mineral Industries, Open File Report O-12-02.

Geologic and Geomorphic Setting Overview Map	Geomorphic Assessment of Wilsonville Creeks	WATERWAYS CONSULTING, INC. Santa Cruz, CA · watways.com · Portland, OR	FIGURE **2**

Geologic and Geomorphic Setting

Geomorphic processes in the creeks that dissect the Wilsonville area are influenced by their recent geologic history (**Figure 2**). Wilsonville sits on sedimentary deposits laid down by the Missoula Floods (Bretz, 1969), a series of dozens of gigantic floods that inundated the Willamette Valley between approximately 20,000 and 14,000 years ago (O'Connor et al., 2020). These cataclysmic floods originated from Glacial Lake Missoula in Montana and traveled down the Columbia River valley. A constriction downstream from Portland hydraulically impounded these flows, causing backwater flooding up the Willamette Valley. One of the main flow pathways for the Missoula Floods into the Willamette Valley was through a path that includes Lake Oswego and the "Rock Creek Gap" north of Wilsonville (O'Connor et al., 2001) (**Figure 3**). At these locations, huge flows moving south into the Willamette Valley were concentrated through narrow gaps in bedrock, forming underwater vortices powerful enough to carve deep channels ("scablands") and lakes ("kolks") in the resistant basalt bedrock in these locations.

The City of Wilsonville lies on an alluvial fan that formed in these floods where concentrated floodwater moving into the Willamette Valley spread out after moving through the Rock Creek Gap. The sudden widening downstream of the gap caused giant lobes of poorly sorted gravel and boulders to deposit along a pathway that bisects the City of Wilsonville (**Figure 2**). Drill logs from Canby and Wilsonville indicate that these coarse-grained, poorly sorted Missoula Flood deposits (labeled ***Mfc*** on **Figure 2**) range from 50 to 120 feet thick and are typically covered with 5-15 feet of sand and silt (Allison, 1978). In Wilsonville, the north-south oriented swath of ***Mfc*** is bounded on both sides by finer grained Missoula Flood deposits (***Mff*** in **Figure 2**). These sediments are thick, stratified silt and clay deposits that cover much of the lowland Willamette Valley floor. The finer-grained sediments (***Mff***) were laid down at a later phase in the Missoula Floods when the Willamette Valley was ponded as the main floods moved through the Columbia River.

Figure 4 is an east-west topographic and geologic profile through the main creeks of Wilsonville, passing through several of the reaches included in this assessment. The profile illustrates the differences between the parallel north-south creeks flowing through Wilsonville. Coffee Lake Creek, the largest creek in the city, flows in an "underfit" valley created by the Missoula Floods, and is underlain by coarse Missoula Flood sediments (***Mfc***). This geological setting explains why the Coffee Lake Creek valley is a wide, flat valley containing ecologically important wetlands, along with other unique geologic features of Wilsonville area, such as scablands and kolks, including the ecologically important Coffee Lake Wetlands as well as the 3.5-acre kolk pond at the Tonquin geologic area managed by Metro.

In contrast with Coffee Lake Creek, Boeckman, Meridian, Arrowhead, Newland, and Kruse Creeks carved deeper canyons in thick deposits of fine-grained Missoula Flood deposits (***Mff***) (**Figure 4**). Boeckman Creek is in a narrow canyon as much as 100 feet deep, with steep, unstable hillslopes prone to landslides. Boeckman, Meridian, Arrowhead, and Newland Creeks appear to have incised through the softer deposits to the point where their beds have encountered more consolidated clay deposits, or in the case of Arrowhead, where it reached the base level established by Coffee Lake Creek. Th presence of marginally resistant, consolidated clay in the streambed in some locations on all of these creeks provides a degree of base level stability. In some cases, including Boeckman and Arrowhead, the creeks appear to be no longer incising, especially in the lower reaches of these watersheds. Conversely, the headwater reaches assessed on Meridian and Newland Creek, appear to be experiencing incision despite exposures of more consolidated substrates. The morphology of the channel and valley on Kruse Creek is more dominated by the presence of valley-wide landslides and a high groundwater table.

Figure 3. *Pathway of Missoula Floods into the Willamette Valley through Wilsonville (modified from Minervini et al., 2003)*

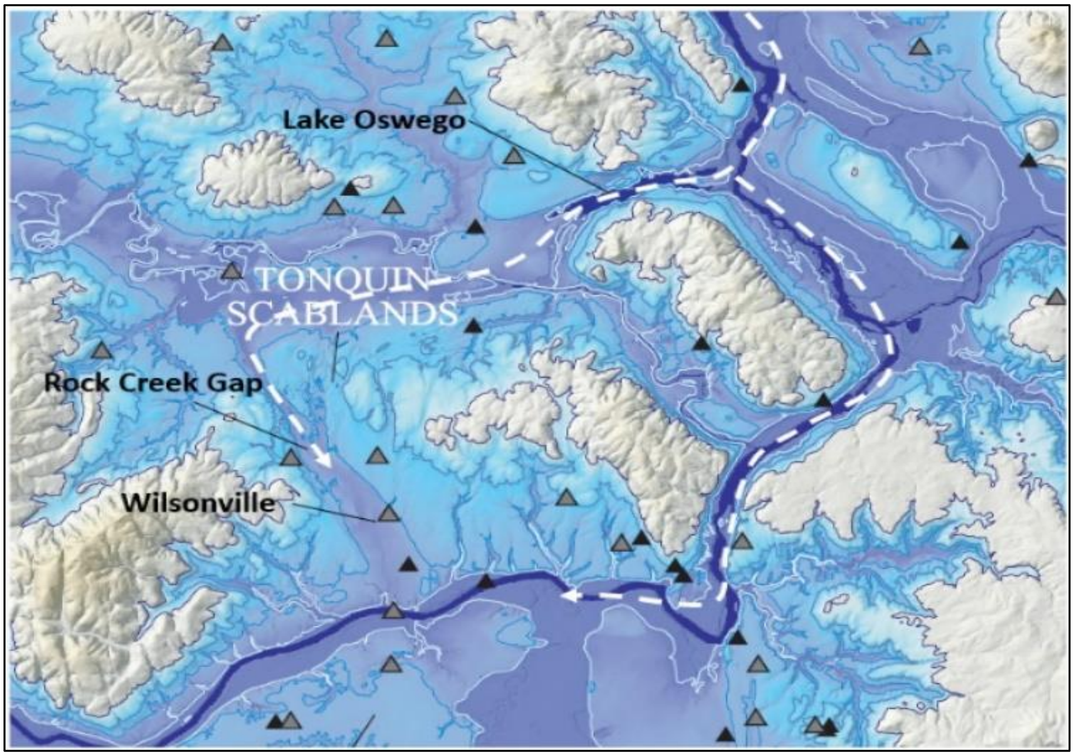
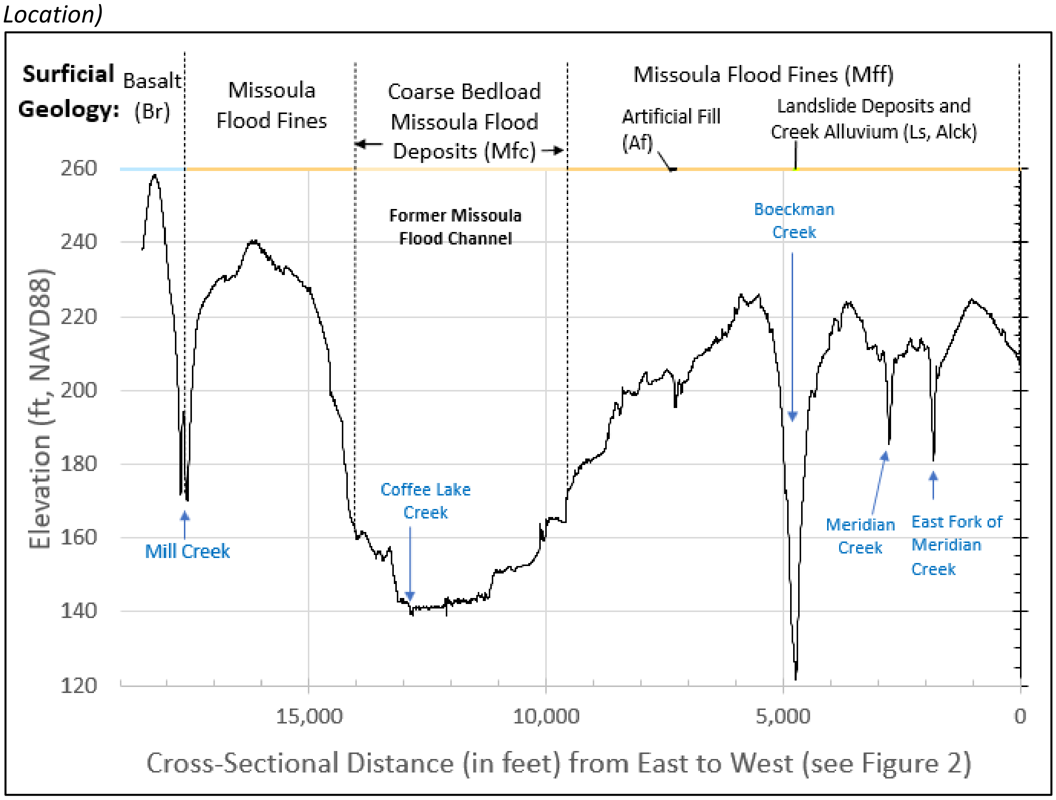


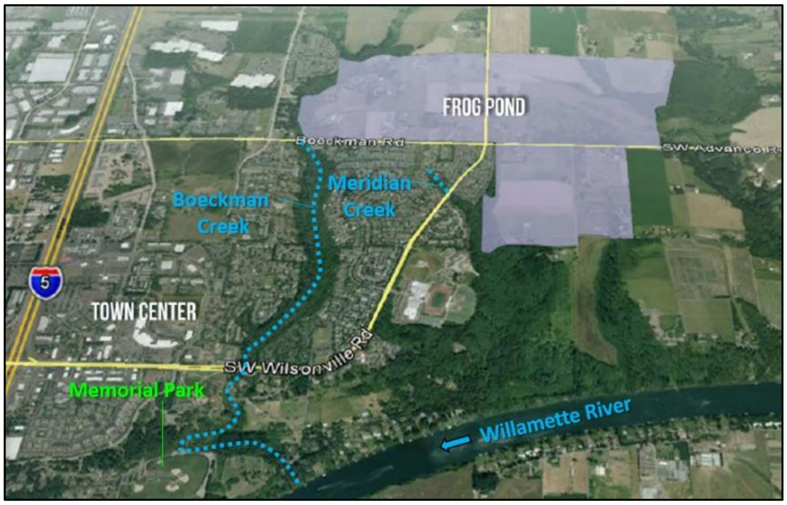
Figure 4. *Topographic and Geologic Cross Section Across the Wilsonville Area (See Fig. 2 for Profile Location)*



Human Impacts and Infrastructure

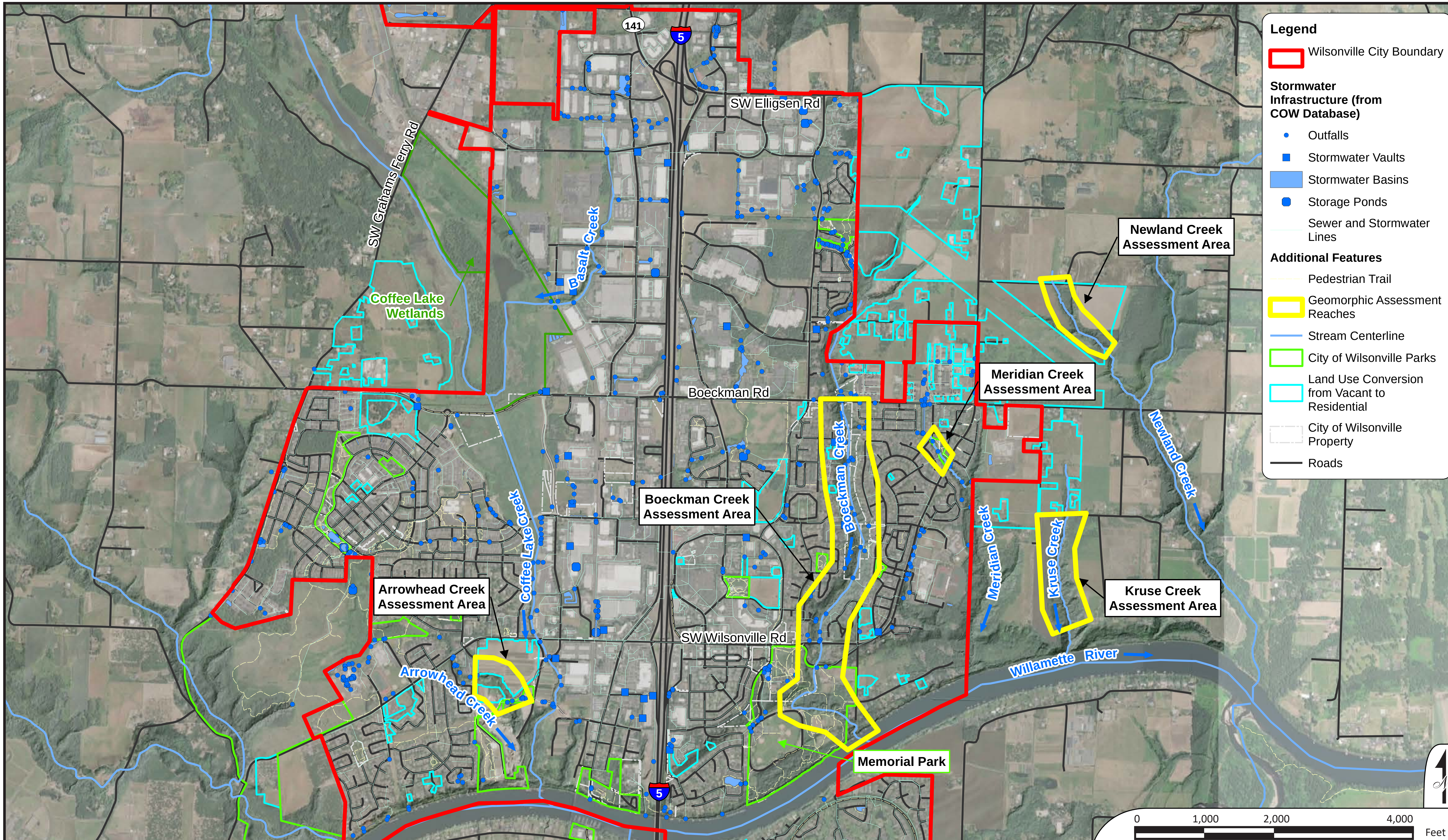
Most of the assessment reaches are adjacent to existing developed areas or are downstream of zones in the process of, or anticipated to be, converted from agricultural uses to residential developments (***Figure 5***). Hydromodification impacts in the assessment reaches are not limited to impacts associated with urban and residential development. Hydromodification impacts on these stream channels have been ongoing for over a century when the forested landscape was converted to agriculture, roads were built, culverts were installed, and fields were tile drained. These land use changes specifically intended to reduce water storage on the landscape while increasing the efficiency of runoff to adjacent waterbodies.

Figure 5. *Location of Phase 1 Assessment Reaches (dashed blue lines) relative to Existing and Planned Developed Areas (modified from APG. 2015)*



In the assessment reaches, Boeckman, Meridian, Arrowhead, Newland and Kruse Creeks flow in incised canyons. Along Boeckman and Meridians Creeks, residences are built to the edges of the canyons and the streams flow in confined valleys 20 to 100 feet deep. Water enters the streams from paved areas through a complex network of stormwater pipes that discharge along the steep valley walls (***Figure 6***).

The assessment reaches in Boeckman and Meridian are downstream of recently developed areas within the Frog Pond Development Area, a 500-acre residential neighborhood under construction within the urban growth boundary (**Figure 5**). The Newland and Kruse Creek assessment reaches are located downstream of an undeveloped portion of the Frog Pond Development area located to the east of Wilsonville and Stafford Roads. The long-planned development will include residences, schools, parks, transit, and trails, including a new regional trail following Boeckman Creek along the assessment reach (APG, 2015). To mitigate for potential hydromodification impacts from the existing and proposed portions of the Frog Pond Development area on the assessment reaches and other receiving streams, the developments are implementing Best Management Practices (BMP's) that are specifically designed to maintain the natural hydrology and limit the discharge of stormflow off of newly created impervious surfaces. Both "upland" and "in-stream" strategies for mitigating hydromodification risks have been adopted by the City and are being implemented within newly developed portions of Wilsonville, including the Frog Pond area (Brown and Caldwell, 2015). Those BMP's include infiltration and detention facilities, neighborhood-based Low Impact Development strategies, retrofitting existing stormwater detention basins, rehabilitating stormwater outfalls along the creek, culvert upgrades, and riparian vegetation improvements. The assessment reaches, especially along Newland and Kruse Creeks, provides an opportunity to establish a baseline of channel conditions prior to development occurring in the contributing watershed.



Human Impacts and Infrastrucure Overview Map

Geomorphic Assessment of Wilsonville Creeks

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FIGURE 6

Field Observations

The assessment included 5 days of field time to document conditions in priority reaches of Boeckman, Meridian, Arrowhead, Newland, and Kruse Creeks. These reaches were prioritized by the City of Wilsonville based on the importance of the streams, likelihood of hydromodification impacts, land access, and available budget. Additional reaches may be added to the assessment in the future.

The highest priority reach was the section of Boeckman Creek from Boeckman Road to the Willamette River, an along-stream distance of 12,200 feet (2.3 miles) (**Figure 7**). The second priority for the assessment was the 600-foot-long (0.1-mile) reach of Meridian Creek adjacent to Willow Creek/Landover Park (also shown in the top right corner of **Figure 7**). Sections of Basalt Creek and Arrowhead Creek were also identified as potential assessment reaches. Arrowhead was prioritized for the assessment over Basalt Creek due to the lack of landowner agreements along Basalt Creek.

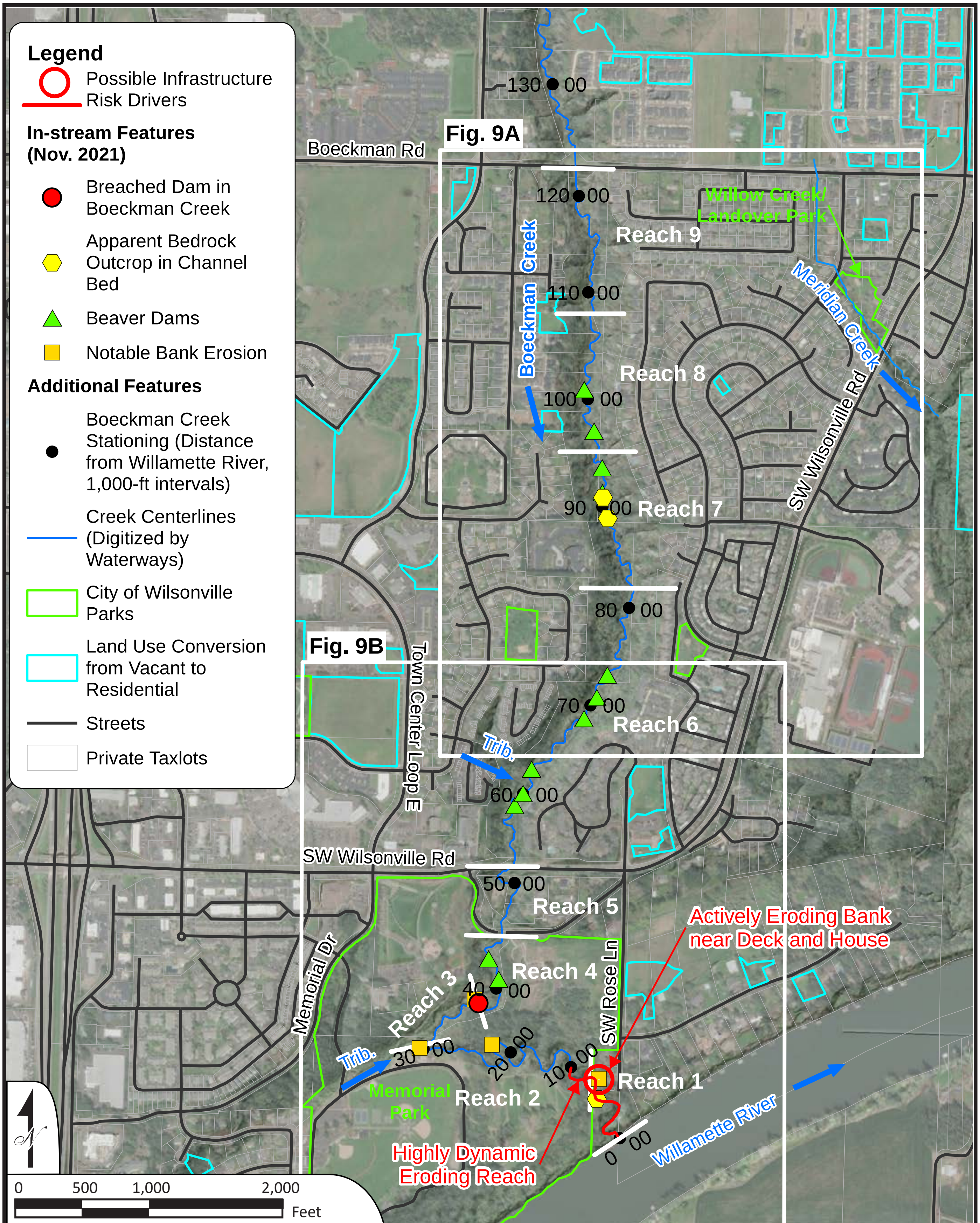
Approximately 1,000 feet (0.2 miles) was assessed on Arrowhead Creek. In Fall 2023, portions of Newland and Kruse Creeks that have the potential to be impacted by the Frog Pond Development or any additional eastward expansion of Wilsonville were also included in the assessment. Approximately 1,700 feet (0.3 miles) of Newland Creek and 2,200 feet (0.4 miles) of Kruse Creek was evaluated.

Boeckman Creek

The field assessment for Boeckman Creek occurred on November 19 and 24, 2021. The first day covered the lower reach within Memorial Park, from the private property boundary at Station 750 to Kolbe Lane (Sta. 4,500). The second day covered the reach from Wilsonville Road (Sta. 5,300) to Boeckman Road (Sta. 12,200). Two sections between the Willamette River and the private property boundary (Sta. 0 to 750) and between Kolbe Lane and Wilsonville Road (Sta. 4,500 to 5,300) were not accessed because those sections were on private property and Waterways did not have access permission. Permissions for the portion of private property located near the Willamette River were received in January 2022 and this section of channel (from Sta. 0 to 750) was assessed on January 25, 2022.

General Observations and Interpretations

- Specific point-scale observations of this section of Boeckman Creek are listed in **Appendix A1**.
- Boeckman Creek is confined within a narrow canyon bounded by steep valley walls prone to erosion and landsliding. At the bottom of the canyon, there is a meandering channel and a narrow, discontinuous floodplain covered by dense invasive species, especially Himalayan blackberry, reed canary grass, and English ivy. Very dense blackberry made for a difficult and slow traverse of the channel.
- Within the assessment reaches, Boeckman Creek has incised to a stable base level with a straight profile and relatively low gradient (about 0.6%), as illustrated in the longitudinal profile (**Figure 8**). The valley is graded to the Willamette River, and Boeckman Creek appears to no longer be actively incising, except in the most downstream reach at the confluence with the Willamette.
- The assessment area was subdivided into nine geomorphic sub-reaches ranging in length from 750 feet to 2,850 feet, within which geomorphic conditions and processes are relatively consistent. The subreaches are shown on the overview map (**Figures 7**), longitudinal profile (**Figure 8**), and detailed maps (**Figures 9a and 9b**). **Table 1** provides information and observations that characterize the geomorphic conditions and infrastructure features within each reach.



Boeckman Creek
Geomorphic Survey Overview

Geomorphic Assessment of Wilsonville Creeks

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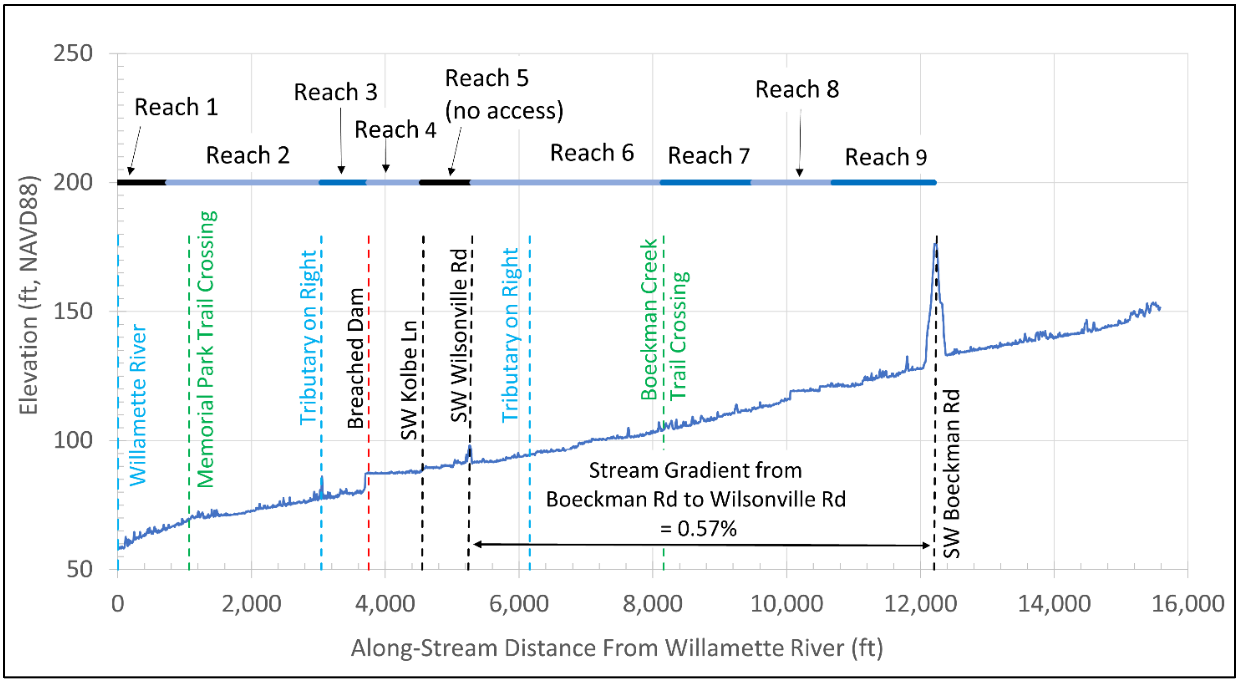
FIGURE
7

Figure 8. *Longitudinal Profile of Boeckman Creek (from 2014 LiDAR data)*



- Beaver are abundant throughout most of the assessment reaches and have a dominant impact on processes along Boeckman Creek. The most obvious impacts are from the channel-spanning dams that create a stairstep of flat water environments. Most of the grade control features shown on the field result map (**Figures 9a and 9b**) are beaver dams. The beaver dams range in height from about 1 foot to about 5 feet and pond long, continuous sections of the assessment area. The dams are actively maintained by beaver and most of them appear to be stable through typical floods in Boeckman Creek. Beaver are less prevalent or absent in the lower reaches of Boeckman Creek (Reaches 1 and 2), and are most abundant in the upper section (Reaches 6 through 9).
- The lack of stable beaver dams and seasonal variability in the backwater extent of the Willamette River along lower Boeckman Creek creates a highly dynamic condition with increased risk of erosion of the bed and banks. Dams throughout the Willamette River watershed, and the associated flow storage that those dams provide, results in a low stage in the Willamette River, relative to historic condition. Hydromodification impacts can potentially exacerbate channel instability by producing high flow events in early fall when the Willamette River is still low and the backwater influence is absent. This reach of Boeckman Creek is the most at-risk from hydrologic changes in the watershed.
- The breached former dam at Sta. 3,750 has an important reach-scale influence on the geomorphology in Boeckman Creek. Although the dam is breached, the remaining concrete and boulders are still present and provide a significant grade control feature, holding about 7 feet of grade (**Figure 8**). A wedge of fine sediment deposited upstream of the dam is covered with reed canary grass and extends as much as 800 feet upstream to the SW Kolbe Lane bridge.

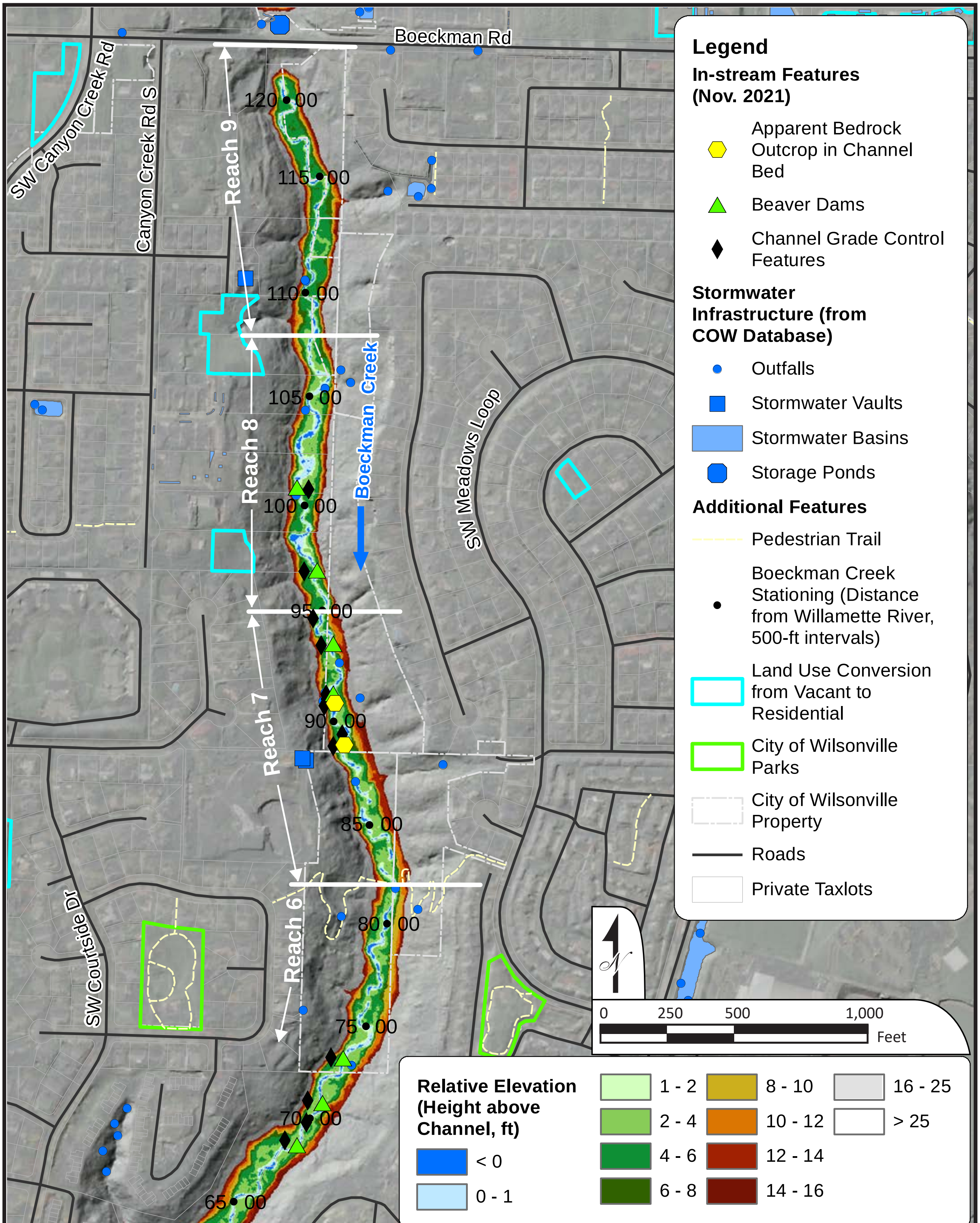
- There are at least three places where consolidated bedrock or other resistant material was observed within the channel bed in Boeckman Creek. These were noted by feel underfoot while wading. It was not possible to observe these resistant bed features due to the presence of turbid water about two to three feet deep at the time of the site visit.
- The presence of stable grade control – including resistant bed material, abundant stable beaver dams, fallen logs, boulders, and the 7-foot-high concrete and boulder grade control at the former dam – distributed throughout the project reach implies that much of Boeckman Creek cannot continue to incise. Collectively these features stabilize most of the channel bed, which is not susceptible to further incision due to hydromodification (**Figures 9a and 9b; Appendix A**).
- Waterways' geomorphologist also inspected the lower portions of two tributaries that enter Boeckman Creek from the west: one at Station 3,050 in Memorial Park, and one at Station 6,020 draining a residential area upstream of Wilsonville Road. Both tributaries appeared to be stable with no obvious infrastructure-related concerns:
    - The downstream tributary enters Boeckman Creek on river-right through a culvert under a road crossing in Memorial Park. The lower section of this tributary is deeply incised, low-gradient, gravel- and sand-bed stream in a dense blackberry thicket. Some bank erosion was observed along the steep banks but was not identified as an infrastructure concern. There is a partially clogged culvert on this tributary at a road crossing several hundred feet upstream of the confluence with Boeckman Creek. The clogged culvert backs water up to a footbridge in a grassy field in the park but does not appear to have any detrimental impacts. More descriptions are provided in **Appendix A1,** and photographs of this tributary can be found in the photo log (**Figure 10a**).
    - The upstream tributary drains the residential area along the west side of the creek north of Wilsonville Road. The tributary was only accessible at one location due to dense blackberry. At that location the channel bed was alluvial fine gravel and appeared stable.

SUMMARY CONCLUSIONS FROM BOECKMAN CREEK

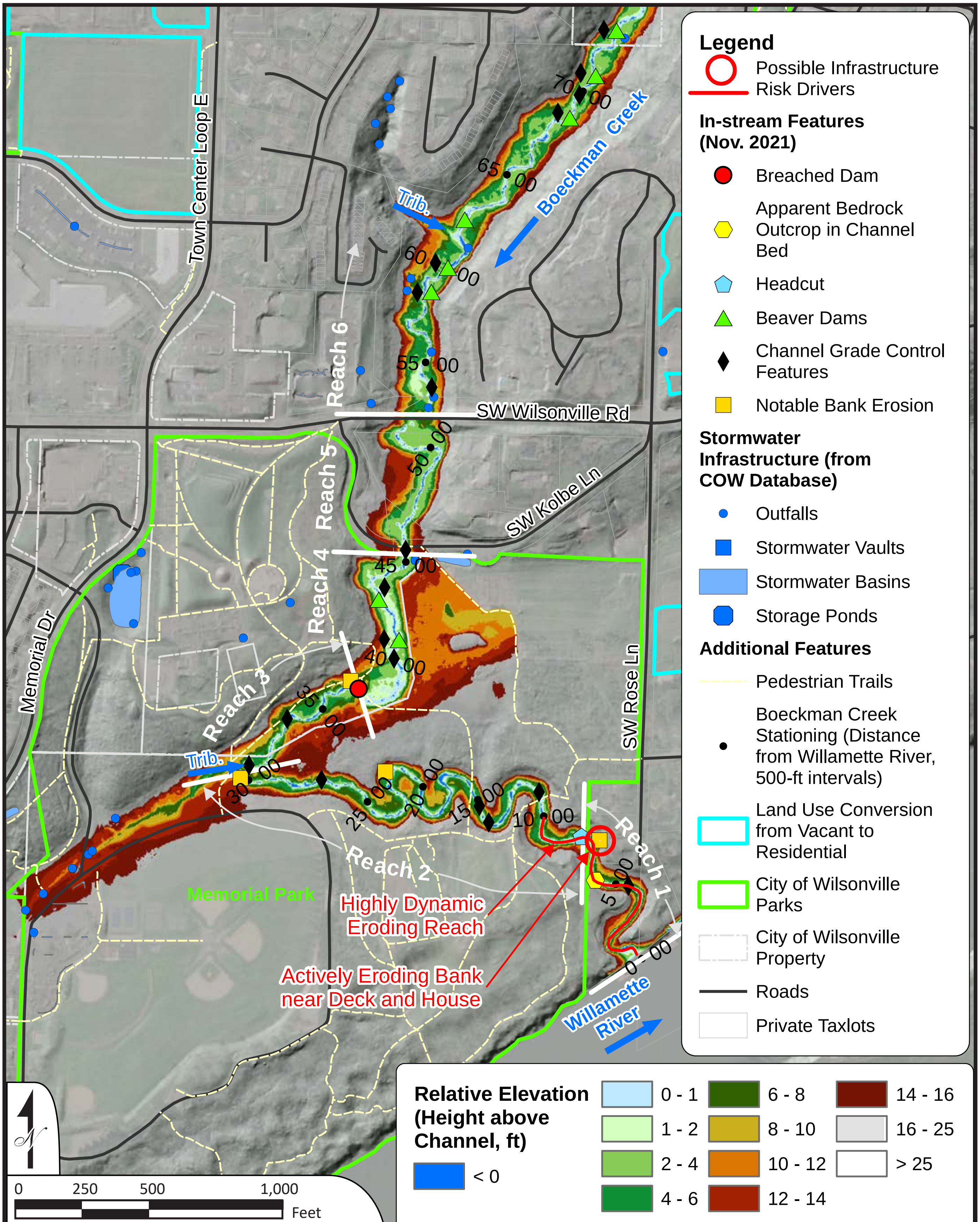
- With the exception of Reach 1, the field reconnaissance did not identify any obvious concerns or infrastructure risk drivers related to geomorphology and hydromodification in the assessed portion of Boeckman Creek. No infrastructure appears at risk in the valley bottom. The stream in the assessment reach is laterally confined and vertically stable, and relatively little infrastructure is in the stream. Any increases to stormwater related to land use changes at the Frog Pond Development area are not expected to pose significant specific infrastructure risks. (*Note that the assessment area did not include the Boeckman Road crossing above the upstream extent of the assessment reach*).
- Within Reach 1, there is a risk of continued channel incision and bank erosion. Several properties have experienced bank failures and loss of land over the past several decades, and an active bank failure is impacting the backyard and deck of one of the properties. This study does not make any findings regarding the cause(s) and extent of bank failure in Reach 1. Further investigation of the bank failure should be conducted by a geotechnical engineer to determine if the source is associated with fill placed behind a now failed retaining wall, or if there is a larger slope stability issue at the site. If a further investigation to determine cause(s), extent, and possible remediation is conducted, then the investigation should consist of a slope stability analysis along with recommendations to address the instability within the context of existing site conditions. There is currently insufficient data to understand erosion rates and associated

risks. Longer-term geomorphic monitoring of this reach might be warranted, which would include establishing cross-sections that would be resurveyed every three to five years to document erosional or depositional trends over time.

- The most significant risks in the canyons may relate to instability of the valley walls, which is outside the scope of this study. In a large rainstorm or possibly during an earthquake, mass wasting (landslides) from the valley wall could potentially occur, possibly blocking the channel, potentially endangering infrastructure near the top of the canyon walls.
- It is possible that a large flood could breach one or more of the apparently stable beaver dams. If that were to happen, one or more waves of incision could move upstream through parts of the assessment reach. However, the consequences of such an event appear to be relatively low given the stable base level, lack of infrastructure in the valley bottom, and the likelihood that the beaver would reestablish impacted dam sites.
- Collapses of individual beaver dams should not endanger or affect infrastructure in Boeckman Creek, but loss of all the beaver dams could have significant negative consequences, including significant loss of ecological value and an increase in infrastructure risks. Therefore, maintaining a healthy riparian corridor consisting of a mix of native riparian species in Boeckman Creek would be a beneficial long term management strategy to maintain the beaver population.
- **Figures 10a and 10b** provides some summary photographs showing conditions within the assessed portion of Boeckman Creek in November 2021 and January 2022.



Boeckman Creek Geomorphic Survey (Upstream)	Geomorphic Assessment of Wilsonville Creeks	WATERWAYS CONSULTING, INC. Santa Cruz, CA · watways.com · Portland, OR	FIGURE 9A



Boeckman Creek Geomorphic Survey (Downstream)

Geomorphic Assessment of Wilsonville Creeks

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FIGURE **9B**

Table 1. *Field Observations for Geomorphic Subreaches Within Boeckman Creek*

				Observational Data							Interpretive or Subjective Information						
Subreach	Downstream Station	Upstream Station	Reach Summary Description	Gradient	Dominant Channel Morphology	Dominant Substrates	Current Condition	Base Level Control	Lateral Constraints	Beaver Presence	Geomorphic Trajectory (Incising, Stable, Aggrading)	Bed Stability	Lateral Stability	Suscept-ibility to Hydro-modification	Infrastructure Risk in Reach	Potential Stream Enhancements	Reach Description
				Based on Profile Extracted from 2014 LiDAR		Bedrock, Boulders, Cobble, Gravel, Sand, Fines (dominant listed first)	Incised, Aggraded, Stable	Site Specific: e.g., Bedrock in Streambed, Culvert, Trunk Stream Confluence, etc. "None" if No Specific Controls Present	Site Specific: Valley Walls, Root Strength, Rock Bank Protection, etc. (listed roughly in orrder of importance)	Yes, No, Maybe	Incising, Stable, Aggrading	1= Stable or Aggrading; 5= Incising	1 = Stable Banks, 5 = Heavily Eroding Banks	1 = Not Susceptible, 5 = Highly Susceptible	1 = No Identified Risks; 5 = Obvious Potential Risks	Site Specific: Add Large Wood, Remove Invasive Species, Floodplain Benching, etc.	
1	0	750	Dynamic reach with seasonal backwater from Willamette River	1.07%	Pool-Riffle	gravel / fines	Incised	Willamette River	Valley walls susceptible to mass wasting	Yes, but no dams	Incising and wideneing	4	3	5	5	Grade control and bank stabilization	Actively incising and eroding, especially upper extent of reach where active small headcuts still migrating. Lower Willamette water level combined with high intensity rainfall in fall cause incision and widening. Recommend detailed geotechnical slope stability analysis in locatoin of active bank erosion and landsliding.
2	750	3,050	Incised Meandering Reach in Willamette Floodplain	0.44%	Pool riffle	Mud, wood, boulder, cobble	Incised, Stable	Some boulder steps, downed logs, Willamette base level	High mud terraces; tree roots	Yes upstream of 2,400' ; Maybe downstrea m of 2,400'	Stable	2	3	2	1	Remove invasive blackberry and ivy	From property boundary at downstream end to the tributary on right in Memorial Park. Reach is within the historic Willamette River floodplain and river terrace. Single-thread, incised meanders with banks between 6 feet and 40 feet high. Generally the amount of incision increases in the downstream direction. Banks are massive mud deposits from Missoula Flood fines and/or Willamette River floodplain deposits. Bed contains mud, wood, and some gravel reaches. From about Station 1,400' downstream, Willamette River bedload deposits are visible in the banks. Little to no beaver presence below Sta 2,400'; beaver present between 2,400 and 3,040'.
3	3,050	3,700	Meander Reach below Breached Dam	0.37%	Pool riffle	Mud, wood	Incised, Stable	Beaver dams, downed logs	Valley walls, reed canary grass root mass	Yes, abundant	Stable	2	2	2	1	Remove invasives, add wood	From right bank tributary in Memorial Park to site of breached dam. Meandering channel with stable banks, beaver dams, relatively low floodplains covered in reed canary grass. Inundated areas are mostly reed canary grass, less blackberry than in other parts of the creek.
4	3,700	4,500	Low Gradient Depositional Reach above Former Dam	0.01%	Pool riffle	Mud, wood	Stable	Breached dam; beaver dam	reed canary grass in floodplain	Yes	Stable	1	2	1	1	Good reach for potential floodplain restoration	Reach from breached dam to SW Kolbe Lane in Memorial Park. Low gradient, meandering reach with relatively low, frequently inundated floodplain. Abundant beaver presence consisting of dams, canals, burrows, slides, and lot of chewed wood. Banks heavily covered with reed canary grass. Water is about 2 to 3 feet dep at this flow (moderately high flow), with mud dominated bed. A floodplain vegetation restoration project to replace reed canary grass with willow and alder could work well here.
5	4,500	5,300	Not Surveyed														Skipped this reach due to property access constraints

				Observational Data							Interpretive or Subjective Information						
Subreach	Downstream Station	Upstream Station	Reach Summary Description	Gradient	Dominant Channel Morphology	Dominant Substrates	Current Condition	Base Level Control	Lateral Constraints	Beaver Presence	Geomorphic Trajectory (Incising, Stable, Aggrading)	Bed Stability	Lateral Stability	Suscept-ibility to Hydro-modification	Infrastructure Risk in Reach	Potential Stream Enhancements	Reach Description
				Based on Profile Extracted from 2014 LiDAR		Bedrock, Boulders, Cobble, Gravel, Sand, Fines (dominant listed first)	Incised, Aggraded, Stable	Site Specific: e.g., Bedrock in Streambed, Culvert, Trunk Stream Confluence, etc. "None" if No Specific Controls Present	Site Specific: Valley Walls, Root Strength, Rock Bank Protection, etc. (listed roughly in orrder of importance)	Yes, No, Maybe	Incising, Stable, Aggrading	1= Stable or Aggrading; 5= Incising	1 = Stable Banks, 5 = Heavily Eroding Banks	1 = Not Susceptible, 5 = Highly Susceptible	1 = No Identified Risks; 5 = Obvious Potential Risks	Site Specific: Add Large Wood, Remove Invasive Species, Floodplain Benching, etc.	
6	5,300	8,150	Stepped Beaver Pond Reach above Wilsonville Road	0.47%	Ponded by beaver dams	Mud, gravel, some bedrock	Incised and stable	Beaver dams	Reed canary grass root mass; valley walls	Yes, abundant	Stable	1	3	1	1 (some trail erosion)	Remove invasives, add wood	Reach from Wilsonville Road to Boeckman Trail footbridge. Reach is mostly ponded by a series of beaver dams, most are small but with at least 2 large dams at Sta 6,250 and 7,300. The dams are built so that ponds are mostly continuous throughout the entire reach, with the toe of each dam close to the head of each pool of the downstream beaver pond. Reach is moderately incised but not as much as in other reaches of Boeckman Creek.
7	8,150	9,500	Mostly Free-Flowing Reach between Beaver Dammed Reaches	0.59%	Pool riffle	Gravel, mud	Stable, little to moderate incision	Beaver dams, bedrock	Reed canary grass root mass; valley walls	Yes, abundant	Stable	2	3	1	1 (some trail erosion)	Remove invasives, add wood	From Boeckman Trail footbridge to big beaver dam at Sta 9,500. Free flowing reach without much beaver activity. Riffle pool, gravel bed with some resistant bedrock in channel bed within the upper part of the reach. Some small beaver dams present but are not dominant.
8	9,500	10,700	Floodplain Inundated by Ponding at Several Large Beaver Dams	0.86%	Ponded by beaver dams	Mud	Stable, low banks	Beaver dams, bedrock	Reed canary grass root mass; valley walls	Yes, abundant	Stable	1	3	1	1	Remove invasives, add wood	From beaver dam at Sta 9,500 to transition to more free-flowing reach. Deep ponded reach, with inundated floodplain over large areas. It is like this because either (1) dams are larger than those inreaches 6 and 9; and/or (2) the reach is less incised with lower banks. Viewed from trail on river left with some stops; unlike downstream reaches, I did not traverse the channel through this entire reach due to difficult access and need to speed up assessment. Did not visit outfall at Sta. 10,500
9	10,700	12,200	Incised Beaver Pond Reach	0.61%	Ponded, pool riffle	Mud, gravel, possible bedrock	Incised and stable	Beaver dams	Reed canary grass root mass; valley walls	Yes, abundant	Stable	2	3	3	1	Remove invasives, add wood	Similar to Reach 6, but deeper incision. Reach dominated by a series of beaver dams, not all were mapped due to difficult access. Did not visit crossing under Boeckman Road due to apparent private property


View across valley in Reach 8


Beaver Dam Near Station 9,600


Beaver Dam Near Station 6,200


Breached Dam At Station 3,700


Incised Tributary in Memorial Park


Entrenched Meanders around Station 1,800

Selected Photos From Boeckman Creek, November 2021	Geomorphic Assessment of Wilsonville Creeks	WATERWAYS CONSULTING, INC. Santa Cruz, CA | watways.com | Portland, OR	**FIGURE** **10A**

Selected Photos From Boeckman Creek, January 2022

Geomorphic Assessment of Wilsonville Creeks

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FIGURE **10B**

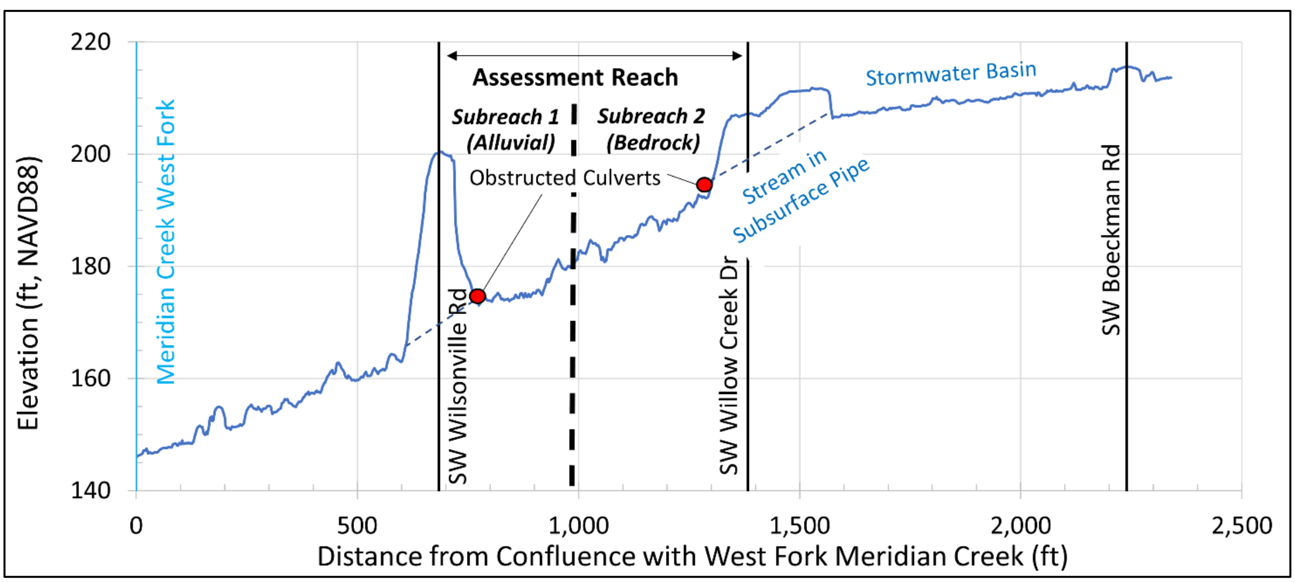
Meridian Creek in Landover Park

The field assessment for Meridian Creek occurred on November 26, 2021. The assessment included a 600-foot-long section of Meridian Creek between Wilsonville Road and SW Willow Creek Drive (**Figure 11**). This reach is immediately downstream of part of the Frog Pond Development Area. **Figure 12** is a longitudinal profile of the creek. **Table 2** summarizes the reach scale observations and interpretations from this site visit, and the point-specific observations are listed in **Appendix A2**. **Figure 13** contain photographs from this section of Meridian Creek.

General Observations and Interpretations

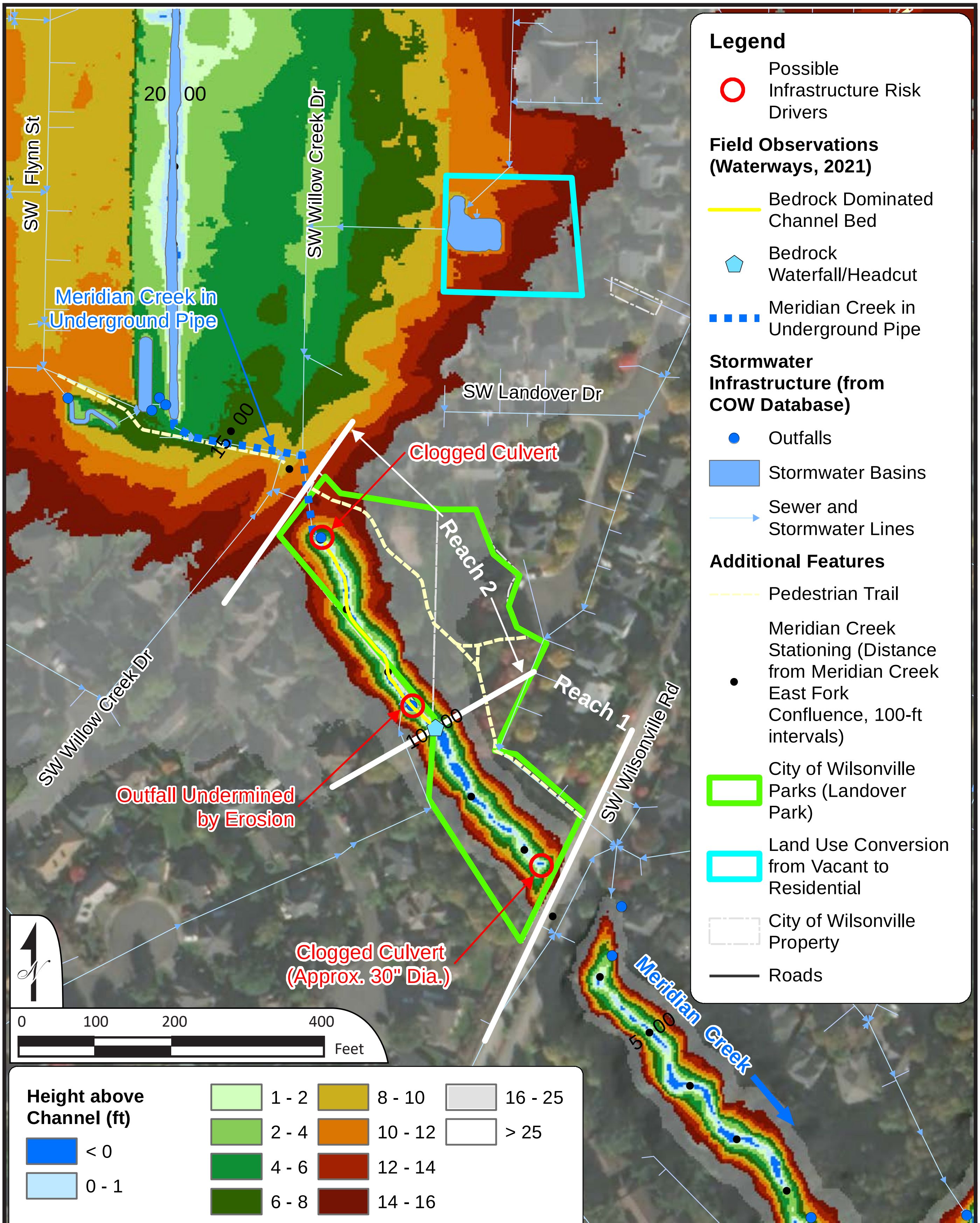
- This portion of Meridian Creek is incised in a very narrow canyon without any floodplains, whose steep slopes bound one side of the channel with a developed park on the other. The canyon is not as deep as the Boeckman Creek canyon, as can be seen in **Figure 4,** but the valley walls are steep with potentially unstable slopes underlain by fine-grained sediments and covered with dense blackberry thickets. The western valley wall is more at risk of landslides because Meridian Creek flows along the western margin of the canyon (right bank looking downstream).
- There are two distinct subreaches within the assessed area, delineated at a 4-foot-high bedrock/hardpan waterfall at Station 1,000 (**Figure 12**). The waterfall does not appear to be an active headcut advancing upstream and appears relatively stable. Downstream of the waterfall, the channel has an alluvial bed and is influenced by an obstructed culvert at Wilsonville Road. Upstream of the waterfall, a resistant layer of consolidated fine-grained sediment is exposed over most of the channel bed.
- The culvert at SW Willow Creek Drive appears to be undersized which may limit more significant hydromodification impacts from occurring downstream. Rock placed downstream of the culvert suggests that streambed erosion has been a concern in the past. This reach likely experienced significant channel incision and headcutting in the past but the active headcutting has been mostly arrested by the presence of hardpan material in the streambed. The discontinuity in the longitudinal profile across SW Willow Creek Drive (**Figure 12**) provides evidence for this field-based interpretation.

Figure 12. *Longitudinal Profile of portion of Meridian Creek (from 2014 LiDAR data)*



Summary Conclusions from Meridian Creek

- The stream is stable in this reach due to the bedrock base level control and being confined laterally by valley walls and culverts at the upstream and downstream end.
- The main risk drivers are the culverts at the downstream and upstream ends of the reach:
  - There is a sediment-clogged culvert at the Meridian Creek crossing at Wilsonville Road (Station 775). The culvert under the high road prism is mostly obstructed and appears to cause ponding during storm runoff (**Figure 12**). It is unlikely that ponded water would overtop Wilsonville Road, but backwatering behind the road could result in significant ponding and potential for piping through the road prism, which was not likely designed to act as a dam. The risks at the crossing should be further evaluated as part of the Stormwater Master Plan. Hydraulic modeling may provide an opportunity to understand maximum inundation depths if the culvert were to plug.
  - The grate at the outlet of the culvert at the Willow Creek Drive appears to have been modified to address past channel incision and headcut migration. This location should be monitored to determine if the stabilization measures installed downstream of the culvert provide adequate, long-term grade stabilization.
- The PVC stormwater outfall on the creek at Station 1,100 is undermined and a 6-foot section has washed out and moved downstream.



Meridian Creek Geomorphic Survey

Geomorphic Assessment of Wilsonville Creeks

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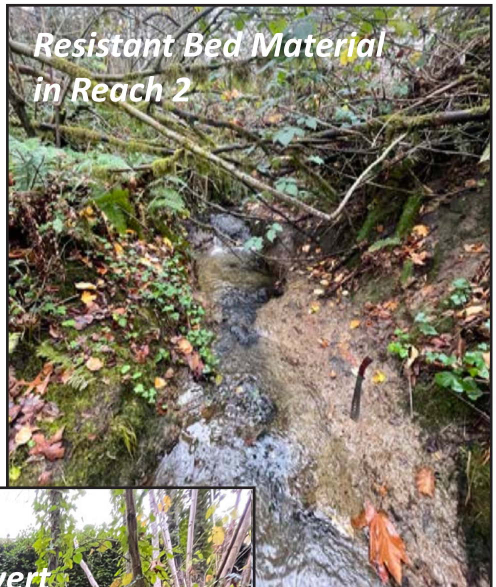
FIGURE 11

Table 2. *Field Observations for Geomorphic Subreaches Within Meridian Creek*

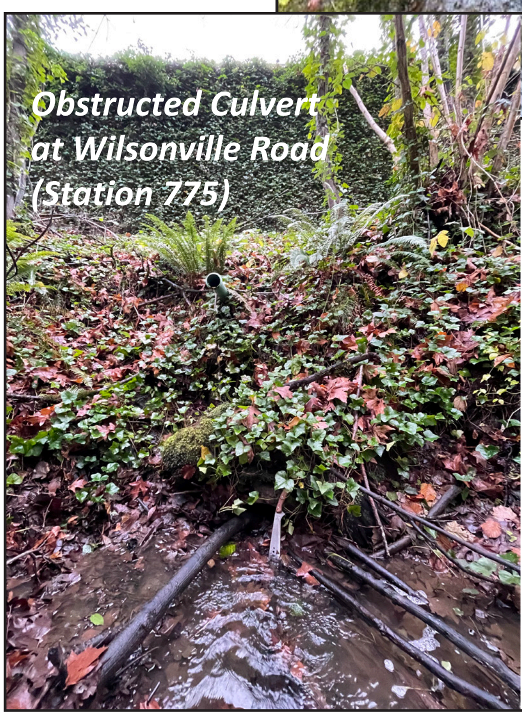
				Observational Data							Interpretive or Subjective Information						
Subreach	Downstream Station	Upstream Station	Reach Summary Description	Gradient	Dominant Channel Morphology	Dominant Substrates	Current Condition	Base Level Control	Lateral Constraints	Beaver Presence	Geomorphic Trajectory (Incising, Stable, Aggrading)	Bed Stability	Lateral Stability	Suscept-ibility to Hydro-modification	Infrastructure Risk in Reach	Potential Stream Enhancements	Reach Description
				Based on Profile Extracted from 2014 LiDAR		Bedrock, Boulders, Cobble, Gravel, Sand, Fines (dominant listed first)	Incised, Aggraded, Stable	Site Specific: e.g., Bedrock in Streambed, Culvert, Trunk Stream Confluence, etc. "None" if No Specific Controls Present	Site Specific: Valley Walls, Root Strength, Rock Bank Protection, etc. (listed roughly in orrder of importance)	Yes, No, Maybe	Incising, Stable, Aggrading	1= Stable or Aggrading; 5= Incising	1 = Stable Banks, 5 = Heavily Eroding Banks	1 = Not Susceptible, 5 = Highly Susceptible	1 = No Identified Risks; 5 = Obvious Potential Risks	Site Specific: Add Large Wood, Remove Invasive Species, Floodplain Benching, etc.	
1	775	1,000	Gravel depositional reach behind clogged culvert	1.05%	Step Pool	Gravel, fines, wood	Incised, Stable	Culvert at Wilsonville Road	Narrow valley wall	No	Stable or aggrading	1	3	4	4	Address downstream drainage, invasives removal	Short alluvial reach behind the obstructed culvert at Wilsonville Road. Gravel bed, one or more small steps formed by fallen logs. Channel is incised to base level at the culvert, but could incise more if culvert is cleared. Small incised channel in narrow valley with unstable mud valley walls subject to landsliding. Obstructed culvert at Wilsonville road could become a problem, and should be evaluated further as to whether it is a risk that should be addressed.
2	1,000	1,300	Reach incised to bedrock above waterfall	3.74%	Plane Bed	Bedrock (consolidated mud)	Incised, Stable	Bedrock channel bed	Narrow valley wall	No	Stable	1	3	3	3	Address upstream culvert drainage, invasives removal	Bedrock reach upstream of a 4'-high waterfall. Reach incised to consolidated mud bedrock. There are at least 2 waterfalls in reach, and at least one boulder step h from probable artificially placed boulders. Dense blackberry throughout reach. The culvert at the upstream end of reach is clogged and backs up water underneath Willow Creek drive.


Clogged Culvert Outlet at SW Willow Creek Drive (Station 1,300)


Close Up of Clogged Culvert at Station 1,300


Resistant Bed Material in Reach 2


Undermined Outfall at Station 1,100


Obstructed Culvert at Wilsonville Road (Station 775)


Close Up of Obstructed Culvert at Wilsonville Rd

Selected Photos From Meridian Creek, November 2021	Geomorphic Assessment of Wilsonville Creeks	WATERWAYS CONSULTING, INC. Santa Cruz, CA · watways.com · Portland, OR	FIGURE 13

Arrowhead Creek

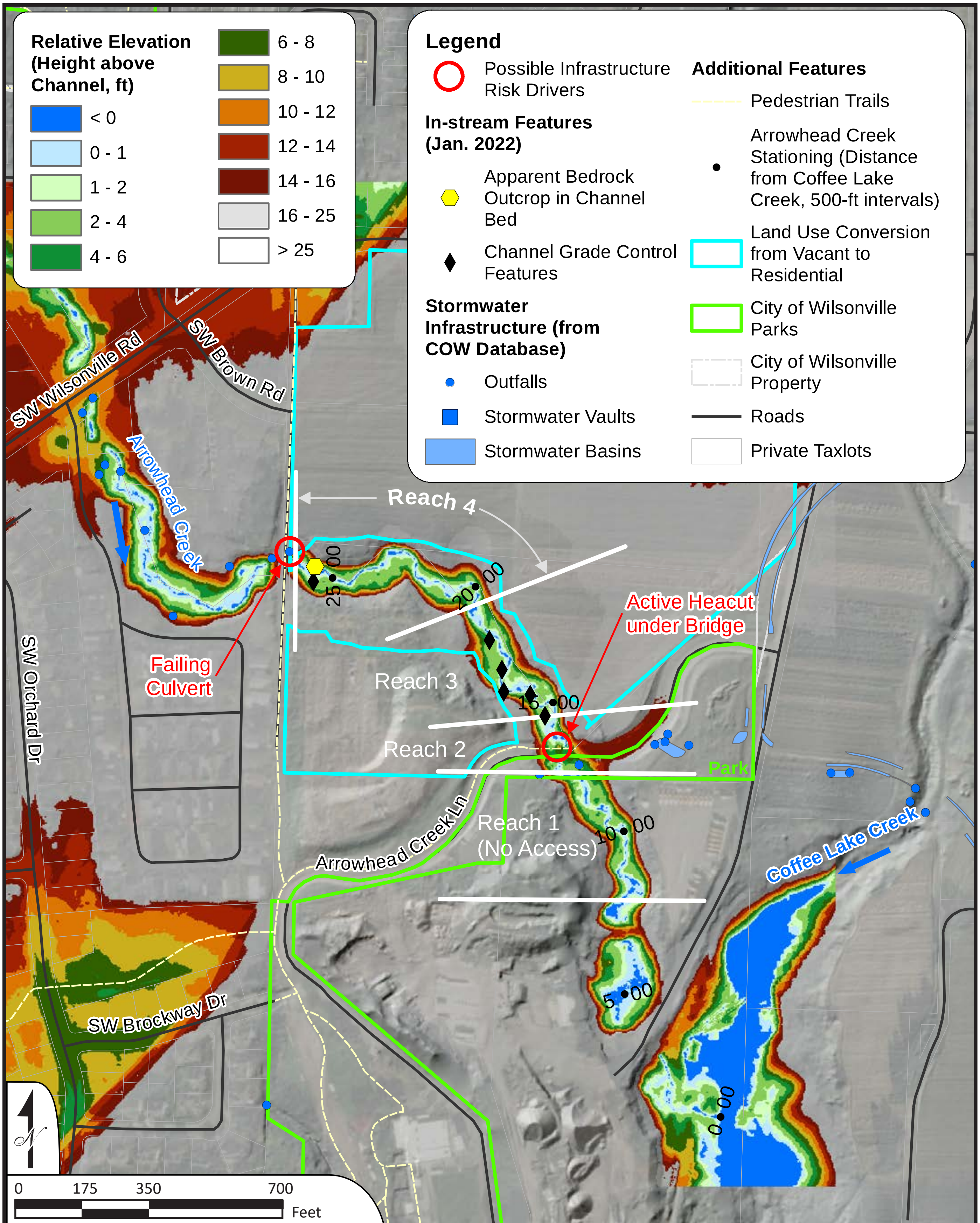
The field assessment for Arrowhead Creek occurred on January 25, 2021. The assessment included a 1,400-foot-long section of Arrowhead Creek between an asphalt pedestrian crossing and Arrowhead Creek Road (**Figure 14**). **Figure 15** is a longitudinal profile of the creek. **Table 3** summarizes the reach scale observations and interpretations from this site visit, and the point-specific observations are listed in **Appendix A3**. **Figure 16** contain photographs from this section of Arrowhead Creek.

General Observations and Interpretations

- The assessment area on Arrowhead Creek was divided into three subreaches based primarily on where beaver are active and have established stable dams that act as both local and regional grade control for the channel at the time of the assessment.
- Throughout the assessment area Arrowhead Creek consists of a meandering channel that is moderately incised within a broad floodplain that ranges between 40 and 80 feet. The channel and floodplain are inset 30 to 40 feet into the fine Missoula Flood deposits.
- Moderate incision of the channel limits high flow access to much of the broad floodplain except where beaver have built dams across the channel, and in some cases across the entire floodplain. In Reach 3, where the beaver dams create continuous backwater conditions along the entire reach, water engages the floodplain creating a complex mosaic of backwater and secondary channels.
- The culvert located at the pedestrian crossing at the upstream extent of the assessment area is in the process of failing and should be considered for replacement. It appeared from the downstream end that water may be piping through the fill and creating void spaces that are causing the culvert to fail. We did not evaluate the upstream end of the culvert due to lack of landowner permissions.
- English ivy dominates much of the project area and has the potential to limit the food and dam building resources for the beaver which could be detrimental to the beaver population and associated channel stability over the longer term. The ivy has already killed, or is at risk of killing, many of the alder and maple throughout the project area.

Summary Conclusions from Arrowhead Creek

- The stream is stable in this reach due to the presence of shallow hardpan and abundant beaver dams that act as local base level control and the fact that the channel is small and meanders across a broad floodplain with stable valley wall confinement.
- The main risk drivers consist of the following:
    - Failing condition of the upstream culvert. The fill prism appears to consist of relatively coarse material and therefore may be somewhat porous, limiting the potential for catastrophic failure of the prism. Further investigation by a geotechnical engineer is recommended.
    - Some instability was observed where Arrowhead Creek flows under the Arrowhead Creek Road bridge that appears to be related to construction of the channel under the crossing. Given the degree of channel stability observed upstream and downstream of the crossing the poor conditions at the crossing was determined to be relatively low risk unless there are significant changes to the active maintenance of the beaver dams.
    - Long-term, the loss of riparian trees and understory associated with dominance of English ivy does present some risk if there is a significant loss of food resources and dam building material for beaver.



Arrowhead Creek Geomorphic Survey

Geomorphic Assessment of Wilsonville Creeks

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FIGURE 14

Figure 15. *Longitudinal Profile of portion of Arrowhead Creek (from 2014 LiDAR data)*

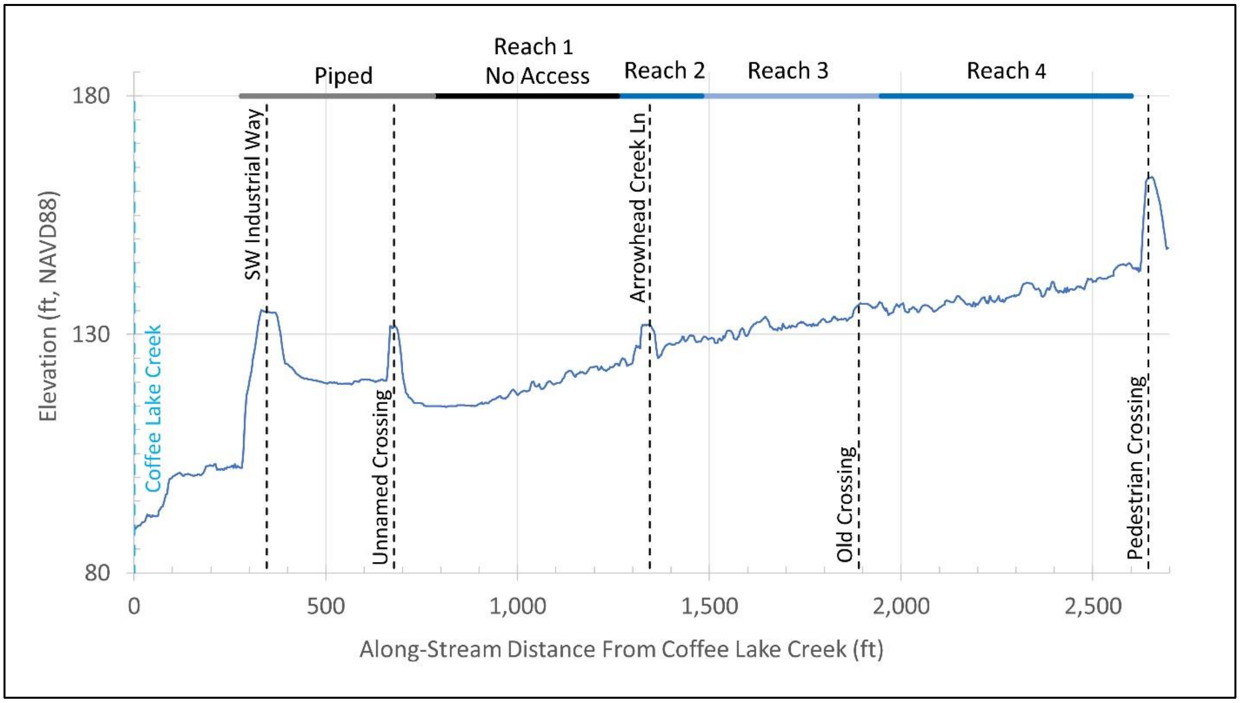
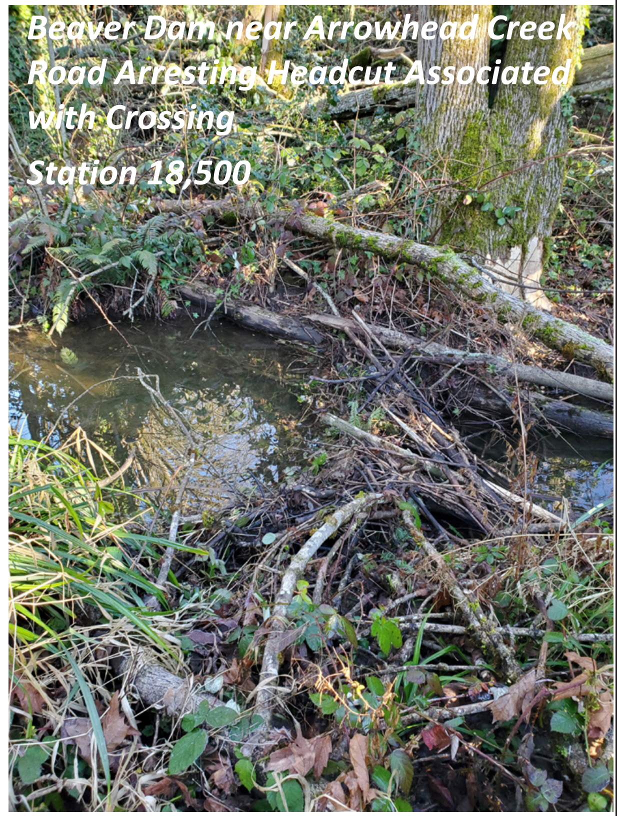


Table 3. *Field Observations for Geomorphic Subreaches Within Arrowhead Creek*

				Observational Data							Interpretive or Subjective Information						
Subreach	Downstream Station	Upstream Station	Reach Summary Description	Gradient	Dominant Channel Morphology	Dominant Substrates	Current Condition	Base Level Control	Lateral Constraints	Beaver Presence	Geomorphic Trajectory (Incising, Stable, Aggrading)	Bed Stability	Lateral Stability	Suscept-ibility to Hydro-modification	Infrastructure Risk in Reach	Potential Stream Enhancements	Reach Description
				Based on Profile Extracted from 2014 LiDAR		Bedrock, Boulders, Cobble, Gravel, Sand, Fines (dominant listed first)	Incised, Aggraded, Stable	Site Specific: e.g., Bedrock in Streambed, Culvert, Trunk Stream Confluence, etc. "None" if No Specific Controls Present	Site Specific: Valley Walls, Root Strength, Rock Bank Protection, etc. (listed roughly in orrder of importance)	Yes, No, Maybe	Incising, Stable, Aggrading	1= Stable or Aggrading; 5= Incising	1 = Stable Banks, 5 = Heavily Eroding Banks	1 = Not Susceptible, 5 = Highly Susceptible	1 = No Identified Risks; 5 = Obvious Potential Risks	Site Specific: Add Large Wood, Remove Invasive Species, Floodplain Benching, etc.	
1	7+80	12+60	Not Surveyed														Did not visit this reach due to property access constraints.
2	12+60 (GPS 11)	14+80	Unstable reach associated with bridge replacement at Arrowhead Creek Road but low risk due to good stability in upstream and downstream reaches	1.95%	plane bed meandering	gravel	incised	limited. Could impact upstream reach	bridge and valley walls	Y, but limited by vegetation	incising but limited activity	3	1	3	3 - irrigation pipe at risk	remove blackberry and revegetate	Bridge reach at Arrowhead Road. Construction of crossing appears to have impacted channel with limited mitigation measures. Riparian not restored so blackberry dominates. Irrigation line crosses channel unburied.
3	14+80	19+50	Meandering channel in highly stable reach associated with actively maintained beaver dams	1.44%	plane bed meandering	hardpan bedrock gravel	incised but stable	bedrock hardpan and beaver dams	valley wall ~25'-30' with low energy	Y	stable	1	2	2	1	Ivy removal and riparian	Beaver dominated. Very similar to Reach 1, but beaver present which have built successive dams backwatering channel. Increased floodplain engagement. Poor ripariain condition long-term. Cottonwood/maple dominated.
4	19+50	26+00	Stable reach with hardpan grade control. Culvert at upstream extent of reach is in the process of failing	1.31%	plane bed meandering	hardpan bedrock gravel	incised but stable	shallow alluvium intermittent on hardpan bedrock	valley walls ~25-ft high with low energy	N	stable	1	2	2	2	Ivy removal and riparian restoration	Subreach consists of 50'-75' valley bottom confined by 25'-30' of 1:1 valley walls. Channel incised 2'-5' into valley bottom with some active inset foodplains. Creek flows on hardpan bedrock. Cottonwood/alder/fir canopy threatened by ivy which dominates groundcover.



Selected Photos From Arrowhead Creek, January 2022	Geomorphic Assessment of Wilsonville Creeks	WATERWAYS CONSULTING, INC. Santa Cruz, CA · watways.com · Portland, OR	FIGURE 16

Newland Creek

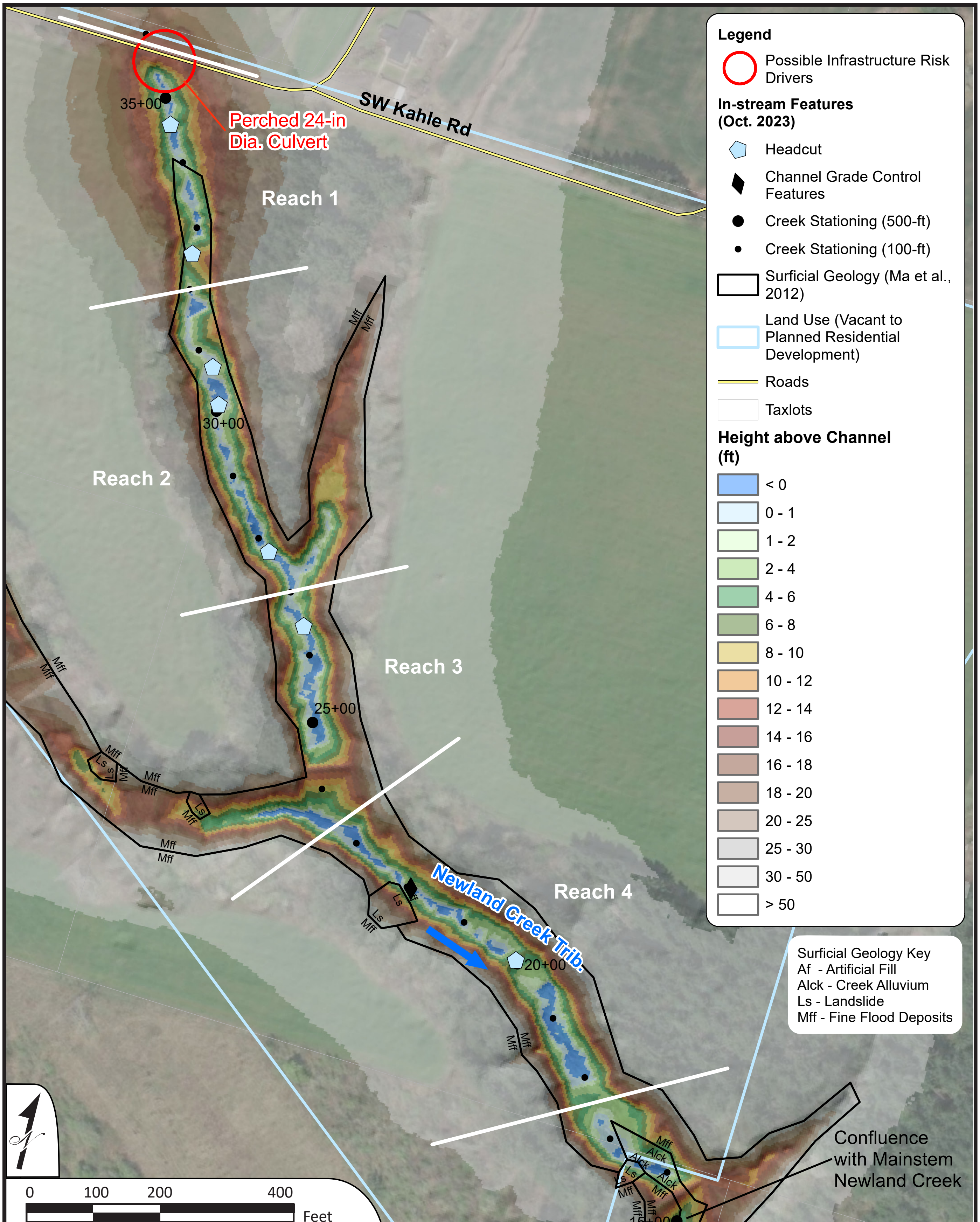
The field assessment for Newland Creek occurred on October 26, 2023. The assessment included a 1,700-foot-long section of a tributary to the mainstem of Newland Creek with the Urban Growth Boundary (UGB) with the upstream extent located at SW Kahle Road (**Figure 17**). **Figure 18** is a longitudinal profile of the creek. **Table 4** summarizes the reach scale observations and interpretations from this site visit, and the point-specific observations are listed in **Appendix A4**. **Figure 19** contain photographs from this section of Newland Creek.

General Observations and Interpretations

- The assessment area on Newland Creek was divided into four subreaches based primarily on the assessment boundaries and two tributaries that entered that had an influence on channel size.
- The culvert located at SW Kahle Road looked relatively new, consisting of a 24” corrugated plastic pipe. The culvert is significantly perched with about a 6-ft drop to the channel bed. Moderately sized angular rock was placed to dissipate energy. SW Kahle Road likely has prevented continued upstream movement of a large headcut by acting as a grade control.
- Upstream of SW Kahle Road the channel is small and the adjacent fields have been tiled and the tile drains closest to the road are exposed and eroding. The road probably also contributes a significant amount of stormwater.
- Reach 1 and 2 are highly incised with a least a half dozen headcuts that are eroding into erodible hardpan material. The channel is a notch in many places, characterized by a channel that is 3 to 4 feet wide and equally as deep cut into a narrow, confined valley that is 20 to 30 feet deep.
- The tributary entering from river left is also very incised.
- The gradient of Reach 4 is much flatter, after a larger tributary enters from river right. The channel is larger but still very incised and a deeper valley.
- Only one large headcut was observed in Reach 4. This reach may be in a widening phase in response to past incision as more bank instability was observed.
- More in-channel wood was observed in Reach 4 along with several debris jams that were holding grade.
- The riparian corridor is in good condition with a mix of mature coniferous and deciduous trees.
- Blackberry is the dominant understory in some areas though there are also significant stands of dogwood and vine maple.

Summary Conclusions from Newland Creek

- Reaches 1, 2, and 3 are highly unstable and likely to incise further and widen over time independent of additional upstream development.
- Reach 4 is at risk of bank instability.
- All reaches were considered to be at risk from hydromodification.
- The main risk drivers consist of the following:
  - Condition of the culvert at SW Kahle Road. Although the risk of failure of this culvert does not appear to be imminent, future development will likely increase downstream risks. As mentioned above, the culvert is likely acting as a grade control, preventing the downstream channel incision from moving upstream. Any future replacement of the crossing will need to incorporate grade control to prevent future upstream channel incision.
  - Instability in the tributaries entering Reach 2 and 3 should be considered if adjacent agricultural lands are developed. The riparian buffers on these tributaries are narrower.



Newland Creek Geomorphic Survey

Geomorphic Assessment of Wilsonville Creeks

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FIGURE 17

Figure 18. *Longitudinal Profile of portion of Newland Creek (from 2014 LiDAR data)*

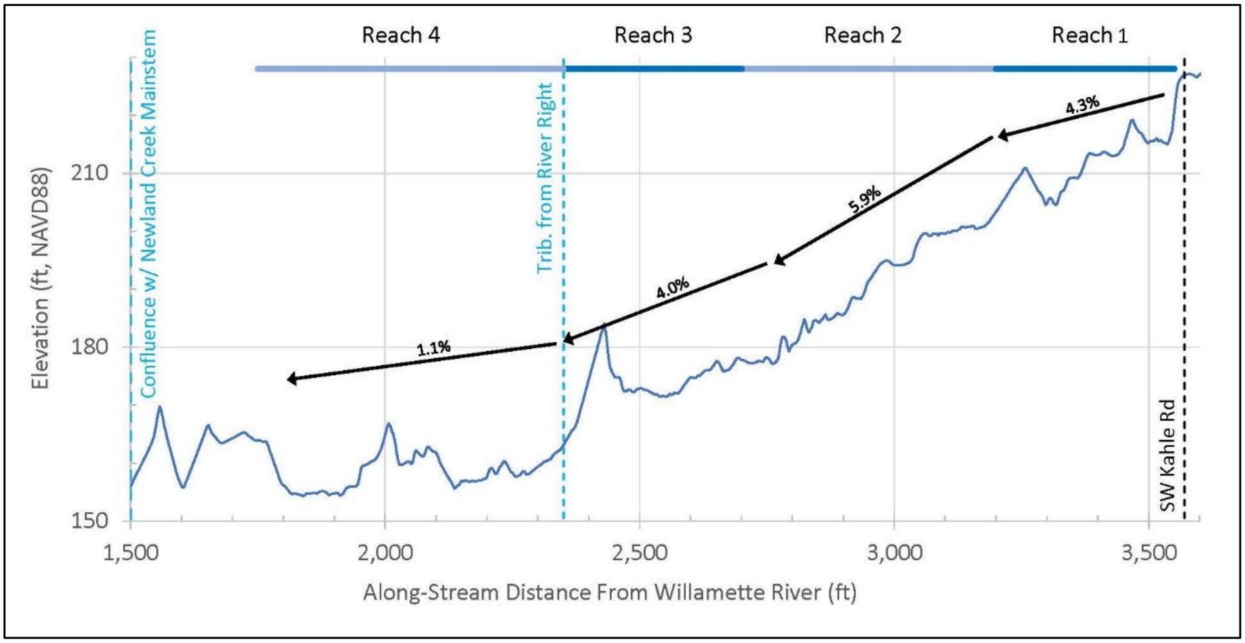


Table 4. *Field Observations for Geomorphic Subreaches Within Newland Creek Tributary*

			Observational Data							Interpretive or Subjective Information						
Subreach	Downstream Station	Upstream Station	Gradient	Channel Pattern Type	Dominant Substrates	Current Condition	Base Level Control	Lateral Constraints	Beaver Presence	Geomorphic Trajectory (Incising, Stable, Aggrading)	Bed Stability	Lateral Stability	Suscept-ability to Hydro-modification	Infrastructure Risk in Reach	Potential Stream Enhancements	Reach Description
			LiDAR-based	Based on Montgomery and Buffington, 1997 (dominant form is listed first)	Bedrock, Boulders, Cobble, Gravel, Sand, Fines (dominant listed first)	Incised, Aggraded, Stable	Site Specific: e.g., Bedrock in Streambed, Culvert, Trunk Stream Confluence, etc. "None" if No Specific Controls Present	Site Specific: Valley Walls, Root Strength, Rock Bank Protection, etc. (listed roughly in order of importance)	Yes, No, Maybe	Incising, Stable, Aggrading	1= Stable or Aggrading; 5= Incising	1 = Stable Banks, 5 = Heavily Eroding Banks	1 = Not Susceptible, 5 = Highly Susceptible	1 = No Identified Risks; 5 = Obvious Potential Risks	Site Specific: Add Large Wood, Remove Invasive Species, Floodplain Benching, etc.	
1	32+00	35+50	4.31%	bedrock/hardpan; confined	hardpan	incised	none	steep hillslopes	No	incising	5	3, but maybe not in widening phase	5	4, upstream culvert and road	Address profile instability if culvert is replaced	Steep, actively incising reach with several large to moderate headcuts. Early stage of channel evolution.
2	27+00	32+50	5.92%	bedrock/hardpan; confined	hardpan	incised	none, though harder bedrock outcrops observed	steep valley walls	No	incising	5	3, but could be entering a widening phase	5	increased bank erosion. Loss of mature riparian trees	Headcuts should be monitored and addressed if results suggest rapid incision	Channel lower slope then reach 1 but highly and actively incising. Good riparian canopy with some non-natives but large mature trees including maple and douglas fir. Some ivy which should be addressed to keep trees healthy.
3	23+50	27+00	4.03%	bedrock/hardpan; confined	hardpan	incised	none	steep valley walls	No	incising	5	3	5	increased incision + bank erosion + loss of canopy trees	Headcuts should be monitored and addressed if results suggest rapid incision	Similar to upstream reach. Small headcut + 2 large ones though hardpan material seems more competent. Valley walls less steep.
4	17+50	23+50	1.12%	plane bed; confined	hardpan w/ angular cobble	incised	hardpan but only limited effectiveness	steep valley walls	No	incising	4	4, some softer bank material, maybe landslides	5	same as previous reaches	Consider adding large wood to channel to improve profile stability channel; though access is poor	Hardpan is more solid in this reach. Hillslopes not as steep though bank material is less consolidated. Maybe old landslides. Most of bed is hardpan though some coarse substrate consisting of basalt from tributary. More wood in channel.

Selected Photos From Newland Creek, October 2023	Geomorphic Assessment of Wilsonville Creeks	WATERWAYS CONSULTING, INC. Santa Cruz, CA · watways.com · Portland, OR	FIGURE **19**

Kruse Creek

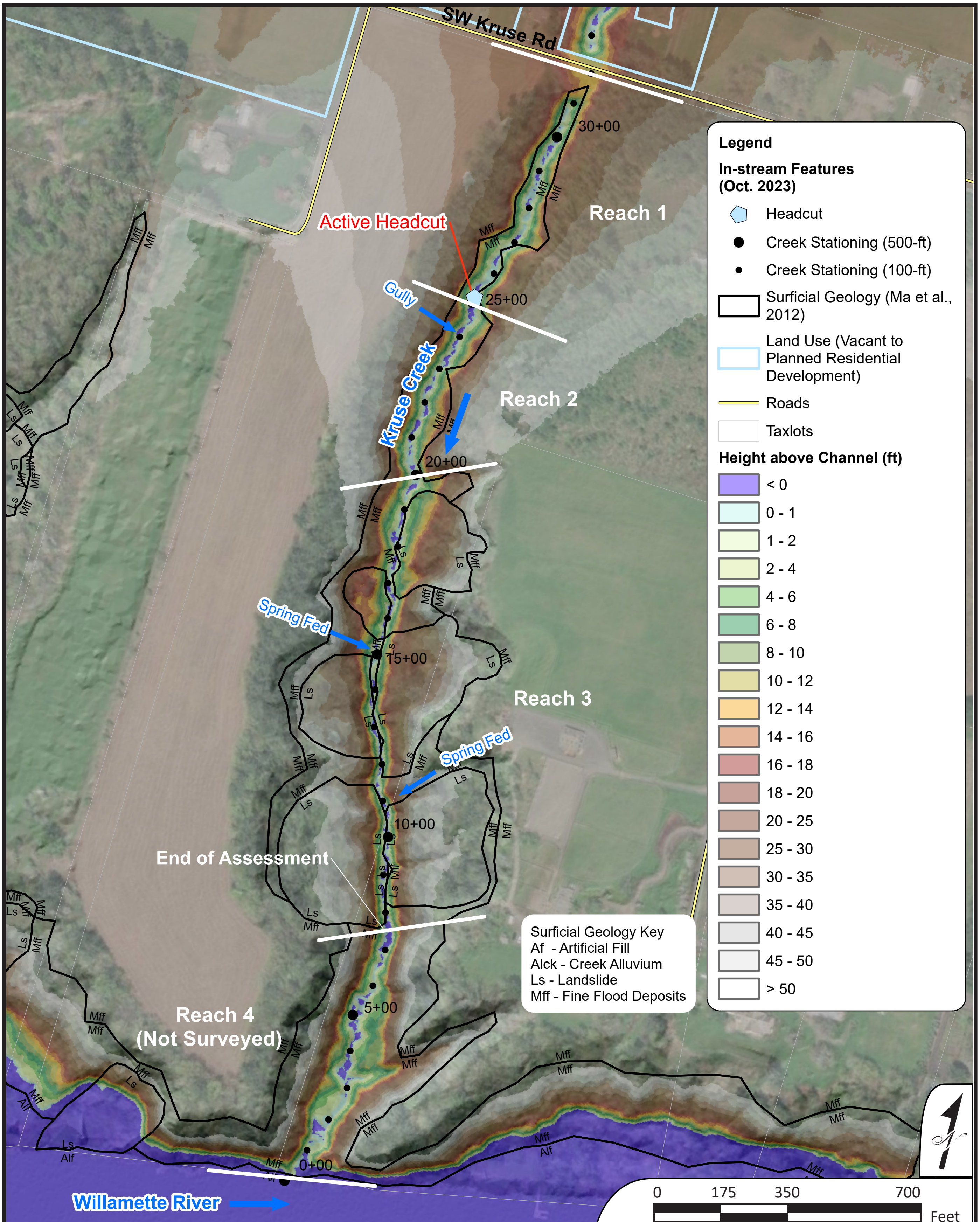
The field assessment for Kruse Creek occurred on October 26, 2023. The assessment included a 2,500-foot-long section of Kruse Creek between SW Kruse Road and the confluence with the Willamette River (**Figure 20**). **Figure 21** is a longitudinal profile of the creek. **Table 3** summarizes the reach scale observations and interpretations from this site visit, and the point-specific observations are listed in **Appendix A5**. **Figure 22** contains photographs from this section of Kruse Creek.

General Observations and Interpretations

- Reaches 1 and 2 are geomorphically distinct from Reach 3 and 4 due to the presence of large landslides from both the western and eastern hillslopes that extend continuously along approximately 1,400 feet of Kruse Creek.
- Although the channel is moderately incised in both Reaches 1 and 2, only one headcut was observed with the rest of the channel being relatively stable. This is likely due to the downstream landslides, which begin at the Reach 2 to 3 transition, and act as a downstream base level for these upstream reaches.
- The culvert at SW Kruse Road was difficult to access due to heavy growth of vegetation but it was perched which suggests some past channel incision that was likely arrested at the crossing.
- Reach 3 and 4 were very inaccessible due to deep channel incision and unstable banks associated with the adjacent large landslides.
- Active landslides and bank failures followed by subsequent channel incision through unconsolidated landslide debris is indicative of channel conditions through all of Reach 3 and potentially Reach 4. High ground water tables and seeps and springs through much of Reach 3 adds to the instability.
- The riparian corridor is in relatively good condition and consists of a mix of mature coniferous and deciduous trees with a good understory. Ivy is prevalent throughout the assessment reach and is climbing up many of the trees.
- On the eastern terrace in Reach 1 there is an extensive area of non-native English holly that was likely part of a former commercial holly farm.

Summary Conclusions from Kruse Creek

- Due to the presence of active landslides through Reach 3, Kruse Creek could be considered naturally unstable. This fact should be considered if the area were to develop in the future with riparian buffers adjusted to account for existing landslide activity and the potential for landward movement of the landslide scarps.
- It is unclear what the risk of hydromodification would be on this section of Kruse Creek. In Reaches 1 and 2 there would likely be additional channel incision and widening. A geotechnical engineer should be consulted to better understand the risk of increased sediment transport in Reach 3 that could cause rapid channel incision and destabilization of the toes of the existing landslides.
- Protection of the existing mature forest should be a priority in this area including management of ivy and removal of holly.
- Profile stabilization will need to be considered if the crossing at SW Kruse Road is upgraded.



Kruse Creek Geomorphic Survey

Geomorphic Assessment of Wilsonville Creeks

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FIGURE 20

Figure 21. *Longitudinal Profile of portion of Kruse Creek (from 2014 LiDAR data)*

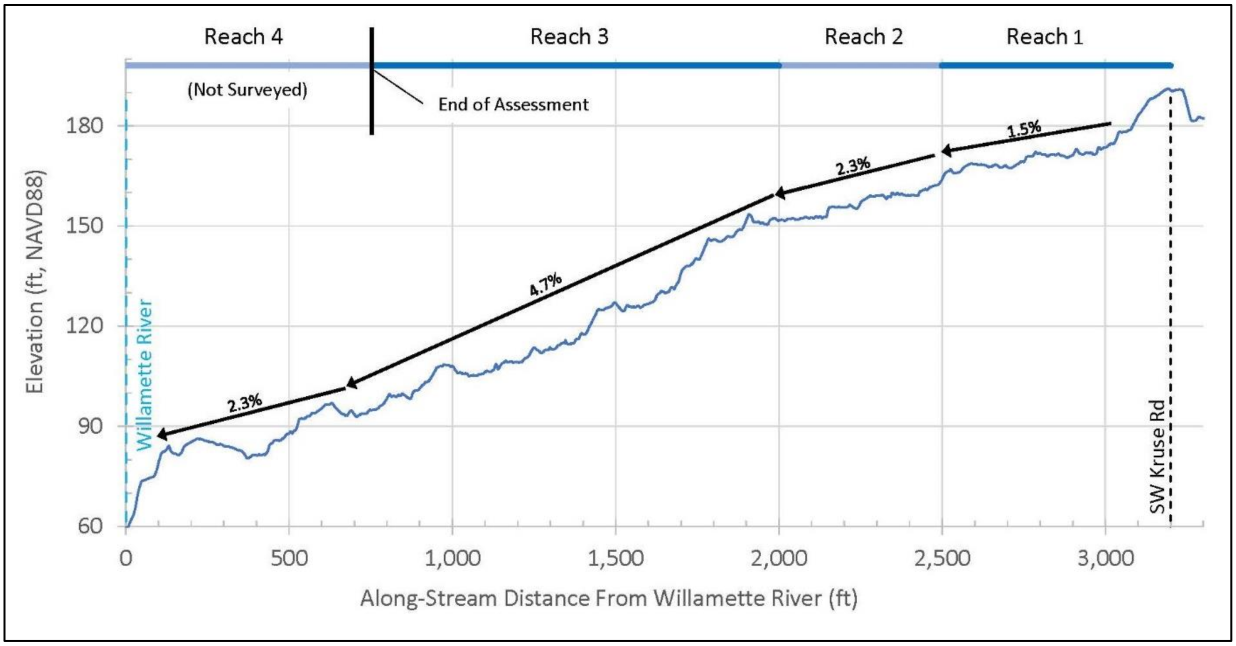

Table 5. *Field Observations for Geomorphic Subreaches Within Kruse Creek*

			Observational Data							Interpretive or Subjective Information						
Subreach	Downstream Station	Upstream Station	Gradient	Channel Pattern Type	Dominant Substrates	Current Condition	Base Level Control	Lateral Constraints	Beaver Presence	Geomorphic Trajectory (Incising, Stable, Aggrading)	Bed Stability	Lateral Stability	Suscept-ability to Hydro-modification	Infrastructure Risk in Reach	Potential Stream Enhancements	Reach Description
			LiDAR-based	Based on Montgomery and Buffington, 1997 (dominant form is listed first)	Bedrock, Boulders, Cobble, Gravel, Sand, Fines (dominant listed first)	Incised, Aggraded, Stable	Site Specific: e.g., Bedrock in Streambed, Culvert, Trunk Stream Confluence, etc. "None" if No Specific Controls Present	Site Specific: Valley Walls, Root Strength, Rock Bank Protection, etc. (listed roughly in order of importance)	Yes, No, Maybe	Incising, Stable, Aggrading	1= Stable or Aggrading; 5= Incising	1 = Stable Banks, 5 = Heavily Eroding Banks	1 = Not Susceptible, 5 = Highly Susceptible	1 = No Identified Risks; 5 = Obvious Potential Risks	Site Specific: Add Large Wood, Remove Invasive Species, Floodplain Benching, etc.	
1	25+00 (PM 3)	32+00 (at culvert)	1.51%	plane bed; confined	fines with some gravel	stable	none, some wood debris	valley slopes adjacent to small floodplain	No	stable, headcut downstream reach boundary	1, high incision potential	2, stable but rate of movement of downstream headcut could increase risk	4	No	ivy removal to save large trees	Low to moderate gradient channel. Small with adjacent low floodplain. Channel 6-ft top, 0.5-ft depth. Overall valley bottom width 20-ft. Lots of blackberry and ivy. Good canopy of douglas fir, cedar, but ivy is growing up a lot of trees. Reach break at headcut.
2	20+00 (PM 5)	25+00	2.29%	bedrock/hardpan; confined	hardpan	incised	none, though harder bedrock outcrops observed	steep valley walls	No	incising	5	3, but could be entering a widening phase	5	increased bank erosion. Loss of mature riparian trees	ivy removal to save large trees	Channel lower slope then reach 1 but highly and actively incising. Good riparian canopy with some non-natives but large mature trees including maple and douglas fir. Some ivy which should be addressed to keep trees healthy.
3	7+50	20+00	4.66%	colluvial; confined	hardpan	incised	none	steep valley walls	No	incising	5	3	5	increased incision + bank erosion + loss of canopy trees	Access is poor; Establish valley wide buffer to limit future infrastructure impacts	Similar to upstream reach. Small headcut + 2 large ones though hardpan material seems more competent. Valley walls less steep.

Selected Photos From Kruse Creek, October 2023

Geomorphic Assessment of Wilsonville Creeks

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FIGURE 22

Summary of Findings

Boeckman Creek

Boeckman Creek flows in a deep valley that appears to have formed quickly following the Missoula Floods, which ended about 15,000 years ago. The creek appears to have achieved a stable base level thousands of years ago, with a flat slope graded to the Willamette River. The assessment identified several smooth, hard surfaces in the channel bed that may be resistant bedrock or hardpan, which would prevent further downcutting and indicate that the stream has reached its limit of incision.

A major base level control in the reach is at the site of a breached concrete dam within Memorial Park (**Figure 9b**). The remnants of the dam are large concrete and boulders, creating a cascade, which should remain stable under future flood scenarios.

Upstream of the dam, and especially above Wilsonville Road, beaver are the primary controller of the morphology of the Boeckman Creek channel. Although the channel itself is moderately incised, beaver dams create a stair-stepped backwater condition that allow high flows to access the floodplain and reduce stream power and associated erosional forces. Numerous large and small dams were identified during the field investigation. The beaver dams create ponded areas and form complex environments and habitats in addition to providing base level stability in Boeckman Creek. Most of the dams appear stable, although they may be more likely to collapse as a result of larger or more frequent floods. The collapse of individual dams should not endanger or affect infrastructure in Boeckman Creek, but loss of all the dams could have significant negative consequences, including significant loss of ecological value and an increase in infrastructure risks. Therefore, maintaining a healthy beaver population in Boeckman Creek would be a beneficial long term management strategy. Riparian restoration, which would include removal of blackberry and ivy, would benefit beaver and improve the long-term resiliency of the reaches dominated by beaver.

The most at-risk area to past and future changes in the hydrology associated with hydromodification within the watershed is near the confluence with the Willamette River (**Figure 9b**). In this reach the combination of high flow conditions, an incised channel, and seasonal backwatering from the Willamette River appear to limit the long-term stability of beaver dams that provide local grade control elsewhere along Boeckman Creek. Although seasonally the Willamette River does provide base level control, hydromodification impacts, especially in fall when the Willamette River is typically low, has led to channel incision and widening in the reach downstream of Memorial Park.

Meridian Creek

Meridian Creek is incised in a small canyon between houses on the west and Landover Park on the east. Meridian Creek is incised to "bedrock," which is a resistant layer of consolidated fine-grained sediment. The valley walls confine the channel on both sides. The valley slopes are covered with dense blackberry and are prone to landsliding, which could affect some backyards. A stormwater outfall pipe on the west side of the stream, near the Reach 1 and Reach 2 boundary, is undermined and a section has washed away (**Figure 11; Photo on Figure 13**).

The primary infrastructure issue in this reach is the crossing of Meridian Creek under Wilsonville Road (**Figure 11; Photos on Figure 13**). The culvert appears to be undersized and is nearly clogged with fine sediment. This obstruction caused a wedge of sediment to accumulate in the channel upstream. The lack of drainage appears to cause some ponding under current conditions, and complete plugging of the culvert seems like a reasonable possibility. It is unlikely that ponded water would overtop Wilsonville Road, but repeated ponding behind the road could cause geotechnical instability through other mechanisms. The risks at this crossing should be further evaluated as part of the Stormwater Master Plan.

Secondary infrastructure issues in this reach are:

- The debris rack at the outlet of the culvert under Willow Creek Drive is clogged with leaves, debris and sediment, backing up water under Willow Creek Drive (**Figure 11; Photo on Figure 13)**. The undersized culvert at Willow Creek Drive may limit future hydromodification impacts downstream.

Arrowhead Creek

The Arrowhead Creek channel meanders across a broad floodplain that is inset approximately 30-40 feet from the upper Missoula Flood terraces. Grade control is provided through a combination of localized exposures of hardpan “bedrock” and beaver dams that are continuous and redundant along more than 60% of the project reach.

The primary infrastructure risk observed through the project reach is the condition of the culvert at the pedestrian pathway at the upstream extent of the assessment area, which is piping and failing and should be evaluated further by a structural engineer (**Figure 14; Photo on Figure 16**). An additional risk factor that was considered low to moderate and should be monitored in the future was the potential for instability and headcut migration within the vicinity of the Arrowhead Creek Lane crossing. The constructed streambed under the relatively new bridge crossing lacks adequate grade control and has the potential to incise further and threaten the series of beaver dams in the upstream, stable reach (**Figure 14).** The lack of grade control may be due to downstream mobilization of the streambed substrate that was installed during construction of the crossing. A pile of angular cobble was noted approximately 200 feet downstream of the crossing that may have been eroded from the channel at the bridge. An indirect risk factor in the assessment area relates to the condition of the riparian corridor. Much of the riparian vegetation is being impacted by the growth of English ivy, which has the potential to impact long-term beaver use of this section of creek, which could impact the primary source for grade control in this section of Arrowhead.

Newland Creek

The assessment reach included a portion of a tributary to the mainstem of Newland Creek within the existing Urban Growth Boundary. The channel is highly incised, and relatively steep, and flows within a canyon that increases in width in the downstream direction as it incises into a broader terrace surface. Past and active channel incision has resulted in a highly perched condition at the culvert at SW Kahle Road which is the upstream boundary of the assessment area. A half dozen headcuts were mapped through the project reach that ranges from 2 feet to 4 feet high with likely low to moderate rates of upstream movement as the bed of the channel flows over hardpan material.

The primary infrastructure risk identified in the project reach is the perched culvert at SW Kahle Road (**Figure 17; Photo on Figure 19**). Although this culvert isn’t immediately at risk due to placement of energy dissipation rock at the outlet, upgrades to the road will need to address the profile discontinuity and also consider the likelihood of additional channel incision associated with future headcut migration. This reach lacks grade control other than exposure of hardpan material in the bed, which will slow channel incision, but not eliminate it, especially if there are significant flow increases that occur in the future associated with development. Channel incision and active headcuts along the two tributary channels entering the assessment reach should also be considered in any future development planning.

Kruse Creek

Geomorphic conditions in the assessed portion of Kruse Creek are dominated by the presence of the presence of large landslides through the lower quarter mile of the canyon. These landslides are associated with a high water table, active springs and seeps along the entire lower canyon, and sets the base level control for the upper sub reaches of the assessment area. Active slumping into and across the Kruse Creek channel, followed by reincision into landslide debris characterizes channel conditions which were difficult to directly access during the assessment.

The primary infrastructure risk observed through the project reach is the condition of the culvert at W Kruse Road (**Figure 20**). The corrugated metal pipe is perched and, although not immediately at risk of failure, would need to be addressed, along with the apparent profile discontinuity, if the crossing was replaced during upgrades to the road, which is currently a narrow, relatively undeveloped asphalt road. Although there is no direct infrastructure risk associated with the mapped landslides, any planned development might have an impact on their rate of movement. Creating large buffers along Kruse Creek that considers existing geologic and geotechnical conditions as well as how those might be exacerbated by changes to watershed hydrology will be important to limit future impacts to infrastructure. Addressing non-native species, especially the potential for English ivy to impact mature trees, would also benefit the Kruse Creek corridor.

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APPENDIX A

Field Observations in

Boeckman, Meridian, Arrowhead, Newland, and Kruse Creeks

Appendix A1 *: Record of Field Observations in Boeckman Creek*

Dates: 11/19/2021, 11/24/2021 and 01/25/2022

Location		Bank Features				Tribu-tary	Channel Bed Features			Infrastructure Features							
Approx River Station (Distance from Willamette R. in ft)	GPS photo ID	Right or Left Bank	Significant Bank Erosion (Length, Height, ft)	Eroding Bank Intensity (1-5)	Bank Protection (type, length, height)	Tributary (Name, R or L, Channel Type)	Bedrock Type	Headcut or step height (ft); Risk level (1-5)	Beaver Dam (Height, ft)	Pipe/Culvert Outfall (Side of channel; Diameter,ft)	Bridge (Name, Type)	Pipe Crossing (type, material, diameter)	Other Feature (type)	Hydromodification Risk	Grade Control Feature	Capital Project Needs	Notes
450	1										Steel beam, full span			3	Rock grade control in channel		Private bridge at upstream extent of Willamette backwater. Accesses 1 property. Landowner there since 1976. Creek has incised and widened when Memorial Park bridge replaced culvert. Rock grade control provides limited protection. Rocks are small and could get flanked.
580	2						X										Bedrock exposed in bed along right bank. Shale. May not be continuous across bed. Overlain by fine sediments.
700	3	L	Active, 50'x25'	5	None								Deck and House	5			Actively eroding bank. Local incision and widening of channel undermined bank. May be exacerbated by fill/retaining wall at house. Retaining wall has since failed.
780	4							18"					Old crossing				Old crossing. Some road fill still present. Upstream extent of ??? headcut migration. Possibly associated with debris log jam.
1000-800	2115-2121																Reach below bridge to private property boundary consist of a 100' section with boulders and gravel, followed downstream by a 100' section of mud and wood bed before reaching property boundary. Appears to be significant bank erosion in the downstream section underneath the private homes (see photo 2121)
1050	2109, 2111, 2127-2129										Trail footbridge						High foot bridge over creek. Low chord is about 20 feet above creek, well engineered. A few boulders and rounded gravel lag deposits in the channel under the bridge
1100	2107, 2112-2113							12" boulder drop							X		Small step with boulder rip rap just upstream of bridge
1400	2096-2100						Willamete River bed material								X		Outcrop of a contact between overlying fine-grained sediments and underlying partially cemeted gravel close to the current water level. Gravel is well rounded basalt pebbles and cobbles, looks like probably old Willamette River bed material. This suggests stream from here down is probably not susceptible to much further incision due to exposing the coarser bed material and also as approaching the base level of the Willamette River
1500	2093-2094														X		Large, recently fallen cedar tree in channel. Log jam beginning to form, accumulating wood, and will probably persist for many years
2000 - 1500	2080-2093																Deeply incised meanders in low gradient channel. Not actively moving meanders. Bank walls as high as 40' and as low as 12 feet above channel Steps are formed at several fallen logs, mostly featureless runs. Abandoned floodplain is covered with mostly ivy (not as much blackberry here)
2050	2079-2080							30" high step, log							X		step from fallen log and debris. Doesn't appear to be a beaver dam

Location		Bank Features				Tribu-tary	Channel Bed Features			Infrastructure Features							
Approx River Station (Distance from Willamette R. in ft)	GPS photo ID	Right or Left Bank	Significant Bank Erosion (Length, Height, ft)	Eroding Bank Intensity (1-5)	Bank Protection (type, length, height)	Tributary (Name, R or L, Channel Type)	Bedrock Type	Headcut or step height (ft); Risk level (1-5)	Beaver Dam (Height, ft)	Pipe/Culvert Outfall (Side of channel; Diameter,ft)	Bridge (Name, Type)	Pipe Crossing (type, material, diameter)	Other Feature (type)	Hydromodification Risk	Grade Control Feature	Capital Project Needs	Notes
2200	2069-2071	L	50' Long by 30' high	2													Bank erosion on outside of a sharp bend in incised meandering reach. 30' high near-vertical brank held up by several large fir trees composed of Missoula Flood fines. There's foot traffic at top of bank, trail may be endangered from erosion (didn't climb up to top to be sure)
2700-2200	2069-2078																Mud and wood channel bottom, 2' to 4' deep at current high flows. Channel bed about 12 feet wide, mostly runs. Ivy/blackberry floodplain, incised. Floodplain is about 6 to 12 feet above floodplain
2700	2066-2068								18"						X		Small step within mud reach, likely beaver dam but not clearly so. Could be a downed log covered with debris. Low gradient, mud reach. Lots of ivy on floodplain
3000	2026-2031	R				Tributary enters from River Right											Tributary enters from river right through a large (>36") corrugated metal culvert under a road fill. Culvert is open but backwatered by Boeckman Creek about 24" deep. Scour pool at mouth of tributary
3050 to 2700	2059-2065; 2132-2134														X		Relatively featureless reach below tributary junction; incised, heavy blackberry and ivy on terraces; mud bed; lots of wood in channel bed
3050	2058	R	75' long by 6' high	3													Bank erosion and incision on river right below fence and facility on the top of bank downstream of tributary.
3050	**TRIBUTARY DESCRIPTION**																Inspected the lower end of tributary at request from B&C. Visited lower portion of tributary up to the road crossing in Memorial Park. Low gradient, deeply incised. For the first 200 to 300 feet upstream of confluence, upstream of access road, the channel is incised in blackberry thicket with no floodplain. Channel is about 5-10' bottom width, about 20' top width. Occasional lower benches, mud in channel
3350	2016, 2024														X		100-foot-long boulder riffle with boulder bank protection on river right @ 3350. Some of the boulders transported a short distance downstream forming a stable base level control over about 50-100' distance
3450	2019-2023; 2135-2138	R															Relatively broad floodplain surface covered with blackberry
3675	2003-2004	R	50' long by 16' high	5													Big eroding bank on right bank just downstream of dam. Banks composed of Missoula Flood fine facies

Location		Bank Features				Tribu-tary	Channel Bed Features			Infrastructure Features							
Approx River Station (Distance from Willamette R. in ft)	GPS photo ID	Right or Left Bank	Significant Bank Erosion (Length, Height, ft)	Eroding Bank Intensity (1-5)	Bank Protection (type, length, height)	Tributary (Name, R or L, Channel Type)	Bedrock Type	Headcut or step height (ft); Risk level (1-5)	Beaver Dam (Height, ft)	Pipe/Culvert Outfall (Side of channel; Diameter,ft)	Bridge (Name, Type)	Pipe Crossing (type, material, diameter)	Other Feature (type)	Hydromodification Risk	Grade Control Feature	Capital Project Needs	Notes
3700	1990-1999, 2145-2147														X		Breached dam in creek. Dam made from stone and mortar, about 15' wide. Even though it is breached it is still a 4 to 5 foot drop over a distance of about 30 feet, and provides a stable base level control. Boulders on the downstream side of dam. Possible fish passage barrier at low flows (not at the current high flow). Currently an aluminum pipe ~8" crosses above channel at former dam, looks like it is no longer used.
3700 to 4000	2148-2156	R											depositional floodplain				Relatively broad, flat surface covered in reed canary grass. Appears to be a deposit in an impoundment behind former dam at 3700
4000	1983	R			2 to 3' boulders								boulder riffle		X		Boulder bank protection and boulders in streambed. It looks like the boulders were installed to protect the right bank and provide grade control. There is about a 2 foot drop over the riffle
4100	1975-1979								2 to 3'						X		2 to 3' high beaver dam. Exact height not clear due to high flows. Appears to be stable
4300	2157, 1968, 1970								18"						X		Beaver dam (?) with reed canary grass root mat. Unclear height due to high flow. Chewed sticks. RCG is providing added strength to apparent damn
4450	1965, 1966	L								30" PVC							Stormwater outfall from parking lot in park. Discharges onto slope about 4 feet above channel. Rocked around outfall, no notable erosion
4500	1960 - 1964										SW Kolbe Lane Single lane vehicle bridge				X		Single lane auto bridge at Kolbe lane. Wood single span lower chord about 12 to 15 feet above channel. Headcuts or small beaver dams under the bridge
11/24/2021 - Wilsonville Road to SW Boeckman Road																	
5250	2168, 2183	R								18"	SW Wilsonville Road Bridge						High bridge with 4 sets of 3 large concrete piers about 40-50' above the streambed. No apparent hazards related to the stream. There is a record of a past stream realignment project here but no obvious evidence of what was done here. Old concrete stormwater outfall into the channel on river right under the bridge
5350	no photo	R															Drainage off senior living community parking lot creates a ponded area on the floodplain on river right, at least during wet season.
5400	2186								2'						X		Small beaver dam a short distance upstream of bridge backs up water around 400 feet. The pond is confined within banks about 15' wide, only about 2' above water level.
5800	2199																Upstream end of beaver pond from dam at 5400' . Flow into pond comes from a beaver dam just 50' upstream of top of pool. Beaver clearly know how to build dams so that the pond ends just below the toe of next upstream dam.

Location		Bank Features				Tribu-tary	Channel Bed Features			Infrastructure Features							
Approx River Station (Distance from Willamette R. in ft)	GPS photo ID	Right or Left Bank	Significant Bank Erosion (Length, Height, ft)	Eroding Bank Intensity (1-5)	Bank Protection (type, length, height)	Tributary (Name, R or L, Channel Type)	Bedrock Type	Headcut or step height (ft); Risk level (1-5)	Beaver Dam (Height, ft)	Pipe/Culvert Outfall (Side of channel; Diameter,ft)	Bridge (Name, Type)	Pipe Crossing (type, material, diameter)	Other Feature (type)	Hydromodification Risk	Grade Control Feature	Capital Project Needs	Notes
5850	2201-2202								2'						X		2 foot high beaver dam just above ponded area from downstream dam
5900	2205	R								Surface water from outfall							Trickle of water entering from gully which begins at a stormwater outfall high up on hillslope/valley wall. The gully is protected with sandbags, minor erosion
6000	2206-2208								1.5'						X		Beaver dam around 18" high at upstream end of pond from the dam at 5850
6200	2220-2226	R				Small tributary											Small tributary from river right, incised in dense blackberry, enters just downstream of the small tributary. I was only able to reach the stream in one spot about 100' from Boeckman Creek confluence due to blackberry. Creek has pebble gravel bed and appears reasonably stable. No clear hazards noted
6250	2213-2216								**4 to 5' high**						X		Big (4 to 5' high) beaver dam inundating lot of area upstream from here. High dam spreads water onto floodplain for as much as 500' upstream
6200-6600	2217-2234																Ponded, meandering reach upstream of large beaver dam at 6250. Water spreads out onto floodplain. Lots of blackberry, slow walking through here.
6550	2233-2235																Large fallen cedar tree across channel. 3'-4' DBH within the ponded area upstream of dam at 6250. Seems certain to trap any wood traveling through this reach for many years to come.
6650	2240-2242								1'						X		Small beaver dam just upstream of the pond behind the dam at 6250
7000	2245-2246							2' high step							X		Small (2') step or beaver dam. Could be behind a collapsed block of root mats, or a fallen tree. Unclear due to accumulated debris, but it's backing up water similar to beaver dam
7100	2248								2'						X		Apparently stable 2' high step in channel as a rsult of a beaver dam reinforced by reed canary grass sod. Looks very stable and long lived
7300	2259-2267								**3-4'**						X		Big beaver dam with lots of reed canary grass covered floodplain that is flooded by this dam
7300-8000	2270-2282																Reach mostly impounded by the big dam at 7300. Impounded area continues almost up to the footbridge. Impenetrable blackberry throughout this reach
8150	2284-2286										Boeckman Creek Trail Bridge						Boeckman Creek trail footbridge crosses over creek. At this location, stream is flowing, not ponded; gravel, with riffle-pool morphology and small wood. Lots of blackberry

Location		Bank Features				Tribu-tary	Channel Bed Features			Infrastructure Features							
Approx River Station (Distance from Willamette R. in ft)	GPS photo ID	Right or Left Bank	Significant Bank Erosion (Length, Height, ft)	Eroding Bank Intensity (1-5)	Bank Protection (type, length, height)	Tributary (Name, R or L, Channel Type)	Bedrock Type	Headcut or step height (ft); Risk level (1-5)	Beaver Dam (Height, ft)	Pipe/Culvert Outfall (Side of channel; Diameter,ft)	Bridge (Name, Type)	Pipe Crossing (type, material, diameter)	Other Feature (type)	Hydromodification Risk	Grade Control Feature	Capital Project Needs	Notes
8150-8650																	Mostly gravel riffle-pool reach from bridge to 8650; low floodplain with blackberries, not ponded reach
8650	2299-2303	L															Gully and drainage from river left. It appears that a PVC culvert pipe under the trail had washed out and was moved out of the way. Former homeless encampment here.
8890															X		Resistant bedrock in channel underwater near the dam.
8900	2308								2' high dam						X		Beaver dam, around 2 feet high. Lots of blackberry
9070															X		Apparent bedrock under water
9075	2315								2' high dam						X		Another beaver dam short distance upstream of the one at 8900, also resistant bed here underwater based on feel (not visible due to turbid water). Clearly a stable base level here
9100	2317-2324									18" pipe and box							Stormwater outfall and energy dissipator on the right bank, just above the beaver dam. It appears to be sitting on basalt bedrock. It remains clear of debris. Appears to be working well, no concerns or hazards noted
9300	2329-2331								2' high dam						X		Small beaver dam ~2' high; pond backs up to toe of the next upstream dam
9500	2335-2337								**5' high**						X		Tall but narrow beaver dam. Dam is built off of one large fallen log. 5 feet high by 15 feet wide
9700	2343-2344								**3-4' high beaver dam**						X		Large beaver dam, difficult to access. Ponds water a far distance upstream.
10000	2345-2346								2' high dam						X		Beaver dam near mapped outfall. Only viewed from the trail, did not get close to it. Difficult access
10000-10500	2350-2351																Reach with mostly ponded water. Beaver pond is effectively inundating much of the valley floor throughout this reach
10500		R								plastic pipe							Large pipe down long hillside on river right valley wall. Did not visit except from trail across the valley

***Appendix A2** : Record of Field Observations in Meridian Creek*

Date: 11/26/2021

Location		Bank Features				Tributary	Channel Bed Features			Infrastructure Features							
Approx River Station	GPS photo ID	Right or Left Bank	Significant Bank Erosion (Length, Height, ft)	Eroding Bank Intensity (1-5)	Bank Protection (type, length, height)	Tributary (Name, R or L, Channel Type)	Bedrock Type	Headcut or step height (ft); Risk level (1-5)	Beaver Dam (Height, ft)	Pipe/Culvert Outfall (Side of channel; Diameter,ft)	Bridge (Name, Type)	Pipe Crossing (type, material, diameter)	Other Feature (type)	Hydromodification Risk	Grade Control Feature	Capital Project Needs	Notes
11/26/2021 - SW Wilsonville Road to SW Willow Creek Dr																	
775	2372-2383										Wilsonville Road				X	Fix drainage at culvert	Meridian Creek crossing at Wilsonville Road. Clogged, apparently undersized (approx 30") culvert under high road prism under Wilsonville Road. Culvert is clogged on the upstream end with about 2 feet of sediment which is backing up a wedge of sediment for about 50 feet. There is a outfall (or possibly overflow pipe inlet) above main culvert, 6" plastic pipe. This is a hydromodification risk factor that should be evaluated. Unlikely there's enough water that it could overtop the road. But could plugging the culvert and an extended period of standing water following a storm destabilize the road embankment?
850	2388-2392									18" PVC							Section of corrugated plastic culvert pipe, about 6' long, along side of the channel. It appears to have been washed down from upstream
875	2393							18" step							X		Small log jam forming a 1.5' foot high step in the channel. Gravel sediment stored in a wedge behind it. If this were to fail or collapse, sediment could easily clog the rest of the culvert at Wilsonville road
1000	2415-2417							4' high waterfall in bedrock`							X		Waterfall in consolidated fine-grained bedrock. Marks transition from alluvial bed below and a bedrock stream above the waterfall.
1050	2421-2425									18" PVC							Stormwater outfall, 18" PVC on river right, about 6' above where the channel is in bedrock.There is a concrete support under the outfall which is undermined and failing. This is where the 6' long piece of pipe at Sta. 850 came from
1200	2448-2452							2' step							X		Boulder step in consolidated mud bedrock. Boulders may have been placed here for some reason,. Perhaps they were installed as bank protection and fell into the creek.
1300	2456-2466														X		Culvert outlet at top of reach under SW Willow Creek Drive. Culvert has a metal grate at the outlet that is clogged mostly by leaves. Some water is leaking through but this is a low flow. It is probably backwatered during storm flow. Currently, there is standing water about 2' deep under Willow Creek Drive behind the clogged grate. The channel upstream of Willow Creek drive is a stormwater basin which may reduce the amount of runoff from the developed area, but this culvert should be evaluated in the context of hydromodification upstream.

Appendix A3 *: Record of Field Observations in Arrowhead Creek*

Date: 1/25/2022

Location		Bank Features				Tribu-tary	Channel Bed Features			Infrastructure Features							
Approx River Station	GPS photo ID	Right or Left Bank	Significant Bank Erosion (Length, Height, ft)	Eroding Bank Intensity (1-5)	Bank Protection (type, length, height)	Tributary (Name, R or L, Channel Type)	Bedrock Type	Headcut or step height (ft); Risk level (1-5)	Beaver Dam (Height, ft)	Pipe/Culvert Outfall (Side of channel; Diameter,ft)	Bridge (Name, Type)	Pipe Crossing (type, material, diameter)	Other Feature (type)	Hydromodification Risk	Grade Control Feature	Capital Project Needs	Notes
13+50	10							3 (2')			Arrowhead Road; freespan truss			3			Arrowhead Road. Freespan concrete truss. Active headcutting at creek under bridge. Mitigated somewhat by beaver activity upstream. Unknown irrigation line (6" PVC) in channcel crosses creek several times.
18+50	5-9								Series of 5 beaver dams. See notes for locations and height								Series of beaver dams. Ramps and chew suggest active site. Dams (Stationing and Height): 18+50 and 17+30 = 18" high; 16+80 = 24" high; 15+90 = 12" high; 14+80=30" high
18+80	4												old crossing	1			Old road bed/crossing. Approach fill still present and evident in LiDAR. Crossing not evident.
23+00	3												rock groin on left bank				Boulder groin on left bank at toe at apex of meander bend. Upper bank ~55' high but no evidence of active erosion. Remnant training structure.
25+50	2						hardpan										Channel flowing on hardpan. Channel 6' wide incised 2'-3' feet into floodplain. No evidence of floodplain activation. Stable channel profile.
26+00	1									Culvert at trail				3			Double concrete box cultert 5'x5' (x2). Only looked at outlet. Drop of 2'-3' to channel. Concrete base of culvert failing. Water subbing under structure. High risk to infrastructure.

Reach Name: Newland Creek Trib. - Reach 1   Date: 10/26/2023   **Appendix A4**

Location		Bank Features				Tributary	Channel Bed Features			Infrastructure Features							
Approx River Station	GPS photo ID	Right or Left Bank	Significant Bank Erosion (Length, Height, ft)	Eroding Bank Intensity (1-5)	Bank Protection (type, length, height)	Tributary (Name, R or L, Channel Type)	Bedrock Type	Headcut or step height (ft); Risk level (1-5)	Beaver Dam (Height, ft)	Pipe/Culvert Outfall (Side of channel; Diameter,ft)	Bridge (Name, Type)	Pipe Crossing (type, material, diameter)	Other Feature (type)	Hydromodification Risk	Grade Control Feature	Capital Project Needs	Notes
35+50	PM 1									24" Dia CPP							Culvert at Kahle Rd 24-in CPP perched 6-ft above channel bed. Stormwater from road enters uncontrolled. Concrete rubble placed at culvert outlet. Outfall relatively stable though channel downstream is highly incised compared to upstream.
34+50	PM 2							3-ft over 10-ft (4)									Channel highly incised into erodible hardpan. Steep on both banks with a narrow channel notch 4-ft wide by 4-ft deep. Headcut 3-ft distributed over 10-ft channel not even deeper and narrower downstream of headcut.
32+50	PM 3							4-ft over 6-ft (5)									Larger headcut 4-ft over 6-ft incised into erodible hardpan. Steep banks.
30+75	PM 5							3-ft (3)									Headcut 3-ft held up by maple roots.
30+00	PM 6							4-ft over 15-ft (3)									Two closely spaced headcuts. 4-ft over 115-ft. Harder bedrock exposure along right bank. Unsure if its continuous across channel.
28+00	PM 7							4-ft (5)									Headcut 4-ft tall. Risk level 5.
26+50	PM 9							3-ft (5)									Headcut 3-ft tall. Risk is 5.
22+00	PM 12								debris jam of small wood								Debris jam holds 18-in of grade. Fine sediment accumulated upstream.
20+00	PM 14							2-ft (3)									Downstream extent of assessment

Reach Name: Kruse Creek   Date: 10/26/2023   **Appendix A5**

Location		Bank Features				Tributary	Channel Bed Features			Infrastructure Features							
Approx River Station	GPS photo ID	Right or Left Bank	Significant Bank Erosion (Length, Height, ft)	Eroding Bank Intensity (1-5)	Bank Protection (type, length, height)	Tributary (Name, R or L, Channel Type)	Bedrock Type	Headcut or step height (ft); Risk level (1-5)	Beaver Dam (Height, ft)	Pipe/Culvert Outfall (Side of channel; Diameter,ft)	Bridge (Name, Type)	Pipe Crossing (type, material, diameter)	Other Feature (type)	Hydromodification Risk	Grade Control Feature	Capital Project Needs	Notes
32+00	PM 1									24" Dia CMP							Culvert 24-in CMP perched 4-ft above channel. Large scour hole and circular erosion. Undercut.
25+00	PM 3							4-ft (5)									Headcut 4-ft. Risk 5
24+00	PM 4					right gully											Small gully entering from right bank 2-ft wide, 3-ft wide. Appears to be stormwater runoff. Extends to conifers 40-ft upslope.
15+00	PM 6					right spring fed											Drainage from landslide area enters from right bank. Flow equal to or exceeds main channel flow. Flow is piping through landslide along bank.
11+00	PM 7					left spring fed											Tributary or drainage input from left bank. Might be from landslide. Steep drainage. Could be highly erosive if additional water is delivered to the drainage.

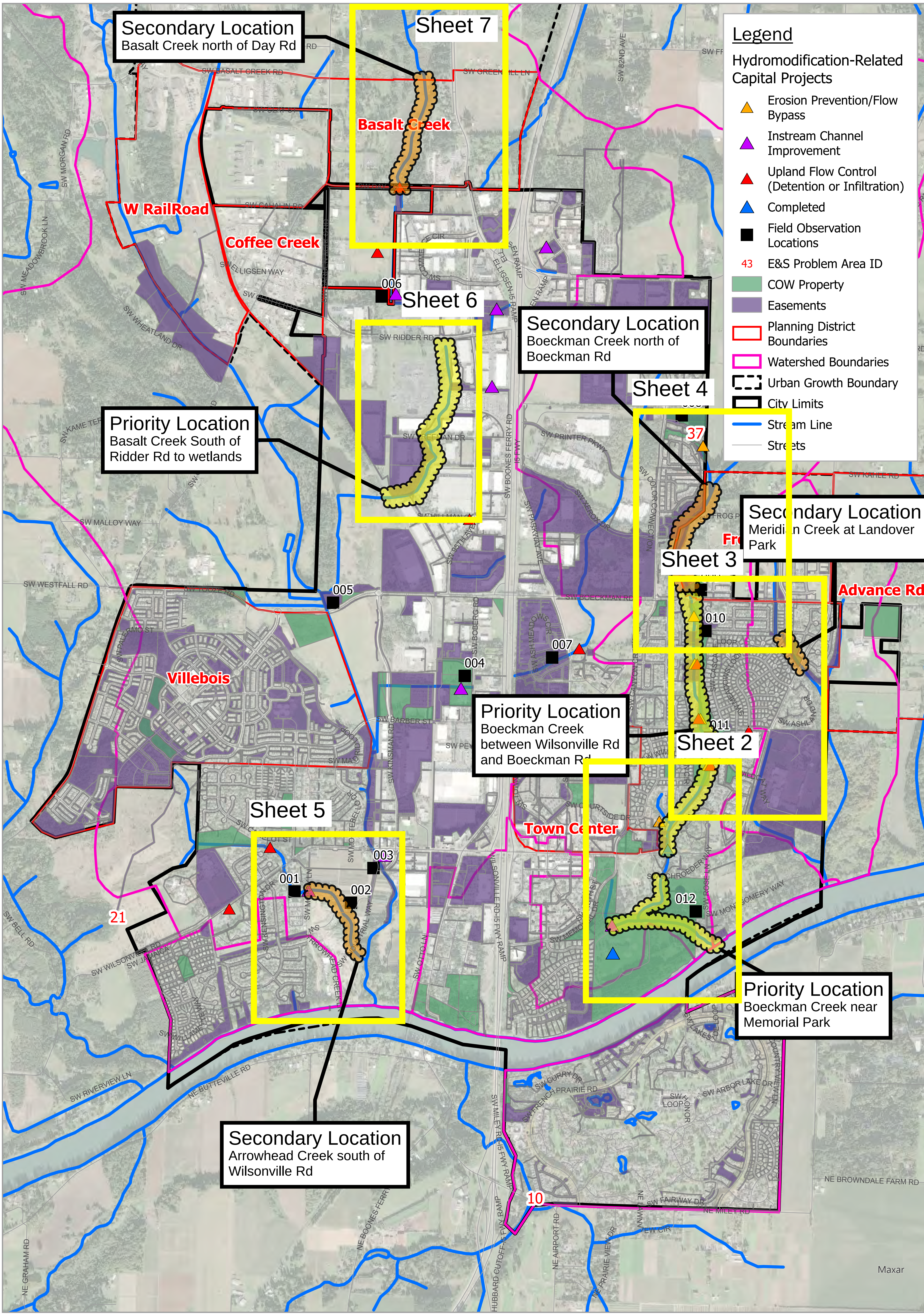
WATERWAYS CONSULTING, INC.

APPENDIX B

Field Maps for

Boeckman, Meridian, Arrowhead,

Newland, and Kruse Creeks



Brown AND Caldwell

City of Wilsonville/
Project # 156157

Stormwater Master Plan

Date: 8/23/2021

Notes:

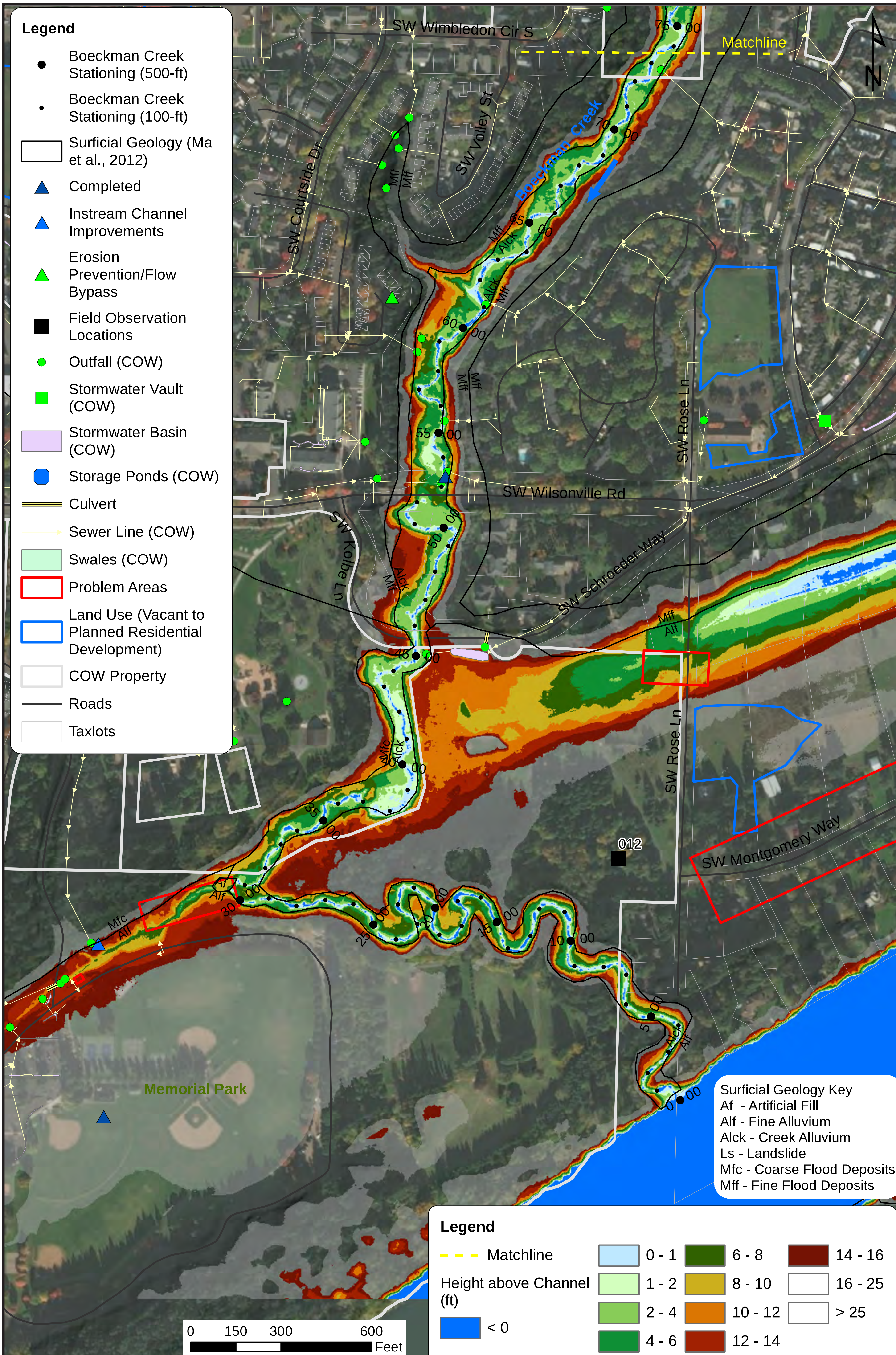
Drawn By: MRG
Checked By:

Spatial Reference:
Name: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl

N

0 1,000 2,000 4,000 Feet

Stream Assessment



Boeckman Creek Downstream (1 of 3) - Priority Location

Wilsonville Stormwater Master Plan

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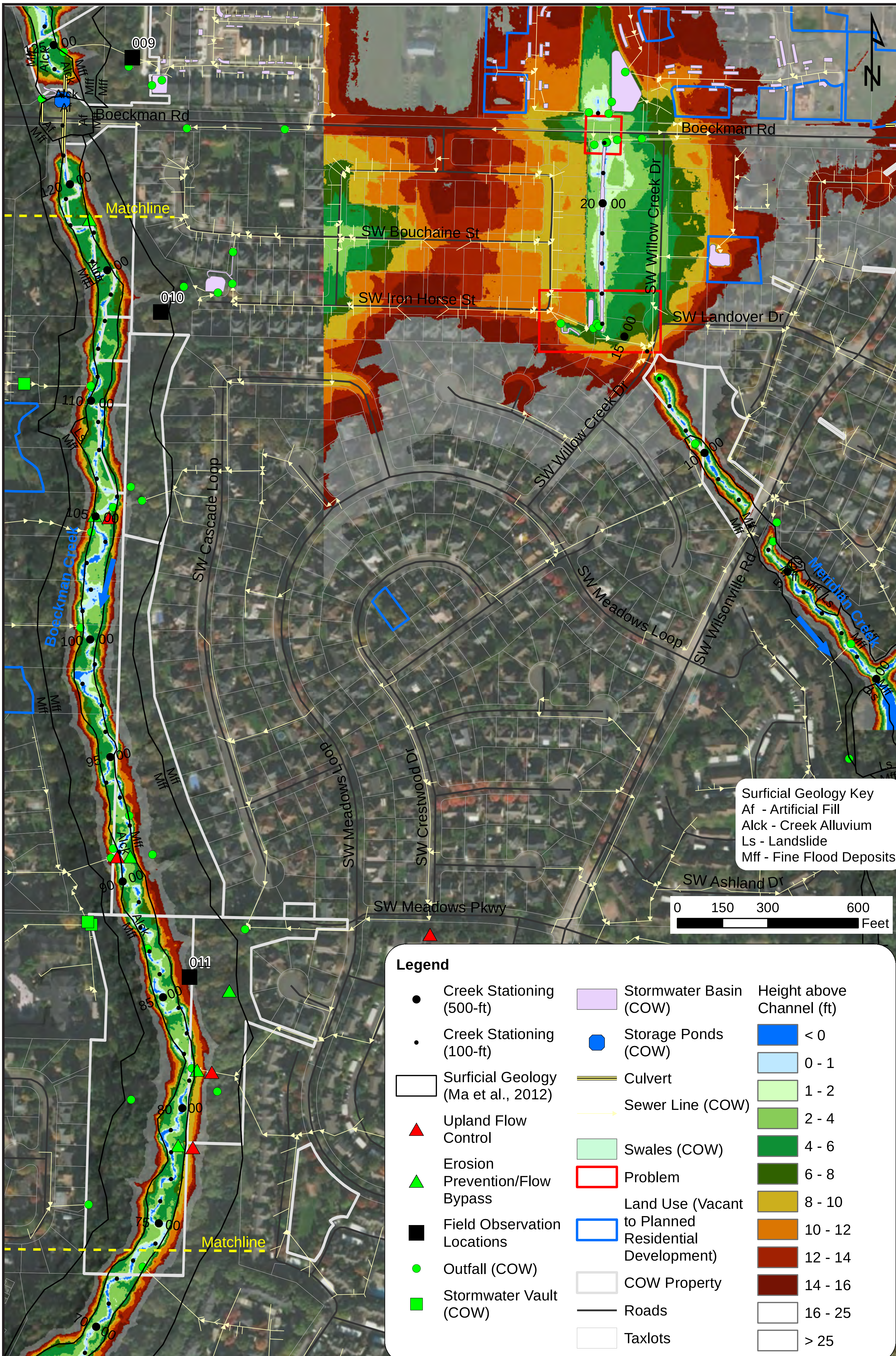
FIGURE 2



Boeckman Creek Mid (2 of 3) - Priority Location

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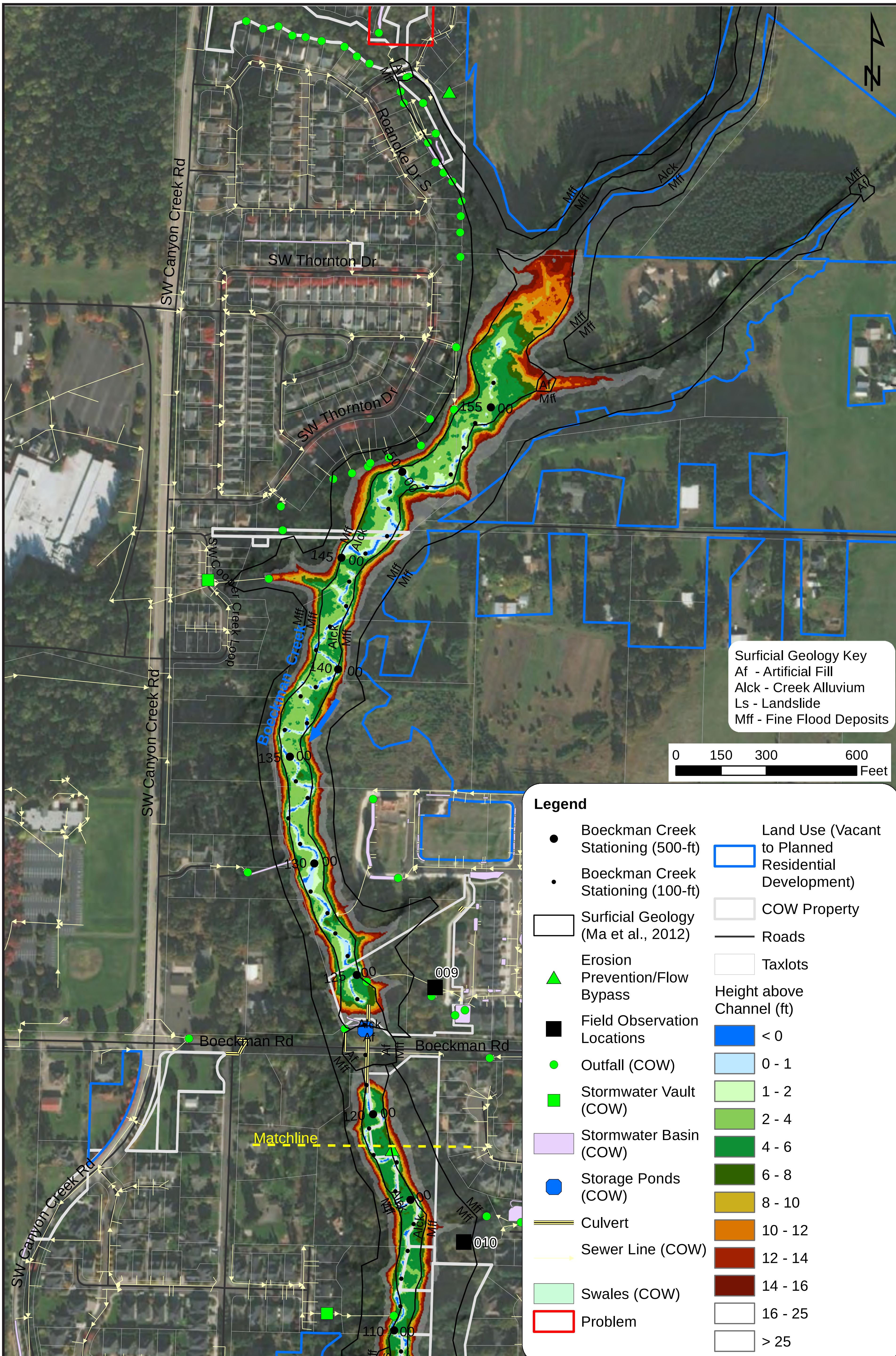
FIGURE 3



Boeckman Creek Upstream (3 of 3) - Secondary Location

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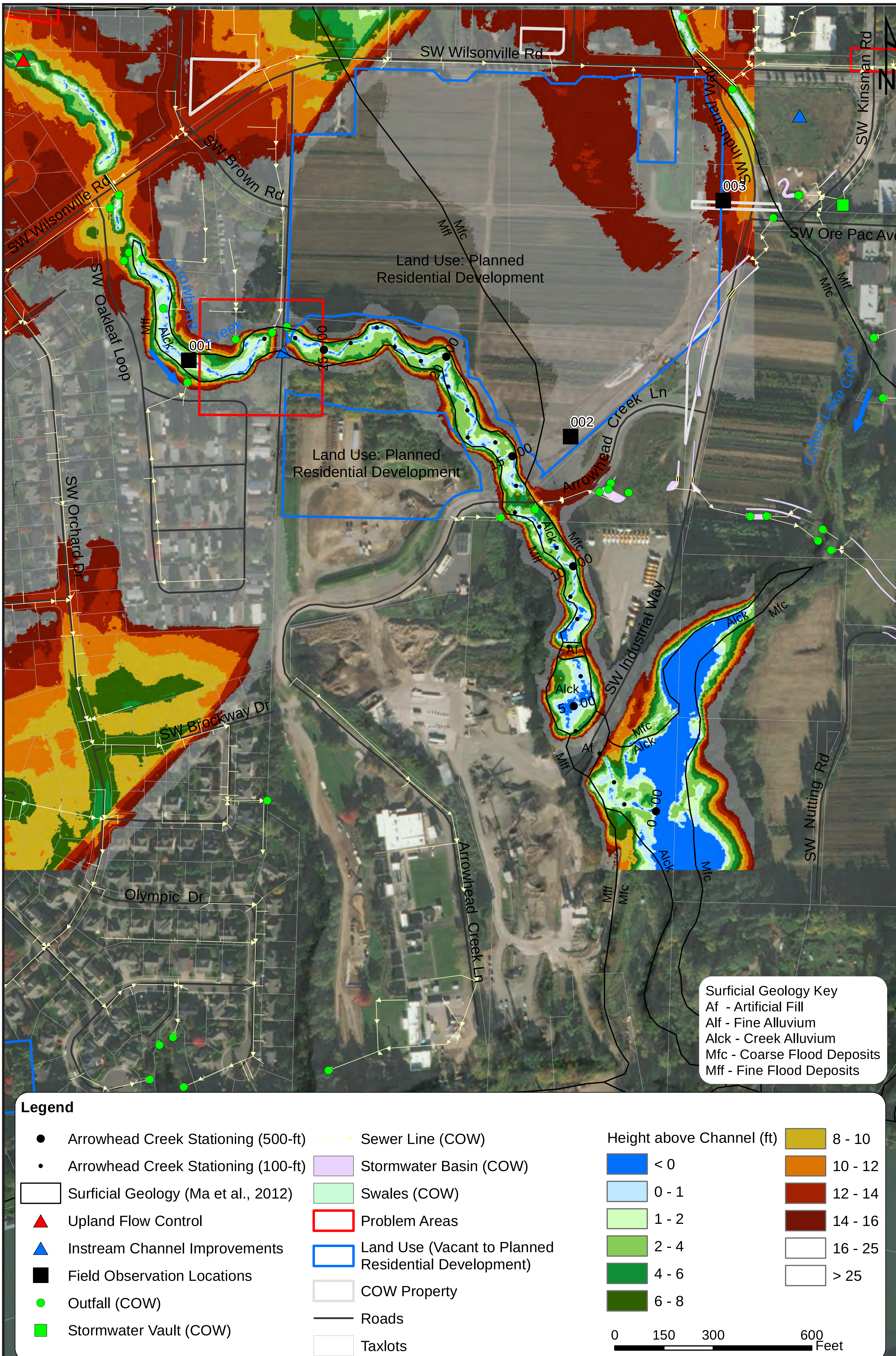
FIGURE 4



Arrowhead Creek Overview - Secondary Location

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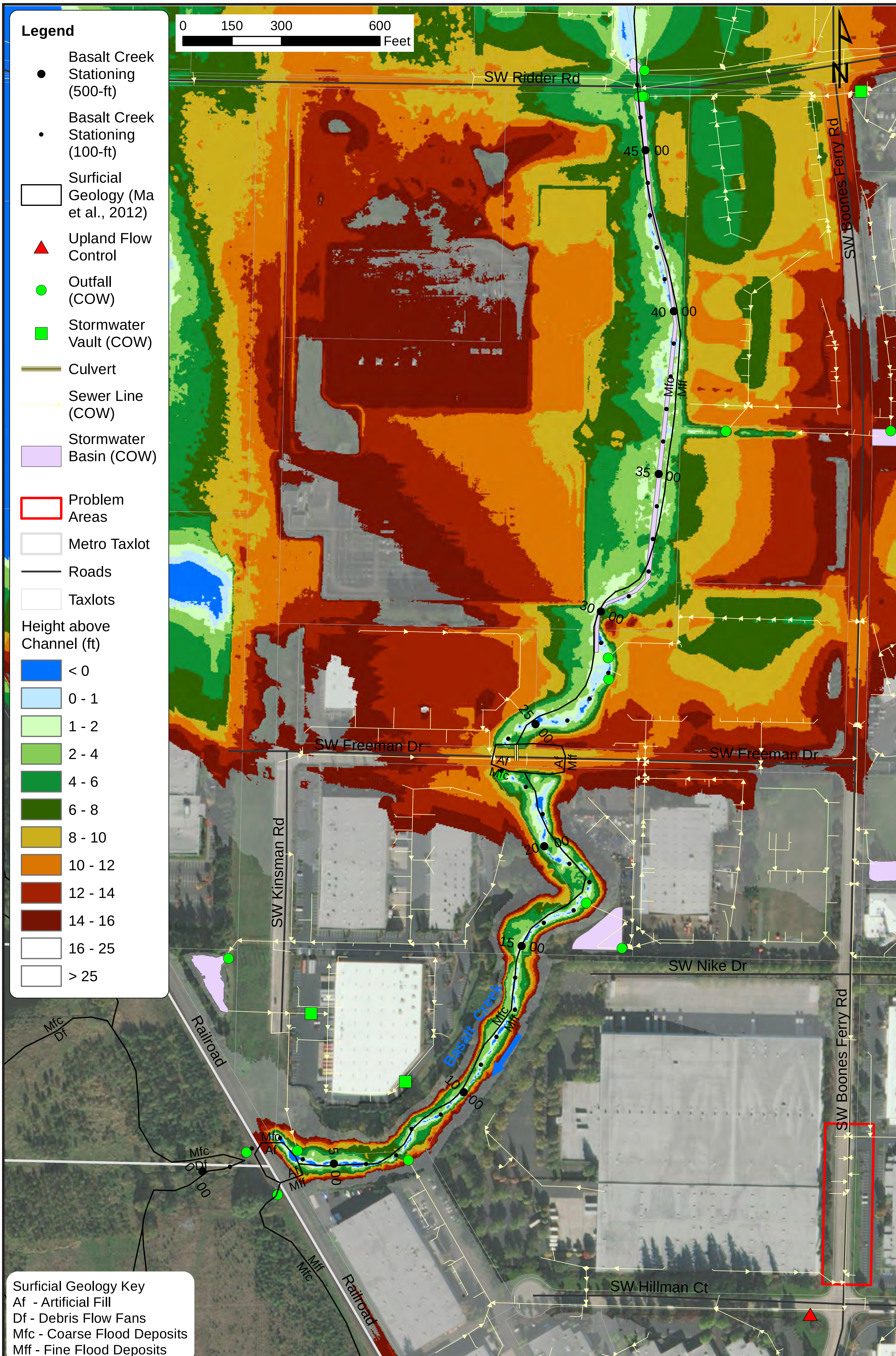
FIGURE 5



Basalt Creek Overview - Priority Location

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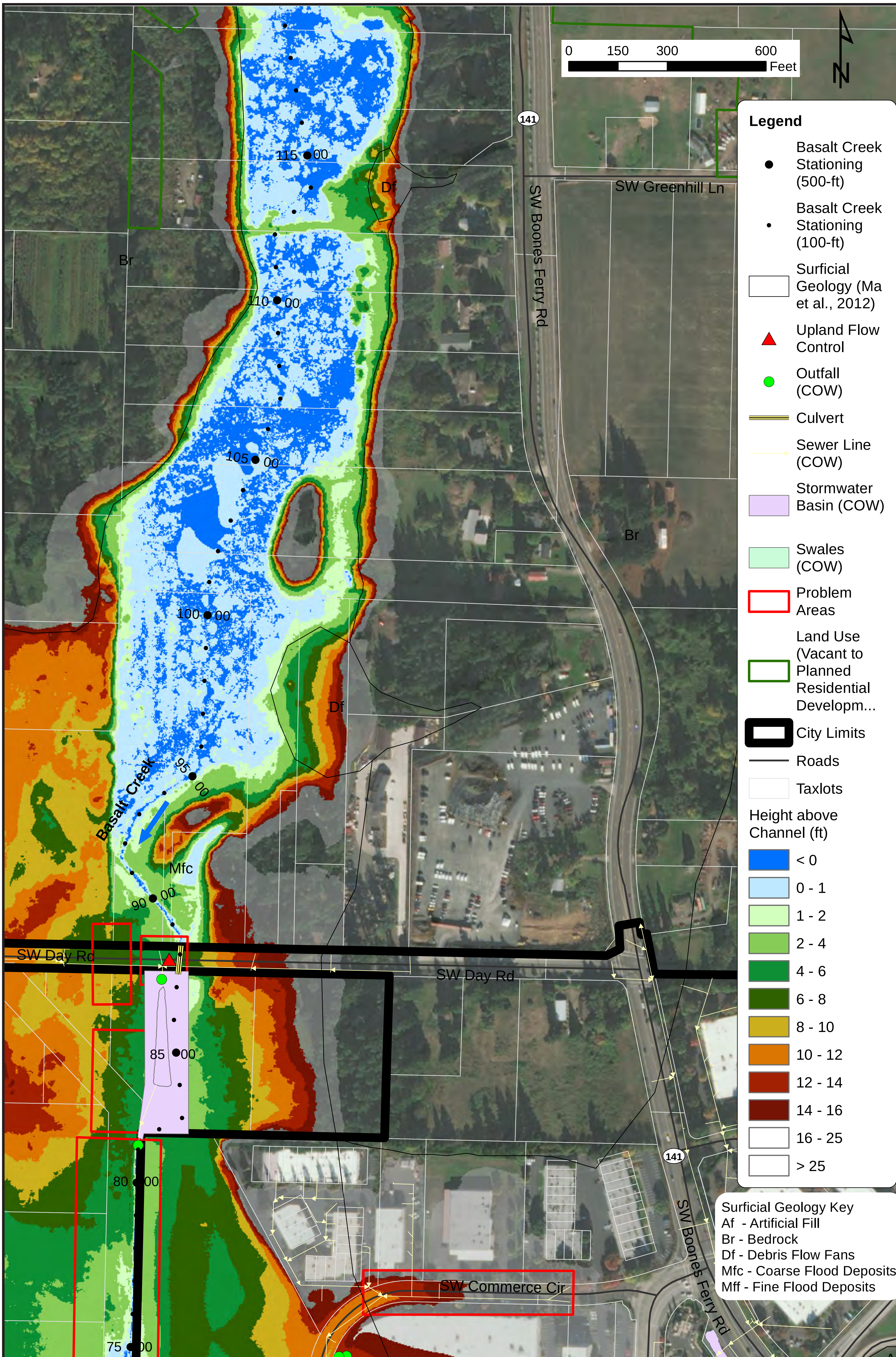
FIGURE 6



Basalt Creek Overview - Secondary Location

Wilsonville Stormwater Master Plan

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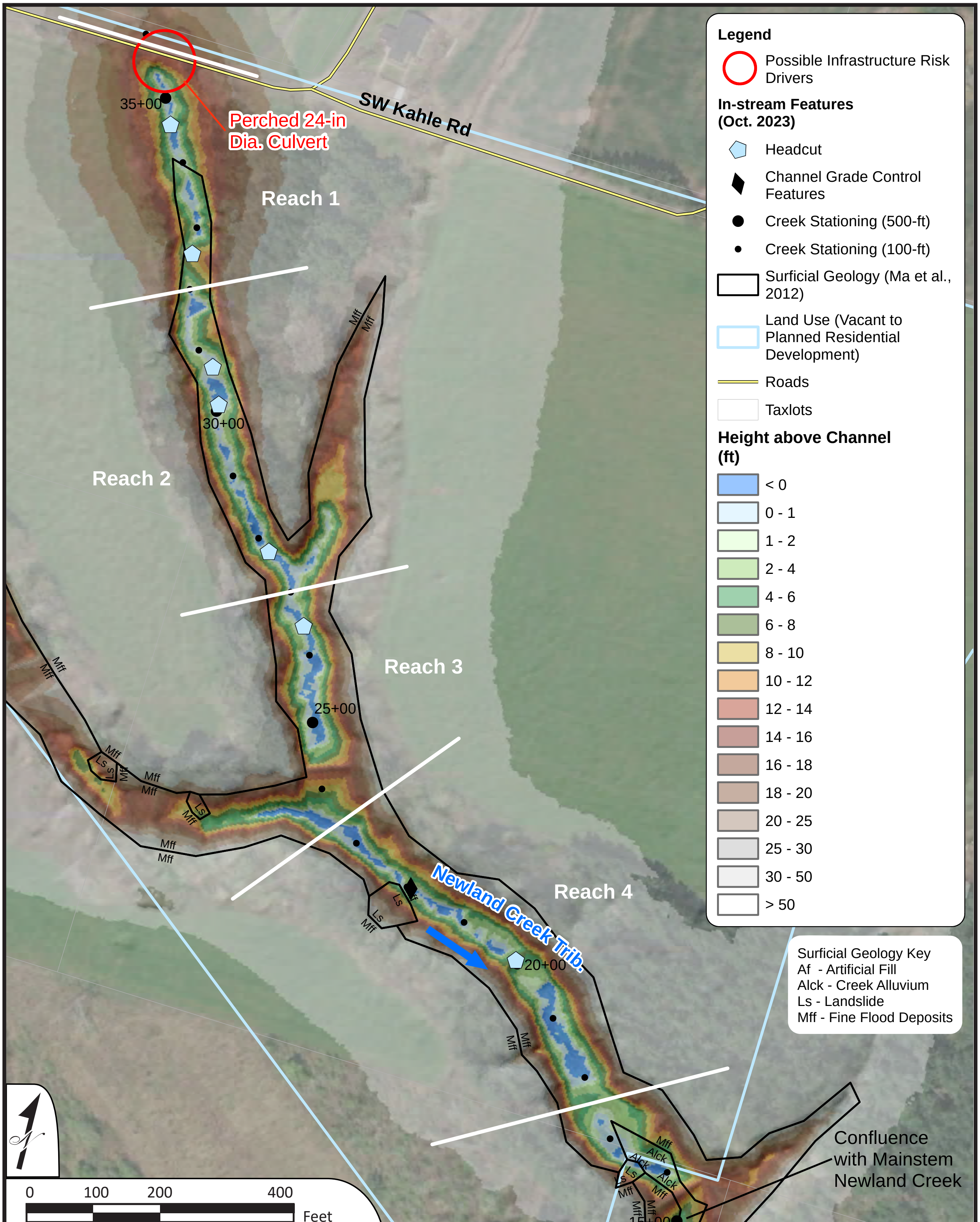
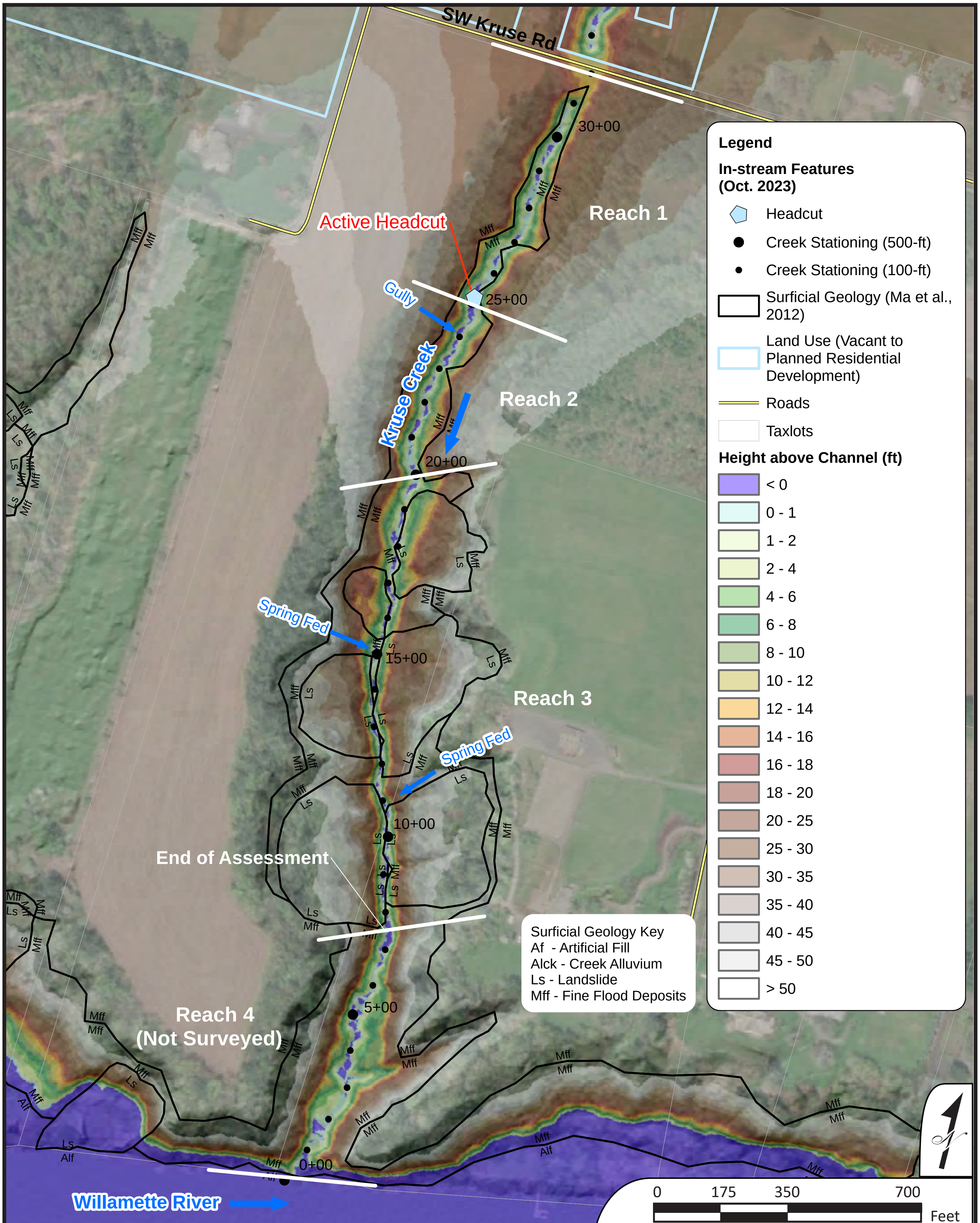
FIGURE 7



Newland Creek Geomorphic Survey	Geomorphic Assessment of Wilsonville Creeks	WATERWAYS CONSULTING, INC. Santa Cruz, CA · watways.com · Portland, OR	FIGURE 8

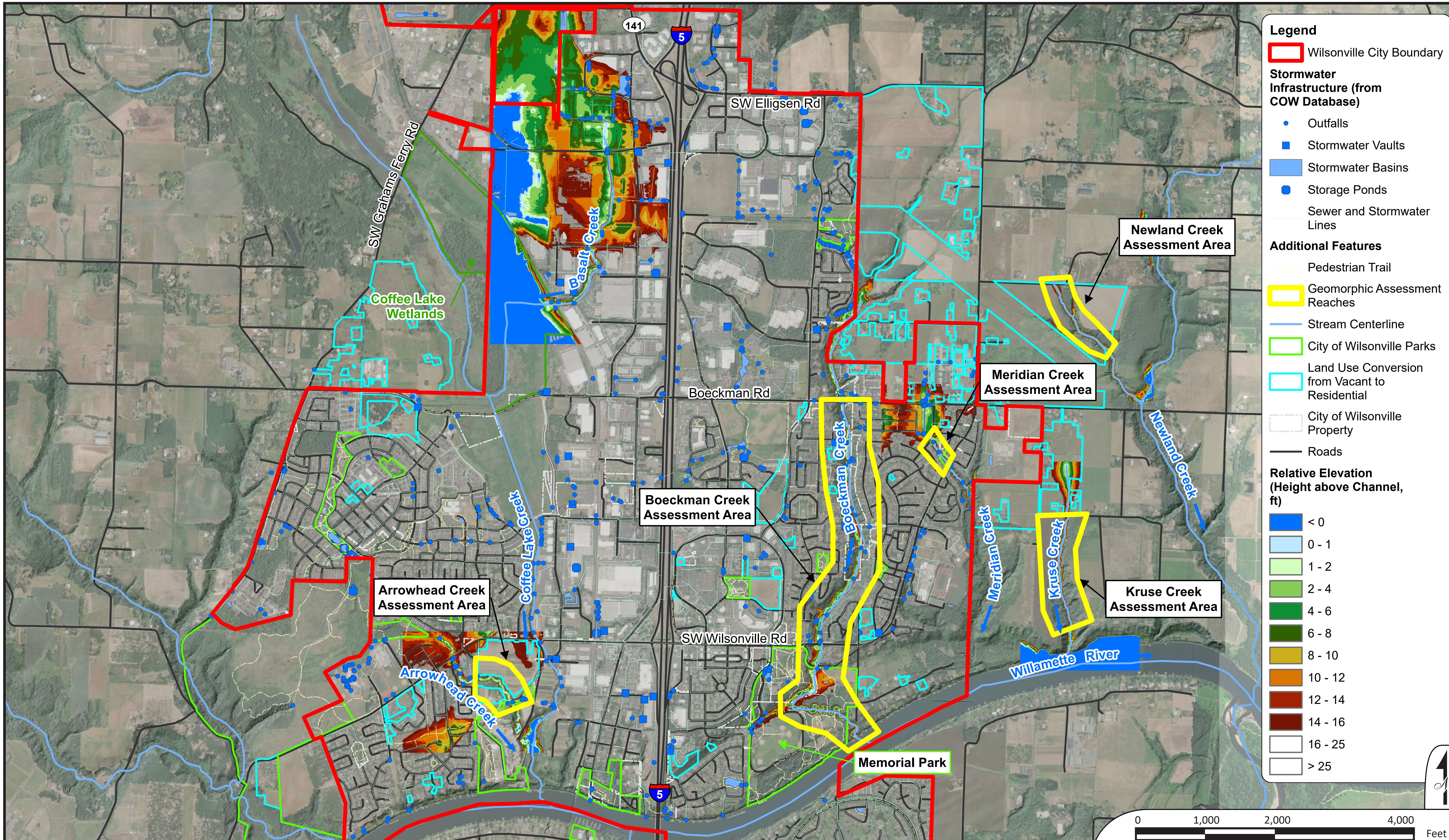


Kruse Creek Geomorphic Survey	Geomorphic Assessment of Wilsonville Creeks	WATERWAYS CONSULTING, INC. Santa Cruz, CA · watways.com · Portland, OR	FIGURE 9

APPENDIX C

Relative Elevation Maps for Boeckman, Meridian, Arrowhead, Newland, and Kruse Creeks in Wilsonville Oregon

(Overview PDF; full data sets are provided as .tif digital files)



Relative Elevation (Height above Channel) Overview Map

Geomorphic Assessment of Wilsonville Creeks

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FIGURE C1

APPENDIX D (provided separately)

Digital Folders Containing Georeferenced Photographs from Boeckman and Meridian Creeks (including .kmz files with geolocated thumbnails)