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Town of Lake Cowichan Integrated Rainwater Management Plan - 2014

FINAL
Volume 2 – Appendices
June 2015 – Rev 0
KWL Project No. 2218.007

Prepared for:

Town of Lake Cowichan

Prepared by:

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Appendix A

Drainage Inventory
(provided in USB)

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Appendix B

Storm Drain CCTV Inspection Reports
(provided in USB)

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Appendix C

Watercourse Mapping and Review Inventory

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DATA Table for Lake Cowichan Stream Mapping 2013

Stream #	Common Name (if known)	GPS #	GPS Description	Location Descriptors	Width (m)	SPEA (m)*	Stream Description	Vegetation Description (dominant underlined)	Impact Classification					Photo No.	Photo Description
									Invasive Species	Riparian Encroachment	Fish Barrier	Man-made channel (ie: concrete flume, riprap, etc.)	Channel Erosion/ Unstable Channel		
July 2, 2013															
1	Creighton?	**029**	u/s end of culvert under Cowichan Lake Rd	Crosses under Cowichan Lake Road between 7785 (Green Acres Residential Resort) & 7797 Cowichan Lake Road	3-4	15	Flow ~ 1000 L/min, channel in good condition, cobble substrate. 2 water lines at culvert under trail.	Treed native vegetation: bigleaf maple, western redcedar, red alder, sword fern, salmonberry, Equisetum, lady fern, vanilla leaf, moss. Lamium at trail edge.						IMG_8632,	IMG_8632:upstream from Wentworth to CLR.
1	Creighton?	**030**	u/s end of double culverts under walking trail between Cowichan Lake Rd/Wentworth	between Cowichan Lake Rd/Wentworth		15								IMG_8633	IMG_8633: downstream from walking trail toward double culverts under driveways.
2	Exeter Creek?	**031**	u/s end of lower culvert (there is an overflow culvert 1 m higher)(under trail?)	between Cowichan Lake Rd/Wentworth	2-4	15	Flow ~ 40 L/min upstream, downstream is dry. Channel in good condition, substrate: fines & large rocks.	Treed native vegetation: bigleaf maple, western redcedar, red alder, grand fir, sword fern, trillium, red huckleberry, wall lettuce, vanilla leaf.						IMG_8635	IMG_8635: view upstream from walking trail (north)
2	Exeter Creek?	**032**	2 culverts under driveway	between Cowichan Lake Rd/Wentworth		15									
2	Exeter Creek?	**036**	u/s of culvert under Cowichan Lake Rd	Crosses roadway west of 7815 Cowichan Lake Rd		15									
3	Holmes Creek?/Williams Spring?	**033**	u/s end of culvert under Cowichan Lake Rd.	7845 Cowichan Lake Rd is on east side of channel.	<1	10	u/s of CLR: grass, mowed swale	grass, mowed swale	Yes	Yes				IMG_8638	IMG_8638: View u/s (north) from Cowichan Lake rd
3	Holmes Creek?/Williams Spring?	**034**	d/s end of culvert under Cowichan Lake Rd & Greendale Rd	d/s of Greendale Rd	0.5-3	10	d/s of Greendale: stream is a 0.5 m flow within a 3 m HWM excavated channel	Young native tree canopy: bigleaf maple, Douglas-fir, sword fern,Himalayan blackberry, Oregon grape, snowberry, starflowers, columbine, orchardgrass, ocean spray, English ivy, salmonberry.	Yes			Yes			
3	Holmes Creek?/Williams Spring?	**035**	d/s end of culvert under Wentworth	crosses under road between 7854 & 7850 Wentworth		10									
4	Watertank Creek?/Jones Brook?	**037**	u/s end of culvert crossing Greendale Rd	approx 30 m from River	3	10	3 m channel, approx flow 100 L/min, assorted cobble substrate, steep gradient; Downstream end of culvert is perched.	Mature tree canopy: western redcedar, western hemlock, red alder, bigleaf maple, sword fern, skunk cabbage, ,oss, vanilla leaf, trillium, wall lettuce			Possible				
4	Watertank Creek?/Jones Brook?	**038**	confluence with Cowichan River	confluence with Cowichan River		10	confluence with Cowichan River								
4	Watertank Creek?/Jones Brook?	**039**	d/s end of culvert under Cowichan Lake Rd	Cowichan Lake Rd & Greendale Rd		10									
4	Watertank Creek?/Jones Brook?	**040**	d/s end of culvert under trail b/n Cowichan Lake Rd and Greendale rd	Cowichan Lake Rd & Greendale Rd		10	culvert is much longer than trail width								
4	Watertank Creek?/Jones Brook?	**060**	u/s end of culvert under Cowichan Lake Rd	Cowichan Lake Rd & Greendale Rd		10	road side edge approx where culvert crosses rd								
5	Trillium Brooks? (Flow 1)	**041**	d/s end of culvert under Cowichan Lake Rd	Cowichan Lake Rd & Greendale Rd		10	Perched culvert leading to dry channel with large plunge pool	bigleaf maple, western redcedar, grand fir, sword fern, vanilla leaf, trillium, red huckleberry			Possible				
5	Trillium Brooks? (Flow 1)	**042**	confluence of drainage from 41 and 59	Cowichan Lake Rd & Greendale Rd		10	drainage from 041 flows west in ditch along trail to join large culvert downslope from Cowichan Lake Rd and flows under trail								
5	Trillium Brooks? (Flow 1)	**043**	d/s end of culvert under trail b/n Cowichan Lake Rd and Greendale rd	Cowichan Lake Rd & Greendale Rd	2	10	perched culvert, deeply incised/downcut channel, 2 m wide, ~5 L/min on surface with subsurface flows, lots of LWD, assorted cobble sizes				Possible		Yes		
5	Trillium Brooks? (Flow 1)	**053**	u/s end of culvert crossing Greendale Rd	Cowichan Lake Rd & Greendale Rd		10	culverts under Greendale								
5	Trillium Brooks? (Flow 1)	**054**	small trib from west flows along Greendale Rd	Cowichan Lake Rd & Greendale Rd		10	small tributary from west								
5	Trillium Brooks? (Flow 1)	**055**	d/s end of culvert crossing Greendale Rd	Cowichan Lake Rd & Greendale Rd		10	perched				Possible				
5	Trillium Brooks? (Flow 1)	**056**	confluence with Cowichan River	Cowichan Lake Rd & Greendale Rd		10	multichannels								
5	Trillium Brooks? (Flow 1)	**059**	u/s end of culvert under Cowichan Lake Rd	Cowichan Lake Rd & Greendale Rd		10	channel north of here is heavily vegetated								
6	Trillium Brooks? (Flow 2)	**044**	u/s end of culvert under trail b/n Cowichan Lake Rd and Greendale rd	Cowichan Lake Rd & Greendale Rd	3	10	perched, 3 m channel with ~40 L/min, lots of LWD	bigleaf maple, western redcedar, western hemlock, sword fern, vanilla leaf,grass, wall lettuce			Possible				
6	Trillium Brooks? (Flow 2)	**047**	u/s end of culvert crossing Greendale Rd	Cowichan Lake Rd & Greendale Rd		10									
6	Trillium Brooks? (Flow 2)	**048**	d/s end of culvert crossing Greendale Rd	Cowichan Lake Rd & Greendale Rd		10	flows into Cowichan River, would be perched at low River flows								
6	Trillium Brooks? (Flow 2)	**058**	u/s end of culvert under Cowichan Lake Rd	Western edge of 7921 Cowichan Lake Rd & Greendale Rd		10									
7	Trillium Brooks? (Flow 3)	**045**	u/s end of standing culvert under trail	Cowichan Lake Rd & Greendale Rd		10	culvert goes on angle under trail	bigleaf maple, grand fir, red alder, western redcedar, sword fern,							
7	Trillium Brooks? (Flow 3)	**046**	perched culvert	Cowichan Lake Rd & Greendale Rd		10	perched culvert ~20 m west flows under cowichan Lake Rd & flows over banks, no defined channel				Possible				

DATA Table for Lake Cowichan Stream Mapping 2013

Stream #	Common Name (if known)	GPS #	GPS Description	Location Descriptors	Width (m)	SPEA (m)*	Stream Description	Vegetation Description (dominant underlined)	Impact Classification					Photo No.	Photo Description
									Invasive Species	Riparian Encroachment	Fish Barrier	Man-made channel (ie: concrete flume, riprap, etc.)	Channel Erosion/ Unstable Channel		
7	Trillium Brooks? (Flow 3)	**052**	u/s end of culvert crossing Greendale Rd	Cowichan Lake Rd & Greendale Rd	2	10	100 L/min, narrow 2 m channel downcut upstream, assorted cobble substrate						Yes		
7	Trillium Brooks? (Flow 3)	**051**	confluence with Cowichan River	Cowichan Lake Rd & Greendale Rd		10	Coho fry in River								
7	Trillium Brooks? (Flow 3)	**057**	u/s end of culvert under Cowichan Lake Rd	east of 7947 Cowichan Lake Rd & Greendale Rd		10	steep channel in gulley u/s of Cowichan Lake Rd								
July 3, 2013															
8	Greendale Brook/Tiny Creek mainstem	**061**	u/s end of culvert crossing Greendale Rd	west of 7975 Greendale Rd	2-3	10	2-3 m channel with small cobble and fines, low gradient.	Bigleaf maple, western redcedar, Douglas-fir, sword fern, salmonberry, skunk cabbage, red elderberry, lady fern, rushes, holly, iris, reed canary grass, lawn on one, or both, sides	Yes	Yes					
8	Greendale Brook/Tiny Creek mainstem	**062**	d/s end of culvert crossing Greendale Rd	west of 7975 Greendale Rd	1	10	1-m incised channel in wider floodplain								
8	Greendale Brook/Tiny Creek mainstem	**063**	stream crossing at driveway 7960 Greendale Rd	7960 Greendale Rd		10									
8	Greendale Brook/Tiny Creek mainstem	**064**	Creek at property line b/n 7950 & 7960 Greendale Rd	7950 & 7960 Greendale Rd		10	numerous coho fry observed							IMG_8654	IMG_8654: View SW at channelized brook
8	Greendale Brook/Tiny Creek mainstem	**065**	Creek bend at property line b/n 7940 & 7950 Greendale Rd	7940 & 7950 Greendale Rd		10	channel turns south toward Cowichan River								
8	Greendale Brook/Tiny Creek mainstem	**066**	creek confluence with Cowichan River	7940 Greendale Rd		10									
8	Greendale Brook/Tiny Creek tributary	**067**	d/s end of culvert under trail b/n Cowichan Lake Rd and Greendale rd	b/n Cowichan Lake Rd & Greendale Rd		10	Brook runs along toe of slope along agricultural field of small farm, ~40 L/min, iron-oxidizing bacteria present. Channel u/s of Greendale is a channelized stream.	Channel u/s of Greendale is well vegetated		Yes					
8	Greendale Brook/Tiny Creek tributary	**068**	u/s end of culvert under trail b/n Cowichan Lake Rd and Greendale rd	b/n Cowichan Lake Rd & Greendale Rd		10	Brook b/n trail and Cowichan Lake Rd has few defined channels, mostly consisting of ponding and wetlands.								
8	Greendale Brook/Tiny Creek tributary	**069**	u/s end of culvert crossing trail	b/n Cowichan Lake Rd & Greendale Rd		10	~50 L/min								
8	Greendale Brook/Tiny Creek tributary	**070**	d/s end of culvert under Cowichan Lake Rd	b/n Cowichan Lake Rd & Greendale Rd		10									
8	Greendale Brook/Tiny Creek mainstem	**071**	d/s end of culvert under Cowichan Lake Rd	b/n Cowichan Lake Rd & Greendale Rd		10	on an angle from the west								
8	Greendale Brook/Tiny Creek mainstem	**072**	u/s end of culvert under trail	b/n Cowichan Lake Rd & Greendale Rd		15	wide, low profile channel, floodplain channel, ~250 L/min.								
8	Greendale Brook/Tiny Creek mainstem	**073**	d/s end of culvert under trail	b/n Cowichan Lake Rd & Greendale Rd		10	perched culvert, with water line/hose running through it								
9	Stanley Creek mainstem	**074**	u/s end of culvert under trail b/n Cowichan Lake Rd and Greendale rd	b/n Cowichan Lake Rd & Greendale Rd	5-7.5	25	5-7.5 m channel, flow ~2000 L/min, large cobble, boulder substrate	Biglef maple, red alder, western redcedar, sword fern, red elderberry, daphne, palmate coltsfoot, Equisetum, grass, salmonberry, lady fern, English ivy, English holly, thimbleberry, reed canary grass, willow, European bittersweet	Yes						
9	Stanley Creek mainstem	**075**	d/s end of culvert under trail b/n Cowichan Lake Rd and Greendale rd	b/n Cowichan Lake Rd & Greendale Rd		25	channel is lined with concrete	yards on both sides b/n Cowichan Lake Rd & Greendale Rd	Yes	Yes		Yes			
9	Stanley Creek mainstem	**076**	d/s end of culvert under Cowichan Lake Rd	b/n Cowichan Lake Rd & Greendale Rd		25		yards on both sides b/n Cowichan Lake Rd & Greendale Rd	Yes	Yes		Yes			
9	Stanley Creek mainstem	**077**	u/s end of culvert under Cowichan Lake Rd	b/n Cowichan Lake Rd & Greendale Rd		25		yards on both sides b/n Cowichan Lake Rd & Greendale Rd	Yes	Yes		Yes			
9a	Stanley Creek mainstem	**078**	confluence of tributary with mainstem	b/n Cowichan Lake Rd & Greendale Rd	1-4	15	1-4 m channel width varies greatly, ~50 L/min	yards on both sides b/n Cowichan Lake Rd & Greendale Rd	Yes	Yes					
9a	tributary to Staney Creek	**079**	d/s end of culvert under trail b/n Cowichan Lake Rd and Greendale rd	b/n Cowichan Lake Rd & Greendale Rd		10		tributary has same vegetation as mainstem	Yes	Yes					
9a	tributary to Staney Creek	**080**	u/s end of culvert under trail b/n Cowichan Lake Rd and Greendale rd	b/n Cowichan Lake Rd & Greendale Rd		10									
9a	tributary to Staney Creek	**081**	(approx) d/s end of culvert under Cowichan Lake Rd	b/n Cowichan Lake Rd & Greendale Rd		10									
9a	tributary to Staney Creek	**082**	(approx) u/s end of culvert under Cowichan Lake Rd	b/n Cowichan Lake Rd & Greendale Rd		10									
9	Stanley Creek mainstem	**083**	u/s end of culvert crossing Greendale Rd	b/n Cowichan Lake Rd & Greendale Rd		15									
9	Stanley Creek mainstem	**084**	d/s end of culvert crossing Greendale Rd	b/n Cowichan Lake Rd & Greendale Rd		15	concrete wall undercutting on right bank					Yes	Yes	IMG_2430	IMG_2430: Photo not taken at GPS point. View east of confluence area from footbridge across Cowichan River
10	unnamed tributary to Stanley(?)	**085**	u/s end of culvert crossing Greendale Rd	Greendale Rd	0.5	10	0.5 m dry channel	lawn, ornamentals, red elderberry, bigleaf maple, grand fir, vanilla leaf, sword fern, nettles	Yes						

DATA Table for Lake Cowichan Stream Mapping 2013

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									Invasive Species	Riparian Encroachment	Fish Barrier	Man-made channel (ie: concrete flume, riprap, etc.)	Channel Erosion/ Unstable Channel		
10	unnamed tributary to Stanley(?)	**086**	d/s end of culvert crossing Greendale Rd	Greendale Rd		10	poorly defined channel, low profile								
11	Neva (?)(likely)	**087**	in wetland east of access road	The Slopes' development		15-30	wetland complex	shrubby wetland surrounded by vegetation as described in 088, dominated by hardhack, sedge, skunk cabbage, common rush, creeping buttercup						IMG_8667	IMG_8667: View of wetland
11	Neva (?)(likely)	**088**	u/s end of culvert crossing access rd	The Slopes' development		15-30	difficult to access and evaluate due to woody debris and blackberries	Treed canopy at edge, yound forest, red alder, Douglas-fir, western hemlock, bigleaf maple, western redcedar, ash, black cottonwood, salmonberry, trailing blackberry, bracken fern, Himalayan blackberry, evergreen blackberry, salal, red huckleberry, sword fern, skunk cabbage, snowberry, Indian plum, willow.	Yes					IMG_8666	IMG_8666: u/s of access road, channel through wetland
11	Neva (?)(likely)	**089**	d/s end of culvert crossing access rd	The Slopes' development		not assessed	difficult to access and evaluate due to woody debris and blackberries	same as upstream	Yes						
11	Neva (?)(likely)	**090**	lowest point in access rd adjacent to wetland to east	The Slopes' development		n/a	low point on access road, culvert crossing is not at low point								
12	Beadnell mainstem	**091**	u/s end of culvert crossing at Youbou Rd	Youbou Rd@Winter Drive	2-2.5	10	2-2.5 m wide channel with low gradient (2-4%) and riffles, flow ~1000 L/min, cobble substrate 1cm - 20 cm	Mature tree canopy of bigleaf maple, red alder, redcedar, sword fern, salmonberry, lady fern, palmate coltsfoot, columbine, trailing blackberry, red huckleberry, fringe cup	Yes					IMG_8670	IMG_8670: View u/s (north) from Youbou Rd
12	tributary to Beadnell	**092**	Stormwater Pond connector end of pipe into Beadnell creek	Youbou Rd@Winter Drive		10	Pond connector end of pipe into Beadnell creek								
12	tributary to Beadnell	**093**	Outlet of stormwater pond	Youbou Rd@Winter Drive		15-30	outlet of large stormwater pond from new development							IMG_8672	IMG_8672: View southwest to drainage outlet from empty stromwater pond.
12	Beadnell mainstem	**094**	d/s end of culvert crossing at Youbou Rd	Youbou Rd@Winter Drive	5.5	20	5.5 m wide channel from fish-friendly culvert, with low gradient (2-4%), flow ~1000 L/min, cobble substrate 1cm -20 cm, large woody debris	Younger tree canopy of bigleaf maple, red alder, redcedar, sword fern, salmonberry, Equisetum, lady fern, palmate coltsfoot, columbine, trailing blackberry, red huckleberry, fringe cup	Yes					IMG_8673	IMG_8673: View d/s (south) from Youbou Rd
12	Beadnell mainstem	**095**	u/s end of culvert crossing under Oak St	Oak Street at School Board Lands	3.0	10	3.0 m concrete flume with concrete step weirs ~30 cm high in series	West side is natural vegetation (red alder younger tree canopy, Equisetum, salmonberry), east side is residential yards		Yes		Yes		IMG_8674	IMG_8674: View u/s (north) of flume with weirs
12	Beadnell mainstem	**096**	d/s end of culvert crossing under Oak St	Oak Street at School Board Lands	3.0	10	3.0 m concrete flume with concrete step weirs ~30 cm high in series	West side is natural vegetation (red alder younger tree canopy, Equisetum, salmonberry), east side is residential yards		Yes		Yes		IMG_8675	IMG_8675: View d/s (south) of flume with weirs
n/a	Grant's Lake	**097**	Grant's Lake south	Grant's Lake at Johel Crescent		15-30	water extends b/n Johel Crescent houses & Trans Canada Trail; (is there a culvert connecting to the wetland on the south side of the trail	Western redcedar, red-osier dogwood, sword fern, skunk cabbage, snowberry						IMG_8676	IMG_8676:south shore of Grant's lake
13	Pt Ideal upper wetland series	**098**	u/s end of culvert under Pt Ideal Rd	Undeveloped land b/n Pt Ideal & Lakeview Park Rd		10	drainage for upstream channel	recently cleared land with new growth, mostly invasive. Very young red alder, thistle, grass, common rush, Scotch broom, Himalayan blackberry, evergreen blackberry	Yes					IMG_8678 IMG_8680	IMG_8678: View northeast u/s to culvert under Pt Ideal rd IMG_8680: View west of drainage channel coming down slopes from upper wetlands
13	Pt Ideal upper wetland series	**099**	channel u/s from culvert at Pt Ideal Rd	Undeveloped land b/n Pt Ideal & Lakeview Park Rd	<1	10	standing water in narow ditch/channel	invasive species	Yes					IMG_8679	IMG_8679: view west u/s of dry channel
	delete	**100**		Undeveloped land b/n Pt Ideal & Lakeview Park Rd		10									
13	Pt Ideal upper wetland series	**101**	channel u/s from culvert at Pt Ideal Rd	Undeveloped land b/n Pt Ideal & Lakeview Park Rd	<1	10	narrow ditch/channel	invasive species	Yes						
13	Pt Ideal upper wetland series	**102**	small pond	Undeveloped land b/n Pt Ideal & Lakeview Park Rd		10	small pond	invasive species	Yes						
13	Pt Ideal upper wetland series	**103**	channel u/s of small pond	Undeveloped land b/n Pt Ideal & Lakeview Park Rd		10	narrow ditched channel u/s from pond, channel drains wetland above (notes from previous site visits in past).	Himalayan blackberry and thistle growth is impenetrable along former access road.	Yes						
13	Pt Ideal upper wetland series	**104**	d/s end of culvert under Pt Ideal Rd	Pt Ideal Rd		10	dry culvert into steep sided ravine								
13	Pt Ideal upper wetland series	**105**	d/s end of culvert under Pt Ideal Rd	Pt Ideal Rd		10	large culvert into steep sided ravine flows into wetland	red alder, bigleaf maple, Equisetum, sword fern, salmonberry, red elderberry							
13	Pt Ideal upper wetland series	**115**	see 115 entry below			15-30									
14	large wetland	**106**	d/s end of culvert under Pt Ideal Rd	Pt Ideal Rd		15-30	large wetland south of Pt Ideal Rd drains by short channel into Cowichan Lake, 10 L/min	young treed canopy: red alder, bigleaf maple, salmonberry, skunk cabbage, sword fern, sedge, hardhack, lady fern						IMG_8682	IMG_8682: wetland

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Stream #	Common Name (if known)	GPS #	GPS Description	Location Descriptors	Width (m)	SPEA (m)*	Stream Description	Vegetation Description (dominant underlined)	Impact Classification					Photo No.	Photo Description
									Invasive Species	Riparian Encroachment	Fish Barrier	Man-made channel (ie: concrete flume, riprap, etc.)	Channel Erosion/ Unstable Channel		
14	large wetland	**107**	u/s end of culvert under Pt Ideal Rd	Pt Ideal Rd		15-30	large wetland south of Pt Ideal Rd drains by short channel into Cowichan Lake							IMG_8683	IMG_8683: wetland
15	small channel	**108**	culvert crossing under trail at end of Pt Ideal Rd	west of Pt Ideal Rd end	1-2	10	1-2 m ditch to lake	trees recently cut down along whole channel		Yes		Yes		IMG_8685	IMG_8685: View down into dry channel (northeast)
15	delete	**109**													
15	small channel	**110**	culvert into private subdivision	west of Pt Ideal Rd end		10	some standing water	red alders have been cut down, salmonberry, sword fern, thimbleberry, western hemlock, red elderberry, lady fern						IMG_8686	IMG_8686:view south u/s from culvert underground into development
15	small channel	**111**	upstream head of ill-defined channel	west of Pt Ideal Rd end	0.5-1	10	0.5-1 m wide very steep channel	young red alders and vegetation as d/s						IMG_8687	IMG_8687: view south u/s at channel
16	Pt Ideal upper wetland series	**112**	d/s end of culvert under campground rd off LakeView Park Rd	Undeveloped land b/n Pt Ideal & Lakeview Park Rd		15-30	connects wetlands on either side of dirt road	black cottonwood, Douglas-fir, western hemlock, red alder, cascara, western red cedar, hardhack, bracken fern, red elderberry, snowberry, sword fern, salmonberry, salal, skunk cabbage, scirpus, willows						IMG_8688	IMG_8688: view north at outlet into wetland at campground road off Lakeview
16	Pt Ideal upper wetland series	**113**	u/s end of culvert under LakeView Park Rd	Undeveloped land b/n Pt Ideal & Lakeview Park Rd		15-30	wetland north of Lakeview Park Rd includes drainage from roadsides	as above						IMG_8689	IMG_8689: View west along roadside drainage into wetlands
16	Pt Ideal upper wetland series	**114**	d/s end of culvert under LakeView Park Rd	Undeveloped land b/n Pt Ideal & Lakeview Park Rd		15-30	drains to large wetland on south side of Lakeview Rd	as above							
13	Pt Ideal upper wetland series	**115**	d/s end of culvert under Pt Ideal Rd	Pt Ideal Rd		10	channel drains into wetland								
17	small channel	**116**	u/s end of culvert under Pt Ideal Rd	Pt Ideal Rd	1	10	1 m wide steep gradientchannel from south	Very young trees adjacent to cleared ROW with trail (west) and house (east): red alder, bigleaf maple, red elderberry, sedge, salmonberry, Himalayan blackberry, curley dock, grass	Yes					IMG_8690	IMG_8690: View South u/s
18	small channel	**117**	u/s end of culvert under Pt Ideal Rd	Pt Ideal Rd	2	10	2 m wide low gradient	red alder, reed canary grass, Himalayan blackberry, evergreen blackberry, morning glory, grass, Scotch broom	Yes					IMG_8692	IMG_8692: Wetland edge at road
18	small channel	**118**	d/s end of culvert under Pt Ideal Rd	Pt Ideal Rd		15-30	at wetted edge of lake	wetland at lake edge: willow red alder, bigleaf maple, red-osier dogwood							
October 9-10, 2013															
19	Oliver/Hatchery mainstem	**126**	u/s end of concrete box culvert 3.2 m wide	Friendship Park,crosses under South Shore Rd.	~6.0	15	Flow ~ 3000-4000 L/min, channel in good condition,meandering channel with wide floodplain, riffles, undercut banks, LWD, substrate: mix boulder, cobbles, sand, fines	Treed native vegetation: mature & immature western redcedar, red alder, bigleaf maple, western hemlock, sword fern, salmonberry, palmate coltsfoot, Equisetum, spiny wood fern, skunk cabbage, sedges, moss. Invasives: Lamium, spurge laurel, holly.	Yes					IMG_2162 IMG_2160 IMG_2165 IMG_2167	IMG_2162: looking upstream from box culvert IMG_2160: looking downstream to box culvert IMG_2165 undercut banks; IMG_2167 constructed riffles
20	stormwater tributary to Oliver/Hatchery	**127**	confluence of small tributary or drain with creek	Friendship Park,immediately u/s of South Shore Rd.	1.0	10	Flow 40 L/min in small U-shaped ditch	Treed native vegetation: mature & immature western redcedar, red alder, bigleaf maple, western hemlock, sword fern, salmonberry, palmate coltsfoot, Equisetum, spiny wood fern, skunk cabbage, sedges, moss. Invasives: Lamium, spurge laurel, holly.	Yes			Yes		IMG_2161	confluence ditch and box culvert
19	Oliver/Hatchery mainstem	**128**	Footbridge over creek	Friendship Park	7.5 m	25	Flow ~ 3000-4000 L/min, channel in good condition,meandering channel with wide floodplain, riffles, undercut banks, LWD, substrate: mix boulder, cobbles, sand, fines	Treed native vegetation: mature & immature western redcedar, red alder, bigleaf maple, western hemlock, sword fern, salmonberry, palmate coltsfoot, Equisetum, spiny wood fern, skunk cabbage, sedges, moss. Invasives: Lamium, spurge laurel, holly.	Yes					IMG_2171	view upstream from footbridge
20	stormwater tributary to Oliver/Hatchery	**129/130**	Crushed 500-600 mm cmp outlet of tributary into ditch to WP 127	Immediately north of South Shore Rd at west edge of Friendship Park: trib is underground above this point.	1.0	10		n/a							
12(?)	old meander to Beadnell	**131**	standing water in depression adjacent to Beadnell Cr flume	Friendship Park at east edge, west of Beadnell Cr flume, could be old meander, original channel, or spring	3	10	standing water in very high cobble/boulder banks	Treed native vegetation: mature & immature western redcedar, red alder, bigleaf maple, red elderberry, sword fern, salmonberry, Devil's club, thimbleberry, Equisetum, bracken fern, moss. Invasives: Himalayan blackberry, ivy, spurge laurel, holly.	Yes					IMG_2173	wide meandering channel with standing water amidst sword ferns

DATA Table for Lake Cowichan Stream Mapping 2013

Stream #	Common Name (if known)	GPS #	GPS Description	Location Descriptors	Width (m)	SPEA (m)*	Stream Description	Vegetation Description (dominant underlined)	Impact Classification					Photo No.	Photo Description
									Invasive Species	Riparian Encroachment	Fish Barrier	Man-made channel (ie: concrete flume, riprap, etc.)	Channel Erosion/ Unstable Channel		
12	Beadnell	**132**	Flume 2.5 m wide	Friendship Park at east edge, just upstream of underground section north of South Shore Rd.	2.5	10	Flow ~ 3000 L/min, channellised in concrete flume with constructed riffles	Residential yards and outbuildings are immediately adjacent to east side of creek with very little vegetation, other than Japanese knotweed (?). West side is treed native vegetation: mature & immature western redcedar, red alder, bigleaf maple, sword fern, salmonberry, Devil's club, thimbleberry, Equisetum, bracken fern, moss. Invasives: Himalayan blackberry, ivy, spurge laurel, holly.	Yes			Yes		IMG_2178 IMG_2179	IMG_2178: streamside development IMG_2179: looking upstream at knotweed(?)
12	Beadnell	**133**	Flume 2.5 m wide, at entrance to underground section	Friendship Park at east edge, at entrance to underground section north of South Shore Rd.	2.5	10	Flow ~ 3000 L/min, channellised in concrete flume with constructed riffles, woody debris jam at entrance	Treed native vegetation: mature & immature western redcedar, red alder, bigleaf maple, sword fern, salmonberry, Devil's club, thimbleberry, Equisetum, bracken fern, moss. Invasives: Himalayan blackberry, ivy, spurge laurel, holly. Understory is 90% H. blackberry here.	Yes			Yes		IMG_2180 IMG_2181	IMG_2180: view east to entrance to underground creek IMG_2181: view from entrance upstream (to north).
19	Oliver/Hatchery mainstem	**134**	channel location, mid-park	Friendship Park near Friendship Trail, mid-park.	7-10	30	Flow ~ 2000-3000 L/min, wide meandering channel up to 10 m wide with gravel bars, LWD, substrate: boulders, cobble, sand and fines	Treed native vegetation: mature & immature western redcedar, red alder, bigleaf maple, western hemlock,red elderberry, sword fern, salmonberry, palmate coltsfoot,Devil's club, Equisetum, spiny wood fern, vanilla leaf, fringecup, moss. Invasives: ivy						IMG_2182 IMG_2183 IMG_2184	IMG_2182: upstream gravel bars IMG_2183:upstream gravel bars, LWD IMG_2184: cobble substrate
19	Oliver/Hatchery mainstem	**135**	Footbridge over creek	Friendship Park on Friendship Trail, mid-park.	5-10	30	Flow ~ 2000-3000 L/min, wide meandering channel up to 10 m wide with gravel bars, LWD, substrate: boulders, cobble, sand and fines	Treed native vegetation: mature & immature western redcedar, red alder, bigleaf maple, western hemlock,red elderberry, sword fern, salmonberry, palmate coltsfoot,Devil's club, Equisetum, spiny wood fern, vanilla leaf, fringecup, moss. Invasives: ivy						IMG_2187 IMG_2188	IMG_2187: Upstream of footbridge IMG_2188: Downstream of footbridge
19	Oliver/Hatchery mainstem	**136**	3 m box culvert from under Stanley Rd (upstream is underground)	Creek is underground south of Friendship Park, between South of South Shore Rd and Stanley Rd.	3	15	Flow ~ 3000-4000 L/min, emerges from underground into constructed banks of asphalt and concrete, asphalt parking area on fill makes up all of the northeast riparian area, LWD, substrate: cobble.	Scattered vegetation, mostly on southwest side Douglas-fir, westerm hemlock, bigleaf maple, western redcedar, salmonberry,Equisetum Invasives: Himalayan blackberry, morning glory, knotweed, figs						IMG_2189 IMG_2190	IMG_2189: downstream from Stanley Rd IMG_2190: artificial banks
19	Oliver/Hatchery mainstem	**137**	Approximate mouth, confluence with north bank of Cowichan River	Confluence with Cowichan River, North bank, south of Stanley Rd		15	South bank: grassy (lawn) delta North bank: constructed riprap and outbuilding on fill to bank edge, substrate: cobble	Grass delta, western redcedar, Nootka rose, sedges. Invasives: Himalayan blackberry, reed canary grass, ivy, weeping willow	Yes	Yes				IMG_2191 IMG_2192	IMG_2191: upstream of confluence IMG_2192: looking downstream at confluence
19	Oliver/Hatchery mainstem	**138**	Between confluence with Cowichan River, North bank, and Stanley Rd	Between confluence with Cowichan River, North bank, and Stanley Rd	5	15	South bank: eroding North bank: constructed riprap and outbuilding on fill to bank edge, substrate: cobble	western redcedar, Nootka rose, sedges. Invasives: Himalayan blackberry, reed canary grass, ivy, weeping willow	Yes			Yes	Yes	IMG_2194 IMG_2195	IMG_2194: looking downstream IMG_2195: looking upstream at box culvert
21		**139**	downstream end of modified ravine/channel at confluence with north bank of Cowichan River	Central Park at end of Stanley Rd at confluence with Cowichan River		10	dry channel with obvious signs of flows and wet vegetation	Poplars (Lombardy?), western redcedar, alders, bigleaf maple, sedges. Invasives: Himalayan blackberry, ivy, spurge laurel, holly.	Yes					IMG_2196	View south into modified channel
21		**140**	top end of modified ravine/channel	Central Park at end of Stanley Rd		10	stormdrain into dry channel with obvious signs of flows and wet vegetation	Poplars (Lombardy?), western redcedar, alders, bigleaf maple, sedges. Invasives: Himalayan blackberry, ivy, spurge laurel, holly.	Yes					IMG_2197	View southwest into top of ravine and storm grate and eop (blue)
22/(20?)	Likely tributary to Oliver Wetland may connect to underground to watercourse 20.	**141**	vertical circular cement casing: flows go underground here from wetland	southwest of Palsson Elementary School,Darnell/ Grosskill Way	2.3-3.0	15-30	Wetland west of school flows along channel into upright cement casing and goes underground at 15-20 L/min, LWD, standing water channel with organic substrate.	Treed native vegetation: mature & immature western redcedar, red alder, bigleaf maple, western hemlock, Douglas-fir, red elderberry, sword fern, salmonberry, Equisetum, spiny wood fern, licroce fern, skunk cabbage, salal, red huckleberry, sedges, moss. Invasives: Himalayan blackberry, ivy, morning glory, spurge laurel, holly.	Yes					IMG_2198	View north to cement casing and upstream
22/(20?)	Likely tributary to Oliver Wetland may connect to underground to watercourse 20.	**142**	HWM of southwestern extent of wetland - not main channel	southwest of Palsson Elementary School,Darnell/ Grosskill Way	n/a	15-30	Southwestern extent of wetland, standing water among tree roots, paved parking lot to west.	Treed native vegetation: mature & immature western redcedar, red alder, bigleaf maple, western hemlock, Douglas-fir, red elderberry, sword fern, salmonberry, Equisetum, spiny wood fern, licroce fern, skunk cabbage, salal, red huckleberry, sedges, moss. Invasives: Himalayan blackberry, ivy, morning glory, spurge laurel, holly.	Yes	Yes				IMG_2202	view of wetland

DATA Table for Lake Cowichan Stream Mapping 2013

Stream #	Common Name (if known)	GPS #	GPS Description	Location Descriptors	Width (m)	SPEA (m)*	Stream Description	Vegetation Description (dominant underlined)	Impact Classification					Photo No.	Photo Description
									Invasive Species	Riparian Encroachment	Fish Barrier	Man-made channel (ie: concrete flume, riprap, etc.)	Channel Erosion/ Unstable Channel		
22/(20?)	Wetland may connect to underground to watercourse 20.	**143**	wetland channel curves to west	southwest of Palsson Elementary School,Darnell/ Grosskill Way	2.5	15-30	Channel has mostly standing water and organic substrate, with evidence of high iron content from iron oxidizing bacteria.	Treed native vegetation: mature & immature western redcedar, red alder, bigleaf maple, western hemlock, Douglas-fir, red elderberry, sword fern, salmonberry, Equisetum, spiny wood fern, licroce fern, skunk cabbage, salal, red huckleberry, sedges, moss. Invasives: Himalayan blackberry, ivy, morning glory, spurge laurel, holly.	Yes					IMG_2205 IMG_2206	IMG_2205: downstream view of channel IMG_2206: upstream view of channel
22/(20?)	Wetland may connect to underground to watercourse 20.	**144**	HWM of western extent of wetland - not main channel	southwest of Palsson Elementary School,Darnell/ Grosskill Way	n/a	15-30	standing water among sedges and tree roots, residences to west, at top of high bank	Treed native vegetation: mature & immature western redcedar, red alder, bigleaf maple, western hemlock, Douglas-fir, red elderberry, sword fern, salmonberry, Equisetum, spiny wood fern, licroce fern, skunk cabbage, salal, red huckleberry, sedges, moss. Invasives: Himalayan blackberry, ivy, morning glory, spurge laurel, holly.	Yes					IMG_2208	wetland composition
22/(20?)	Likely tributary to Oliver Wetland may connect to underground to watercourse 20.	**145**	interior of wetland photo point - not main channel	southwest of Palsson Elementary School,Darnell/ Grosskill Way	n/a	15-30	standing water among sedges and tree roots	Treed native vegetation: mature & immature western redcedar, red alder, bigleaf maple, western hemlock, Douglas-fir, red elderberry, sword fern, salmonberry, Equisetum, spiny wood fern, licroce fern, skunk cabbage, salal, red huckleberry, sedges, moss. Invasives: Himalayan blackberry, ivy, morning glory, spurge laurel, holly.	Yes					IMG_2210	view south of wetland
22/(20?)	Likely tributary to Oliver Wetland may connect to underground to watercourse 20.	**146-148 only one needed, GPS difficulty**	northern edge of wetland at parking lot - not main channel	west of Palsson Elementary School,Darnell/ Grosskill Way	n/a	15-30	open wet meadow south and west of parking lot	Open meadow with treed fringe: species types similar to downstream, but with think invasives: reed canary grass, Himalayan blackberry, ivy, morning glory, spurge laurel, holly. Parking lot to north and east of this wetland, residences to west.	Yes	Yes				IMG_2211 IMG_2212	IMG_2211: wetland view to southeast, reed canary grass IMG_2212: wetland view to southwest of blackberry
19	Oliver/Hatchery mainstem	**149**	u/s end of box culvert >3 m under Grosskleg Way	Creek crosses under Grosskleg Way, north of park.	3.5-6	20	Flows 2000-3000 L/min, wide natural meandering channel with wide floodplain and shallow banks, LWD substrate: boulder, cobbles, sand, fines. Residential development both sides.	Mature treed native vegetation: bigleaf maple, western redcedar, western hemlock, Douglas-fir, red alder, red osier dogwood, salmonberry, sword fern, spiny wood fern, palmate coltsfoot, skunk cabbage, bracken fern, vanilla leaf.						IMG_2214	upstream view of Oliver Creek
19	Oliver/Hatchery mainstem	**150**	d/s end of large perched oval cmp 3m x 2m under Grosskleg Way	Friendship Park: Creek crosses under Grosskleg Way	3-5	15	Flows 2000-3000 L/min, culvert is perched, but may be passable by salmonids, wide natural meandering channel with wide floodplain, undercut banks, LWD, substrate: boulder, cobbles, sand, fines. Trail along west bank.	Mature treed native vegetation: bigleaf maple, western redcedar, western hemlock, Douglas-fir, red alder, red osier dogwood, salmonberry, sword fern, spiny wood fern, deer fern, palmate coltsfoot, skunk cabbage, bracken fern, vanilla leaf. Exotics: laburnum sp.						IMG_2215 IMG_2217	IMG_2215: view downstream from Grosskleg Way IMG_2217: view of perched culvert looking northwest
23	stormwater tributary to Oliver/Hatchery	**151**	incised channel adjacent to school area, upstream of trail, flows southeast to Oliver	North Friendship Park - adjacent to (east of) school	2		deep, incised channel in woods with organic (dirt) substrate, dry. Circular: no stormwater source found. Outlets to Oliver Creek.	same as Oliver Creek Vegetation at 150							
23	stormwater tributary to Oliver/Hatchery	**152**	bend in incised channel adjacent to school area	North Friendship Park - adjacent to (east of) school	2		deep, incised channel in woods with organic (dirt) substrate, dry. Circular: no stormwater source found. Outlets to Oliver Creek.								
23	stormwater tributary to Oliver/Hatchery	**153**	bend in incised channel adjacent to school area	North Friendship Park - adjacent to (east of) school	1		deep, incised channel in woods with organic (dirt) substrate, dry. Circular: no stormwater source found. Outlets to Oliver Creek.								
23	stormwater tributary to Oliver/Hatchery	**154**	bend in incised channel adjacent to school area	North Friendship Park - adjacent to (east of) school	1		deep, incised channel in woods with organic (dirt) substrate, dry. Circular: no stormwater source found. Outlets to Oliver Creek.								
23	stormwater tributary to Oliver/Hatchery	**155**	bend in incised channel adjacent to school area	North Friendship Park - adjacent to (east of) school	1		deep, incised channel in woods with organic (dirt) substrate, dry. Circular: no stormwater source found. Outlets to Oliver Creek.								
23	stormwater tributary to Oliver/Hatchery	**156**	less incised channel adjacent to school area, highest elevation of channel, flows north	North Friendship Park - adjacent to (east of) school	1		Standing water/flows north to 155. Highest elevation and more shallow section of incised channel in woods with organic (dirt) substrate, dry. Circular: no stormwater source found. Outlets to Oliver Creek.								

DATA Table for Lake Cowichan Stream Mapping 2013

Stream #	Common Name (if known)	GPS #	GPS Description	Location Descriptors	Width (m)	SPEA (m)*	Stream Description	Vegetation Description (dominant underlined)	Impact Classification					Photo No.	Photo Description
									Invasive Species	Riparian Encroachment	Fish Barrier	Man-made channel (ie: concrete flume, riprap, etc.)	Channel Erosion/ Unstable Channel		
23	stormwater tributary to Oliver/Hatchery	157	incised channel adjacent to school area, flows south	North Friendship Park - adjacent to (east of) school	1		Divide between 156 and 152, flows south to 152, deep, incised channel in woods with organic (dirt) substrate, dry. Circular: no stormwater source found. Outlets to Oliver Creek.							IMG_2221	IMG_2221: View northwest of overflow channel
23	stormwater tributary to Oliver/Hatchery	158	confluence of channel with west bank of Oliver Creek	North Friendship Park - adjacent to (east of) school	n/a	10	Confluence of stormwater tributary to Oliver Creek. Shallow at this location, dry.								
19	Oliver/Hatchery mainstem	159	Footbridge over creek, corresponds to WP 135, quality check	North Friendship Park	see 135		see 135	see 135							
24	Schoolboard wetland	160	wetland channel culverted under walking trail on east side of Oliver Creek, flows to Oliver Creek	North Friendship Park	2-4	15-30	dual 300 mm black corrugated pipes draining Schoolboard wetland via channel to Oliver Creek, flow 20 L/min in organic substrate	Mature western redcedars, sword fern, spiny wood fern, skunk cabbage						IMG_2222 IMG_2223	IMG_2222: view east, upstream into wetland IMG_2223: view southwest of downstream channel to Oliver
19	Oliver/Hatchery old meander/overflow	161	mid-length of overflow channel, likely original Oliver Creek channel blocked by historical blowdown	North Friendship Park	1-2	not assessed	dry overflow channel, very likely historical channel of Oliver. Substrate mostly organic mixed with boulder, cobble.	see 135						IMG_2225 IMG_2226	IMG_2225: Downstream view of old channel IMG_2226: Historical erosion of cedar roots in old channel
19	Oliver/Hatchery old meander/overflow	162	bend in overflow channel, likely original Oliver Creek channel blocked by historical blowdown	North Friendship Park	1-2	not assessed	Bend in dry overflow channel, very likely historical channel of Oliver. Substrate mostly organic mixed with boulder, cobble.	see 135							
19	Oliver/Hatchery mainstem with old meander/overflow	163	Downstream confluence of overflow channel with Oliver Creek, likely original Oliver Creek channel blocked by historical blowdown	North Friendship Park	1-2	not assessed	Downstream confluence of dry overflow channel, very likely historical channel of Oliver. Substrate mostly organic mixed with boulder, cobble.	see 135							
19	Oliver/Hatchery old meander/overflow	164	standing water in overflow channel, likely original Oliver Creek channel blocked by historical blowdown	North Friendship Park	1-2	not assessed	Standing water in overflow channel, very likely historical channel of Oliver. Substrate mostly organic mixed with boulder, cobble.	see 135							
19	Oliver/Hatchery mainstem with old meander/overflow	165	Upstream confluence/overflow location of channel with Oliver Creek, likely original Oliver Creek channel blocked by historical blowdown located here	North Friendship Park	1-2	not assessed	Mostly dry overflow channel, very likely historical channel of Oliver, altered to due obvious blowdown at this location. Substrate mostly organic mixed with boulder, cobble.	see 135						IMG_2227 IMG_2229 IMG_2230	IMG_2227: view upstream to blowdown and confluence IMG_2229: view of Oliver extreme bend due to blowdown IMG_2230: view downstream to blowdown and confluence
	delete	166													
	n/a	167	newly excavated well head	North Friendship Park	n/a	n/a	recently installed well-head	excavation clearing in native vegetation forest, still un-vegetated.		Yes				IMG_2231	wellhead
19	Oliver/Hatchery mainstem	168	concrete control structure (eroded) on Oliver Creek	North of Grosskleg Way	1.1 (5)	20	Old eroded concrete flow control structure, restricts low flows with 1.1 m opening, however wall in low and higher flows would be unrestricted, LWD, wide meandering stream becomes steeper and narrower upstream of this location, substrate: boulder, cobbles, sand, fines.	Mature treed native vegetation: bigleaf maple, western redcedar, western hemlock, Douglas-fir, red alder, red osier dogwood, salmonberry, sword fern, spiny wood fern, palmate coltsfoot, skunk cabbage, bracken fern, vanilla leaf.				Yes	Yes	IMG_2235 IMG_2237	IMG_2235: View downstream from control structure IMG_2237: view upstream to control structure and waterfall tributary
19	stormwater tributary to Oliver/Hatchery	169	waterfall tributary at confluence with Oliver Creek	North of Grosskleg Way, emanating from newer housing development		10								IMG_2234	IMG_2234: View of stormwater outfallsource of tributary
19	Oliver/Hatchery mainstem	170	last easily accessible bend in Oliver u/s of Grosskleg Way	North of Grosskleg Way	3-6	20	Steeper channel than downstream, LWD, substrate: boulder, cobbles, sand, fines.	Mature treed native vegetation: bigleaf maple, western redcedar, western hemlock, Douglas-fir, red alder, red osier dogwood, salmonberry, sword fern, spiny wood fern, palmate coltsfoot, skunk cabbage, bracken fern, vanilla leaf.							
19	Schoolboard wetland	171	Photopoint of School Board Wetland from high bank	East of Grosskleg Way, School Board Lands	NA	15-30	Wetland with standing water, old cars, tires, debris and garbage, LWD	Wetland of red osier dogwood, bigleaf maple, red alder, sword fern.						IMG_2238	IMG_2238: View SE of wetland from high bank
12	Beadnell	172	footbridge on flume of Beadnell Creek	School Board Lands	2.5	10	Cement walled flume with residences and residential activity immediately adjacent on east side (at stream edge).	Mature and immature redcedar, Douglas-fir, bigleaf maple, red alder, sword fern. Very little groundcover.		Yes		Yes		IMG_2239 IMG_2240	IMG_2239: View downstream from footbridge IMG_2240: View upstream to footbride
12	Beadnell	173	Beadnell Creek top of flume at CMP, downstream from disused roadway	School Board Lands	2.4	10	Cement walled flume with oval CMP (1.4 m X 2.2 m), engine parts in stream. Flow ~1000 L/mi, ,substrate: gravel and sand over cement	Mature and immature redcedar, Douglas-fir, bigleaf maple, red alder, sword fern, Devil's club. Very little groundcover.				Yes		IMG_2241 IMG_2243	IMG_2241: View downstream IMG_2243: View upstream to CMP
12-2a/11	Beadnell seeps/Neva confluence?	174	1st tributary flow (12-2a: likely Neva Creek) to main Seep Tributary (12-2) to Beadneel Creek crossing over disused dirt road	School Board Lands: North end in forest, south of Youbou Rd	2.0	10	Small tributary crossing over dirt road from North with very shallow channel of sand and gravel, flow ~40L/min	Immature forest of young red alder and salmonberry, thimbleberry and fringecup						IMG_2245 IMG_2246	IMG_2245: View upstream IMG_2246: View downstream

DATA Table for Lake Cowichan Stream Mapping 2013

Stream #	Common Name (if known)	GPS #	GPS Description	Location Descriptors	Width (m)	SPEA (m)*	Stream Description	Vegetation Description (dominant underlined)	Impact Classification					Photo No.	Photo Description
									Invasive Species	Riparian Encroachment	Fish Barrier	Man-made channel (ie: concrete flume, riprap, etc.)	Channel Erosion/ Unstable Channel		
12-2 & 12-2b	Beadnell seeps	175	Confluence of 2nd tributary (12-2b) from seeps with main Seeps Tributary (12-2)	School Board Lands: North end in forest, south of Youbou Rd		10	Confluence of main Seep Tributary (~200 L/min) to Beadnell Creek and smaller tributary from North; shallow meandering channel of fines and gravel, sand.	Immature forest of bigleaf maple, hemlock, young red alder and salmonberry, thimbleberry and red huckleberry						IMG_2249	IMG_2249: Viewfrom confluence of downstream (ESE)
12-2b	Beadnell seeps	176	2nd tributary flow (12-2b) crossing under disused dirt road to main Seep Tributary (12-2)	School Board Lands: North end in forest, south of Youbou Rd	1.0	10	Small tributary crossing from North under dirt road through CMP with narrow cut channel of sand and gravel, flow ~150L/min, LWD.	Immature forest of bigleaf maple, hemlock, young red alder and salmonberry, sword fern, skunk cabbage, thimbleberry and red huckleberry						IMG_2247 IMG_2248	IMG_2247: View downstream from road (SE) IMG_2248: View upstream from road (NW)
12-2c	Beadnell seeps	177	swampy area north of dirt road generally feeds main Seep Tributary (12-2)	School Board Lands: North end in forest, south of Youbou Rd		15-30	Swampy area of standing water north of dirt road generally feeds main Seep Tributary	Immature forest of young red alder, salmonberry, skunk cabbage, sword fern, deer fern						IMG_2250	IMG_2250: View north from dirt road
12-2	Beadnell seeps	178	Main Seep Tributary (12-2) to south of dirt road	School Board Lands: North end in forest, south of Youbou Rd	1.5-3.0	10	Main Seep Tributary flowing from west to east in poorly defined swampy channels, with flow ~ 200 L/min.	Immature forest of young red alder, salmonberry, skunk cabbage, sword fern, deer fern						IMG_2251 IMG_2254	IMG_2251: View downstream IMG_2254: View upstream
12-2	Beadnell seeps	179	Main Seep Tributary (12-2) to south of dirt road	School Board Lands: North end in forest, south of Youbou Rd	1.6	10	Main Seep Tributary flowing from west to east in well-defined channel, with LWD, meanders, cut banks, and small gravel bars.	Mature hemlock, cedar, immature red alder, sword fern, lady fern, skunk cabbage, Equisetum sp., sedges, palmate coltsfoot						IMG_2255 IMG_2256	IMG_2255: View of cutbanks and gravel bars IMG_2256: View upstream of obvious stream channel erosion
12-2	Beadnell seeps	180	Main Seep Tributary (12-2) headwater (end)	School Board Lands: North end in forest, south of Youbou Rd		30	Main Seep Tributary flowing from west to east in shallow gravel channel with LWD at head of stream (flows from seeps) where significant reconstruction has taken place to divert/alter channel flows. Shallow stream channel shows rusty orange colour indicative of iron-utilizing bacteria, wetted only.	Mature hemlock, cedar, immature red alder, sword fern, lady fern, skunk cabbage, Equisetum sp., sedges, palmate coltsfoot						IMG_2257 IMG_2258 IMG_2259	IMG_2257: Upstream IMG_2258: Downstream IMG_2259: End of stream at reconstruction area
		181	DELETE point												
12	Beadnell	182	Main channel of Beadnell Creek downstream of Youbou Rd at reconstruction	School Board Lands: North end in forest, south of Youbou Rd	2-10	30	Sharp bend in main channel of Beadnell Creek is braided gravel channel of highly varible width immediately adjacent to main Seeps Tributary headwaters. Channel has been heavily modified with gravel movement and gravel berms are built up to separate main flow from seeps tributary. Heavy machinery tracks visible. Humocky with LWD.	Mature hemlock, cedar, immature red alder, sword fern, lady fern, skunk cabbage, Equisetum sp., sedges, palmate coltsfoot				Yes	Yes	IMG_2260 IMG_2261 IMG_2262	IMG_2260: Downstream bend showing alterations and LWD IMG_2261: Downstream showing alterations and LWD IMG_2262: Upstream showing braided gravel channel and alterations
12-2b	Beadnell seeps	183	Headwater swamp/seep of 2nd tributary flow (12-2b), immediately south of Youbou Road at tree house.	School Board Lands: North end in forest, south of Youbou Rd	1-2	10	Headwater swamp/seep of shallow flow to point 176, with iron-utilizing bacteria.	Hemlock, cedar, bigleaf maple, immature red alder, salmonberry, Equisetum, salal, skunk cabbage, sword fern						IMG_2263 IMG_2264	IMG_2263: downstream view south IMG_2264: Flows emerge/originate at mature trees
12-2a	Beadnell seeps	184	1st seep tributary (12-2a), downstream of Youbou Road, far upstream of main Seeps Tributary	School Board Lands: North end in forest, south of Youbou Rd	1.8	10	1st seep tributary in shallow and low profile gravel channel, flow ~40 L/min	Immature forest of young red alder, salmonberry, skunk cabbage, sword fern, deer fern						IMG_2265	IMG_2265: View downstream (south)
12-2a/11	Beadnell seeps/Neva Creek(?)	184	1st seep tributary (12-2a: likely Neva Creek), downstream of Youbou Road, far upstream of main Seeps Tributary	School Board Lands: North end in forest, south of Youbou Rd	1.8	10	1st seep tributary in shallow and low profile gravel channel, flow ~40 L/min	Immature forest of young red alder, salmonberry, skunk cabbage, sword fern, deer fern						IMG_2265	IMG_2265: View downstream (south)
12-2a/11	Beadnell seeps/Neva Creek(?)	185	Slightly perched CMP downstream of Youbou Road for 1st seep tributary (12-2a: likely Neva Creek)	School Board Lands: North end in forest, south of Youbou Rd		10	Slightly perched 1.2 m CMP downstream of Youbou Road for 1st seep tributary, rocky steep section from road.	Immature forest of hemlock, young red alder, salmonberry, sword fern, deer fern						IMG_2266	IMG_2266: View upstream (north) to Youbou Road culvert
12-2	Beadnell seeps	187	main Seep Tributary (12-2) immediately upstream of confluence CMP	School Board Lands	2.4	10	main Seeps tributary immediately upstream from Beadnell Creek confluence CMP, channel through mature tree roots varies widely, substrate: gravel and fine sand, flow ~150 L/min	Mature and immature redcedar, Douglas-fir, bigleaf maple, red alder, sword fern, salmonberry						IMG_2244 IMG_2268	IMG_2244: view SSW upstream of main Seeps trib from road IMG_2268: View upstream of main Seeps trib (NW)
12 & 12-2	Beadnell	188	CMP, upstream from disused roadway, confluence of Beadnell Creek (12) and main Seep Tributary (12-2)	School Board Lands		10	CMP	Mature and immature redcedar, Douglas-fir, bigleaf maple, red alder, sword fern, salmonberry						IMG_2269	IMG_2269: View (SW) to confluence CMP
12	Beadnell	189	Beadnell Creek braided floodplain u/s of road at flume start	School Board Lands		10	braided stream channel								
12	Beadnell	190	Beadnell Creek at fish box	School Board Lands	1.0 - 3.5	10	Newly constructed channel of rip rap, flow ~1000 L/min, width generally 3.5 m, constricted to 1.0 m at fish box	Mature and immature redcedar, Douglas-fir, bigleaf maple, red alder, sword fern, salmonberry						IMG_2270 IMG_2271 IMG_2274	IMG_2270: Upstream view of fish box IMG_2271: Downstream View IMG_2274: Downstream view of constructed channel
12	Beadnell	191	Beadnell Creek upstream of fish box	School Board Lands	>5	15	Wide slow flowing braided mainstem of Beadnell channel thick with ferns.	Mature and immature redcedar, Douglas-fir, hemlock, bigleaf maple, red alder, bracken fern, spiny wood fern, salal, red huckleberry, sword fern, salmonberry						IMG_2273	IMG_2273: Upstream view of Beadnell Creek in wide channel

DATA Table for Lake Cowichan Stream Mapping 2013

Stream #	Common Name (if known)	GPS #	GPS Description	Location Descriptors	Width (m)	SPEA (m)*	Stream Description	Vegetation Description (dominant underlined)	Impact Classification					Photo No.	Photo Description
									Invasive Species	Riparian Encroachment	Fish Barrier	Man-made channel (ie: concrete flume, riprap, etc.)	Channel Erosion/ Unstable Channel		
25	Tern Creek mainstem	**192**	Tern Creek u/s end of culvert abutment under Elk Rd (open channel upstream from here)	crosses under Elk Rd	1.0	10	deep, rocky channel upstream from culvert, flow ~150 L/min. Not assessed in-stream due to access	Mature and immature redcedar, Douglas-fir, bigleaf maple, red alder, sword fern, salmonberry, spiny wood fern, Equisetum, skunk cabbage, Himalayan blackberry, holly	Yes					IMG_2275	IMG_2275: Upstream view of Tern Creek from Elk Rd
25	Tern Creek mainstem	**193**	Tern Creek d/s end of culvert under Elk Rd (open channel downstream from here)	crosses under Elk Rd	1.3	10	Deeply incised channel downstream from perched 900 mm cmp, flow ~150 L/min.	Mature and immature redcedar, Douglas-fir, bigleaf maple, red alder, sword fern, salmonberry, spiny wood fern, Equisetum, skunk cabbage, Himalayan blackberry, holly	Yes		Possible			IMG_2276	IMG_2276: Downstream view of Tern Creek from Elk Rd
25	pond tributary to Tern Creek	**194**	u/s end of culvert under road from ornamental pond at property on corner of Elk Rd and driveway to 104/106 (? Rd?)	downstream of Elk Rd on private driveway	na	15-30	u/s end of pipe draining ornamental pond and discharging into Tern Creek							IMG_2277	IMG_2277: Ornamental pond discharging into Tern Creek, view from Elk Rd
25	Tern Creek mainstem	**195**	u/s end of culvert under driveway 104/106 (? Rd?) south of Elk Rd	upstream end of culvert under driveway at 104/106	2.5-3.0	10	creek u/s of here to Elk Rd is wide and swampy with LWD, narrowing to steeply sided channel at ~500 mm cmp	As above, with many downed trees and heavy himalayan blackberry thicket at road crossing	Yes					IMG_2279	IMG_2279: View northwest upstream at Tern creek from culvert under driveway
25	Tern Creek mainstem	**196**	d/s end of culvert under driveway 104/106 (? Rd?) south of Elk Rd	104/106 (?) Elk Rd		10	Creek downstream slopes steeply from ~500 mm cmp, rocky and modified by recent expansion and encroachment of residential driveway and parking area at 106 (Elk? Rd). 10-20 m of fill to channel edge.	redcedar, elderbrry, bigleaf maple, sword fern, salmonberry, spiny wood fern, himalayan blackberry	Yes	yes				IMG_2280 IMG_2281	IMG_2280:View east downstream from culvert, fill and erosion IMG_2281:Close up ofbank erosion at culvert
25	Tern Creek mainstem	**197/198**	centre of footbridge across creek (197/198 same point)	104/106 (?) Elk Rd	1.8	10	very steep (>15%), large boulder, modified channel, driveway fill downstream is encroaching to channel edge with large boulders (up to 1 m diameter) at top of bank, steep banks with LWD and erosion evident. ~200 L/min	Mature redcedar, elderbrry, bigleaf maple, sword fern		Yes		Yes		IMG_2283 IMG_2285 IMG_2286 IMG_2287	IMG_2283: View d/s to footbridge IMG_2285: View west upstream to upper parking fill IMG_2286: stream substrate IMG_2287: View east downstream
	Tern Creek	--	could not locate Tern Road crossing culverts without trespass on private property												
	tributary flows to Tern Creek (?)	**199**	u/s end of culvert crosses under road, may be tributary to Tern Creek	Beaver Rd culvert crossing			dry, but historic flow evidence observed								
	tributary flows to Tern Creek (?)	**200**	u/s end of culvert crosses under road, may be tributary to Tern Creek	Beaver Rd culvert crossing			wet area with no determined channel (Cowichan Lake Baptist Church) 400 mm culvert crosses under road, may be tributary to Tern Creek. No outlet found d/s on opposite side of road	bigleaf maples, conifers, salmonberry, sedges, spiny wood fern, Himalayan blackberry, morning glory, filled with yard & garden waste						IMG_2290	IMG_2290: View North to open wet area above culvert
	tributary flows to Tern Creek (?)	**201**	u/s end of ditch north of Savoy Rd from under Tern Rd ROW	Savoy Rd at Tern Rd ROW	1		1 m wide vegetated ditch, ~ 10 L/min							IMG_2291	IMG_2291: View North to open ditch
	tributary flows to Tern Creek (?)	**202**	d/s end of ditch north of Savoy Rd from under Tern Rd ROW at culvert heading d/s under Savoy	Savoy Rd at Tern Rd ROW	1		1 m wide vegetated ditch								
25	Tern Creek mainstem	**203**	u/s end of 800-900 mm outlet from pond inline with creek (underground d/s from here)	45 North Shore Rd		15-30	rockwalled pond of sedges with 800-900 mm pvc with rebar debris grate outlet, with cobble/gravel substrate flow ~200 L/min	residential yard/lawn	Yes	Yes		Yes		IMG_2292 IMG_2293 IMG_2295	IMG_2292: view northwest u/s at pond IMG_2293: view south at culvert outlet from pond IMG_2295: View west u/s at cement sandbag channel and gravel substrate
25	Tern Creek mainstem	**204**	footbridge over creek	47 North Shore Rd	0.7-1.3	10	cement sandbag channel 0.5 m deep, 0.7-1.3 m varying width, nice gravel/cobble substrate	residential yard/lawn	Yes	Yes		Yes		IMG_2296 IMG_2299	IMG_2296: View u/s to footbridge IMG_2299: View d/s east to footbridge from outlet
25	Tern Creek mainstem	**205**	d/s end of brick covered culvert and start of concrete sandbag channel (underground u/s from here)	47 North Shore Rd		10	outlet from u/s underground flows through brick culvert (?) into cement sandbag channel 0.5 m deep, 0.7-1.3 m varying width with cobble/gravel substrate; ~200 L/min	residential yard/lawn	Yes	Yes		Yes		IMG_2297	IMG_2297: View Northwest of brick covered culvert
25	Tern Creek mainstem	**206**	stormwater MH in North Shore Rd	North Shore Rd			underground section of creek								
25	Tern Creek mainstem	**207**	d/s end of culvert under Park Rd	Park Rd	>1.5	10	open rock lined channel with one steep bank and one gradual bank, widens from 1.5 m, boulder and cobble substrate with indicators for high iron content. Homeowner reports sightings of Coho and Rainbow Trout.	mature redcedar, bigleaf maple, spiny wood fern, sword fern,skunk cabbage, heavy ivy & periwinkle infestation	Yes			Yes		IMG_2300 IMG_2305	IMG_2300: View southeast d/s of rock lined channel IMG_2305: View u/s of bend in creek
25	Tern Creek mainstem	**208**	bend in creek	Park Rd	2.6	10	open channel creek with gravel/cobble/boulders, wide channel with built up rock bank	mature redcedar, bigleaf maple, spiny wood fern, sword fern,skunk cabbage, heavy ivy & periwinkle infestation	Yes			Yes		IMG_2301	IMG_2301: view east d/s of bend in creek
25	Tern Creek mainstem	**209**	u/s end of 800 mm CMP	Park Rd	2.6	10	creek enters 800 mm culvert; substrate gravel/cobble/boulders, wide channel with built up rock bank	mature redcedar, bigleaf maple, spiny wood fern, sword fern,skunk cabbage, heavy ivy & periwinkle infestation	Yes			Yes		IMG_2304 IMG_2307	IMG_2304: View South of u/s end of 800 mm CMP IMG_2307: View North u/s from CMP

DATA Table for Lake Cowichan Stream Mapping 2013

Stream #	Common Name (if known)	GPS #	GPS Description	Location Descriptors	Width (m)	SPEA (m)*	Stream Description	Vegetation Description (dominant underlined)	Impact Classification					Photo No.	Photo Description
									Invasive Species	Riparian Encroachment	Fish Barrier	Man-made channel (ie: concrete flume, riprap, etc.)	Channel Erosion/ Unstable Channel		
25	Tern Creek mainstem	210	confluence with Cowichan River	Park Rd	1-1.5	10	incised channel, vegetated banks, thick vegetative debris at confluence ~200 L/min	mature redcedar, bigleaf maple, spiny wood fern, sword fern, salmonberry, skunk cabbage, Equisetum, sedges, heavy ivy & holly infestation	Yes					IMG_2309 IMG_2310	IMG_2309: Viewnorth u/s from confluence with Cowichan IMG_2310: View south d/s to confluence with Cowichan
25	Tern Creek mainstem	211	channel	Park Rd	0.7-1.0	10	incised channel in vegetated steep banks	mature redcedar, bigleaf maple, spiny wood fern, sword fern, salmonberry, skunk cabbage, Equisetum, sedges, heavy ivy & holly infestation	Yes					IMG_2311 IMG_2314	IMG_2311: View Southeast d/s of ivy infestation IMG_2314: incised narrow channel in ivy
25	Tern Creek mainstem	212		Park Rd		10	rock retaining wall down to water level, wide floodplain with gravel/cobble substrate	mature redcedar, bigleaf maple, spiny wood fern, sword fern, salmonberry, skunk cabbage, Equisetum, sedges, heavy ivy & holly infestation	Yes					IMG_2315	IMG_2315: d/s view (south) of shady vegetated channel
25	Tern Creek mainstem	213	corner of rock retaining wall	Park Rd		10	rock retaining wall down to water level, wide floodplain with gravel/cobble substrate	yard & garden waste in stream	Yes	Yes		Yes		IMG_2316 IMG_2322	IMG_2316: View northwest of rock retaining wall IMG_2322: View east of retaining wall and channel
25	Tern Creek mainstem	214	d/s end of 800 mm CMP	Park Rd		10	wide channel floodplain to south, gravel/cobble substrate							IMG_2319	IMG_2319: View upstream to culvert
October 23, 2013															
26	Upper Tiny Creek/Castle Creek	215	u/s culvert crossing Youbou Rd/Cowichan Valley Hwy	Youbou Rd/Cowichan Valley Hwy intersection		10	heavy blackberries prevent access to channel, filled with reed canary grass, no water heard. Channel appear to enter from the east from ditch along north side of Hwy. No flows or historic channels seen directly north of this location (contrary to historic mapping), with extensive serching. Street address map indicates creek was diverted during hwy construction.	2nd growth Douglas-fir, bigleaf maple, young red alder, Himalayan blackberry, Scotch broom, reed canary grass	Yes			yes		IMG_2394 IMG_2396 IMG_2398	IMG_2394: View north to u/s end of culvert area IMG_2396: View south toward culvert crossing hwy from u/s area formerly marked as stream channel, no evidence seen of flows. IMG_2398: View of access rd in area u/s of culvert formerly marked as stream channel, no evidence seen of flows.
26	Upper Tiny Creek/Castle Creek	216	d/s end of culvert under driveway in ditch along Cowichan Valley Hwy	North side of Cowichan Valley Hwy, east of Youbou intersection, 8045 Cowichan Valley Hwy	1.5	10	d/s end of 450-500 mm CMP under driveway, 1.5 m wide deep ditch, approx flow 40 L/min	roadside cut vegetation: red alder saplings, sitka willow, rushes, grasses and Scotch broom	Yes			Yes		IMG_2388 IMG_2390	IMG_2388: View d/s (west) from driveway crossing at 8045 CV Hwy IMG_2390: View u/s (east) from driveway crossing at 8045 CV Hwy
26	Upper Tiny Creek/Castle Creek	217	end of pipe discharging into roadside ditch	immediately west of 8045 Cowichan Valley Hwy		10	600 mm CMP discharging into deep ditch with approx flow 40 L/min, 1 m above ditch bottom. CMP originates from North, appears to be mainstem of tributary.		Yes			Yes		IMG_2391	IMG_2391: View of culvert discharging into hwy ditch
26	Upper Tiny Creek/Castle Creek	218	d/s end of culvert under Youbou Rd/Cowichan Valley Hwy.	Youbou Rd/Cowichan Valley Hwy intersection		10	channel flows southwest along south side of Cowichan Valley Hwy to confluence with Stanley Cr at GPS#240.	Douglas-fir, red alder, juvenile western redcedar, salal, bracken fern, bigleaf maple samplings, red huckleberry, trailing blackberry, Scotch brrom, sword fern	Yes					IMG_2392	IMG_2392: View southwest of d/s end of culvert under CV Hwy, roadside ditch flows southwest toward Stanley Cr.
9	Stanley Creek mainstem	219	u/s culvert crossing Youbou Rd	Youbou Rd	2.5-4.5	15	2.5 m oval, fish-friendly CMP, channel 4.5 increasing to 5 m upstream, boulders, cobble and gravel, few fine sediments, step-pools. Flows approx 500 L/min with rafted large woody debris, boulder banks indicative of high winter flows.	New forest: young red alder, salmonberry. young bigleaf maple, tall unknown laurel, Himalyan blackberry, spurge laurel, sword fern, Equisetum sp, sparse understory.	Yes					IMG_2400 IMG_2401 IMG_2402 IMG_2403	IMG_2400: View North (u/s) from Youbou Rd IMG_2401: View North (u/s) from culvert IMG_2402: View south (d/s) into culvert under Youbou Rd IMG_2403: View North (u/s) from culvert
9	Stanley Creek mainstem	220	d/s end of culvert crossing Youbou Rd	Youbou Rd	6	20	1.8 m tall CMP, large pool at eop, 6 m wide channel d/s estimated, sand and gravel heavier d/s than u/s of Youbou, higher sinuousity d/s.	Mature western redcedar and Douglas-fir, bigleaf maple, sword fern, English holly,						IMG_2405	IMG_2405: View south (d/s) from Youbou Rd
11	Neva (?)/Swan	221	u/s end of 1200 mm CMP under Youbou Rd	North of Youbou Rd	1-1.5	10	1-1.5 m dry channel with extremely heavy scouring leading into 1200 mm CMP, large boulders in fine matrix, deeply eroded channel with pits lined with fines	Young forest of red alder, bigleaf maple, western redcedar, dense sword fern, Himalayan blackberry, salmonberry	Yes					IMG_2408	IMG_2408: View d/s to CMP under Youbou Rd
11	Neva (?)/Swan	222	bend in channel	North of Youbou Rd	1	10	bend in channel to north at transformation from heavily eroded channel d/s to shallow and barely discernable 1 m channel u/s from here. Dry.		Yes				Yes		
11	Neva (?)/Swan	223	d/s end of excavation pits	North of Youbou Rd	2-3	10	Very large and deep machine excavated channel and berms		Yes					IMG_2409	IMG_2409: View u/s (north) at deeply machine-excavated channel
27	Birdcage Spring	224	d/s end of pedestrian Trail crossing	South Shore Rd		10	400 mm CMP discharges into steeply sided ravine thence into Cowichan River. Fish impassable.	Heavy growth of juvenile western redcedar, bigleaf maple, sword fern, spiny wood fern, palmate coltsfoot			Yes			IMG_2428 IMG_2429	IMG_2428: View east into ravine vegetation at eop IMG_2429: View northeast from bridge at confluence withCowichan River
27	Birdcage Spring	225	u/s end of culvert under pedestrian Trail to footbridge crossing	South Shore Rd	n/a	10	400 mm CMP below pool in deep ravine/well created from CV Trail/RR roadbed. Pool has sandy bottom.	Mature bigleaf maple							

DATA Table for Lake Cowichan Stream Mapping 2013

Stream #	Common Name (if known)	GPS #	GPS Description	Location Descriptors	Width (m)	SPEA (m)*	Stream Description	Vegetation Description (dominant underlined)	Impact Classification					Photo No.	Photo Description
									Invasive Species	Riparian Encroachment	Fish Barrier	Man-made channel (ie: concrete flume, riprap, etc.)	Channel Erosion/ Unstable Channel		
27	Birdcage Spring	**226**	d/s end of culvert under South Shore Rd	South Shore Rd		10	high perched 300 mm CMP from under road discharges into sandy pool, approx flow 200 L/min							IMG_2411 IMG_2413	IMG_2411: View northwest (u/s) to perched culvert IMG_2413: View north (u/s) to perched culvert
27	Birdcage Spring	**227**	u/s end of culvert underSouth Shore Rd	South Shore Rd		10	Grassy swale, water flows into 300 mm green pvc pipe.	Grassy swale with rushes, but mostly Himalayan blackberry and buttercup,	Yes					IMG_2415	IMG_2415: View north (u/s) of flows in grassy swale draining into cmp
28	Atchison Creek	**228**	d/s end of culvert under South Shore Rd	South Shore Rd	2-4	15	Approximate flows of 300 L/min emmanate from culvert in concrete wall into publically inaccessible deep ravine. Channel steep varying from 2-4 m width. Channel is likely entirely underground u/s of this location.	Mature red alder, bigleaf maple, chestnut, cedars, salmonberry, spiny wood fern, word fern, morning glory, English holly, spurge laurel	Yes		Possible	Yes		IMG_2426 IMG_2427	IMG_2426: View east at vegetation d/s of S.Shore Rd IMG_2427: View down into eop ravine d/s of rd
12	Beadnell mainstem	**229**	d/s end of culvert under South Shore Road	124 South Shore Rd	2.0	10	Square cement culvert, deep and steep rock wall banks, open section of creek only 2.0 m wide and ~ 5 m long, flow ~2000 L/min, constructed bottom with cement weirs, boulders and cobble	Landscaped residential lawns, oaks, English holly, Lamium, cedar hedges, spiny wood fern	Yes	Yes		Yes		IMG_2424 IMG_2416 IMG_2417	IMG_2424: View south to d/s location IMG_2416: View u/s from driveway IMG_2417: View u/s from driveway of rock walls
12	Beadnell mainstem	**230**	d/s end of culvert under driveway of 124 South Shore Road	124 South Shore Rd	1.5	10	1.5 m wide cement culvert under driveway leads into highly contained deep channel reinforced with large boulder hardscape	residential ornamental	Yes	Yes				IMG_2423 IMG_2422	IMG_2423: View d/s from driveway IMG_2422: View u/s to driveway culvert
12	Beadnell mainstem	**231**	confluence with Cowichan River	124 South Shore Rd	1.5-4.0	15	1.5-4.0 m wide channel to floodplain confluence, creek bottom appears to be bedrock with cobble, with crumbling retaining wall west bank and natural east bank	residential lawn and red alder, cedars, salmonberry, Douglas-fir, weeping willow, sword fern, palmate coltsfoot, English ivy, holly, Spurge laurel	Yes	Yes		Yes		IMG_2418 IMG_2419 IMG_2420 IMG_2421 IMG_2431	IMG_2418: Narrow channel within wide floodplain at confluence with Cowichan IMG_2419: View u/s from confluence, eroding walls and bank protection IMG_2420: View from east bank IMG_2421: View from east bank IMG_2431: View west of confluence from footbridge across Cowichan River
10	unnamed tributary to Stanley(?)	**232**	d/s end of culvert under Cowichan Lake Rd	Cowichan Lake Rd/Cowichan Valley Hwy intersection		10	d/e end of crushed ~300 mm cmp, dry, filled in channel	Red alder, understory of juvenile redcedar, Douglas-fir, bigleaf maple, Himalayan blackberry, palmate coltsfoot	Yes						
10	unnamed tributary to Stanley(?)	**233**	u/s end of culvert under trail between Cowichan Lake Rd & Greendale Rd	Cowichan Lake Rd/Cowichan Valley Hwy intersection		10	perched CMP in concrete sandbags creates pool of standing water, no flow observe, wide wetted areas u/s	common sedge, in understory as above						IMG_2432 IMG_2446	IMG_2432: View northwest (u/s) along wetted area IMG_2446: view south (d/s) at culvert under trail and downstream forested section
10	unnamed tributary to Stanley(?)	**234**	d/s end of culvert under trail between Cowichan Lake Rd & Greendale Rd	Cowichan Lake Rd/Cowichan Valley Hwy intersection		10	CMP in concrete flows into wide wetted area bordering trail and combines with flows from west, then combined flows through culvert downstream toward flows at GPS #085/086, Large tree across streambed	Bigleaf maple, western redcedar, sword fern, spiny wood fern. Downstream channel borders large chicken yard with no understory.		yes				IMG_2433 IMG_2436 IMG_2445	IMG_2433: View d/s (south) of tree across channel IMG_2436: View d/s (south) to next culvert IMG_2445: View South (d/s) of streamside vegettation
10	unnamed tributary to Stanley(?)	**235**	d/s end of culvert at S. Shore Rd & trail	Cowichan Lake Rd/Cowichan Valley Hwy intersection	1-1.5	10	600 mm CMP discharging from Kenvir Rd/Cowichan Lake Rd/Cowichan Valley Hwy intersection, flows approx 30-50 L/min into 1-1.5 m wide channel, grass filled ditch	Mature red alder, bigleaf maple, Thimbleberry, salmonberry, Himalayan blackberry, reed canary grass, ivy, salal, Equisetum, sword fern, spiny wood fern, scouring rush, red elderberry	Yes			Yes		IMG_2438 IMG_2440	IMG_2438: View west (u/s) to culvert from trail side ditch IMG_2440: View east (d/s) from culvert along trail side ditch
10	unnamed tributary to Stanley(?)	**236**	u/s end of culvert under trail	Cowichan Lake Rd/Cowichan Valley Hwy intersection		10	flow splits east along south side of trail and and into 300 mm culvert to north side of trail, ditch becomes narrow wetland d/s	as above	Yes					IMG_2442	IMG_2442: View east (d/s) of black culvert crossing trail (GPS 236 on right, GPS 237 on left)
10	unnamed tributary to Stanley(?)	**237**	d/s end of culvert under traill	Cowichan Lake Rd/Cowichan Valley Hwy intersection		10	flows from culvert under trail to trailside ditch of narrow wetland area	as above	Yes					IMG_2442	see above
10	unnamed tributary to Stanley(?)	**238**	u/s end of culvert under Cowichan Lake Rd-approx location	Cowichan Lake Rd/Cowichan Valley Hwy intersection		10	approximate location of u/s culvert, thick blackberry prevents access, catchment area vegetated and small. Likely only roadside drainage	cleared fields with no trees or high shrubs, Reed canary grass, Himalayan blackberry, bigleaf maple small saplings	Yes	Yes				IMG_2447	IMG_2447: View north of small catchment (u/s) of culvert
9	Stanley Creek mainstem	**239**	d/s end of culvert under Cowichan Valley Hwy	Cowichan Valley Hwy b/n Youbou Rd & Cowichan Lake Rd	7-9	30	2.5 m wide fish friendly CMP with gravel bottom filled to 1/5-1/4. Wide channel, DRY. D/S is 7-9 m wide large boulder in large cobble/gravel mix, with heavy erosion on both banks and residential yards up to bank edge	d/s young forest: bigleaf maple, western redcedar, Douglas-fir, red alder, sword fern, little to no understory.	Yes	Yes			Yes	IMG_2451 IMG_2452 IMG_2453	IMG_2451: View South (d/s) of wide dry channel IMG_2452: View north (u/s) to culvert under CV Hwy IMG_2453: View u/s into dry fish friendly culvert
9/26	Confluenc of Stanley Creekmainstem/Upper Tiny Creek/Castle Creek	**240**	confluence of Upper Tiny Creek/Castle Creek with Stanley	Cowichan Valley Hwy b/n Youbou Rd & Cowichan Lake Rd	1.5	10	1.5 m wide, deeply cut channel (1 m deep), of large boulders in downcut earthen ditch, very steep gradient		Yes				Yes	IMG_2450	IMG_2450: View north of confluence with Stanley Creek
9	Stanley Creek mainstem	**241**	u/s end of culvert under Cowichan Valley Hwy	Cowichan Valley Hwy b/n Youbou Rd & Cowichan Lake Rd	6-8	30	Steep gradient step pool boulder channel, 6-8 m wide, DRY. Heavily eroded with undercut banks and large woody debris.	bigleaf maple, Douglas-fir, sword fern, little to no understory.					Yes	IMG_2454 IMG_2456	IMG_2454: View northwest (u/s) from CV Hwy of dry channel IMG_2456:View southeast (d/s) of dry channel to CV Hwy culvert

DATA Table for Lake Cowichan Stream Mapping 2013

Stream #	Common Name (if known)	GPS #	GPS Description	Location Descriptors	Width (m)	SPEA (m)*	Stream Description	Vegetation Description (dominant underlined)	Impact Classification					Photo No.	Photo Description
									Invasive Species	Riparian Encroachment	Fish Barrier	Man-made channel (ie: concrete flume, riprap, etc.)	Channel Erosion/ Unstable Channel		
9	Stanley Creek mainstem	**242**	mid-channel point where u/s flows disappear subsurface	Cowichan Valley Hwy b/n Youbou Rd & Cowichan Lake Rd		30	Channel description same as downstream, but flows of approximately 500 L/m disappear subsurface at this location. Channel is DRY downstream from this point	bigleaf maple, western redcedar, Douglas-fir, sword fern, little to no understory.						IMG_2455	IMG_2455: View northwest (u/s) to point of flow going subsurface
9	Stanley Creek mainstem	**243**	d/s end of culvert under Madill	Madill Rd	6-10	30	4 m wide (2 m tall) fish friendly culvert with open bottom, boulders, high banks, est flows 1000 L/min, salmon seen by residents at times	bigleaf maple, Douglas-fir, western redcedar, sword fern, little to no understory. Invasive clematis.						IMG_2457	IMG_2457: downstream view (south) from Madill
9	Stanley Creek mainstem	**244**	u/s end of culvert under Madill	Madill Rd	5-8	25	pools in 4 m wide (2 m tall) fish friendly culvert with open bottom, boulders, steeper and narrower channel u/s of culvert than downstream, high banks, weasel observed using stream for corridor	bigleaf maple, Douglas-fir, western redcedar, sword fern, little to no understory.						IMG_2458 IMG_2460 IMG_2463 IMG_2464	IMG_2458: View u/s from Madill IMG_2460: View of u/s end of fish friendly culvert IMG_2463: View d/s into culvert under Madill IMG_2464: View u/s (northwest) from culvert
19	Oliver/Hatchery mainstem	**245**	d/s end of 2000 mm CMP under Youbou Rd	Youbou Road	5-9	30	2000 mm cmp flows into very wide and very deep pool, boulders in cobbles & fine sediment, downstream portion appears constructed (riffles, pools)	redcedar, bigleaf maple, Douglas-fir, red alder, aspen?, salmonberry, sword fern						IMG_2470 IMG_2471	IMG_2470: View from top of CMP under Youbou, southeast of Oliver constructed riffles d/s IMG_2471: same (close up)
19	stormwater tributary to Oliver/Hatchery	**246**	tributary to main stem	Youbou Road	1.5-2	10	wide and dry channel with evidence of flows, no visible headwater								
19	Oliver/Hatchery mainstem	**247**	u/s end of 2000 mm CMP under Youbou Rd	Youbou Road	3-5	15	Gravel and small cobble substrate, less boulders (channel very different than d/s of Youbou Rd), ~1500 L/min, shallow grade, low banks with undercuts at riffles, fine sediment on rocks; 2 m culvert is fish friendly, cobble/gravel filled.	redcedar, bigleaf maple, Douglas-fir, red alder, salmonberry, sword fern						IMG_2474 IMG_2475 IMG_2476 IMG_2478 IMG_2479	IMG_2474: View North u/s of Youbou Rd. IMG_2475:u/s end of 2000 mm culvert IMG_2476: fish friendly, cobble/gravel filled culvert IMG_2478:cobble and banks IMG_2479: cobble
19	stormwater tributary to Oliver/Hatchery	**248**	roadside ditch tributary to Oliver	8293 Youbou Road		10	Roadside ravine ditch flows east to Oliver. U/s this flow parallels driveway north to south. driveway goes over Oliver Creek further u/s. Private Property							IMG_2481 IMG_2480	IMG_2481: View North of west-east ditch flow in roadside ravine IMG_2480: View North u/s of north-south ditch
25	Tern Creek mainstem	**249**	d/s end of culvert under Beaver Rd	Beaver Rd		10	swampy with 2-3 m wide channel, low gradient, thick mud, heavy LWD coverage over stream channel, barely flowing, culverts inaccessible due to Himalayan blackberry	Western hemlock, red alder, salmonberry, sword fern, skunk cabbage, Equisetum, red huckleberry, spiny wood fern, Himalayan blackberry	Yes					IMG_2482	IMG_2482: View d/s (SE) of swampy low gradient channel with thick forest cover
25	Tern Creek mainstem	**250**	u/s end of culvert under Beaver Rd	8365 Beaver Rd		10	swampy channel, culverts inaccessible due to Himalayan blackberry	Western hemlock, red alder, salmonberry, spiny wood fern, Himalayan blackberry	Yes					IMG_2484	IMG_2484: View u/s (NW) of thick blackberries in channel
25	Tern Creek mainstem	**251**	d/s end of 900 mm culvert under Youbou Rd	Youbou Rd		10	flow ~100 L/min from 900 mm CMP, rocky, shallow gradient downstream to small dropoff with constructed waterfall downstream of CMP	Red alder, bigleaf maple, red elderberry, salmonberry, Himalayan blackberry, bracken fern, sword fern, Equisetum, willows			Possible	Yes		IMG_2488 IMG_2489	IMG_2488: Channel between Youbou & Elk rds IMG_2489: Channel between Youbou & Elk rds
25	Tern Creek mainstem	**252**	u/s end of 900 mm culvert under Youbou Rd	Youbou Rd		10	channel covered by dense woody debris, branches, possibly road side vegetation cutting debris	Red alder, bigleaf maple, red elderberry, salmonberry, Himalayan blackberry, bracken fern, sword fern, Equisetum, willows	Yes	Yes					
December 23, 2013															
29	Olson Springs (?) & Eilbeck Cree k(?) @ Riverside/Duck Park	**254**	eop on east side of Duck Park	Duck Park off River Road & Park Road		10	150-200 mm aqua pvc pipe discharges into Cowichan River, flow ~20 L/min. Too small to be the underground section of historic creek? No rain for 2+ days. Could not find any other flows on this shoreline to indicate other creek mouth.	Park: lawn and some trees	Yes	Yes				DSCF0258 DSCF0259 DSCF0261	DSCF0258: View of ditch confluence with Lake Cowichan DSCF0259: Wide view of ditch confluence with Lake Cowichan (right of photo) DSCF0261: View southeast from Park Rd of confluence and park
29	Olson Springs (?) & Eilbeck Cree k(?) @ Riverside/Duck Park	**255**	end of waterfall	139 North Shore Road		10	small waterfall at residential lawn where stormwater has been channelled into ornamental garden.	gardens and lawn	Yes	Yes		Yes			
30	Pedersen Creek (?)	**256**	beginning of pipe heading under gravel parking lot at boat launch	Marina Park@ Wavell/North Shore Rd	2-3	10	2-3 m wide channel flows into concrete slab culvert (not visualized). Surface frozen, flow not estimated.	Grassy mowed park with Alder, western redcedar, bigleaf maple, Himalayan blackberry (95%), equisetum, sedges, grasses	Yes			yes		DSCF0265	View southwest to channel entering culvert under parking lot
30	Pedersen Creek (?)	**257**	end of pipe, flows into Lake Cowichan d/s of here	Marina Park@ Wavell/North Shore Rd, west side of boat launch		10	Crushed CMP 500-600 mm, no flow, standing water.	sedges, grasses, invasives	Yes	Yes	Possible			DSCF0262 DSCF0264	DSCF0262: close up of crushed cmp outflow to Lake DSCF0264: crushed cmp outflow is between stump and tree
30	Pedersen Creek (?)	**258**	5 m u/s of 256 culvert	Marina Park@ Wavell/North Shore Rd		10	winding stream channel englfed by Himalayan blackberries, not accessible.	Grassy mowed park with Alder, western redcedar, bigleaf maple, Himalayan blackberry (95%), equisetum, sedges, grasses	Yes	Yes				DSCF0266	View west to blackberry covered channel

DATA Table for Lake Cowichan Stream Mapping 2013

Stream #	Common Name (if known)	GPS #	GPS Description	Location Descriptors	Width (m)	SPEA (m)*	Stream Description	Vegetation Description (dominant underlined)	Impact Classification					Photo No.	Photo Description
									Invasive Species	Riparian Encroachment	Fish Barrier	Man-made channel (ie: concrete flume, riprap, etc.)	Channel Erosion/ Unstable Channel		
30	Pedersen Creek (?)	**259**	possible location of d/s culvert crossing under North Shore Rd	Marina Park@ Wavell/North Shore Rd		10	low profile and gravel/fine sediment substrate channel with no complexity, covered in Himalayan blackberry	Grassy mowed park with Alder, western redcedar, bigleaf maple, Himalayan blackberry (95%), equisetum, sedges, grasses	Yes	Yes				DSCF0268	View southeast (downstream) from Wavell Rd culvert crossing
31	Maple Leaf Brook (?)	**260**	end of pipe under North Shore Rd	Wavell/North Shore Rd	1-3	10	flows emerge from under road into blast rock channel 1-3 m wide, 3-5% slope,with steep banks and estimated flow 20 L/min	Ornamental trees and shrubs, sedges and equisetum	Yes			Yes		DSCF0267	View South (downstream) from Wavell Rd to Lake Cowichan along channel
29 (?)	Olson Springs (?) & Eilbeck Cree k(?) @ Riverside/Duck Park	**261**	u/s end of pipe under Elk Rd	Elk Rd and River Rd			Roadside ditch along Elk Rd flowsinto 300 mm aqua pipe under Elk Rd, estimated flows 10 L/min	grassy ditch, juvenile Douglas-fir & alder, with ornamentals	Yes					DSCF0269	View from culvert north (upstream) of flows down Elk Rd
31	Appears to flow to Maple Leaf Brook (may also be known as Wilson Brook or Wavell Brook)	**262**	d/s flow under Castley Heights	272 CastleyHeights: north side of property	0.5	10	narrow, downstream channel from road in narrow (~0.5 m) channel, flows ~25/L/min.	Alder, willow, western redcedar and Douglas-fir, mixed with lawn, ornamentals and gardens	Yes					DSCF0270	View east (downstream) of channel following property edge of lawn
31	Appears to flow to Maple Leaf Brook (may also be known as Wilson Brook or Wavell Brook)	**263**	u/s side of Castley Heights, approximate location of culvert (blackberry thicket reduced access)	west side Castley Heights		10	channel hidden from view flows from steep hillside, may be springs here	Himalayan blackberry, grasses and Scotch broom in cleared hillside.	Yes					DSCF0271	View northwest (upstream) of recently cleared, steep hillside with channel obscured, or absent. Springs may be located here.
31/30/29?	Appears to flow to Maple Leaf Brook (may also be known as Wilson Brook or Wavell Brook), but may flow to Pedersen or Eilbeck Cr.	**264**	U/s end of pipe under Indian Rd & River Rd intersection	Indian Rd & River Rd intersection			600 mm dry cmp in grassy swales running from north (along west side of Indian Rd) and from west (on north side of River Rd). This flow may go down River Rd or into Castley flows	Grass and Scotch broom	Yes	Yes				DSCF0272	View west (upstream) from culvert at intersection
31	Appears to flow to Maple Leaf Brook (may also be known as Wilson Brook or Wavell Brook)	**265**	U/S end of pipe under driveway at top of hill	driveway for group of houses at 241 North Shore Rd or Wavell Rd	<1 m	10	Flows from very steep hillside (45%) along ravine, recently clear cut of all trees and vegetation, flows ~25 L/min and <1 m wide.	Himalayan blackberry, clear cut of all trees and saplings	Yes					DSCF0273 DSCF0274	DSCF0273: View of recently cleared ravine slopes and stream channel, view northeast. Stream flows left to right DSCF0274: View northwest (upstream) of recently cleared ravine slopes and stream channel.
31	Appears to flow to Maple Leaf Brook (may also be known as Wilson Brook or Wavell Brook)	**266**	D/S end of pipe from under driveway	driveway for group of houses at 241 North Shore Rd or Wavell Rd	1	10	d/s end of pipe under upper end of driveway, ~25 L/min, narrow (~1 m) grassy ditch	Himalayan blackberry, grass and ornamentals, buttercup	Yes						
31	Appears to flow to Maple Leaf Brook (may also be known as Wilson Brook or Wavell Brook)	**267**	U/S end of pipe under driveway with flows from west	driveway for group of houses at 241 North Shore Rd or Wavell Rd	1	10	estimated 600 mm pipe under driveway of 241 N Shore Rd, or along driveway, outflow not found. Flows converge here from GPS266 and small ditch from West,est ~40 L/min.	Himalayan blackberry, grass and ornamentals, buttercup, cedar hedge	Yes					DSCF0275	View downstream (south) to cmp and ditch confluence from right (west) along line of cedars.
32	Beaver Creek	**268**	Bend in stream at end of access road (closest to mouth permissablebecause of restricted area)	west end of access road in Sayward Park b/4 No Trespass gate	2-3	10	deeply defined 2-3 m channel with gravel/cobble substrate and eroded banks with exposed roots, est flow ~300 L/min, LWD, 1-2% grade	Young alder forest, Himalayan blackberry, Nootka rose, sedges, willows, dense shrub/sapling layer.	Yes				Yes	DSCF0276 DSCF0277 DSCF0278	DSCF0276: View west (downstream) of channel DSCF0277: View south (upstream) of bend in stream DSCF0278: View south (upstream) of heavy vegetation
32	Beaver Creek	**269**	creek flows along north side of pedestrian trail	pedestrian trail north of Pt Ideal Rd	3-4	15	3-4 m wide channel with gravel/cobble substrate, low profile, est flow ~300 L/min	Young alder forest with scattered mature red alders, Himalayan blackberry, evergreen blackberry, salmonberry, sword fern, English holly, Nootka rose, sedges, willows, dense shrub/sapling layer.	Yes					DSCF0279	View west of wide channel (downstream) in thicket
32	Beaver Creek	**270**	u/s end of culvert under pedestrian path	pedestrian trail north of Pt Ideal Rd	6-7	20	~1000 mm fish-friendly cmp, channel 6-7 m wide, meandering, low profile u/s of culvert, LWD,	Young alder forest with scattered mature red alders and western redcedar, Himalayan blackberry, salmonberry, sword fern, Nootka rose, sedges, willows, dense shrub/sapling layer.	Yes					DSCF0281 DSCF0282	DSCF0281 DSCF0282
32	Beaver Creek	**271**	d/s end of culvert under pedestrian path	pedestrian trail north of Pt Ideal Rd	3-6	20	~1000 mm fish-friendly cmp, channel widens and is swampy with vegetation	Young alder forest with scattered mature red alders, Himalayan blackberry, salmonberry, sword fern, Nootka rose, sedges, willows, dense shrub/sapling layer.	Yes					DSCF0280	View north west of wide swampy area at culvert
32	Beaver Creek	**272**	d/s end of bridge under Pt Ideal Rd	Pt Ideal Rd	5-7	20	d/s end of 2 m wide steel arch, fish-friendly bridge/culvert under road, channel widens to 5-7 m and low profile	Himalayan blackberry, red alder, salmonberry	Yes					DSCF0283	View North (downstream) of riparian vegetation from Pt Ideal Rd
32	Beaver Creek	**273**	u/s end of bridge under Pt Ideal Rd	Pt Ideal Rd	5	15	u/s end of 2 m wide steel arch, fish-friendly bridge/culvert under road, channel is wide and meandering, but with defined banks, with sand and gravel substrate	Red alder, western redcedar, bracken fern, Himalayan blackberry, sedges, salmonberry, sowrd fern, willows, Nootka rose, buttercup	Yes					DSCF0284 DSCF0285 DSCF0286	DSCF0284: View south (upstream) from Pt Ideal Rd DSCF0285: sand and gravel substrate DSCF0286: View north (downstream) to culvert under Pt Ideal Rd
32	Beaver Creek	**274**	Footbridge over creek	pedestrian trail south of Pt Ideal Rd		15	Large swampy area exists to east. Concrete encased pipes crossing stream creates riffles. Gravel substrate.	Red alder, western redcedar, juvenile bigleaf maple, Douglas-fir, bracken fern, Himalayan blackberry, sedges, salmonberry, sowrd fern, willows, Nootka rose, buttercup	Yes					DSCF0287	DSCF0287: View southeast to concrete pipes creating riffle.
32	Beaver Creek	**275**	edge of stream for photo points	pedestrian trail south of Pt Ideal Rd		20	10 m floodplain with path adjacent to creek. LWD in abundance.	Forest transitioning to open understory of ferns.						DSCF0290	DSCF0290: View u/s (southeast) LWD and alders

DATA Table for Lake Cowichan Stream Mapping 2013

Stream #	Common Name (if known)	GPS #	GPS Description	Location Descriptors	Width (m)	SPEA (m)*	Stream Description	Vegetation Description (dominant underlined)	Impact Classification					Photo No.	Photo Description
									Invasive Species	Riparian Encroachment	Fish Barrier	Man-made channel (ie: concrete flume, riprap, etc.)	Channel Erosion/ Unstable Channel		
32	Beaver Creek	**276**	Wooden footbridge over creek	pedestrian trail south of Pt Ideal Rd	4-7	20	channel 7 m wide here and narrowing upstream to ~4 m. 1-2% grade. Mix of large boulders, gravel. Excavated creek bed adjacent to footbridge and remains of former wooden structures of unknown purpose.	Red alder, western redcedar, holly, sedges, salmonberry, sword fern, Nootka rose.						DSCF0292 DSCF0294 DSCF0295	DSCF0292: View u/s to footbridge (south) DSCF0294: View of footbridge and excavated side channel, u/s of footbridge DSCF0295: View d/s from footbridge (north)
32	Beaver Creek	**277**	NE Extent of wetland adjacent to Creek	Pt Ideal Rd		15-30	Large swampy area adjacent to creek and south of Pt Ideal Rd.	as above.							
32	Beaver Creek	**278**	d/s side of culvert under road	South Shore Road b/n Fern Rd and Stone Ave.	3.5	15	1.5 m CMP with steep riprap banks transitioning to low banks and natural channel d/s. Channel width immediately d/s of culvert 3.5 m, 1-2% grade. Flow approx 300 L/min. Large rock substrate adjacent to rd.	Western redcedar, red alder, Himalayan blackberry, morning glory, sword fern, salmonberry, equisetum	Yes			Yes		DSCF0296	DSCF0296: View north of creek d/s from South Shore Rd
32	Beaver Creek	**279**	u/s side of culvert under road	South Shore Road b/n Fern Rd and Stone Ave.	2	10	Concrete flume 2 m wide channels creek into 1.5 m CMP under road.		Yes					DSCF0297 DSCF0300	DSCF0296: View d/s (north) of creek u/s of South Shore Rd DSCF0300: View u/s (south) of flume from u/s side of South Shore Rd
33	Ravine Creek	**280**	600 mm pipe/start of creek	Ravine Park between Stone Ave & Stevens Crescent	2	10	600 mm aqua pvc, in steep-sided ravine, channel 2 m wide. Standing water in grass, no flow.	Red alder (mature & juvenile), Himalayan blackberry, Scotch broom, sword fern, grass	Yes					DSCF0301 DSCF0302	DSCF0301: View u/s of 600 mm pipe DSCF0302: View d/s of wetted area
33	Ravine Creek	**281**	end of wetland into pipe	Ravine Park between Stone Ave & Stevens Crescent at King George St South		15-30	Steep-sided alder wetland u/s ends at 375 mm aqua pvc pipe under road at cement chamber. Iron oxidizing bacteria prevelant. Flow ~ 15 L/min.	Red alder (mature & juvenile), bigleaf maple, sedges, Himalayan blackberry, Scotch broom, sword fern, bracken fern, morning glory, daphne spurge laurel, grass	Yes					DSCF0306 DSCF0308 DSCF0311	DSCF0306: Steep-sided alder wetland DSCF0308: inflow chamber at d/s end of wetland DSCF0311: iron-oxidizing bacteria
34	Greenwell Creek	**282**	u/s (south) side of Hobson path	Hobson Ave path		15-30	low profile red alder sapling swamp with meandering channel u/s of path, densely vegetated and unwalkable.	Red alder saplings, bigleaf maple, sword fern, equisetum, salal, bracken fern, sedges, Himalayan blackberry, hard hack	Yes					DSCF0312	DSCF0312: View South (u/s) of alder sapling swamp
34	Greenwell Creek	**283**	d/s (north) side of Hobson path	Hobson Ave path	6	15	1000 mm cmp from under road empties into 6 m wide channel with gravel substrate, narrowing to 1.5-2 m channel immediately downstream. Flow approx 50 L/min.	Red alder saplings, western redcedar, Douglas-fir, sword fern, equisetum, salal, bracken fern, sedges, Himalayan blackberry, hard hack	Yes					DSCF0314 DSCF0315	DSCF0314: View north (d/s) of wide outflow area DSCF0315:View north (d/s) of forest character
34	Greenwell Creek	**284**	photopoint adj to creek	School on Hammond Rd	1.5-2	10	1.5-2 m channel in steep eroded banks (evidence of heavy foot traffic adjacent to school), 2-5% grade with mixed substrate of sand, clay, cobble, boulders.	Red alder, Douglas-fir, sword fern, western redcedar, sedges, salal, salmonberry, dull oregon-grape, bracken fern, holly.		Yes				DSCF0316 DSCF0317	DSCF0316: View north (d/s) of narrowed channel DSCF0317: View south (u/s) of channel
34	Greenwell Creek	**285**	u/s end of culvert under School driveway	School on Hammond Rd	2-3	10	dual 800 mm cmps at end of 2-3 m wide mobile channel with in-stream vegetation,gravel substrate.							DSCF0318	DSCF0318: View d/s (north) to cmps
34	Greenwell Creek	**286**	d/s end of culvert under School driveway	School on Hammond Rd	8-10	30	wide channel 8-10 m before becoming channelized downstream. Boulder, cobble, sand substrate, flow approximately 50 L/min.	Western redcedar dominated forest downstream of road, with sword fern, sedges, red alder						DSCF0319	DSCF0319: View d/s (north) from cmps at wide channel
34a	Tributary ditch to Greenwell	**287**	path of ditch	Cowichan Valley Trail	1	10	1 m wide channel in ditch/swale along Cowichan Valley Trail, substrate soil. Appears to be tributary to Greenwell. Flow frozen.	Red alder, sword fern, sedges, Douglas-fir, Himalayan blackberry, buttercup				Yes		DSCF0327 DSCF0328	DSCF0327: View east from ad hoc access crossing of ditch by vehicles/atvs DSCF0328: Logs used to create access to Trail through widened ditch.
34a	Tributary ditch to Greenwel	**288**	cmp at head of ditch	Cowichan Valley Trail		10	evidence of flows from pipe hidden by blackberries	Red alder, sword fern, sedges, Douglas-fir, Himalayan blackberry, buttercup	Yes						
34	Greenwell Creek	**289**	u/s end of culvert under Trail	Cowichan Valley Trail		30	900 mm Concrete casing ("1944") under Trail, flow approximately 100 L/min, substrate boulder, cobble, gravel, sand mix. 2-4% grade. Abundant LWD. Meandering channel in wide flood plain.	Mature western redcedar forest with sparse understory, historic logging visible, nursery logs, bigleaf maple, sword fern, bracken fern, salal, salmonberry, red huckleberry, laurel, English holly, lady fern, dull Oregon-grape, trailing blackberry.	Yes					DSCF0332 DSCF0334 DSCF0336	DSCF0332: View u/s (south) to nursery logs and u/s channel DSCF0334: View d/s (north) to cement culvert DSCF0336: View u/s south of LWD and meandering channel in swampy conditions
34a	Tributary ditch to Greenwell	**290**	transition of channel type	Cowichan Valley Trail		10	Tributary spreads out into open forest and flow appears to be sub-root zone.								
34b	Diverted South Money Creek, tributary ditch to Greenwell	**291**	u/s end of cmp on south side of Trail, crossing under Boundary Rd ROW	Cowichan Valley Trail/Boundary Rd ROW	1.5	10	600 mm cmp carries flow in 1.5 m wide ditch along south side of Cowichan Valley Trail. Drains wetland area to east, adjacent to gravel pit.	red alder, Scotch broom, Himalayan blackberry, reed canary grass, hardhack	Yes			Yes		DSCF0338	DSCF0338: View east of forested wetland area u/s of ditch
34b	Diverted South Money Creek, tributary ditch to Greenwell	**292**	d/s end of cmp on south side of Trail, crossing under Boundary Rd ROW	Cowichan Valley Trail/Boundary Rd ROW	1.5	10	1.5 m wide ditch	red alder, Scotch broom, Himalayan blackberry, reed canary grass, hardhack	Yes			Yes			
34b	Diverted South Money Creek, tributary ditch to Greenwell	**293**	d/s end of cmp on north side of Trail, crossing under Boundary Rd ROW	Cowichan Valley Trail/Boundary Rd ROW	<1	10	ditch, dry with sedges	Douglas-fir, Himalayan blackberry, Scotch broom, Nootka rose, sedges	Yes			Yes			

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									Invasive Species	Riparian Encroachment	Fish Barrier	Man-made channel (ie: concrete flume, riprap, etc.)	Channel Erosion/ Unstable Channel		
34b	Diverted South Money Creek, tributary ditch to Greenwell	**294**	tributary flow from small wetland on south side of Trail	Cowichan Valley Trail	1	10	newly excavated 1 m wide channel draining small wetland, soil substrate. Approximate flow 30 L/min.	Douglas-fir, western redcedar, salal, Scotch broom, Himalayan blackberry, sword fern, sedges, bracken fern, reed canary grass, rushes, equisetum, scattered alder groves.	Yes			Yes		DSCF0337 DSCF0340	DSCF0337: wetland in gravel pit DSCF0340: excavated channel from wetland to trail side ditch
34b	Diverted South Money Creek, tributary ditch to Greenwell	**295**	tributary flow from small wetland on south side of Trail	Cowichan Valley Trail at Cottonwood St South ROW		10	flow from small wetland.	Douglas-fir, western redcedar, salal, Scotch broom, Himalayan blackberry, sword fern, sedges, bracken fern, reed canary grass, rushes, equisetum, scattered alder groves.	Yes					DSCF0342 DSCF0343	DSCF0342: View west of roadside ditch DSCF0343: View south to small wetland
	delete	**296**	delete												
34b	Diverted South Money Creek, tributary ditch to Greenwell	**297**	u/s end of pipe under Pine St ROW, south side of Trail	Cowichan Valley Trail/Pine St ROW		10	700 mm aqua pvc under Pine St ROW, approximate flow 50-70 L/min in 1-1.5 m wide channel		Yes					DSCF0345 DSCF0346 DSCF0347	DSCF0345: View westof trail side ditches DSCF0346: View west of u/s end of culvert and view of trail side ditch leading to Greenwell Creek DSCF0347: View east of trail side ditches
34b	Diverted South Money Creek, tributary ditch to Greenwell	**298**	d/s end of pipe under Pine St ROW, south side of Trail	Cowichan Valley Trail/Pine St ROW		10	700 mm aqua pvc under Pine St ROW, approximate flow 50-70 L/min in 1-1.5 m wide channel. From here flow leads to GPS 289, bypassing culvert at 301 (South Money Creek)		Yes						
35	Tributary ditch to South Money Creek	**299**	ditch on north side of Trail	Cowichan Valley Trail/Pine St ROW	1	10	grassy ditch,wet								
35	South Money Creek	**300**	d/s (north) end of concrete culvert under Trail	Cowichan Valley Trail adj to Pine St ROW	1.5	10	d/s end of cement and rock terrace culvert from under Cowichan Valley Trail. Channel 1.5 m wide is covered by wooden slats topped by sod and lawn. Underground d/s (north) from here. Flows approximately 30 L/min	residential yard, lawn and grass	Yes	Yes		Yes		DSCF0348	DSCF0348: View west at d/s end of culvert and u/s end of underground section of South Money Creek
35	South Money Creek	**301**	u/s end (south) of concrete culvert under Trail	Cowichan Valley Trail near Pine St ROW		10	u/s end of cement culvert ("1949") under Cowichan Valley Trail with trash rack cover.		Yes	Yes				DSCF0349	DSCF0349: View east of excavated channel bypassing culvert to South Money Creek, redirecting flow to Greenwell Creek
34b	Diverted South Money Creek, tributary ditch to Greenwell	**302**	excavated bypass channel	Cowichan Valley Trail near Pine St ROW	1	10	1 m wide excavated channel, rock lined.					Yes		DSCF0349	DSCF0349: View eastnortheast of excavated channel bypassing culvert to South Money Creek, redirecting flow to Greenwell Creek
33	Ravine Creek	**303**	d/s end of cmp under Hammond St	Hammond St/Cowichan Valley Trail/Sahtlan Rd	1	10	400 mm crushed cmp flows into steep 1 m wide ditch	Cleared ROW, Himalayan blackberry, juvenile red alder	Yes					DSCF0351	DSCF0351: View north of cleared path and culverts
33	Ravine Creek	**304**	u/s end of cmp under footpath	Hammond St/Cowichan Valley Trail/Sahtlan Rd	1	10	500 mm cmp	Cleared ROW, Himalayan blackberry, juvenile red alder	Yes						
33	Ravine Creek	**305**	d/s end of perched cmp under footpath	Hammond St/Cowichan Valley Trail/Sahtlan Rd	1	10	500 mm perched cmp, approximate flow 80 L/min into 1 m wide ditch	Cleared ROW, Himalayan blackberry, juvenile red alder	Yes					DSCF0350	DSCF0350: View south of perched culvert and footpath
33	Ravine Creek	**306**	u/s end of cmp under Sahtlan Rd	Hammond St/Cowichan Valley Trail/Sahtlan Rd	1	10	600 mm cmp under Sahtlan Rd	Cleared ROW, Himalayan blackberry, juvenile red alder	Yes						
36	Money's Wetland	**307**	d/s end of culvert	Cowichan Ave East/Pine St	8-10	15-30	8-10 m wide channel leading to wetland, estimated flow 80-100 L/min	cattail, red alder, reed canary grass, Himalayan blackberry, equisetum, Scotch broom, salmonberry, English ivy, English holly.	Yes					DSCF0352 DSCF0353	DSCF0352: View north of Money's Wetland east side DSCF0353: View u/s (south) of channel from underground portions of Greenwell/South Money/ Money Creeks
36	Money's Wetland	**308**	narrow channel	Cowichan Ave East/Pine St	1-2	15-30	channel narrows with steep high banks	cattail, red alder, reed canary grass, Himalayan blackberry, equisetum, Scotch broom, salmonberry, English ivy, English holly.	Yes					DSCF0354	DSCF0354: View d/s west of channel leading to Money's Wetland
36a	Tributary ditch to Money's Wetland	**309**	u/s end of aqua pvc	Money's Wetland footpath/Quamichan Ave ROW	1-2	10	375 mm aqua pvc collects flow from 1-2 m wide ditch along Quamichan Ave ROW and leads into Money's Wetland	Red alders, sedges, mowed grass park						DSCF0356	DSCF0356: View east along ditch from culvert to wetland
36	Money's Wetland	**310**	d/s end of aqua pvc	Money's Wetland footpath/Quamichan Ave ROW		15-30	375 mm aqua pvc collects flow from 1-2 m wide ditch along Quamichan Ave ROW and leads into Money's Wetland	Red alder, salmonberry, Himalayan blackberry, reed canary grass, sedges, rushes, equisetum,	Yes					DSCF0357	DSCF0357: View west from culvert into intersection of culverts and channels at confluence of Ravine Creek flows with the combined flows from Greenwell/Money/South Money Creeks.
36	Money's Wetland	**311**	u/s end of cmp	Money's Wetland footpath/Quamichan Ave ROW		15-30	900 mm cmp from east portion of wetland (flows from Greenwell/Money/South Money)	Red alder, salmonberry, Himalayan blackberry, reed canary grass, sedges, rushes, equisetum,	Yes						
36	Money's Wetland	**312**	d/s end of cmp	Money's Wetland footpath/Quamichan Ave ROW		15-30	900 mm cmp from east portion of wetland (flows from Greenwell/Money/South Money)	Red alder, salmonberry, Himalayan blackberry, reed canary grass, sedges, rushes, equisetum,	Yes					DSCF0357	DSCF0357: View west from culvert into intersection of culverts and channels at confluence of Ravine Creek flows with the combined flows from Greenwell/Money/South Money Creeks.
36	Money's Wetland	**313**	narrow channel bwteen wetlands	Money's Wetland footpath/Quamichan Ave ROW	2	15-30	open channel bypassing concrete pipe connecting Ravine Creek flows with wetland at main confluence of all creeks.	Red alder, salmonberry, Himalayan blackberry, reed canary grass, sedges, rushes, equisetum,	Yes					DSCF0359	DSCF0359: View west from culvert into intersection of culverts and channels at confluence of Ravine Creek flows with the combined flows from Greenwell/Money/South Money Creeks.
36	Money's Wetland	**314**	u/s end of culvertunder walking trail	Money's Wetland walking trail		15-30	single 900 mm cmp under walking trail with metal trash rack, flow approximately 200 L/min	Red alder, salmonberry, Himalayan blackberry, reed canary grass, sedges, rushes, equisetum,	Yes					DSCF0360	DSCF0360: View of culvert outlet from Money's Wetland, south side of trail.

DATA Table for Lake Cowichan Stream Mapping 2013

Stream #	Common Name (if known)	GPS #	GPS Description	Location Descriptors	Width (m)	SPEA (m)*	Stream Description	Vegetation Description (dominant underlined)	Impact Classification					Photo No.	Photo Description
									Invasive Species	Riparian Encroachment	Fish Barrier	Man-made channel (ie: concrete flume, riprap, etc.)	Channel Erosion/ Unstable Channel		
36	Money's Wetland	**315**	d/s end of culvert under walking trail	Money's Wetland walking trail	3	15-30	dual cmps (not matching upstream end of pipe at GPS214), slightly perched, lead into 3 m wide channel to Cowichan River, cobble and boulder substrate.	Red alder, salmonberry, Himalayan blackberry, reed canary grass, sedges, rushes, equisetum,	Yes		Possible			DSCF0361	DSCF0361: Dual culverts outlet Money's Wetland to Cowichan River
36a	Tributary ditch to Money's Wetland	**316**	centre of culvert crossing at ROW	Pine St ROW/Quamichan Ave ROW		10	wet ditch along Quamichan Ave	reed canary grass, sedges	Yes			Yes			
36a	Tributary ditch to Money's Wetland	**317**	d/s end of crushed culvert under Rd	Quamichan Ave		15-30	culvert discharges from wet area to south of Quamichan Ave	Western redcedar, red alder, dogwood							
36a	Tributary ditch to Money's Wetland	**318**	east end of narrow wetland	Quamichan Ave	9	15-30	long narrow wetland north of Quamichan, 9 m wide.	Western redcedar, red alder, dogwood						DSCF0364 DSCF0366	DSCF0364: View northeast of wetland DSCF0366: View west of narrow wetland
33	Ravine Creek	**319**	d/s end of culvert from Ravine Creek	Cowichan Ave East/Poplar St		15-30	cmp into wide channel leading to wetland, steep banks	red alder, bigleaf maple, reed canary grass, Himalayan blackberry	Yes						
36	Money's Wetland	**320**	southeast side of wetland channel	Poplar ROW		15-30	wide channel leading into wetland								

Appendix D

Town of Lake Cowichan
Design Storm Calculations

KERR WOOD LEIDAL
consulting engineers

Design Storms for the Lake Cowichan Study

10-Year 1-Hour			10-Year 2-Hour			10-Year 6-Hour			100-Year 1-Hour			100-Year 2-Hour			100-Year 6-Hour			25-Year 1-Hour			25-Year 2-Hour			25-Year 6-Hour		
T, hr	Accum P, mm	P, mm	T, hr	Accum P, mm	P, mm	T, hr	Accum P, mm	P, mm	T, hr	Accum P, mm	P, mm	T, hr	Accum P, mm	P, mm	T, hr	Accum P, mm	P, mm	T, hr	Accum P, mm	P, mm	T, hr	Accum P, mm	P, mm	T, hr	Accum P, mm	P, mm
0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
0.05	2.38	2.38	0.1	3.52	3.52	0.3	7.08	7.08	0.05	3.40	3.40	0.1	4.60	4.60	0.3	8.88	8.88	0.05	2.79	2.79	0.1	3.96	3.96	0.3	7.80	7.80
0.1	5.16	2.78	0.2	7.63	4.11	0.6	15.33	8.26	0.1	7.36	3.97	0.2	9.97	5.37	0.6	19.24	10.36	0.1	6.04	3.25	0.2	8.59	4.62	0.6	16.89	9.10
0.15	7.94	2.78	0.3	11.75	4.11	0.9	23.59	8.26	0.15	11.33	3.97	0.3	15.34	5.37	0.9	29.60	10.36	0.15	9.29	3.25	0.3	13.21	4.62	0.9	25.99	9.10
0.2	10.13	2.18	0.4	14.98	3.23	1.2	30.08	6.49	0.2	14.45	3.12	0.4	19.55	4.22	1.2	37.73	8.14	0.2	11.85	2.56	0.4	16.85	3.63	1.2	33.14	7.15
0.25	11.72	1.59	0.5	17.33	2.35	1.5	34.79	4.72	0.25	16.71	2.27	0.5	22.62	3.07	1.5	43.65	5.92	0.25	13.71	1.86	0.5	19.49	2.64	1.5	38.34	5.20
0.3	12.91	1.19	0.6	19.09	1.76	1.8	38.33	3.54	0.3	18.41	1.70	0.6	24.92	2.30	1.8	48.09	4.44	0.3	15.10	1.39	0.6	21.47	1.98	1.8	42.24	3.90
0.35	14.10	1.19	0.7	20.85	1.76	2.1	41.87	3.54	0.35	20.11	1.70	0.7	27.22	2.30	2.1	52.53	4.44	0.35	16.49	1.39	0.7	23.45	1.98	2.1	46.13	3.90
0.4	14.89	0.79	0.8	22.02	1.17	2.4	44.23	2.36	0.4	21.24	1.13	0.8	28.75	1.53	2.4	55.49	2.96	0.4	17.42	0.93	0.8	24.77	1.32	2.4	48.73	2.60
0.45	15.49	0.60	0.9	22.90	0.88	2.7	46.00	1.77	0.45	22.09	0.85	0.9	29.90	1.15	2.7	57.71	2.22	0.45	18.12	0.70	0.9	25.77	0.99	2.7	50.68	1.95
0.5	16.28	0.79	1	24.08	1.17	3	48.36	2.36	0.5	23.23	1.13	1	31.44	1.53	3	60.67	2.96	0.5	19.05	0.93	1	27.09	1.32	3	53.28	2.60
0.55	16.68	0.40	1.1	24.67	0.59	3.3	49.54	1.18	0.55	23.79	0.57	1.1	32.20	0.77	3.3	62.15	1.48	0.55	19.51	0.46	1.1	27.75	0.66	3.3	54.58	1.30
0.6	17.28	0.60	1.2	25.55	0.88	3.6	51.30	1.77	0.6	24.64	0.85	1.2	33.35	1.15	3.6	64.37	2.22	0.6	20.21	0.70	1.2	28.74	0.99	3.6	56.53	1.95
0.65	17.67	0.40	1.3	26.13	0.59	3.9	52.48	1.18	0.65	25.21	0.57	1.3	34.12	0.77	3.9	65.85	1.48	0.65	20.68	0.46	1.3	29.40	0.66	3.9	57.83	1.30
0.7	18.07	0.40	1.4	26.72	0.59	4.2	53.66	1.18	0.7	25.78	0.57	1.4	34.89	0.77	4.2	67.33	1.48	0.7	21.14	0.46	1.4	30.06	0.66	4.2	59.13	1.30
0.75	18.47	0.40	1.5	27.31	0.59	4.5	54.84	1.18	0.75	26.34	0.57	1.5	35.65	0.77	4.5	68.81	1.48	0.75	21.61	0.46	1.5	30.72	0.66	4.5	60.43	1.30
0.8	18.86	0.40	1.6	27.90	0.59	4.8	56.02	1.18	0.8	26.91	0.57	1.6	36.42	0.77	4.8	70.29	1.48	0.8	22.07	0.46	1.6	31.38	0.66	4.8	61.73	1.30
0.85	19.06	0.20	1.7	28.19	0.29	5.1	56.61	0.59	0.85	27.19	0.28	1.7	36.80	0.38	5.1	71.03	0.74	0.85	22.30	0.23	1.7	31.71	0.33	5.1	62.38	0.65
0.9	19.26	0.20	1.8	28.48	0.29	5.4	57.20	0.59	0.9	27.48	0.28	1.8	37.19	0.38	5.4	71.77	0.74	0.9	22.54	0.23	1.8	32.04	0.33	5.4	63.03	0.65
0.95	19.66	0.40	1.9	29.07	0.59	5.7	58.38	1.18	0.95	28.04	0.57	1.9	37.95	0.77	5.7	73.25	1.48	0.95	23.00	0.46	1.9	32.70	0.66	5.7	64.33	1.30
1	19.86	0.20	2	29.36	0.29	6	58.97	0.59	1	28.33	0.28	2	38.34	0.38	6	73.99	0.74	1	23.23	0.23	2	33.03	0.33	6	64.98	0.65

10-Year 12-Hour			10-Year 24-Hour						100-Year 12-Hour			100-Year 24-Hour						25-Year 12-Hour			25-Year 24-Hour					
T, hr	Accum P, mm	P, mm	T, hr	Accum P, mm	P, mm				T, hr	Accum P, mm	P, mm	T, hr	Accum P, mm	P, mm				T, hr	Accum P, mm	P, mm	T, hr	Accum P, mm	P, mm			
0	0.00	0.00	0	0.00	0.00				0	0.00	0.00	0	0.00	0.00				0	0.00	0.00	0	0.00	0.00			
0.25	1.67	1.67	0.5	2.74	2.74				0.25	2.06	2.06	0.5	3.42	3.42				0.25	1.83	1.83	0.5	3.01	3.01			
0.5	3.54	1.86	1	5.78	3.03				0.5	4.37	4.37	1	7.24	7.24				0.5	3.87	3.87	1	6.36	6.36			
0.75	5.59	2.05	1.5	9.10	3.33				0.75	6.92	6.92	1.5	11.45	11.45				0.75	6.12	6.12	1.5	10.04	10.04			
1	7.74	2.15	2	12.58	3.47				1	9.61	9.61	2	15.86	15.86				1	8.49	8.49	2	13.88	13.88			
1.25	9.99	2.25	2.5	16.19	3.62				1.25	12.41	12.41	2.5	20.46	20.46				1.25	10.96	10.96	2.5	17.89	17.89			
1.5	12.23	2.25	3	19.81	3.62				1.5	15.22	15.22	3	25.07	25.07				1.5	13.43	13.43	3	21.90	21.90			
1.75	14.48	2.25	3.5	23.42	3.62				1.75	18.03	18.03	3.5	29.67	29.67				1.75	15.90	15.90	3.5	25.91	25.91			
2	16.82	2.34	4	27.18	3.76				2	20.96	20.96	4	34.48	34.48				2	18.47	18.47	4	30.08	30.08			
2.25	19.35	2.53	4.5	31.23	4.05				2.25	24.14	24.14	4.5	39.67	39.67				2.25	21.27	21.27	4.5	34.59	34.59			
2.5	22.08	2.72	5	35.57	4.34				2.5	27.58	27.58	5	45.26	45.26				2.5	24.27	24.27	5	39.42	39.42			
2.75	24.99	2.91	5.5	40.21	4.63				2.75	31.26	31.26	5.5	51.25	51.25				2.75	27.50	27.50	5.5	44.59	44.59			
3	28.10	3.11	6	45.13	4.92				3	35.19	35.19	6	57.63	57.63				3	30.93	30.93	6	50.09	50.09			
3.25	31.59	3.49	6.5	50.63	5.50				3.25	39.63	39.63	6.5	64.79	64.79				3.25	34.80	34.80	6.5	56.26	56.26			
3.5	35.65	4.06	7	57.00	6.37				3.5	44.81	44.81	7	73.14	73.14				3.5	39.31	39.31	7	63.42	63.42			
3.75	40.38	4.73	7.5	64.39	7.39				3.75	50.87	50.87	7.5	82.87	82.87				3.75	44.57	44.57	7.5	71.74	71.74			
4	52.09	11.71	8	82.38	17.98				4	66.05	66.05	8	106.99	106.99				4	57.66	57.66	8	92.16	92.16			
4.25	58.06	5.97	8.5	91.65	9.28				4.25	73.74	73.74	8.5	119.28	119.28				4.25	64.32	64.32	8.5	102.63	102.63			
4.5	62.60	4.54	9	98.75	7.10				4.5	79.54	79.54	9	128.61	128.61				4.5	69.37	69.37	9	110.62	110.62			
4.75	66.18	3.58	9.5	103.93	5.18				4.75	84.10	84.10	9.5	135.98	135.98				4.75	73.34	73.34	9.5	116.95	116.95			
5	69.48	3.30	10	107.85	3.92				5	88.28	88.28	10	142.75	142.75				5	76.99	76.99	10	122.78	122.78			
5.25	72.49	3.01	10.5	111.33	3.48				5.25	92.09	92.09	10.5	148.93	148.93				5.25	80.32	80.32	10.5	128.11	128.11			
5.5	75.31	2.82	11	114.52	3.19				5.5	95.65	95.65	11	154.72	154.72				5.5	83.43	83.43	11	133.12	133.12			
5.75	78.03	2.72	11.5	117.57	3.05				5.75	99.08	99.08	11.5	160.31	160.31				5.75	86.44	86.44	11.5	137.95	137.95			
6	80.66	2.63	12	120.47	2.90				6	102.39	102.39	12	165.70	165.70				6	89.34	89.34	12	142.63	142.63			
6.25	83.19	2.53	12.5	123.23	2.76				6.25	105.57	105.57	12.5	170.90	170.90				6.25	92.13	92.13	12.5	147.13	147.13			
6.5	85.63	2.44	13	125.84	2.61				6.5	108.63	108.63	13	175.90	175.90				6.5	94.82	94.82	13	151.47	151.47			
6.75	88.07	2.44	13.5	128.46	2.61				6.75	111.69	111.69	13.5	180.90	180.90				6.75	97.50	97.50	13.5	154.99	154.99			
7	90.41	2.34	14	130.92	2.47				7	114.62	114.62	14	185.70	185.70				7	100.08	100.08	14	157.81	157.81			
7.25	92.75	2.34	14.5	133.39	2.47				7.25	117.55	117.55	14.5	190.50	190.50				7.25	102.66	102.66	14.5	160.62	160.62			
7.5	95.00	2.25	15	135.71	2.32				7.5	120.36	120.36	15	195.04	195.04				7.5	105.13	105.13	15	163.28	163.28			
7.75	97.24	2.25	15.5	138.03	2.32				7.75	123.17	123.17	15.5	198.19	198.19				7.75	107.60	107.60	15.5	165.93	165.93			
8	99.39	2.15	16	140.21	2.18				8	125.85	125.85	16	201.15	201.15				8	109.96	109.96	16	168.42	168.42			
8.25	101.54	2.15	16.5	142.39	2.18				8.25	128.53	128.53	16.5	204.10	204.10				8.25	112.32	112.32	16.5	170.90	170.90			
8.5	103.41	1.87	17	144.57	2.18				8.5	131.22	131.22	17	207.06	207.06				8.5	114.69	114.69	17	173.39	173.39			
8.75	104.75	1.34	17.5	146.60	2.03				8.75	133.77	133.77	17.5	209.82	209.82				8.75	116.94	116.94	17.5	175.71	175.71			
9	106.09	1.34	18	148.63	2.03				9	136.33	136.33	18	212.58	212.58				9	119.20	119.20	18	178.03	178.03			
9.25	107.33	1.24	18.5	150.52	1.89				9.25	138.77	138.77	18.5	215.14	215.14				9.25	121.35	121.35	18.5	180.19	180.19			
9.5	108.57	1.24	19	152.40	1.89				9.5	141.20	141.20	19	217.70	217.70				9.5	123.49	123.49	19	182.34	182.34			
9.75	109.72	1.15	19.5	154.15	1.74				9.75	143.51	143.51	19.5	220.07	220.07				9.75	125.54	125.54	19.5	184.33	184.33			
10	110.87	1.15	20	155.89	1.74				10	145.81	145.81	20	222.43	222.43				10	127.58	127.58	20	186.32	186.32			
10.25	112.01	1.15	20.5	157.63	1.74				10.25	148.12	148.12	20.5	224.80	224.80				10.25	129.62	129.62	20.5	188.31	188.31			
10.5	113.16	1.15	21	159.37	1.74				10.5	150.43	150.43	21	227.16	227.16				10.5	131.66	131.66	21	190.30	190.30			
10.75	114.31	1.15	21.5	161.11	1.74				10.75	152.74	152.74	21.5	229.52	229.52				10.75	133.70	133.70	21.5	192.29	192.29			
11	115.45	1.15	22	162.85	1.74				11	155.04	155.04	22	231.89	231.89				11	135.74	135.74	22	194.28	194.28			
11.25	116.50	1.05	22.5	164.45	1.60				11.25	157.23	157.23	22.5	234.06	234.06				11.25	137.67	137.67	22.5	196.10	196.10			
11.5	117.55	1.05	23	166.05	1.60				11.5	159.41	159.41	23	236.22	236.22				11.5	139.61	139.61	23	197.92	197.92			
11.75	118.61	1.05	23.5	167.64	1.60				11.75	161.59	161.59	23.5	238.39	238.39				11.75	141.54	141.54	23.5	199.75	199.75			
12	119.66	1.05	24	169.24	1.60				12	163.77	163.77	24	240.56	240.56				12	143.13	143.13	24	201.57	201.57			

Appendix E

Drainage Assessment Results

KERR WOOD LEIDAL
consulting engineers

Index Page	Pipe Number	Slope (%)	Existing Diameter (m)	Length (m)	Peak Design Flow (m^3/s)	% of Full Capacity	Proposed Diameter (m)	Replacement Cost ($)	Priority
A1	**13**	**6%**	**0.3**	**97**	**0.07**	**54%**	**0.375**	**$ 25,792**	**High**
A1	15	1%	0.1	10	0.01	150%	0.2	$ 1,743	Minimum Standard
A1	21	4%	0.6	18	0.34	28%	-	-	-
A1	**217**	**7%**	**0.15**	**89**	**0.03**	**116%**	**0.3**	**$ 20,431**	**High**
A1	218	11%	0.2	42	0.08	68%	-	-	-
A1	219	2%	0.3	45	0.06	50%	-	-	-
A1	22	4%	0.75	9	0.45	21%	-	-	-
A1	467	5%	0.75	60	0.36	27%	-	-	-
A1	475	9%	0.25	50	0.15	85%	-	-	-
A1	**491**	**1%**	**0.45**	**48**	**0.51**	**152%**	**0.6**	**$ 23,030**	**High**
A1	492	5%	0.45	30	0.60	99%	0.525	$ 10,991	Medium
A1	493	6%	0.6	23	0.23	27%	-	-	-
A1	503	2%	0.45	13	0.60	137%	0.6	$ 6,387	Medium
A1	505	1%	0.5	96	0.23	86%	0.525	$ 35,876	Low
A1	506	0%	0.45	119	0.21	109%	0.525	$ 44,361	Medium
A1	507	0%	0.35	132	0.05	55%	-	-	-
A1	508	0%	0.6	133	0.04	36%	-	-	-
A1	509	0%	0.75	78	0.39	258%	-	-	-
A1	510	0%	0.45	73	0.03	16%	-	-	-
A1	511	2%	0.6	27	0.05	5%	-	-	-
A1	512	2%	0.2	24	0.04	84%	-	-	-
A1	514	2%	0.75	10	1.81	106%	-	-	-
A1	531	5%	0.6	33	0.41	31%	-	-	-
A1	532	6%	0.2	123	0.05	68%	-	-	-
A1	533	5%	0.375	30	0.13	35%	-	-	-
A1	534	8%	0.2	9	0.04	40%	-	-	-
A1	536	9%	0.3	58	0.08	27%	-	-	-
A1	537	3%	0.25	16	0.09	82%	0.3	$ 3,765	Low
A1	538	14%	0.25	67	0.11	49%	0.3	$ 15,497	Low
A1	**539**	**2%**	**0.15**	**60**	**0.03**	**152%**	**0.3**	**$ 13,758**	**High**
A1	543	9%	0.45	3	0.24	28%	-	-	-
A1	544	3%	0.45	12	0.24	50%	-	-	-
A1	545	4%	0.45	75	0.36	67%	-	-	-
A1	546	15%	0.45	22	0.70	63%	-	-	-
A1	548	2%	0.2	76	0.03	67%	0.3	$ 17,491	Medium
A1	554	2%	0.8	13	1.15	65%	-	-	-
A1	63	9%	0.25	27	0.15	83%	-	-	-
A1	64	1%	0.4	22	0.10	46%	-	-	-
A1	65	0%	0.4	12	0.05	281%	-	-	-
A1	66	2%	0.2	62	0.07	150%	0.25	$ 12,202	Low
A1	67	2%	0.7	13	0.46	40%	-	-	-
A1	69	1%	0.6	25	0.25	57%	-	-	-
A1	70	2%	0.25	89	0.09	99%	-	-	-
A1	71	9%	0.25	108	0.11	61%	-	-	-
A1	**72**	**8%**	**0.2**	**129**	**0.10**	**112%**	**0.25**	**$ 25,533**	**High**
A1	73	2%	0.3	99	0.03	19%	-	-	-
A2	1000	90%	0.2	1	0.03	7%	-	-	-
A2	1002	3%	0.6	41	0.18	13%	-	-	-
A2	10	3%	0.4	14	0.21	55%	-	-	-
A2	11	2%	0.45	67	0.17	45%	-	-	-
A2	118	3%	0.525	5	0.22	50%	-	-	-
A2	12	4%	0.35	2	0.14	46%	-	-	-
A2	123	7%	0.525	14	0.22	36%	-	-	-
A2	14	9%	0.2	52	0.07	68%	-	-	-
A2	**17**	**1%**	**0.25**	**11**	**0.07**	**98%**	**0.45**	**$ 3,945**	**High**
A2	**192**	**4%**	**0.3**	**17**	**0.10**	**119%**	**0.525**	**$ 6,159**	**High**
A2	**194**	**1%**	**0.15**	**7**	**0.04**	**308%**	**0.2**	**$ 1,743**	**High**
A2	196	48%	0.3	11	0.00	1%	-	-	-
A2	197	1%	0.3	112	0.14	124%	0.375	$ 29,924	Medium
A2	198	0%	0.3	51	0.13	230%	0.375	$ 13,455	Medium
A2	199	1%	0.2	95	0.03	76%	-	-	-
A2	**200**	**4%**	**0.3**	**72**	**0.10**	**108%**	**0.6**	**$ 34,187**	**High**
A2	**201**	**10%**	**0.2**	**111**	**0.11**	**107%**	**0.25**	**$ 21,929**	**High**
A2	**202**	**0%**	**0.2**	**9**	**0.03**	**125%**	**0.3**	**$ 2,296**	**High**
A2	**203**	**1%**	**0.2**	**14**	**0.04**	**143%**	**0.3**	**$ 3,280**	**High**
A2	204	4%	0.1	15	0.01	134%	0.2	$ 2,597	Minimum Standard
A2	**205**	**10%**	**0.2**	**23**	**0.10**	**98%**	**0.25**	**$ 4,585**	**High**
A2	212	1%	0.5	14	0.18	43%	0.6	$ 6,590	Medium
A2	213_B	3%	0.5	138	0.26	42%	0.6	$ 65,866	Medium
A2	**216**	**5%**	**0.2**	**4**	**0.07**	**97%**	**0.375**	**$ 1,142**	**High**
A2	227	1%	0.15	8	0.01	52%	0.2	$ 1,743	Minimum Standard
A2	228	1%	0.6	34	0.11	46%	-	-	-
A2	**229**	**2%**	**0.25**	**52**	**0.08**	**167%**	**0.6**	**$ 24,644**	**High**
A2	**230**	**1%**	**0.1**	**8**	**0.01**	**135%**	**0.2**	**$ 1,743**	**High**
A2	231	2%	0.3	10	0.02	14%	-	-	-
A2	232	2%	0.25	16	0.04	86%	-	-	-
A2	233	1%	0.2	5	0.00	1%	-	-	-
A2	234	0%	0.2	4	0.00	13%	-	-	-
A2	**235**	**3%**	**0.2**	**159**	**0.06**	**106%**	**0.3**	**$ 36,400**	**High**
A2	**236**	**2%**	**0.2**	**8**	**0.08**	**168%**	**0.375**	**$ 2,662**	**High**

Index Page	Pipe Number	Slope (%)	Existing Diameter (m)	Length (m)	Peak Design Flow (m^3/s)	% of Full Capacity	Proposed Diameter (m)	Replacement Cost ($)	Priority
A2	237	1%	0.1	7	0.02	390%	0.2	$ 1,743	Minimum Standard
A2	**238**	**1%**	**0.15**	**49**	**0.02**	**134%**	**0.25**	**$ 9,704**	**High**
A2	239	3%	0.2	88	0.00	0%	-	-	-
A2	242	7%	0.5	9	0.00	0%	-	-	-
A2	**243**	**2%**	**0.1**	**7**	**0.01**	**175%**	**0.2**	**$ 1,743**	**High**
A2	244	1%	0.6	28	0.35	55%	-	-	-
A2	426	1%	0.2	16	0.03	72%	-	-	-
A2	427	6%	0.3	55	0.04	29%	-	-	-
A2	428	5%	0.45	20	0.14	39%	-	-	-
A2	429	-1%	0.525	3	0.22	58%	-	-	-
A2	430	1%	0.3	6	0.05	103%	-	-	-
A2	431	1%	0.525	101	0.29	117%	0.75	$ 60,441	Medium
A2	432	1%	0.15	6	0.03	292%	0.2	$ 1,743	Minimum Standard
A2	433	1%	0.45	8	0.06	9%	-	-	-
A2	436	6%	0.2	72	0.04	44%	-	-	-
A2	438	15%	0.3	1	0.01	3%	-	-	-
A2	**439**	**6%**	**0.2**	**6**	**0.13**	**169%**	**0.45**	**$ 3,474**	**High**
A2	44	10%	0.2	50	0.01	9%	-	-	-
A2	**440**	**7%**	**0.25**	**17**	**0.13**	**78%**	**0.375**	**$ 4,536**	**High**
A2	**441**	**4%**	**0.2**	**11**	**0.13**	**370%**	**0.375**	**$ 3,061**	**High**
A2	**442**	**2%**	**0.15**	**26**	**0.03**	**130%**	**0.25**	**$ 5,226**	**High**
A2	466	1%	0.15	19	0.02	121%	0.2	$ 3,303	Minimum Standard
A2	468	1%	0.5	93	0.15	34%	-	-	-
A2	469	8%	0.375	55	0.07	14%	-	-	-
A2	**470**	**3%**	**0.2**	**32**	**0.07**	**128%**	**0.375**	**$ 8,643**	**High**
A2	471	12%	0.2	9	0.05	43%	-	-	-
A2	472	5%	0.25	141	0.11	82%	-	-	-
A2	473	9%	0.15	40	0.05	97%	0.2	$ 6,946	Minimum Standard
A2	474	30%	0.2	8	0.05	25%	-	-	-
A2	483	4%	0.25	51	0.14	123%	-	-	-
A2	**484**	**3%**	**0.3**	**94**	**0.23**	**129%**	**0.375**	**$ 25,040**	**High**
A2	485	3%	0.3	26	0.01	16%	-	-	-
A2	486	1%	0.5	19	0.06	29%	-	-	-
A2	487	1%	0.3	4	0.12	113%	0.525	$ 3,721	Medium
A2	488	13%	0.4	45	0.27	35%	-	-	-
A2	489	6%	0.5	30	0.27	30%	-	-	-
A2	490	3%	0.5	75	0.27	39%	-	-	-
A2	495	5%	0.15	49	0.02	106%	0.2	$ 8,625	Minimum Standard
A2	496	1%	0.25	34	0.04	52%	-	-	-
A2	497	2%	0.3	76	0.09	79%	-	-	-
A2	**498**	**4%**	**0.15**	**164**	**0.03**	**108%**	**0.2**	**$ 28,671**	**High**
A2	540	1%	0.45	8	0.07	36%	-	-	-
A2	541	4%	0.2	7	0.03	46%	-	-	-
A2	556	12%	0.6	18	0.18	15%	-	-	-
A2	68	1%	0.6	22	0.13	36%	-	-	-
A2	7	3%	0.3	93	0.02	11%	-	-	-
A2	8	7%	0.25	29	0.01	7%	-	-	-
A2	**9**	**2%**	**0.35**	**47**	**0.20**	**90%**	**0.375**	**$ 12,438**	**High**
A3	18	0%	0.45	53	0.16	148%	0.6	$ 25,507	Medium
A3	19	1%	0.15	10	0.01	70%	0.2	$ 1,743	Minimum Standard
A3	**20**	**3%**	**0.15**	**10**	**0.01**	**40%**	**0.2**	**$ 1,743**	**High**
A3	**300**	**1%**	**0.15**	**11**	**0.03**	**170%**	**0.3**	**$ 2,638**	**High**
A3	**301**	**1%**	**0.15**	**14**	**0.02**	**111%**	**0.3**	**$ 3,137**	**High**
A3	449	12%	0.15	12	0.05	98%	0.2	$ 2,087	Minimum Standard
A3	450	3%	0.2	42	0.06	110%	0.25	$ 8,248	Low
A3	**451**	**0%**	**0.2**	**26**	**0.04**	**252%**	**0.3**	**$ 5,946**	**High**
A3	452	4%	0.2	40	0.05	122%	0.25	$ 7,890	Low
A3	**453**	**3%**	**0.1**	**19**	**0.01**	**118%**	**0.2**	**$ 3,397**	**High**
A3	454	1%	0.5	83	0.22	110%	0.6	$ 39,530	Medium
A3	**480**	**4%**	**0.6**	**63**	**0.68**	**55%**	**0.75**	**$ 37,609**	**High**
A3	481	3%	0.9	22	0.95	59%	-	-	-
A3	482	7%	0.9	34	1.02	38%	-	-	-
A3	85	0%	0.2	10	0.02	141%	-	-	-
A3	**86**	**0%**	**0.2**	**17**	**0.03**	**249%**	**0.3**	**$ 3,794**	**High**
A3	**87**	**3%**	**0.3**	**18**	**0.09**	**102%**	**0.45**	**$ 6,186**	**High**
A3	**88**	**1%**	**0.3**	**40**	**0.08**	**182%**	**0.45**	**$ 13,765**	**High**
A3	89	6%	0.375	8	0.02	8%	-	-	-
A3	90	7%	0.375	14	0.02	6%	-	-	-
A3	91	4%	0.375	19	0.10	52%	0.45	$ 6,430	Medium
A3	92	4%	0.15	30	0.03	88%	0.2	$ 5,272	Minimum Standard
A3	**93**	**1%**	**0.15**	**54**	**0.02**	**144%**	**0.2**	**$ 9,497**	**High**
A4	456	0%	0.375	40	0.14	142%	0.45	$ 13,826	Medium
A4	457	0%	0.3	51	0.13	205%	0.375	$ 13,706	Medium
A4	458	1%	0.3	97	0.11	148%	0.375	$ 25,773	Medium
A4	**459**	**1%**	**0.2**	**63**	**0.04**	**115%**	**0.25**	**$ 12,443**	**High**
A4	542	5%	0.2	45	0.07	98%	0.3	$ 10,247	Medium
A4	94	1%	0.2	88	0.05	174%	0.3	$ 20,141	Medium
A4	**95**	**1%**	**0.15**	**40**	**0.02**	**107%**	**0.2**	**$ 6,963**	**High**
A4	96	1%	0.2	27	0.04	168%	-	-	-
A4	97	1%	0.2	54	0.06	179%	0.3	$ 12,347	Medium

Index Page	Pipe Number	Slope (%)	Existing Diameter (m)	Length (m)	Peak Design Flow (m^3/s)	% of Full Capacity	Proposed Diameter (m)	Replacement Cost ($)	Priority
A4	98	1%	0.2	17	0.00	4%	-	-	-
B1	**166**	**0%**	**0.2**	**20**	**0.05**	**333%**	**0.45**	**$ 6,896**	**High**
B1	2	17%	0.2	86	0.05	38%	-	-	-
B1	24	13%	0.2	35	0.16	138%	0.25	$ 6,968	Low
B1	253	1%	0.3	13	0.01	10%	-	-	-
B1	**254**	**4%**	**0.15**	**34**	**0.05**	**139%**	**0.45**	**$ 11,737**	**High**
B1	256	12%	0.5	43	0.51	38%	-	-	-
B1	**257**	**5%**	**0.15**	**71**	**0.04**	**110%**	**0.3**	**$ 16,264**	**High**
B1	**258**	**2%**	**0.1**	**20**	**0.01**	**200%**	**0.2**	**$ 3,450**	**High**
B1	259	34%	0.3	15	0.02	3%	-	-	-
B1	260	6%	0.45	48	0.16	23%	-	-	-
B1	3	13%	0.2	30	0.07	60%	-	-	-
B1	347	16%	0.25	94	0.02	8%	-	-	-
B1	**348**	**0%**	**0.15**	**18**	**0.04**	**628%**	**0.3**	**$ 4,129**	**High**
B1	349	3%	0.15	16	0.02	67%	0.2	$ 2,826	Minimum Standard
B1	350	9%	0.45	53	0.52	62%	-	-	-
B1	**351**	**14%**	**0.375**	**14**	**0.36**	**100%**	**0.525**	**$ 5,218**	**High**
B1	352	6%	0.3	1	0.11	49%	-	-	-
B1	**353**	**14%**	**0.1**	**101**	**0.02**	**110%**	**0.2**	**$ 17,544**	**High**
B1	356	0%	0.45	19	0.06	183%	0.6	$ 8,825	Medium
B1	**359**	**-1%**	**0.15**	**15**	**0.03**	**150%**	**0.3**	**$ 3,464**	**High**
B1	360	5%	0.25	22	0.05	35%	-	-	-
B1	444	-1%	0.25	15	0.07	277%	0.3	$ 3,536	Low
B1	445	5%	0.25	12	0.03	24%	-	-	-
B1	446	12%	0.375	4	0.00	1%	-	-	-
B1	447	3%	0.7	13	0.03	3%	-	-	-
B1	448	1%	0.6	10	0.34	97%	-	-	-
B1	**499**	**16%**	**0.4**	**173**	**0.43**	**97%**	**0.525**	**$ 64,260**	**High**
B1	75	14%	0.375	18	0.00	0%	-	-	-
B1	76	18%	0.7	33	0.02	0%	-	-	-
B1	79	4%	0.15	33	0.01	33%	0.2	$ 5,682	Minimum Standard
B1	80	25%	0.45	63	0.10	7%	-	-	-
B1	82	4%	0.3	37	0.17	91%	-	-	-
B1	83	35%	0.5	10	0.15	12%	-	-	-
B2	100	4%	0.9	35	0.99	27%	-	-	-
B2	1003	4%	0.25	34	0.00	0%	-	-	-
B2	1004	0%	0.25	19	0.00	0%	-	-	-
B2	**101**	**5%**	**0.2**	**36**	**0.05**	**73%**	**0.25**	**$ 7,176**	**High**
B2	**102**	**3%**	**0.2**	**51**	**0.05**	**86%**	**0.25**	**$ 10,115**	**High**
B2	**103**	**1%**	**0.15**	**38**	**0.03**	**226%**	**0.25**	**$ 7,596**	**High**
B2	**104**	**0%**	**0.375**	**82**	**0.11**	**152%**	**0.6**	**$ 39,271**	**High**
B2	105	0%	0.25	18	0.01	585%	-	-	-
B2	117	4%	0.45	136	0.36	118%	0.9	$ 97,335	Medium
B2	119	2%	0.45	9	0.16	72%	-	-	-
B2	120	3%	0.45	12	0.00	1%	-	-	-
B2	121	3%	0.45	38	0.02	8%	-	-	-
B2	122	13%	0.15	7	0.02	41%	0.2	$ 1,743	Minimum Standard
B2	124	1%	0.2	19	0.03	118%	0.3	$ 4,379	Medium
B2	**125**	**1%**	**0.1**	**27**	**0.01**	**262%**	**0.3**	**$ 6,151**	**High**
B2	**126**	**1%**	**0.15**	**21**	**0.03**	**270%**	**0.25**	**$ 4,240**	**High**
B2	127	1%	0.2	18	0.04	134%	0.25	$ 3,507	Low
B2	128	0%	0.3	21	0.08	300%	0.375	$ 5,537	Medium
B2	**129**	**0%**	**0.2**	**5**	**0.01**	**146%**	**0.3**	**$ 2,296**	**High**
B2	130	4%	0.2	24	0.02	61%	-	-	-
B2	131	3%	0.25	24	0.06	117%	-	-	-
B2	132	3%	0.25	20	0.08	84%	-	-	-
B2	133	1%	0.3	19	0.02	30%	-	-	-
B2	134	-2%	0.3	8	0.04	47%	-	-	-
B2	135	1%	0.3	62	0.05	79%	-	-	-
B2	136	1%	0.45	29	0.08	33%	-	-	-
B2	137	3%	0.2	3	0.04	69%	0.3	$ 2,296	Medium
B2	138	0%	0.3	3	0.00	7%	-	-	-
B2	139	1%	0.2	1	0.04	85%	0.3	$ 2,296	Medium
B2	140	0%	0.4	18	0.01	6%	-	-	-
B2	141	0%	0.4	20	0.01	9%	-	-	-
B2	142	0%	0.3	18	0.04	128%	-	-	-
B2	143	1%	0.15	25	0.02	125%	0.2	$ 4,324	Minimum Standard
B2	144	1%	0.2	7	0.00	9%	-	-	-
B2	145	0%	0.2	4	0.01	66%	-	-	-
B2	146	2%	0.2	27	0.00	5%	-	-	-
B2	147	1%	0.25	7	0.02	37%	-	-	-
B2	148	0%	0.3	42	0.04	75%	0.375	$ 11,096	Medium
B2	149	2%	0.15	20	0.02	84%	0.2	$ 3,546	Minimum Standard
B2	150	2%	0.25	23	0.02	21%	-	-	-
B2	151	2%	0.15	7	0.00	6%	0.2	$ 1,743	Minimum Standard
B2	152	3%	0.15	15	0.01	27%	0.2	$ 2,556	Minimum Standard
B2	153	1%	0.15	15	0.00	10%	0.2	$ 2,547	Minimum Standard
B2	154	1%	0.45	17	0.08	33%	-	-	-
B2	155	0%	0.5	13	0.09	59%	-	-	-
B2	**158**	**0%**	**0.2**	**13**	**0.02**	**178%**	**0.3**	**$ 2,937**	**High**

Index Page	Pipe Number	Slope (%)	Existing Diameter (m)	Length (m)	Peak Design Flow (m^3/s)	% of Full Capacity	Proposed Diameter (m)	Replacement Cost ($)	Priority
B2	163	3%	0.3	115	0.09	104%	0.45	$ 39,996	Highest
B2	164	18%	0.2	23	0.12	87%	-	-	-
B2	**165**	**3%**	**0.3**	**11**	**0.08**	**93%**	**0.375**	**$ 3,057**	**High**
B2	167	12%	0.2	22	0.10	89%	-	-	-
B2	**168**	**3%**	**0.2**	**20**	**0.06**	**103%**	**0.375**	**$ 5,439**	**High**
B2	169	-1%	0.25	18	0.05	88%	-	-	-
B2	170	13%	0.15	12	0.04	64%	0.2	$ 2,139	Minimum Standard
B2	171	0%	0.15	13	0.03	581%	0.2	$ 2,212	Minimum Standard
B2	172	1%	0.15	17	0.02	97%	0.2	$ 2,992	Minimum Standard
B2	173	8%	0.15	4	0.05	116%	0.25	$ 1,978	Low
B2	189	2%	0.2	48	0.02	47%	-	-	-
B2	190	-1%	0.2	17	0.01	60%	-	-	-
B2	**191**	**2%**	**0.15**	**16**	**0.01**	**62%**	**0.2**	**$ 2,843**	**High**
B2	**193**	**2%**	**0.3**	**13**	**0.05**	**30%**	**0.375**	**$ 3,504**	**High**
B2	195	1%	0.2	15	0.07	215%	0.375	$ 3,874	Medium
B2	**220**	**0%**	**0.2**	**2**	**0.08**	**645%**	**0.675**	**$ 5,240**	**High**
B2	**221**	**0%**	**0.15**	**37**	**0.01**	**239%**	**0.25**	**$ 7,236**	**High**
B2	**223**	**2%**	**0.15**	**9**	**0.01**	**41%**	**0.2**	**$ 1,743**	**High**
B2	**224**	**2%**	**0.15**	**6**	**0.01**	**29%**	**0.2**	**$ 1,743**	**High**
B2	225	5%	0.8	4	0.18	5%	-	-	-
B2	226	5%	0.2	13	0.01	18%	-	-	-
B2	25	1%	0.2	5	0.03	109%	-	-	-
B2	26	4%	0.15	37	0.02	61%	0.2	$ 6,473	Minimum Standard
B2	**261**	**6%**	**0.2**	**4**	**0.06**	**137%**	**0.3**	**$ 2,296**	**High**
B2	**262**	**1%**	**0.25**	**2**	**0.03**	**124%**	**0.3**	**$ 2,296**	**High**
B2	**263**	**4%**	**0.3**	**13**	**0.07**	**72%**	**0.375**	**$ 3,474**	**High**
B2	**266**	**0%**	**0.5**	**14**	**0.25**	**186%**	**0.6**	**$ 6,716**	**High**
B2	**267**	**2%**	**0.1**	**21**	**0.01**	**169%**	**0.25**	**$ 4,226**	**High**
B2	345	3%	0.45	109	0.11	42%	-	-	-
B2	**346**	**4%**	**0.525**	**135**	**0.59**	**66%**	**0.6**	**$ 64,522**	**High**
B2	**357**	**1%**	**0.525**	**50**	**0.47**	**196%**	**1.2**	**$ 57,316**	**High**
B2	358	0%	0.525	16	0.47	333%	1.2	$ 18,390	Medium
B2	361	0%	0.15	22	0.02	678%	0.45	$ 7,760	Medium
B2	362	-1%	0.4	20	0.01	38%	-	-	-
B2	**363**	**0%**	**0.1**	**11**	**0.01**	**497%**	**0.2**	**$ 1,955**	**High**
B2	364	0%	0.25	22	0.02	107%	-	-	-
B2	365	1%	0.25	76	0.04	90%	-	-	-
B2	366	1%	0.3	9	0.08	131%	-	-	-
B2	367	1%	0.3	9	0.08	131%	-	-	-
B2	370	1%	0.2	3	0.02	73%	-	-	-
B2	371	2%	0.3	17	0.02	23%	-	-	-
B2	372	1%	0.525	32	0.15	52%	-	-	-
B2	373	1%	0.5	10	0.42	100%	0.525	$ 3,721	Low
B2	374	5%	0.15	6	0.00	13%	0.2	$ 1,743	Minimum Standard
B2	376	2%	0.3	26	0.11	158%	0.45	$ 8,987	Medium
B2	377	1%	0.15	8	0.04	291%	0.2	$ 1,743	Minimum Standard
B2	378	2%	0.3	24	0.05	36%	-	-	-
B2	379	0%	0.3	105	0.08	111%	0.45	$ 36,447	Medium
B2	380	0%	0.15	3	0.02	266%	0.2	$ 1,743	Minimum Standard
B2	**381**	**1%**	**0.1**	**7**	**0.01**	**256%**	**0.2**	**$ 1,743**	**High**
B2	382	0%	0.25	68	0.01	21%	-	-	-
B2	383	0%	0.15	39	0.01	350%	0.2	$ 6,754	Minimum Standard
B2	385	2%	0.45	14	0.11	31%	-	-	-
B2	388	1%	0.2	5	0.04	148%	-	-	-
B2	389	0%	0.75	7	0.17	32%	-	-	-
B2	395	0%	0.25	2	0.00	8%	-	-	-
B2	396	2%	0.5	20	0.01	1%	-	-	-
B2	397	0%	0.2	44	0.06	211%	0.45	$ 15,315	Medium
B2	**398**	**1%**	**0.25**	**25**	**0.06**	**123%**	**0.45**	**$ 8,622**	**High**
B2	**399**	**1%**	**0.3**	**22**	**0.05**	**56%**	**0.45**	**$ 7,596**	**High**
B2	4	1%	0.25	5	0.08	199%	-	-	-
B2	400	1%	0.3	11	0.02	16%	-	-	-
B2	**401**	**0%**	**0.3**	**5**	**0.02**	**26%**	**0.375**	**$ 2,662**	**High**
B2	**402**	**1%**	**0.3**	**20**	**0.07**	**78%**	**0.45**	**$ 7,008**	**High**
B2	403	1%	0.15	7	0.00	8%	0.2	$ 1,743	Minimum Standard
B2	404	1%	0.3	8	0.01	10%	-	-	-
B2	**405**	**2%**	**0.3**	**40**	**0.09**	**71%**	**0.375**	**$ 10,623**	**High**
B2	406	11%	0.15	5	0.03	63%	0.2	$ 1,743	Minimum Standard
B2	**407**	**2%**	**0.2**	**17**	**0.06**	**130%**	**0.3**	**$ 3,929**	**High**
B2	**408**	**8%**	**0.15**	**3**	**0.03**	**75%**	**0.2**	**$ 1,743**	**High**
B2	409	1%	0.2	7	0.04	128%	-	-	-
B2	410	1%	0.2	13	0.05	157%	-	-	-
B2	**411**	**1%**	**0.2**	**11**	**0.08**	**239%**	**0.3**	**$ 2,565**	**High**
B2	412	2%	0.25	25	0.01	14%	-	-	-
B2	413	3%	0.15	17	0.00	16%	0.2	$ 3,022	Minimum Standard
B2	414	4%	0.15	5	0.02	65%	0.2	$ 1,743	Minimum Standard
B2	415	7%	0.2	46	0.03	31%	-	-	-
B2	417	1%	0.3	116	0.05	88%	0.45	$ 40,472	Highest
B2	**418**	**3%**	**0.2**	**15**	**0.04**	**74%**	**0.3**	**$ 3,500**	**High**
B2	**419**	**0%**	**0.15**	**3**	**0.03**	**378%**	**0.2**	**$ 1,743**	**High**

Index Page	Pipe Number	Slope (%)	Existing Diameter (m)	Length (m)	Peak Design Flow (m^3/s)	% of Full Capacity	Proposed Diameter (m)	Replacement Cost ($)	Priority
B2	**420**	**1%**	**0.2**	**18**	**0.03**	**77%**	**0.3**	**$ 4,184**	**High**
B2	422	1%	0.45	86	0.36	174%	-	-	-
B2	423	1%	0.3	111	0.11	148%	0.75	$ 66,154	Medium
B2	**424**	**1%**	**0.3**	**77**	**0.08**	**158%**	**0.75**	**$ 46,277**	**High**
B2	**425**	**0%**	**0.3**	**42**	**0.09**	**200%**	**0.75**	**$ 25,295**	**High**
B2	443	7%	0.4	42	0.06	19%	-	-	-
B2	**478**	**2%**	**0.5**	**39**	**0.25**	**83%**	**0.6**	**$ 18,579**	**High**
B2	479	4%	0.5	33	0.23	52%	-	-	-
B2	5	8%	0.375	25	0.12	47%	0.525	$ 9,187	Medium
B2	504	1%	0.2	2	0.03	101%	-	-	-
B2	549	4%	0.9	15	1.16	33%	-	-	-
B2	555	1%	0.3	78	0.03	42%	-	-	-
B2	557	1%	0.3	51	0.09	86%	0.45	$ 17,829	Medium
B2	**58**	**10%**	**0.2**	**2**	**0.09**	**82%**	**0.375**	**$ 415**	**High**
B2	59	1%	0.3	77	0.12	176%	0.45	$ 26,758	Medium
B2	**6**	**3%**	**0.2**	**95**	**0.06**	**93%**	**0.375**	**$ 25,194**	**High**
B2	81	2%	0.3	37	0.15	105%	0.45	$ 12,764	Medium
B2	C68	-2%	0.3	23	0.06	38%	0.45	$ 7,956	Medium
B2	C93	0%	0.75	50	0.17	32%	-	-	-
B3	**1**	**3%**	**0.1**	**6**	**0.01**	**156%**	**0.2**	**$ 1,743**	**High**
B3	1000	116%	0.25	2	0.18	18%	-	-	-
B3	1001	1%	0.5	37	0.14	59%	0.75	$ 22,365	Medium
B3	**16**	**1%**	**0.15**	**9**	**0.01**	**68%**	**0.2**	**$ 1,743**	**High**
B3	160	0%	0.6	9	0.14	83%	0.75	$ 5,370	Medium
B3	188	3%	0.6	178	0.35	65%	0.75	$ 106,546	Highest
B3	23	1%	0.375	161	0.17	136%	0.45	$ 55,847	Medium
B3	**247**	**5%**	**0.15**	**48**	**0.04**	**106%**	**0.2**	**$ 8,346**	**High**
B3	248	1%	0.1	8	0.00	11%	0.2	$ 1,743	Minimum Standard
B3	249	0%	0.1	6	0.00	5%	0.2	$ 1,743	Minimum Standard
B3	**250**	**0%**	**0.1**	**36**	**0.01**	**281%**	**0.3**	**$ 8,211**	**High**
B3	251	1%	0.2	42	0.01	25%	-	-	-
B3	252	0%	0.25	10	0.03	334%	0.3	$ 2,296	Low
B3	268	1%	0.375	43	0.14	112%	-	-	-
B3	**269**	**2%**	**0.15**	**12**	**0.02**	**77%**	**0.2**	**$ 2,099**	**High**
B3	**27**	**4%**	**0.2**	**45**	**0.05**	**81%**	**0.25**	**$ 8,815**	**High**
B3	**270**	**2%**	**0.15**	**38**	**0.03**	**140%**	**0.25**	**$ 7,560**	**High**
B3	**271**	**1%**	**0.1**	**5**	**0.01**	**118%**	**0.2**	**$ 1,743**	**High**
B3	**272**	**5%**	**0.2**	**45**	**0.04**	**60%**	**0.25**	**$ 8,918**	**High**
B3	**273**	**3%**	**0.2**	**11**	**0.04**	**72%**	**0.3**	**$ 2,479**	**High**
B3	**274**	**1%**	**0.2**	**23**	**0.04**	**103%**	**0.3**	**$ 5,384**	**High**
B3	**275**	**-2%**	**0.2**	**2**	**0.03**	**76%**	**0.3**	**$ 2,296**	**High**
B3	276	1%	0.15	13	0.00	20%	0.2	$ 2,215	Minimum Standard
B3	**277**	**19%**	**0.15**	**1**	**0.03**	**81%**	**0.375**	**$ 2,662**	**High**
B3	278	1%	0.2	12	0.03	171%	0.375	$ 3,230	Medium
B3	279	0%	0.1	21	0.01	3179%	0.2	$ 3,727	Minimum Standard
B3	280	9%	0.15	31	0.02	45%	0.2	$ 5,399	Minimum Standard
B3	**281**	**3%**	**0.1**	**49**	**0.01**	**121%**	**0.2**	**$ 8,622**	**High**
B3	**282**	**1%**	**0.1**	**6**	**0.00**	**81%**	**0.2**	**$ 1,743**	**High**
B3	**283**	**1%**	**0.15**	**6**	**0.01**	**41%**	**0.2**	**$ 1,743**	**High**
B3	284	2%	0.25	57	0.03	82%	-	-	-
B3	285	7%	0.15	22	0.04	111%	0.2	$ 3,799	Minimum Standard
B3	**286**	**1%**	**0.2**	**24**	**0.06**	**181%**	**0.375**	**$ 6,293**	**High**
B3	**287**	**3%**	**0.2**	**37**	**0.06**	**93%**	**0.25**	**$ 7,404**	**High**
B3	**288**	**0%**	**0.2**	**7**	**0.05**	**387%**	**0.25**	**$ 1,978**	**High**
B3	289	46%	0.2	15	0.05	22%	-	-	-
B3	290	2%	0.2	17	0.00	3%	-	-	-
B3	291	1%	0.3	5	0.02	38%	-	-	-
B3	292	3%	0.3	46	0.10	58%	-	-	-
B3	293	1%	0.45	177	0.18	71%	0.75	$ 105,638	Medium
B3	294	-1%	0.45	19	0.10	37%	0.75	$ 11,268	Medium
B3	295	1%	0.45	15	0.10	52%	0.75	$ 9,122	Medium
B3	296	21%	0.15	16	0.04	55%	0.2	$ 2,772	Minimum Standard
B3	**297**	**1%**	**0.15**	**21**	**0.03**	**343%**	**0.3**	**$ 4,926**	**High**
B3	**302**	**2%**	**0.15**	**100**	**0.03**	**122%**	**0.3**	**$ 22,970**	**High**
B3	**303**	**0%**	**0.3**	**44**	**0.10**	**420%**	**0.6**	**$ 21,169**	**High**
B3	**304**	**1%**	**0.15**	**168**	**0.02**	**127%**	**0.375**	**$ 44,815**	**High**
B3	**305**	**0%**	**0.3**	**23**	**0.11**	**326%**	**0.75**	**$ 13,784**	**High**
B3	**306**	**0%**	**0.45**	**106**	**0.15**	**161%**	**0.9**	**$ 75,698**	**High**
B3	**307**	**0%**	**0.15**	**7**	**0.01**	**69%**	**0.2**	**$ 1,743**	**High**
B3	**308**	**1%**	**0.15**	**18**	**0.01**	**116%**	**0.2**	**$ 3,211**	**High**
B3	**309**	**0%**	**0.15**	**52**	**0.02**	**549%**	**0.2**	**$ 8,985**	**High**
B3	**310**	**0%**	**0.15**	**37**	**0.01**	**186%**	**0.375**	**$ 9,793**	**High**
B3	**311**	**4%**	**0.15**	**103**	**0.02**	**105%**	**0.3**	**$ 23,628**	**High**
B3	312	1%	0.2	38	0.04	146%	0.25	$ 7,492	Low
B3	314	1%	0.25	62	0.09	125%	-	-	-
B3	315	0%	0.2	16	0.05	228%	0.25	$ 3,098	Low
B3	316	1%	0.2	16	0.05	146%	0.25	$ 3,186	Low
B3	**317**	**0%**	**0.45**	**34**	**0.51**	**328%**	**0.75**	**$ 20,358**	**High**
B3	319	2%	0.9	15	0.51	27%	-	-	-
B3	**320**	**0%**	**0.9**	**58**	**0.68**	**190%**	**1.05**	**$ 54,660**	**High**

Index Page	Pipe Number	Slope (%)	Existing Diameter (m)	Length (m)	Peak Design Flow (m^3/s)	% of Full Capacity	Proposed Diameter (m)	Replacement Cost ($)	Priority
B3	321	0%	0.45	40	0.27	316%	0.75	$ 23,651	Medium
B3	323	5%	0.45	148	0.27	41%	0.75	$ 88,547	Medium
B3	325	2%	0.2	18	0.05	119%	-	-	-
B3	**327**	**4%**	**0.2**	**20**	**0.05**	**72%**	**0.25**	**$ 4,021**	**High**
B3	**328**	**4%**	**0.1**	**9**	**0.02**	**229%**	**0.2**	**$ 1,743**	**High**
B3	329	4%	0.2	19	0.03	40%	-	-	-
B3	330	3%	0.3	23	0.03	18%	-	-	-
B3	**331**	**1%**	**0.2**	**7**	**0.10**	**310%**	**0.3**	**$ 2,296**	**High**
B3	**332**	**6%**	**0.3**	**45**	**0.11**	**84%**	**0.375**	**$ 11,868**	**High**
B3	333	0%	0.1	6	0.00	161%	0.2	$ 1,743	Minimum Standard
B3	**334**	**1%**	**0.15**	**7**	**0.03**	**150%**	**0.2**	**$ 1,743**	**High**
B3	**335**	**2%**	**0.3**	**13**	**0.12**	**144%**	**0.45**	**$ 4,520**	**High**
B3	**336**	**2%**	**0.15**	**5**	**0.01**	**64%**	**0.2**	**$ 1,743**	**High**
B3	**337**	**4%**	**0.3**	**37**	**0.12**	**108%**	**0.45**	**$ 12,758**	**High**
B3	338	0%	0.45	22	0.17	143%	0.6	$ 10,400	Medium
B3	339	6%	0.3	3	0.06	26%	-	-	-
B3	341	-1%	0.45	2	0.17	62%	0.6	$ 4,769	Medium
B3	434	0%	0.3	39	0.06	131%	-	-	-
B3	435	4%	0.3	72	0.06	29%	-	-	-
B3	460	0%	0.4	77	0.22	216%	1.05	$ 72,630	Medium
B3	**461**	**0%**	**0.15**	**32**	**0.03**	**468%**	**0.2**	**$ 5,617**	**High**
B3	462	8%	0.25	60	0.12	70%	-	-	-
B3	463	1%	0.2	42	0.02	43%	-	-	-
B3	464	1%	0.25	9	0.04	155%	-	-	-
B3	465	1%	0.45	21	0.04	16%	-	-	-
B3	**501**	**4%**	**0.3**	**33**	**0.10**	**50%**	**0.375**	**$ 8,686**	**High**
B3	502	11%	0.25	34	0.03	15%	-	-	-
B3	**550**	**1%**	**0.2**	**37**	**0.04**	**137%**	**0.45**	**$ 12,950**	**High**
B3	**551**	**1%**	**0.2**	**8**	**0.05**	**180%**	**0.375**	**$ 2,662**	**High**
B3	552	2%	0.6	167	0.46	92%	0.75	$ 99,831	Highest
B3	**553**	**0%**	**0.6**	**7**	**0.47**	**283%**	**0.75**	**$ 4,044**	**High**
B3	60	1%	0.3	4	0.05	69%	-	-	-
B3	61	0%	0.25	35	0.02	39%	-	-	-
B3	62	1%	0.25	86	0.06	84%	-	-	-
B3	84	5%	0.15	7	0.03	97%	0.2	$ 1,743	Minimum Standard
C1	264	3%	0.1	15	0.02	160%	0.2	$ 2,558	Minimum Standard
C1	265	3%	0.15	19	0.03	94%	0.2	$ 3,232	Minimum Standard
C1	558	2%	0.3	3	0.31	5743%	0.6	$ 4,769	Medium
C1	559	1%	0.9	25	1.93	143%	-	-	-
C1	**77**	**3%**	**0.1**	**18**	**0.01**	**172%**	**0.2**	**$ 3,131**	**High**
C1	**78**	**2%**	**0.15**	**22**	**0.03**	**123%**	**0.2**	**$ 3,809**	**High**
C2	106	3%	0.25	23	0.05	53%	-	-	-
C2	107	7%	0.2	28	0.10	120%	-	-	-
C2	**108**	**3%**	**0.3**	**92**	**0.15**	**86%**	**0.375**	**$ 24,420**	**High**
C2	**109**	**0%**	**0.3**	**60**	**0.10**	**174%**	**0.525**	**$ 22,345**	**High**
C2	**110**	**1%**	**0.3**	**21**	**0.10**	**111%**	**0.6**	**$ 10,095**	**High**
C2	111	8%	0.25	7	0.05	27%	-	-	-
C2	**112**	**7%**	**0.375**	**19**	**0.29**	**63%**	**0.6**	**$ 8,892**	**High**
C2	**113**	**0%**	**0.475**	**29**	**0.35**	**519%**	**0.9**	**$ 20,861**	**High**
C2	114	24%	0.375	7	0.02	2%	-	-	-
C2	115	1%	0.45	39	0.35	116%	0.9	$ 27,640	Medium
C2	**116**	**3%**	**0.15**	**14**	**0.04**	**152%**	**0.2**	**$ 2,389**	**High**
C2	174	15%	0.45	53	0.39	36%	-	-	-
C2	**175**	**2%**	**0.375**	**58**	**0.30**	**215%**	**0.75**	**$ 34,946**	**High**
C2	**176**	**7%**	**0.375**	**26**	**0.30**	**113%**	**0.6**	**$ 12,181**	**High**
C2	177	7%	0.45	53	0.32	75%	0.675	$ 27,606	Medium
C2	342	9%	0.6	33	0.82	82%	-	-	-
C2	**344**	**3%**	**0.3**	**24**	**0.31**	**174%**	**0.525**	**$ 8,868**	**High**
C2	354	3%	0.3	29	0.12	67%	-	-	-
C2	**560**	**9%**	**0.45**	**14**	**0.85**	**184%**	**0.6**	**$ 6,600**	**High**
C2	**561**	**16%**	**0.45**	**25**	**0.82**	**127%**	**0.525**	**$ 8,168**	**High**
C2	57	21%	0.6	14	0.02	1%	-	-	-
C2	99	4%	0.9	52	0.86	24%	-	-	-
C3	156	3%	0.25	31	0.04	38%	-	-	-
C3	157	3%	0.25	12	0.13	122%	-	-	-
C3	**159**	**4%**	**0.3**	**191**	**0.20**	**103%**	**0.45**	**$ 66,266**	**High**
C3	**161**	**2%**	**0.3**	**72**	**0.19**	**139%**	**0.45**	**$ 24,860**	**High**
C3	**162**	**4%**	**0.3**	**107**	**0.17**	**90%**	**0.375**	**$ 28,496**	**High**
C3	178	3%	0.5	21	0.08	21%	-	-	-
C3	179	1%	0.3	19	0.04	35%	-	-	-
C3	180	2%	0.5	15	0.06	19%	-	-	-
C3	181	5%	0.3	20	0.02	15%	-	-	-
C3	**182**	**4%**	**0.25**	**130**	**0.08**	**114%**	**0.45**	**$ 45,007**	**High**
C3	183	1%	0.3	6	0.02	21%	-	-	-
C3	184	4%	0.3	20	0.01	4%	-	-	-
C3	185	3%	0.3	3	0.09	85%	0.45	$ 3,474	Medium
C3	186	1%	0.3	11	0.03	28%	-	-	-
C3	**187**	**3%**	**0.3**	**107**	**0.17**	**95%**	**0.375**	**$ 28,435**	**High**
C3	547	5%	0.5	8	0.20	40%	0.525	$ 3,721	Low
C3	562	1%	0.15	29	0.02	144%	0.2	$ 5,044	Minimum Standard

Index Page	Pipe Number	Slope (%)	Existing Diameter (m)	Length (m)	Peak Design Flow (m^3/s)	% of Full Capacity	Proposed Diameter (m)	Replacement Cost ($)	Priority
C3	563	3%	0.3	24	0.19	109%	0.525	$ 8,861	Medium
C3	564	3%	0.6	40	0.00	0%	-	-	-
C3	565	0%	0.6	34	0.26	118%	-	-	-
C3	**74**	**3%**	**0.3**	**69**	**0.21**	**117%**	**0.375**	**$ 18,366**	**High**
C3	C94	1%	0.15	81	0.02	136%	0.2	$ 14,165	Minimum Standard
D1	213	12%	0.3	40	0.09	28%	-	-	-
D1	28	5%	0.375	63	0.13	33%	-	-	-
D1	29	1%	0.3	12	0.10	102%	-	-	-
D1	30	13%	0.375	6	0.10	15%	-	-	-
D1	31	7%	0.375	47	0.29	61%	-	-	-
D1	32	1%	0.3	22	0.10	104%	-	-	-
D1	33	5%	0.2	53	0.03	39%	-	-	-
D1	34	5%	0.2	39	0.01	16%	-	-	-
D1	35	6%	0.375	43	0.18	43%	-	-	-
D1	36	4%	0.375	36	0.17	52%	-	-	-
D1	37	4%	0.375	36	0.15	47%	-	-	-
D1	38	9%	0.375	36	0.10	20%	-	-	-
D1	39	21%	0.375	10	0.10	12%	-	-	-
D1	40	7%	0.3	20	0.15	58%	-	-	-
D1	41	7%	0.3	47	0.13	53%	-	-	-
D1	42	4%	0.2	34	0.06	84%	-	-	-
D1	43	38%	0.3	22	0.13	22%	-	-	-
D1	45	3%	0.2	45	0.01	19%	0.3	$ 10,265	Medium
D1	46	7%	0.2	58	0.02	19%	-	-	-
D1	47	1%	0.375	56	0.10	76%	-	-	-
D1	48	1%	0.25	51	0.06	129%	-	-	-
D1	49	3%	0.2	87	0.05	89%	-	-	-
D1	50	10%	0.25	53	0.14	71%	0.3	$ 12,205	Low
D1	51	1%	0.2	22	0.00	0%	0.3	$ 5,016	Medium
D1	52	12%	0.2	26	0.13	116%	0.3	$ 5,967	Medium
D1	53	12%	0.2	30	0.12	103%	0.3	$ 6,914	Medium
D1	54	14%	0.25	47	0.03	15%	-	-	-
D1	55	10%	0.2	63	0.05	45%	0.3	$ 14,456	Medium
D1	56	8%	0.2	29	0.11	112%	0.3	$ 6,614	Medium

Legend

Priority	Description
None	No upgrade required, existing pipe
Minimum Standard	Pipe not surcharging but increase size to standard minum 200 mm diameter
Low	Pipe surcharing increase one standard pipe diameter
Medium	Pipe surcharging incease two or more standard pipe diameters
High	Flooding with hydraulic gradeline above ground level for a least 15 minutes or at least 0.3 m above ground
Highest	Flooding with no safe designated overland flood route

Notes:
1. Results based on peak flow existing land use
2. Some pipes that are not surcharging (less than 100% full capacity) require upgrading as a result of increased upstream pipe diameter and requirement always increase never decrease pipe diameters when moving downstream through the drainage network.

Town of Lake Cowichan
Integrated Rainwater Management Plan

Legend

- Culvert
- Creeks from Habitat Plan
- Modelled Ditch/Creek
- Unchanged Conduit
- Legal
- Municipal Town Boundary
- Grid Index
- Water body

Proposed Diameter (m)

- 0.2
- 0.25
- 0.3
- 0.375
- 0.45
- 0.525
- 0.6
- 0.675
- 0.75
- 0.9
- 1.05
- 1.2
- Creeks_HabitatPlan_Flow

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200 0 200 (m)

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10-Year Return Period Flood - Proposed Storm Main Diameters

Overview

Town of Lake Cowichan
Integrated Rainwater Management Plan

Legend

- Creeks from Habitat
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Proposed Diameter with Conduit Number (m)

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- 0.25
- 0.3
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- 0.45
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- 0.675
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- 0.9
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50 0 50 (m)
1:3,000

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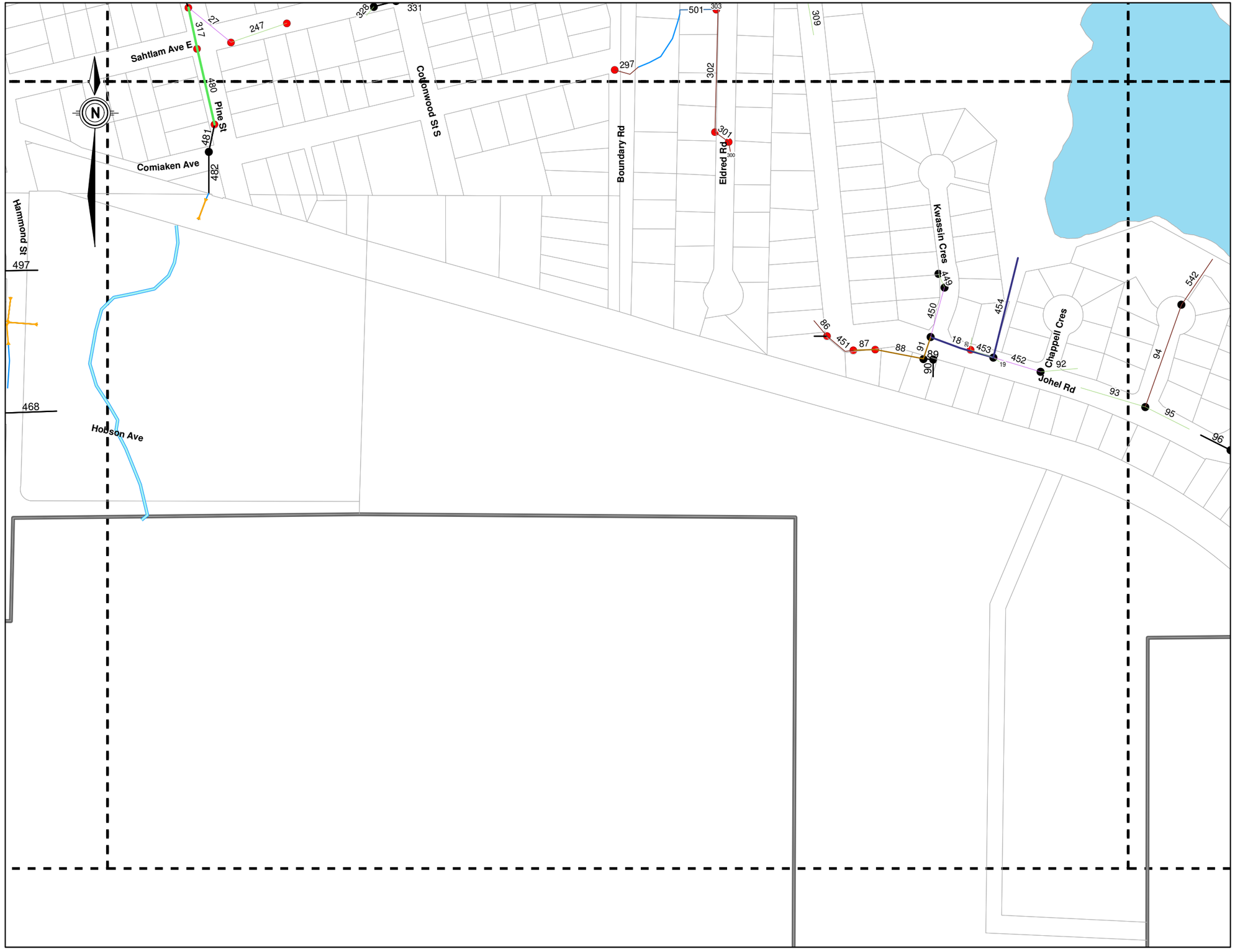

Town of Lake Cowichan
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50 0 50 (m)

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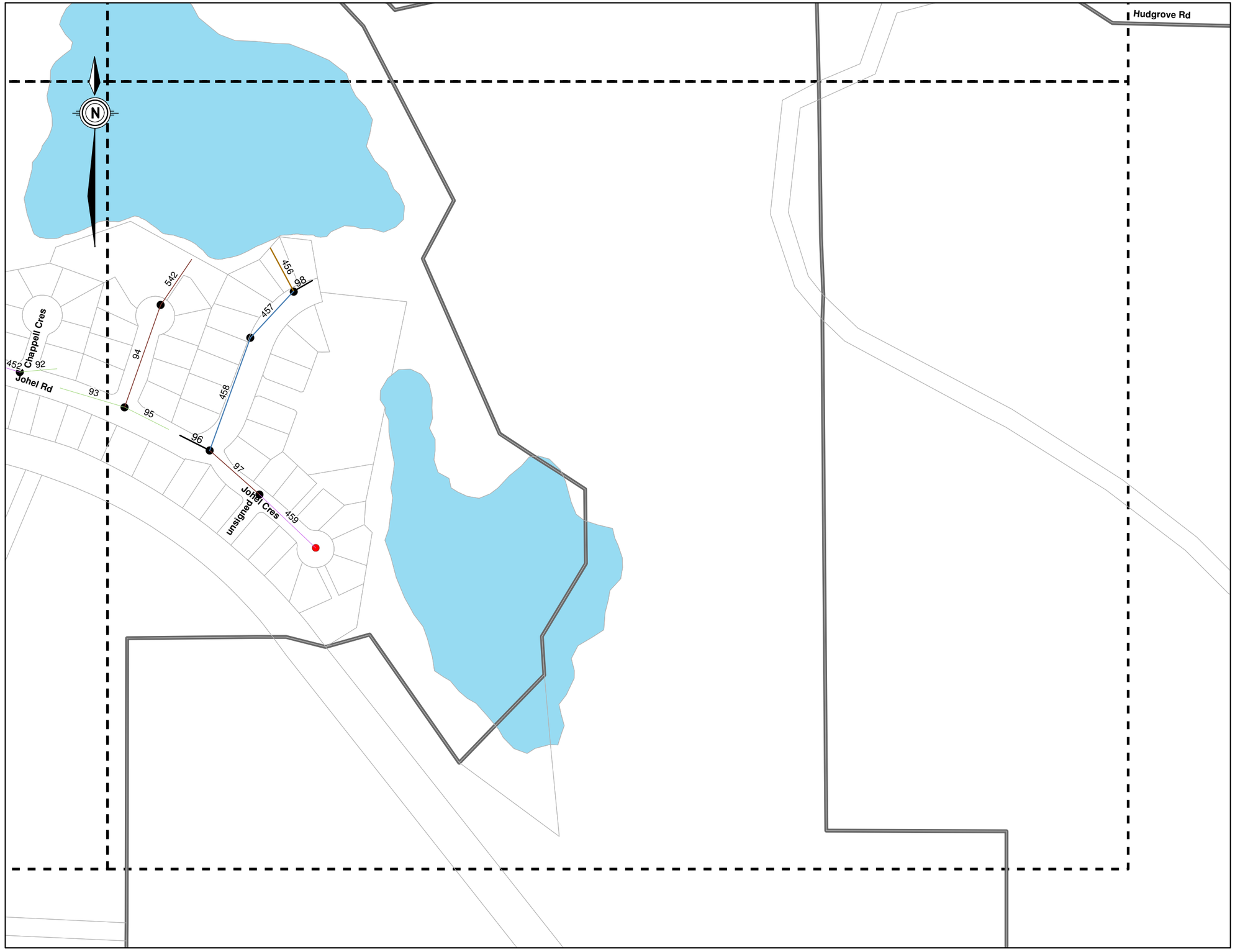

Town of Lake Cowichan
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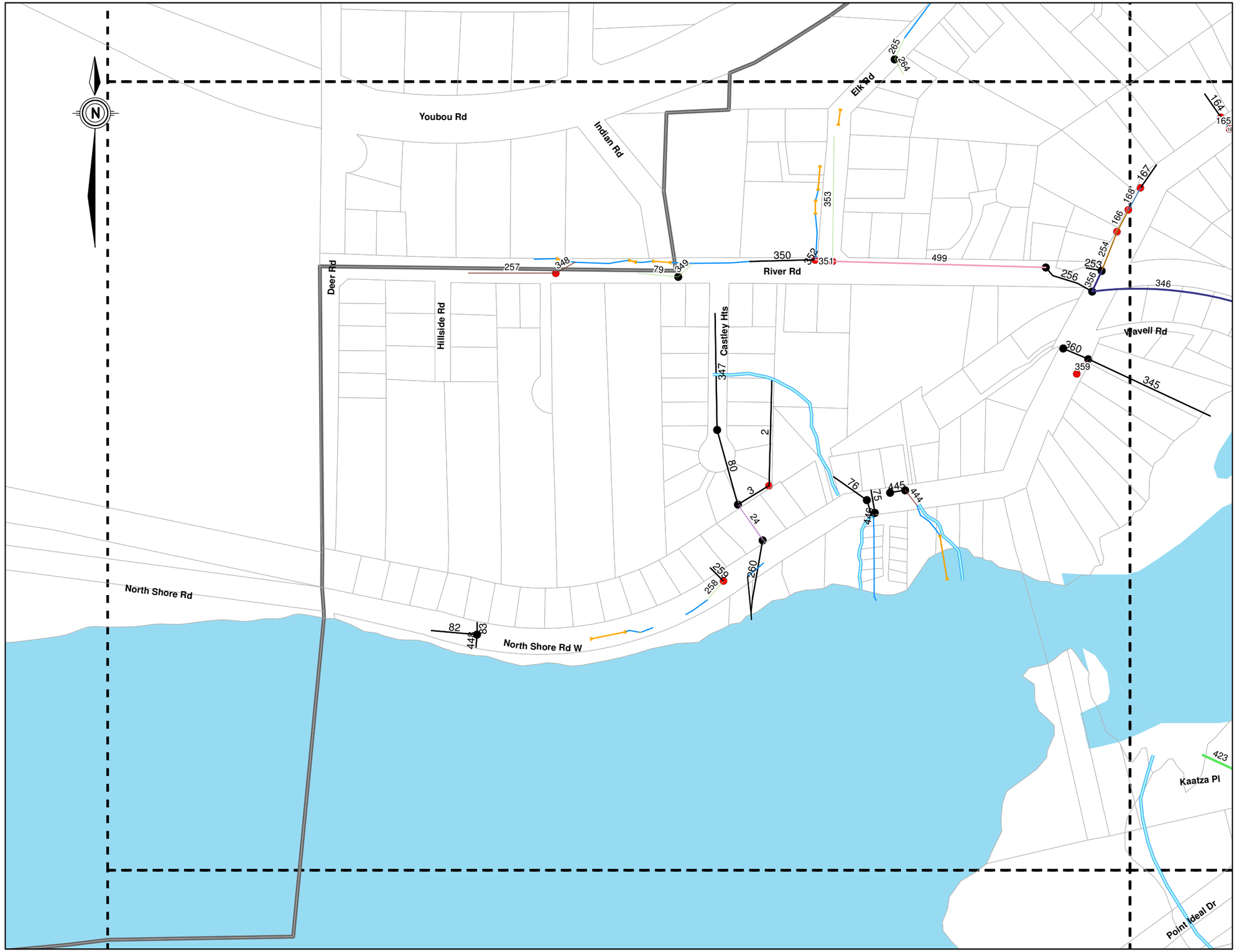

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50 0 50 (m)
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50 0 50 (m)

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50 0 50 (m)

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50 0 50 (m)

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50 0 50 (m)

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50 0 50 (m)

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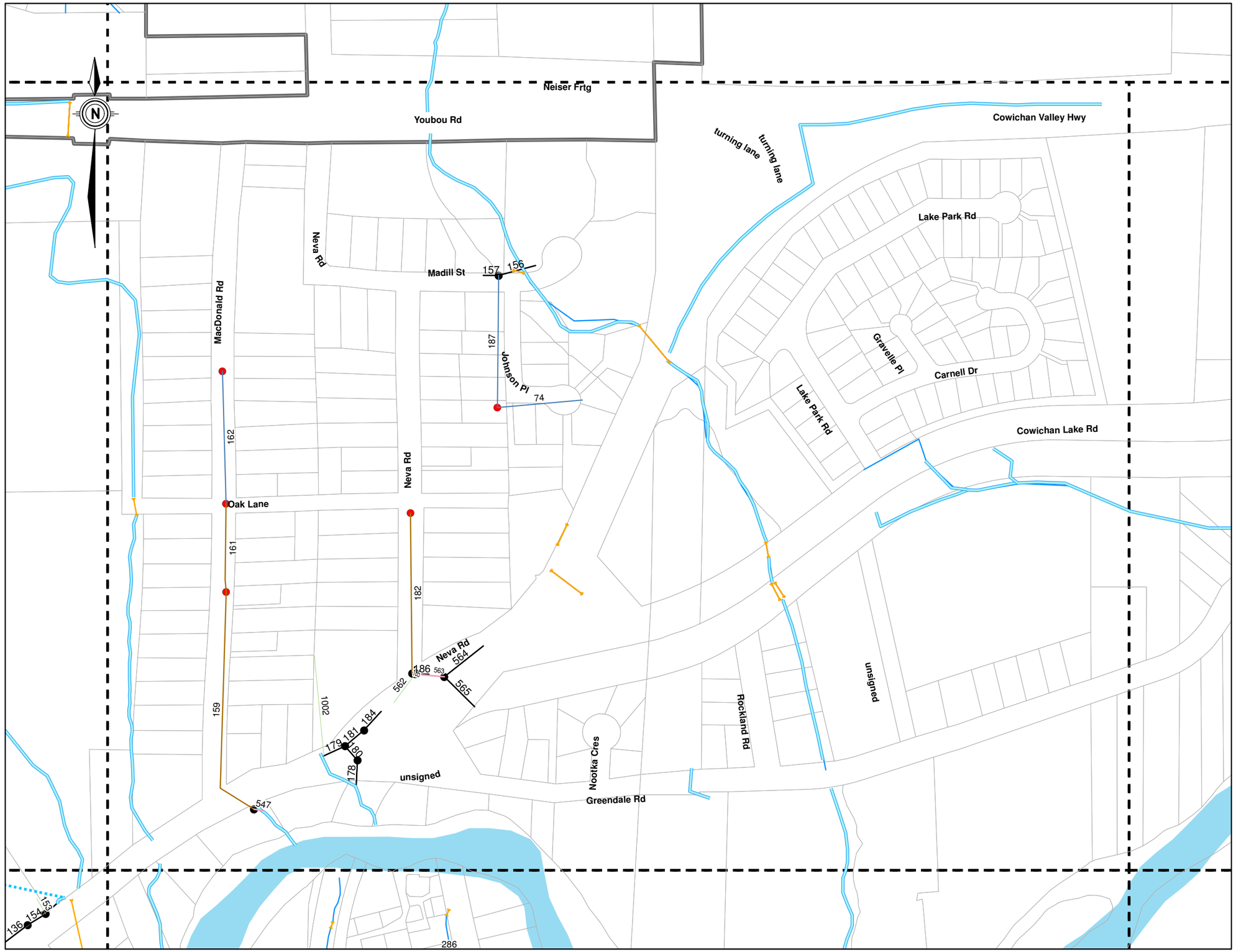
Town of Lake Cowichan
Integrated Rainwater Management Plan



Legend

- Creeks from Habitat
- Model Ditch/Creek
- Unchanged Conduit
- Legal
- Municipal Town Boundary
- Non-flooded
- Flooded Manhole (min 15 Minutes Flooded and Surhcarged Depth greater than 0.3 m)
- Grid Index
- Water body

Proposed Diameter with Conduit Number (m)

- 0.2
- 0.25
- 0.3
- 0.375
- 0.45
- 0.525
- 0.6
- 0.675
- 0.75
- 0.9
- 1.05
- 1.2
- Creeks_HabitatPlan_Flow

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50 0 50 (m)

1:3,000

Project No.	Date
2218-007	April 2015

10-Year Return Period Flood - Proposed Storm Main Diameters

Index Page C3

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Author: MScruton

Cowichan Valley Hwy

Greendale Rd

Wentworth Rd

Cowichan Lake Rd

Cowichan Lake Rd

Arthur Rd

N

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50 0 50 (m)

1:3,000

Project No.	Date
2218-007	April 2015

10-Year Return Period Flood - Proposed Storm Main Diameters

Index Page C4

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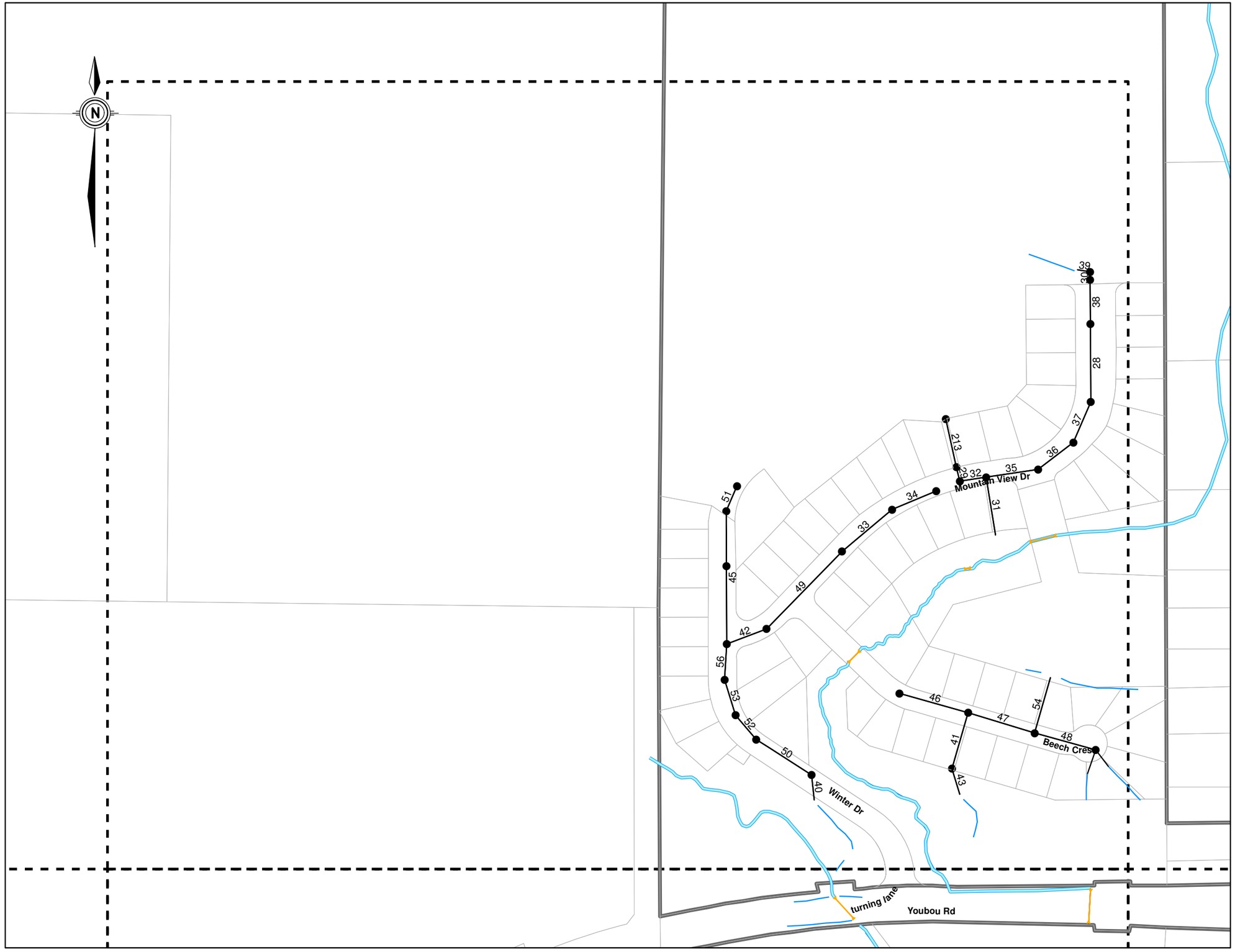
Author: MScruton



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1:3,000

Project No.	Date
2218-007	April 2015

10-Year Return Period Flood - Proposed Storm Main Diameters

Index Page D1

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Author: MScruton

Appendix F

Measures to Protect Streamside Protection and Enhancement Areas

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APPENDIX F - Measures to Protect the SPEA

The Streamside Protection and Enhancement Area (SPEA), is defined in the Riparian Areas Regulation as an area adjacent to a stream that links aquatic to terrestrial ecosystems and includes both existing and potential riparian vegetation and existing and potential adjacent upland vegetation that exerts an influence on the stream. No development is permitted within the SPEA without prior written approval from DFO and the Municipal government.

The RAR also requires "Measures" to protect the integrity of the SPEA, when using the detailed assessment method. Measures consist of prescriptions and/or guidelines for development that, when carried out, will protect the SPEA from degradation. For example, if the SPEA extends part way up a steep slope, Measures may include recommendations for protecting slope stability up to and beyond the top of the bank. Although no specific width for a Measures zone is mentioned in the RAR, in this case, the zone affected by the described Measures extends from the high water mark to the outer edge of Riparian Assessment Area (i.e. 30 m from the 'top of bank,' as defined in the RAR). Given the topography and channel/landscape characteristics of the areas surveyed, this distance should be sufficient to protect the integrity of the SPEA, if the recommended management actions are taken.

To comply with the RAR, eight categories must be addressed in the Measures: danger trees, windthrow, slope stability, protection of trees in the SPEA, encroachment, sediment and erosion control, stormwater management, and floodplain concerns. For this report, some of these categories are combined for ease of discussion (e.g. tree-related measures). An additional category, Restoration, is described, as an additional measure to protect the SPEA from further degradation, and to enhance the function of the streams and wetlands. Due to the poor condition of many of the streams and wetlands, simply implementing a setback will not be sufficient in many cases to prevent further deterioration of the stream channel and proliferation of invasive species. Note that restoration is not required by the RAR, but we recommend that the Town of Lake Cowichan include it as a requirement for the Development Permit Area.

The general objectives of the Measures described below are to:

1. Protect the existing vegetation within and at the edge of the SPEA,
2. Protect steep slopes from compaction and erosion,
3. Minimize sedimentation and erosion during construction,
4. Prevent encroachment into the SPEA, and
5. Plan development so as to maintain the hydrological balance of the site by preserving vegetated areas wherever possible and infiltrating, evaporating and detaining rainwater.
6. These measures are described in general form, since all must be addressed in any development. If a property owner wishes to modify these requirements, it is recommended they retain a Qualified Environmental Professional and carry out an individual RAR assessment.

Slope Stability

In steep areas, slopes may be prone to erosion and wasting, particularly if vegetation is removed and/or additional surface or groundwater is delivered to the slopes. In areas with a slope greater than 2:1, it is recommended to obtain the advice of a geotechnical engineer in the planning stages of development. And in general, no development should occur within 10 metres of the change in slope (top of ravine bank),this includes removing any vegetation or altering drainage patterns such that the slope integrity may be at risk.

Existing native vegetation often provides the best possible insurance against slope failure, and its preservation entails a first line of defense. Other considerations include the following:

Development, including roads, building envelopes and trails, must not occur near steep slopes. Temporary construction sites (e.g. equipment staging) must also be located away from steep slopes.

Trails located near the top of steep slopes must be constructed of permeable materials, and be bordered by an appropriately sized corridor of native vegetation between the trail and the slope.

Stormwater may not be discharged onto or adjacent to any steep slopes, as it could cause saturation or gully formation that could lead to slope failure; rather, it should be infiltrated near the source, in appropriately designed structures such as raingardens or bioswales that are located outside of the SPEA, and well back from the top of slopes.

Septic fields must be situated well back from steep slopes, to prevent saturation of the soils.

Excessive irrigation must not be undertaken near the top of steep slopes, and yards that back onto the top of steep banks should retain native vegetation or xeriscaping that requires little watering.

If any question arises as to the appropriateness of development activity, or any development is proposed on or near a steep slope that could impact the SPEA, a geotechnical engineer must be retained.

Tree management (danger trees, windthrow and protection of trees in the SPEA)

Trees are important elements of functional riparian ecosystems for providing slope stability, habitat required by terrestrial species, and for shade, which prevents heating of the water to maintain temperatures required by salmonids. Danger trees are those trees that have been damaged due to physical disturbance or pathogens such that the tree and/or large branches are at risk of falling and causing damage to people and property. The RAR permits removal of these trees within the SPEA, with the written approval of a certified arborist, provided they are replaced with appropriate native species, as per the requirements of the arborist.

Trees felled within the SPEA are required to be left as coarse/large woody debris, which is important to terrestrial and aquatic organisms, and to physical stream function. Where possible (e.g. where slope stability is not a concern), danger trees that require removal and are located near stream channels should be pushed over with their root wads intact, to provide natural anchoring of the tree in the channel and bank. Windthrow may be a concern if clearing of existing trees/forest for development exposes other trees to being blown over or portions broken off from the wind.

Therefore, tree management measures must ensure that the trees in the SPEA are not put at risk of damage, for example by clearing right to the edge of the SPEA. Prior to clearing, a certified arborist must be consulted to assess this risk, and possibly to recommend changes to the configuration of the development layout. “Feathering” and selective pruning may also be options to reduce the wind forces on the trees. Trees become more susceptible to windthrow when their root zones are damaged by compaction, therefore a certified arborist should be retained to recommend appropriate distances for locating buildings and trails in treed areas. Windthrow on steep slopes also has importance for slope stability, therefore it is recommended for the geotechnical engineer and arborist (and other QEPs) to work cooperatively in their assessments and recommendations.

Trees in the SPEA must be protected, by ensuring that the SPEA is well-marked and that personnel and equipment do not encroach into this area. The advice of a certified arborist

is required during the planning stages of construction, to protect the integrity of the root structures of significant trees, which may extend beyond the SPEA. Particular attention should be paid to excavations and to the layout of paved areas such as roads and driveways, to ensure that root zones are not damaged. Wherever possible, permeable surfacing should be installed near trees, to allow water supply to the roots. Once the certified arborist has recommended an appropriate perimeter for construction works around specific trees, highly visible fencing should be installed, and construction crews should be briefed on the tree protection program. Monitoring during construction phases must ensure that the trees are adequately protected.

Encroachment

Encroachment refers to the concern for human disturbance of riparian ecosystems, e.g. by trampling, unsanctioned trails, landscaping beyond property lines and dumping of refuse and yard waste. The RAR recommends fencing to clearly demarcate the SPEA boundary and prevent access by people.

Education should play an important role in advising people of the importance of intact riparian zones and of proper waste disposal. Providing community (or strata-level) composting facilities could also reduce yard waste dumping. Education can be accomplished with signage, community education/stewardship events, and distribution of publications such as the Living by Water brochure (http://livingbywater.ca).

In certain cases, there may also be a case to be made for sensitively designed nature/interpretive trails and viewing areas near the streams/wetlands (i.e. within the SPEA), as they can play an important role in public education and stewardship, and prevent unsanctioned trail formation in inappropriate locations. As this is technically not allowed under the RAR, a Letter of Advice from the Department of Fisheries and Oceans would be required. Any such proposals should be planned only in low-gradient locations, and should minimize the removal of existing vegetation. Furthermore, permeable surfacing with a minimal footprint should be used, as should non-treated wood or other natural materials.

Erosion and Sediment Control During Construction

The developer/land owner is responsible for designing an effective erosion and sediment control plan to ensure that no sediment-laden water enters the SPEA or any watercourse on the property, and that erosion of nearby slopes does not occur such that the SPEA is damaged. The RAR also prohibits treatment, including filtration, of stormwater within the SPEA.

The federal Fisheries Act (1985) prohibits the deposition of a deleterious substance (including sediment) in water frequented by fish. Furthermore, any stormwater discharges into adjacent downstream receiving environments (especially freshwater ecosystems) must ensure that the federal and provincial water quality guidelines for the protection of aquatic life are not exceeded in the receiving environments. The federal guidelines are administered by the Canadian Council of Ministers of the Environment (CCME) and provincial guidelines are administered by the BC MFLNRO. In order to comply with the Act and guidelines, it is essential that any Erosion and Sediment Control Plan be designed to an adequate standard.

Three documents that outline general principles and approaches for managing stormwater and controlling sediment and erosion are:

1. “Stormwater Planning: a Guidebook for British Columbia,” produced by BC MoE (2002);
2. “Land Development Guidelines for the Protection of Aquatic Habitat,” produced by DFO (1992); and

3. "Storm water management for industrial activities: developing pollution prevention plans and best management practices," produced by the U.S. Environmental Protection Agency (1992).

The EPA (1992) document has been found to be the most stringent in its standards and best management practices (BMPs), which meet and exceed provincial BMPs and guidelines. It is therefore recommended as the standard for erosion and sediment control. The principal requirement of the US EPA method is the development of a Stormwater Pollution Prevention Plan (SPPP or PPP), which must be implemented prior to commencement of any on-site construction activity. The PPP team should consist of (at a minimum) the regulating agency, Qualified Environmental Professional, general contractor and equipment operators. Proactive planning should be emphasized over reactive response to spills or other accidents. Documentation, in terms of standards and expectations, as well as reporting of actions, should also form an important part of the program. Checklists, drafted by the QEP and approved by the PPP team, can provide a means for the designated monitor to ensure that all systems are in place and functional at the various stages of construction. These phases can be designated as follows:

Planning. At this stage, erosion and sediment control is mitigated before it begins, by planning construction to minimize risk (e.g. major excavations are performed at the driest time of year; minimal necessary site disturbance at one time; suitable locations are designated for stockpiling fill and materials). The PPP team is brought together and agrees on the plans and procedures for Erosion and Sediment Control. Any required training and briefing (e.g. on the use of spill response kits) should be undertaken at this stage. Water control and infiltration structures may be constructed in advance of the actual construction, to allow time for disturbed soils to settle and possibly for vegetation to establish. Baseline water quality information and photographs can also be collected at this stage.

Construction Phase I (e.g. installation of services). Specific fuelling and vehicle wash areas, that are located away from watercourses (or potential drainage), need to be designated and bermed off, and communicated to equipment operators. Equipment staging areas and fill storage areas also should be located well away from the SPEA. To prevent off-site tracking of soil and sediment, a truck wash station or rock-lined drive should be installed, ensuring that cleaned-off sediment is properly contained. Any other best management practices (BMPs) required to prevent erosion and sedimentation at this stage should be implemented. The reporting and spill response procedures should be reviewed and communicated to all personnel. The QEP or designated environmental monitor should be on site frequently at this stage to ensure all ESC measures are implemented and functioning well.

Construction Phase II (e.g. individual lot preparation). ESC measures specific to the lot site (or to a larger construction area if many lots are involved) should be installed at this stage. As new personnel are brought on, the ESC plan needs to be communicated to them; regular site meetings with the evolving PPP team should continue, possibly more frequently if required. Previously established ESC structures need to be inspected and maintained/adjusted if necessary. Site disturbance should be minimized with careful planning, particularly if the project spans the wet season. Existing vegetation should be preserved to the extent possible, and replanted in cleared areas as soon as possible. Fill stockpiled for longer than a few weeks should be seeded with grass or other quick-growing vegetation, or covered with tarps.

Construction Phase III (e.g. house/building construction). A focus on building at this stage requires ensuring that proper disposal facilities are in place (e.g. for recyclables, wood waste, paint/solvents), a tidy worksite is maintained, and potentially hazardous materials are kept away from storm drains and watercourses. Previously established practices should be continued, and new personnel continuously briefed. ESC structures

require regular inspection and maintenance. Vegetation should be planted as soon as possible, with temporary cover (e.g. grass seed) or permanent cover (landscaping).

Floodplains

This measure generally applies to areas with sizeable floodplains of low frequency (e.g. 1/200 year events), where development could potentially occur in these areas. In the Town of Lake Cowichan, only the Cowichan River has mapped 1/200-year floodplain boundaries, none of the smaller tributary streams surveyed appear to have extensive floodplains. Floodplains should be protected from damage due to development impacts within appropriately assessed SPEAs.

Restoration

With few exceptions, all the streams and wetlands assessed in this survey have been degraded due to human activities, some severely so. Channelization of streams, i.e. conversion of a sinuous channel with floodplains to a straight ditch with vertical banks, is probably the most widespread type of disturbance. Extensive clearing of the vegetation adjacent to the streams is also common. Some stream sections have been placed in underground culverts, which simply transfer the risk of flooding and erosion to downstream properties. Consequently, simply establishing a "setback" from the existing channel will not likely result in improvement of stream function (including fisheries values) without intervention in the form of restoration. Although adjacent land use in many areas may prevent restoration to the historic condition, there is nevertheless room for substantial improvement given the current constraints. The recommended general approach is one of establishing a "proper functioning condition," (as per Prichard, 1998), which includes re-establishing the key hydrological, soil and vegetation features necessary for the stream to dissipate the energy of high flows without excessive erosion/deposition or lowering of the water table.

Depending on the specific site conditions, this may include:

- Re-sloping of stream banks, to re-create floodplains (possibly in the form of terraces where wide floodplains are not practical);
- Constructing new stream channel sections and/or side channels, to increase sinuosity and channel complexity, dissipate high flow energy and prevent downstream flooding;
- Introducing or augmenting large woody debris (e.g. large sections of tree with root wads intact), to allow for sediment deposition and create new floodplains and fish habitat;
- Bioengineering with live plant materials, e.g. wattle fences using willow, to mitigate channel and bank erosion (this method is highly effective and preferred over bank hardening with rock);
- Removing invasive plant species, with careful attention to timing and methods to ensure stream banks and adjacent steep slopes are not destabilized;
- Planting with a suite of native riparian species.

Restoration opportunities and salmon enhancement activities for streams within the Town of Lake Cowichan have been outlined in detail by Ted Burns in A Salmonid Protection and Production Plan for the Cowichan Valley Regional District (2002), and a Qualified Environmental Professional can provide site-specific guidance on the ground for these measures.

Summary of Measures to Protect the SPEA

The Riparian Development Permit Area Bylaw should provide guidelines to address the measures required for development within the Development Permit Area. The measures must address:

Slope Stability, particularly with regard to maintaining the natural hydrology (e.g. infiltrate stormwater near the source and do not direct runoff toward steep slopes), and construction near steep slopes, e.g. where slopes are steeper than 2:1, no development should within 10 metres of the change in slope and/or obtain the advice of a geotechnical engineer;

Tree Management, such as determining the potential risk of danger trees and windthrow, as well as measures to protect trees within the SPEA;

Encroachment, ensuring there is no encroachment into the SPEA during and following development (e.g. signage, fencing, education);

Erosion & Sediment Control, ensuring an E&SC Plan is implemented and monitored during construction (e.g. phasing land clearing, installing silt fences, covering exposed soil, etc.);

Stormwater Management, designing and constructing appropriate stormwater management to ensure that post-construction runoff does not negatively affect the SPEA or watercourse (e.g. infiltration basins, rain gardens, bioswales);

Floodplains, protecting an adequate area from development; and,

Restoration: considering the extensive changes to the landscape within the Town of Lake Cowichan from urban expansion, restoration is a key component of ensuring the health of the SPEA, watercourses, and fish populations; as part of development, restoration should be undertaken (e.g. re-establish riparian vegetation, re-slope banks, increase sinuosity, increase channel complexity).

Appendix G

Drainage Improvement Cost Estimates

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Appendix G - Unit Cost Estimate Breakdown

For Material and Labour Costs

Size (mm)	Outside Width (m)	Outside Height (m)	Type	Pipe Cost ($/m)	Pipe Cost Increase 15% ($/m)	Asphalt Cutting ($/m)	Trench Base Width (m)	Average Depth (m)	Excavation Volume (m3/m)	Bedding Volume (m3/m)	Bedding ($/m)	Backfill Volume (m3/m)	Granular Backfill ($/m)	Excavation Top Width (m)	Road Restoration ($/m)	Manholes ($/each)	Manholes ($/m)	Main Production (m/day)	Crew	Labour Rate ($/day)	Labour ($/m)	Total (no dewater) ($/m)	Dewatering ($/m)	Dewatering Treatment ($/m)	Unit Cost ($/m)
200	0.2	0.2	PVC	$ 22	$ 25.30	$ 10	0.50	1	0.6	0.5	$ 17.10	0.1	$ 2.59	0.6	$ 36.0	5000	$ 50	60	Crew 1	5040	$ 84.00	**$ 225**	131	131	**$ 487**
250	0.25	0.25	PVC	$ 35	$ 40.25	$ 10	0.55	1	0.6	0.5	$ 19.11	0.1	$ 2.60	0.7	$ 39.0	5000	$ 50	60	Crew 1	5040	$ 84.00	**$ 245**	131	131	**$ 507**
300	0.3	0.3	PVC	$ 50	$ 57.50	$ 10	0.6	1	0.7	0.6	$ 21.15	0.1	$ 2.57	0.7	$ 42.0	5000	$ 50	53	Crew 2	6400	$ 120.75	**$ 304**	137	137	**$ 578**
375	0.375	0.375	PVC	$ 68	$ 78.20	$ 10	0.675	1	0.8	0.7	$ 24.29	0.1	$ 2.47	0.8	$ 46.5	5000	$ 50	45	Crew 2	6400	$ 142.22	**$ 354**	146	146	**$ 645**
450	0.55	0.55	Conc.	$ 87	$ 100.05	$ 10	0.85	1	1.0	0.9	$ 31.93	0.1	$ 1.95	1.0	$ 57.0	7500	$ 75	40	Crew 2	6400	$ 160.00	**$ 436**	153	153	**$ 742**
525	0.625	0.625	Conc.	$ 97	$ 111.55	$ 10	0.925	1	1.1	1.0	$ 35.35	0.1	$ 1.61	1.0	$ 61.5	7500	$ 75	37	Crew 2	6400	$ 172.97	**$ 468**	158	158	**$ 785**
600	0.7	0.7	Conc.	$ 160	$ 184.00	$ 10	1	1.05	1.2	1.1	$ 38.86	0.1	$ 2.70	1.2	$ 69.0	7500	$ 75	30	Crew 2	6400	$ 213.33	**$ 593**	175	175	**$ 943**
675	0.775	0.775	Conc.	$ 180	$ 207.00	$ 10	1.075	1.125	1.4	1.2	$ 42.44	0.2	$ 4.74	1.3	$ 78.0	7500	$ 75	28	Crew 2	6400	$ 228.57	**$ 646**	181	181	**$ 1,008**
750	0.85	0.85	Conc.	$ 220	$ 253.00	$ 10	1.15	1.2	1.6	1.3	$ 46.11	0.2	$ 7.39	1.5	$ 87.0	7500	$ 75	27	Crew 2	6400	$ 237.04	**$ 716**	185	185	**$ 1,085**
900	1	1	Conc.	$ 271	$ 311.65	$ 10	1.3	1.35	2.0	1.5	$ 53.71	0.5	$ 13.81	1.8	$ 105.0	7500	$ 75	22	Crew 2	6400	$ 290.91	**$ 860**	207	207	**$ 1,274**
1050	1.25	1.25	Conc.	$ 396	$ 455.40	$ 10	1.55	1.5	2.7	1.9	$ 67.12	0.7	$ 22.23	2.2	$ 129.0	7500	$ 75	22	Crew 3	7816	$ 355.27	**$ 1,114**	207	207	**$ 1,528**
1200	1.4	1.4	Conc.	$ 515	$ 592.25	$ 10	1.7	1.65	3.2	2.2	$ 75.62	1.1	$ 32.38	2.5	$ 147.0	7500	$ 75	20	Crew 3	7816	$ 390.80	**$ 1,323**	219	219	**$ 1,761**
1350	1.55	1.55	Conc.	$ 666	$ 765.90	$ 10	1.85	1.8	3.9	2.4	$ 84.46	1.5	$ 44.27	2.8	$ 165.0	7500	$ 75	17.5	Crew 3	7816	$ 446.63	**$ 1,591**	238	238	**$ 2,066**
1500	1.7	1.7	Conc.	$ 821	$ 944.15	$ 10	2	1.95	4.6	2.7	$ 93.63	1.9	$ 57.89	3.1	$ 183.0	7500	$ 75	15	Crew 3	7816	$ 521.07	**$ 1,885**	263	263	**$ 2,410**
1650	1.85	1.85	Conc.	$ 1,064	$ 1,223.60	$ 10	2.15	2.1	5.4	2.9	$ 103.14	2.4	$ 73.25	3.4	$ 201.0	7500	$ 75	13.5	Crew 3	7816	$ 578.96	**$ 2,265**	282	282	**$ 2,829**
1800	2	2	Conc.	$ 1,186	$ 1,363.90	$ 10	2.3	2.25	6.2	3.2	$ 112.99	3.0	$ 90.35	3.7	$ 219.0	7500	$ 75	12	Crew 3	7816	$ 651.33	**$ 2,523**	306	306	**$ 3,135**
1800x900	2.2	1.3	Conc. Box	$ 1,095	$ 1,259.25	$ 10	2.5	2.4	7.3	2.0	$ 71.40	5.2	$ 157.39	4.0	$ 240.0	5000	$ 50	13	Crew 4	12136	$ 933.54	**$ 2,722**	289	289	**$ 3,300**
1800x1200	2.2	1.6	Conc. Box	$ 1,430	$ 1,644.50	$ 10	2.5	2.4	7.3	2.2	$ 77.70	5.1	$ 151.99	4.0	$ 240.0	5000	$ 50	12	Crew 4	12136	$ 1,011.33	**$ 3,186**	306	306	**$ 3,798**
2400x1500	2.8	1.9	Conc. Box	$ 1,890	$ 2,173.50	$ 10	3.1	3	11.7	2.7	$ 93.45	9.0	$ 269.89	5.2	$ 312.0	5000	$ 50	9	Crew 4	12136	$ 1,348.44	**$ 4,257**	379	379	**$ 5,016**
2400x2400	2.8	2.8	Conc. Box	$ 2,265	$ 2,604.75	$ 10	3.1	3	11.7	3.2	$ 112.35	8.5	$ 253.69	5.2	$ 312.0	5000	$ 50	7	Crew 4	12136	$ 1,733.71	**$ 5,077**	463	463	**$ 6,002**
3050x1500	3.45	1.9	Conc. Box	$ 2,640	$ 3,036.00	$ 10	3.75	3.65	17.6	3.0	$ 103.69	14.7	$ 440.03	6.5	$ 390.0	5000	$ 50	6	Crew 4	12136	$ 2,022.67	**$ 6,052**	525	525	**$ 7,102**
3050x2400	3.45	2.8	Conc. Box	$ 3,250	$ 3,737.50	$ 10	3.75	3.65	17.6	3.5	$ 122.59	14.1	$ 423.83	6.5	$ 390.0	5000	$ 50	5	Crew 4	12136	$ 2,427.20	**$ 7,161**	613	613	**$ 8,386**

For Labour Costs

	Excavators				Skid Steer	Backhoe	Crane	Truck		Crew				Pumps		
Crew	Cat 307 ($/hr) 110	Cat 314 ($/hr) 125	Cat 320 ($/hr) 140	Cat 325 ($/hr) 160	Cat 242B ($/hr) 75	Cat 416 ($/hr) 100	30 ton ($/hr) 170	Tandem ($/hr) 105	Pick-up ($/hr) 12	Super ($/hr) 78	Skilled ($/hr) 50	Labour ($/hr) 40	Traffic ($/hr) 35	Bypass ($/hr) 25	Crew Rate ($/hr)	Crew Rate ($/day)
Crew 1	1					1		2	1	1	1		2	0	630	5040
Crew 2			1		1	1		2	1	1	1	1	2	1	800	6400
Crew 3				1	1	1		3	2	1	1	2	2	1	977	7816
Crew 4			1	1	1	1	1	4	2	1	2	3	3	1	1517	12136

Stormdrain Unit Cost Summary

Size (mm)	Material Cost ($/m) + 15% Increase	Installation Cost ($/m) + 25% Increase	Total Cost ($/m)
200	$ 29.10	$ 237.12	$ 266.21
250	$ 46.29	$ 243.38	$ 289.67
300	$ 66.13	$ 295.60	$ 361.72
375	$ 89.93	$ 331.85	$ 421.78
400	$ 115.06	$ 407.36	$ 522.42
450	$ 115.06	$ 407.36	$ 522.42
525	$ 128.28	$ 433.04	$ 561.33
600	$ 211.60	$ 498.61	$ 710.21
675	$ 238.05	$ 535.94	$ 773.99
750	$ 290.95	$ 565.67	$ 856.62
900	$ 358.40	$ 673.04	$ 1,031.44
1050	$ 523.71	$ 810.78	$ 1,334.49
1200	$ 681.09	$ 901.00	$ 1,582.09
1350	$ 880.79	$ 1,019.20	$ 1,899.98
1500	$ 1,085.77	$ 1,163.24	$ 2,249.01
1650	$ 1,407.14	$ 1,289.20	$ 2,696.34