Cottle Creek Urban Salmonid Habitat Assessment

Prepared For:
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1. Introduction

The Friends of Cottle Creek (FOCC) is a local streamkeeper group comprised of volunteers who came together (as a committee of the Nanaimo and Area Land Trust or NALT) in 2024 to promote a better understanding of the health of the creek and its supporting ecosystems. The FOCC sought funding from the Regional District of Nanaimo's (RDN) Stewardship Seed Funding to undertake an assessment of the creek's physical condition, using the Urban Salmonid Habitat Program (USHP) assessment methodology (Michalski, Reid & Stewart, 2001). The BC Conservation Foundation (BCCF) was contracted to provide professional guidance and support for the project. This report summarizes the in-stream habitat and riparian conditions observed in Cottle Creek in August and September of 2025.

This USHP report has benefited from ongoing fish population monitoring and stream hydrology monitoring projects undertaken by the FOCC and partner organizations over the past year. The report has integrated these data to assist in providing recommendations for improving the watershed's aquatic health.

2. Study Area & Background

Cottle Creek is located in the City of Nanaimo, lying between Departure Creek to the west and Walley Creek to the north. The creek is a 5.5 km long third order stream and is the primary watercourse in the Linley Valley. Its drainage area is 486 hectares, of which 40% of its catchment is undeveloped second and third growth Coastal Douglas Fir forests. The dominant land tenures are owned by the City (Linley Valley Cottle Lake Park, Lost Lake Park), and the Province of BC (District Lot 56; Fig. 1).

The confirmed salmonid-bearing portion of the stream runs approximately 2.5 km from Cottle Lake to Departure Bay, and includes lake and stream resident Coastal Cutthroat Trout (*Oncorhynchus clarkii clarkii;* hereafter "CCT"). A physical barrier directly above tidewater in Departure Bay has made Cottle Creek inaccessable to anadromous populations of Pacific Salmon. However, a "wild" population of resident CCT have survived and thrived in the watershed. There are no (Provincial) records of fish being stocked in Cottle Creek.

The limited development within the watershed boundary and unique biophysical features of the stream (e.g., singularly supporting CCT) make the Linley Valley/Cottle Creek a one-of-a-kind watershed in the City. These circumstances present an opportunity to use the resident CCT as indicators of watershed health, with their persistence and relative abundance in the watershed being a valuable tool to monitor the health of the stream.

Cottle Creek originates from a stormwater detention pond that was a wetland prior to the surrounding land being subdivided into single family housing in the early 1990's. Surrounding municipal drains are directed to Brookwood Pond at 5740 Brookwood Drive. The pond has a controlled outlet that discharges into a storm drain that runs under Brookwood Drive before daylighting into an open channel in Linley Park behind Cottleview Drive. The creek then flows into a marsh behind residences along Pacific Edge Way, then

through several large properties running south adjacent to Arrowsmith Road. At Landalt Road, the creek flows into a 20m long x 4m wide culvert that appears impassable to salmonids at this time (P. Law pers. comm., August, 2025).

Despite Cottle Lake being fish-bearing, two of the three tributaries that flow into it are assumed to be non-fish bearing, as the channels appear ephemeral (dry in the summer months). One tributary enters the lake from the west through a series of wetlands that drain Linley Valley Cottle Lake Park. A second tributary drains from a series of wetlands in the Rock City Road area, and a third tributary (North Cottle Creek) enters the lake from the north, originating at Lost Lake. Young-of-the-year CCT have been observed in this tributary near where it flows into the lake.

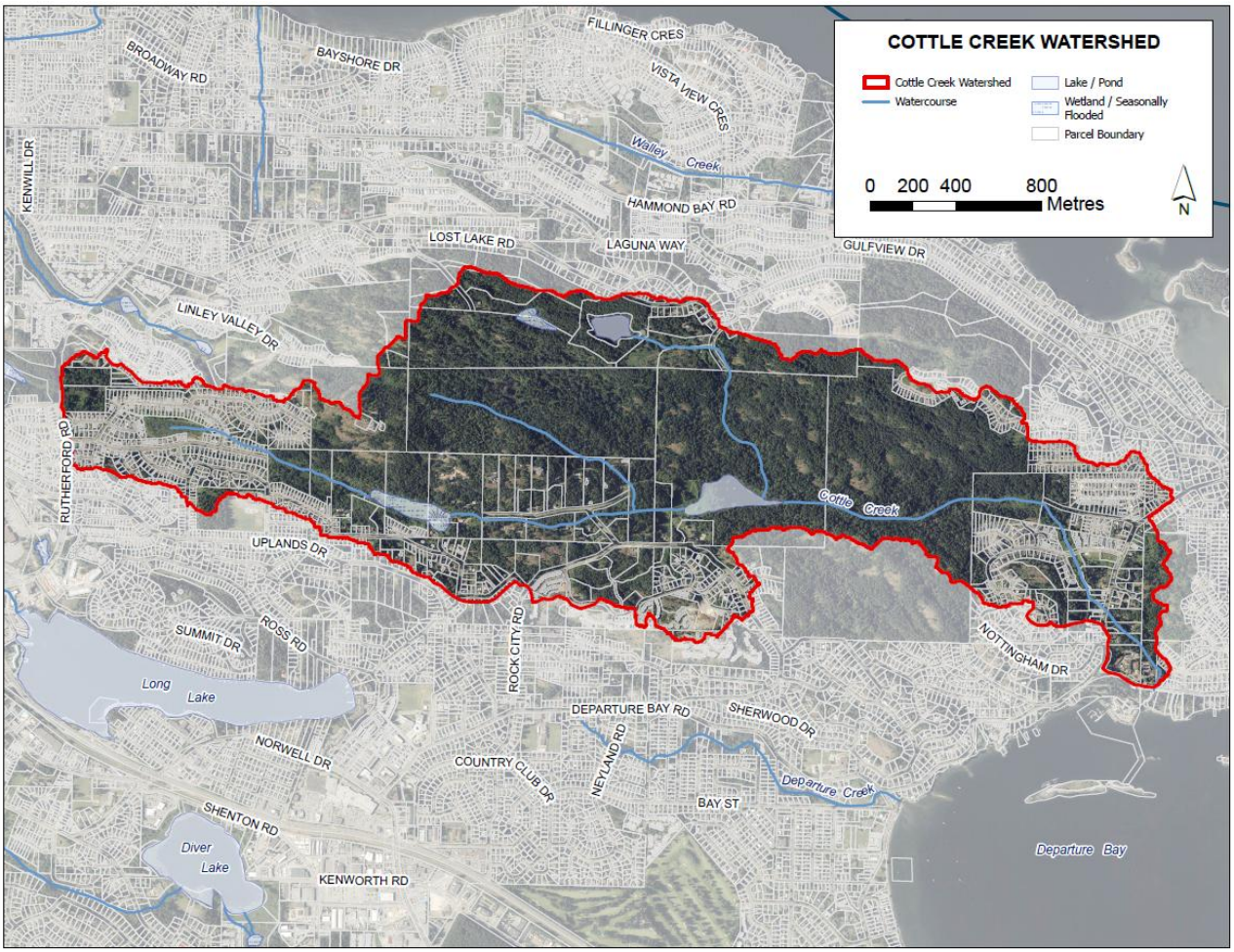

Figure 1. Cottle Creek Watershed Map (City of Nanaimo, 2025).

Past Studies in the Watershed

Cottle Creek and the surrounding Linley Valley have been subject to a number of Environmental reports over the past 35 years, including:

- A Fish and Fish Habitat Assessment undertaken to develop the Miller Farm at 3335 Hammond Bay Road (Aquaterra, 2002).

- Water quality and benthic invertebrate monitoring by Vancouver Island University (VIU RMOT 306 Environmental Monitoring Reports, 2012-2023).
- A biophysical inventory of Linley Valley for City of Nanaimo Parks (Environmental Dynamics Inc., 2017).
- A stormwater analysis of the Cottle Creek watershed for the City of Nanaimo Engineering (Kerr Wood Leidal & Associates, 2021)

Although these reports do provide a better understanding of the ecological condition of the watershed, they are of limited use in understanding the status and health of Cottle Creek's aquatic ecosystems.

Developing a Watershed Health Monitoring Strategy

Beginning in the fall of 2024, the FOCC developed a monitoring strategy to better undertstand the biotic and abiotic factors that influence the watershed's ecological conditions. Previous and ongoing assessments include:

1. Fish presence and distribution
2. Stream flow monitoring
3. Water quality
4. Riparian health

Details of each project are outlined below:

Fish Presence & Distribution

In August 2024, NALT launched a Coastal Cutthroat Trout Assessment and Monitoring Project with support from the Freshwater Fisheries Society of BC (Victoria). The project is a collaborative, community-driven initiative aimed at generating essential long-term data on the presence and distribution of CCT in Nanaimo area streams and rivers (https://nalt.bc.ca/cutthroat-trout/). As part of this project, the FOCC have performed sampling for CCT on multiple occasions between October, 2024 and July, 2025 in Cottle Creek, yielding 36 CCT ranging from 67-165 mm fork length (Table 1 & Fig. 2 in appendix).

Stream Flow Monitoring

The FOCC have been monitoring flows in Cottle Creek since September 2024 as part of BCCF's Community Flow Monitoring Network (CFMN) project (https://www.cfmnvi.com/). The project is a partnership between BCCF and the provincial Ministry of Environment and Parks that aids stewardship groups in the collection, verification, and analysis of flow data (https://aqrt.nrs.gov.bc.ca/). The prime objective for Cottle Creek is to better understand the hydrology of the watershed.

Water Quality Monitoring

The Departure Creek Streamkeepers have partnered with the RDN since 2012 to monitor a suite of surface water parameters at three locations on Cottle Creek (Province of BC EMS Sites E290473, E290475, E309186). These data are used to assess trends in water quality.

Riparian Health

In the spring of 2025, the FOCC began a field assessment of riparian zones along the creek, with funding support from the City of Nanaimo, using a Province of BC Forest and Range Evaluation Program field assessment protocol (BC Ministry of Forests, 2025). The objective of this riparian survey is to determine the extent that historical logging and current land use in the watershed has affected stream health.

Coastal Cutthroat Trout as a Sentinel Species of Watershed Health

CCT have been designated a "blue-listed" species by the British Columbia Ministry of Environment & Parks in the BC Provincial Vertebrate Animal Tracking List (BC CDC, 2025). This designation means CCT are classified as a provincial species of "special concern, vulnerable to extirpation or extinction", due to their biology and life histories that make them particularly sensitive to human activities or natural climactic events (Cannings and Ptolemy, 1998; Costello, 2008).

The Cottle Creek watershed supports both stream- and lake-dwelling CCT that are assumed to be a "pure, wild strain" (Fig. 2). Due to an absence of provincial stocking records and fish barriers preventing anadromous passage, this population has presumably never been exposed to hybridization with hatchery-origin or other wild trout. The native CCT have likely evolved over thousands of years to adapt to specific ecological conditions, such as water temperature and chemistry, as well as natural food availability, in this comparatively small Vancouver Island watershed.

Figure 2. CCT in Reach 3 of Cottle Creek, July 16, 2025.

The existence of natural bedrock falls near the stream's mouth in Departure Bay means Cottle Creek CCT have never faced competition from salmon species like Coho (*Oncorhynchus kisutch*), which have historically occupied neighbouring streams, including Walley and Departure creeks. Consequently, professional biologists view Cottle Creek CCT as a key element of local biodiversity that merit protection and enhanced stewardship as the city continues to grow in future years.

On the east coast of Vancouver Island (and elsewhere), many urban streams have been frequently channelized, altered hydrologically, and are intermittently subject to contamination from releases of harmful pollutants via stormwater drainage systems. Additionally, many were historically logged to their banks, thereby losing supplies of large woody debris from the lack of old growth coniferous trees. In some cases, urban streams have also been managed by municipalities exclusively for drainage capacity, without concern for aquatic habitat values. That said, a compelling case can now be made that healthy, small streams supporting wild CCT populations are desirable community assets, contributing to healthy human environments (Slaney and Roberts, 2005).

CCT can serve as a sentinel species for urban watershed health due to their widespread distribution and long-term residence in streams, like Cottle Creek. They are sensitive to water chemistry, temperature, flow and cover, making them effective indicators of watershed quality and health (Slaney and Roberts, 2005).

3. Methods

Defining Reaches

This survey was focused on the fish bearing segments of Cottle Creek; reach descriptions and lengths are outlined in Table 1.

The USHP assessment reaches were finalized in the field prior to the field survey. Reach breaks were determined by continuity of habitat, channel morphology, and riparian characteristics.

Table 1. USHP surveyed reach lengths and descriptions.

Reach	Length (m)	Description
1	31	Tidewater to Stephenson Point Road culvert. Tidewater to concrete weir (~150 m) not surveyed. Cascade/pool morphology. Bedrock/boulder dominant narrow ravine between private properties. Many fish barriers. Pool downstream of culvert has confirmed CCT presence.
2	535	Stephenson Point Road culvert to Hammond Bay Road culvert. Channel spanning concrete dam at mid-point is complete barrier. Mix of park, commercial, and private land use. Walking trails and sewer main crisscross stream for entire reach.

3	658	Hammond Bay Road to culvert at 200 Linley Road. Pool/riffle morphology. Channel runs through private property with exception of Cottle Creek Park. Historical "Miller Farm" location.
4	457	200 Linley Drive culvert to 1st aluminum pedestrian bridge on Linley Valley trail. Mostly on private land of 200 Linley Dr.
5	651	1st aluminum bridge to 2nd aluminum bridge on Linley Valley Trail. Channel is mainly in steep ravine with walking trail following above right bank.
6	242	2nd aluminum bridge on Linley Valley Trail to beaver dam at outlet of Cottle Lake. Entirely within Linley Valley Park
7	24	Lowest 24 m of North Cottle Creek. Ephemeral tributary of Cottle Lake that flows from Lost Lake. Contains known spawning habitat of lake resident CCT.
8	380	Inflow of Cottle Lake to Landalt Road culvert. Mainly on private property. First ~120 m inaccessible wetland not surveyed.

Figure 3. Overview map of Cottle Creek USHP surveyed reaches.

Stream and Riparian Survey Methods

The stream habitat assessment was conducted using an assessment methodology developed by the Province of BC (Michalski, Reid & Stewart, 2001.) The methodology involves collecting stream habitat data that can then be compared to provincial standards for juvenile salmonid habitat (Johnston & Slaney, 1996).

In-stream habitat and riparian zone metrics were recorded for each discrete habitat unit (specifically pools and riffles) as outlined in the Vancouver Island USHP Manual (Michalski,

Reid & Stewart, 2001). Data was collected on up to 21 elements per habitat unit (Appendix Fig. 1). Each unit was given a consecutive placemark number, starting at the beginning of each reach. The start of each unit was marked in the field with flagging tape. The date and placement number were recorded on the tape and attached to vegetation beside the site. Habitat measurements were taken using the following tools:

- Handheld Suunto clinometer
- Hip chain
- 30 m tape measure
- 2 m wading staffs marked in 5 cm increments
- Rangefinder

All culverts encountered were assessed using the "Fish Passage Assessment at Culverted Sites: Rapid Field Measurements to Determine the Likelihood of a Barrier to Fish Passage" assessment method (WLRS, 2021). Culvert length, embeddedness, slope, and diameter were recorded in the field and a numeric score to determine likelihood of fish passage was calculated after the survey.

Georeferenced placemarks and photographs for habitat units were measured and recorded using Avenza Maps (Avenza Systems Inc., Ontario) with an integrated PDF schema (Clough, 2016), using mapping provided by GIS staff from the RDN.

Water quality parameters (temperature, pH, dissolved oxygen, total dissolved solids, and conductivity) were recorded at representative sites within each reach on September 8th, 2025 using a YSI Pro 2030 meter (Xylem Inc., Washington DC, USA), and compared to the BC Approved Water Quality Guidelines for Aquatic Life, Wildlife & Agriculture (WLRS, 2025).

Upon completion of the survey, data was exported in both .csv and .kml file formats to allow for data analysis using the USHP Excel program, and mapping in Google Earth Pro. All data points recorded in the field were transferred to the USHP excel spreadsheet, which is pre-programmed with formulas and macros that calculate a "rating" based on the habitat parameters recorded. Each habitat parameter within each discrete habitat unit builds an aggregate score for each habitat parameter within each reach, which is displayed as a rating of 1 (good), 3 (fair), or 5 (poor). This method allowed a numeric summary and comparison of Cottle Creek to the biostandards of a healthy stream based on Johnston & Slaney's Fish Habitat Assessment Procedures (1996). A summary table of habitat parameter ratings was produced for each reach, to aid in identifying restoration opportunities.

4. Results

The field survey was conducted over nine days between August 7th and September 8th, 2025. Training of volunteers in the field survey techniques occurred at the beginning of the project and was led by Tyler Welsh (NALT fisheries technician). The survey was led by Joe Clark (BCCF Fisheries Technician) and assisted by FOCC volunteers (Craig Wightman, Maggie Estok, Judy Wickland, and Peter Law).

Results for each reach are broken into 'fish habitat' and 'riparian', which include a summary of condition, the associated USHP rating table, photographs, and a reach map with points of interest. Restoration opportunities by reach and a summary table of restoration opportunities (Table 19) are found in the Discussion.

At the time of this assessment, Cottle Creek was in a summer low-flow condition with an average discharge of 2.1 L/s across the survey period (August – September, 2025), which is 1.06 % of mean annual discharge or MAD (i.e., preliminary MAD estimate of 199 L/s from Ally Wall, BCCF, Dec. 8, 2025). In total, 192 habitat units were recorded during the assessment. The creek had an average wetted width of 1.9 m and an average channel width of 4.9 m. The average percent wetted area was 34.2. A total of 95 pools and 97 riffles were measured across the 8 reaches. A total of 37 pools with an average depth >20 cm were identified. Large Woody Debris (LWD) and undercut banks were the dominant cover types in pools (51 % & 35 %, respectively). The total area of cover within pools >20 cm average depth made up 7.9 % of the total wetted area of the stream.

Reach 1

Cottle Creek's Reach 1 is approximately 120 m long and runs from tidewater in Departure Bay to the Stephenson Point Road culvert (Fig. 5). A total of three habitat units were recorded in the first 30 m of Reach one. A concrete weir (Fig. 6a), 30 m downstream of the Stephenson Point Road culvert, marked the endpoint of the surveyed area in Reach 1, as the area downstream contains bedrock falls and is an impassible barrier for fish. Fish presence has been confirmed by minnow trapping in the pool directly downstream of the culvert by the FOCC, hence, its inclusion in this survey.

The reach runs in a forested ravine ~20 m wide between two private properties on Stephenson Point Road. The creek has an average wetted width of 2.2 m and average channel width of 5.2 m in this reach. Due to the limited access fish have, only two pools and one riffle were measured upstream of the concrete weir (field survey terminus). Habitat and water quality ratings are found in Table 2 and riparian ratings are shown in Table 3. Mean scores for fish habitat, water quality, and riparian zone in Reach 1 were all "fair".

The Stephenson Point Road culvert (Figure 6c) is a corrugated steel pipe with a 2 m diameter that runs 17 m long at a 3% gradient. The culvert scored 31 using the rapid assessment method, which classifies it as a fish barrier at all flows (WLRS, 2021).

Table 2. Reach 1 fish habitat and water quality results and ratings. Results are an aggregate score calculated from the habitat parameters recorded during this assessment.

Habitat Parameter	Result	Rating	Result
% Pool Area	55	3	Fair
Large Woody Debris/Bankfull Channel Width	0	5	Poor
% Cover in Pools	10	3	Fair
Average% Boulder Cover	7	5	Poor
Average % Fines	20	3	Fair
Average % Gravel	13	not rated	not rated
% of Reach Eroded	0	1	Good
Obstructions	2	2	Fair
% of Reach Altered	0	1	Good
% Wetted Area	53	5	Poor
Dissolved Oxygen	9.37	1	Good
pH	7.35	1	Good

Table 3. Reach 1 riparian results and ratings. Results are an aggregate score calculated from the habitat parameters recorded during this assessment.

Riparian Ratings	Result	Rating	Result
Land Use	20	3	Fair
Riparian Slope	8	1	Good
Bank Stability	14	2	Fair
% Crown Cover	77	1	Good
% of Reach Accessed	16	3	Fair
Average Vegetation Depth	12	5	Poor

Within the reach, these habitat characteristics were rated "Good"**:**

- **Water quality**: Although rated high during the survey, there is a connecting street storm drain that discharges runoff from Stephenson Point Road on left bank, which is a point source of the tire toxicant 6-PPD-Quinone.

- **Erosion**: Very little erosion was noted, likely due to high flow events being buffered by the large pool at the outfall of the Stephenson Point Road culvert and the dominance of bedrock.
- **Crown Cover**: The narrow and forested ravine that contains Reach 1 has a mixed canopy of mature red alder (*Alnus rubra*), arbutus (*Arbutus menziesii*), and Douglas fir (*Pseudotsuga menziesii*), offering year-round shade to the majority of the reach.

Within the reach, these habitat characteristics were rated "Poor":

- **Large Woody Debris & Boulder Cover:** No LWD was found; however, some large boulders provided cover in pools. An undercut bank has been created in the pool immediately downstream of the Stephenson Point Road culvert.
- **Vegetation Depth**: Reach 1 is surrounded by a narrow band of forest that borders two private properties at 3250 & 3258 Stephenson Point Road with an average width of 10 m on both banks.

Figure 5. Cottle Creek Reach 1 survey map. Red line is surveyed area and black line is area not surveyed.

Figure 6. Reach 1 photos.

a) Concrete weir at survey terminus

b) Riffle downstream of culvert pool

c) Stephenson Point Road culvert and pool

Reach 2

Reach 2 of Cottle Creek runs 535 m from Stephenson Point Road to Hammond Bay Road (Fig. 7).

A total of 32 habitat units were recorded in the reach. The first ~150 m of Reach 2 runs adjacent to Stephenson Point Park on left bank with a private daycare and federal government storage yard near the right bank. The stream has an average gradient of 3.3%. Substrate was mostly cobbles (29%) and boulders (19%), and riffles were the dominant habitat type (53%). The average wetted width was 2.14 m and the average bankfull width was 5.20 m. A total of 16 pools were recorded in the reach, with 9 of those averaging a depth >20 cm. Undercut banks were the dominant cover type in pools, making up 75%.

A municipal sewer line runs along the stream bank for almost the entirety of Reach 2, crossing underneath the stream within the park. At several points along the reach there are banks armoured with boulders and concrete walls to protect the pipe from erosion. A narrow walking trail used by locals follows the stream for the entire length of the reach. A channel-spanning concrete dam (10.5 m x 2.5 m) marks the mid-point of the reach (Figure 8a). Upstream of the dam, the stream has a lower gradient and flows through five private properties until reaching Hammond Bay Road. A flow monitoring station was installed at a driveway culvert (Fig. 8d) in 2024 as part of BCCF's CFMN.

Reach 2 fish habitat was highly fragmented, with seven obstructions observed (the most in all surveyed reaches). CCT were only observed above the concrete dam during the survey of Reach 2.

Habitat rating for this reach was fair to poor (Table 4) and the average riparian rating was fair (Table 5). Despite part of the reach flowing through municipal park, the reach is heavily altered (17%) due to bank armoring for municipal infrastructure, informal public access trails, road crossings, and encroachment of private property lawns.

The private property driveway culvert is a 2 m diameter corrugated steel pipe that is 10 m long at a 2 % gradient. The culvert scored 18 using the rapid assessment method, classifying it as likely a fish barrier at all flows (WLRS, 2021).

The Hammond Bay Road Culvert is 2 m in diameter, 20 m long at a 1% slope. The culvert scored 20 using the rapid assessment method, classifying it as a likely fish barrier at all flows (WLRS, 2021).

Table 4. Reach 2 fish habitat and water quality results and ratings. Results are an aggregate score calculated from the habitat parameters recorded during this assessment.

Habitat Parameter	Result	Rating	Result
% Pool Area	47	3	Fair
Large Woody Debris/Bankfull Channel Width	0.3	5	Poor
% Cover in Pools	10	3	Fair
Average% Boulder Cover	2	5	Poor
Average % Fines	20	5	Poor
Average % Gravel	16	not rated	not rated
% of Reach Eroded	39	5	Poor
Obstructions	7	7	Poor
% of Reach Altered	17	5	Poor
% Wetted Area	41	5	Poor
Dissolved Oxygen	9.09	1	Good
pH	6.16	3	Fair

Table 5. Reach 2 riparian results and ratings. Results are an aggregate score calculated from the habitat parameters recorded during this assessment.

Riparian Ratings	Result	Rating	Result
Land Use	152	2	Fair
Riparian Slope	82	1	Good
Bank Stability	179	3	Fair
% Crown Cover	76	1	Good
% of Reach Accessed	36	5	Poor
Average Vegetation Depth	20	5	Poor

Within Reach 2, these habitat characteristics were rated "Good**":**

- **Water Quality:** All water quality parameters recorded were within the British Columbia Approved Water Quality Guidelines for Aquatic Life, Wildlife & Agriculture (WLRS, 2025).
- **Crown Cover:** Forest canopy in Stephenson Point Park is made up mostly of red cedar (*Thuja plicata*) and Douglas fir, which provide year-round cover to the stream. Properties bordering Hammond Bay Road have a dominant canopy of bigleaf maple (*Acer macrophyllum*) trees, whose leaves drop in the fall months exposing the creek to some winter sunlight.

Within Reach 2, these habitat characteristics were rated "Poor":

- **Large Woody Debris:** Natural recruitment of LWD is limited in the section of Reach 2 downstream of the concrete dam, as woody debris has accumulated above the dam. Efforts by City crews to maintain sewer infrastructure and road culverts may also play a role in the lack of LWD observed in this reach.
- **Boulder Cover & Fines:** Although boulders were present, many were above the wetted stream edge at the time of survey, or were embedded in fines. Most boulders observed in the stream appeared to be pieces of rip-rap that have been placed to protect banks, especially near Hammond Bay Road.
- **Erosion:** Nearly 40% of the stream channel showed signs of erosion. Debris from recent flood events were noted in the riparian zone as high as 3 m above the current wetted edge, an indication of possible high storm flows in the stream.
- **Obstructions:** This reach is dominated by bedrock outcrops that encourage a "step-pool" morphology that creates velocity obstructions like small chutes that juvenile fish will have difficulty navigating. A channel spanning dam is the most significant of the human-made obstructions. A search of BC's IMAP for a provincial water license associated with the structure was not successful. Other obstructions include a concrete sill, a corrugated steel culvert under a private driveway, and the Hammond Bay Road culvert. These four sites create barriers to fish movement.
- **Alterations:** Reach 2 has been heavily altered, mainly by bank armoring (rip-rap and concrete) associated with protecting a municipal sewer line and the two culverts at the upper end of the reach. Private property lawns encroach on the stream edge for the upper ~100 m of the reach, as well.
- **Access:** Almost the entire reach is accessible via a narrow trail that begins at Stephenson Point Park and follows the stream until entering the backyard of private property at 3232 Hammond Bay Road. Use of this trail by locals was observed frequently during the survey. Right bank access from a daycare facility on Stephenson Point Road is also an issue, as the creek was observed as an active play area for the daycare children.
- **Vegetation Depth:** Vegetation depth on the left bank averaged 12 m and never exceeded 20 m due to the extent of commercial and residential development. Right bank vegetation depth averaged 28 m. Mature trees are present on both banks for

the entire reach, but it was noted that the shrub layer and understory were thin, especially in the area of Stephenson Point Park.

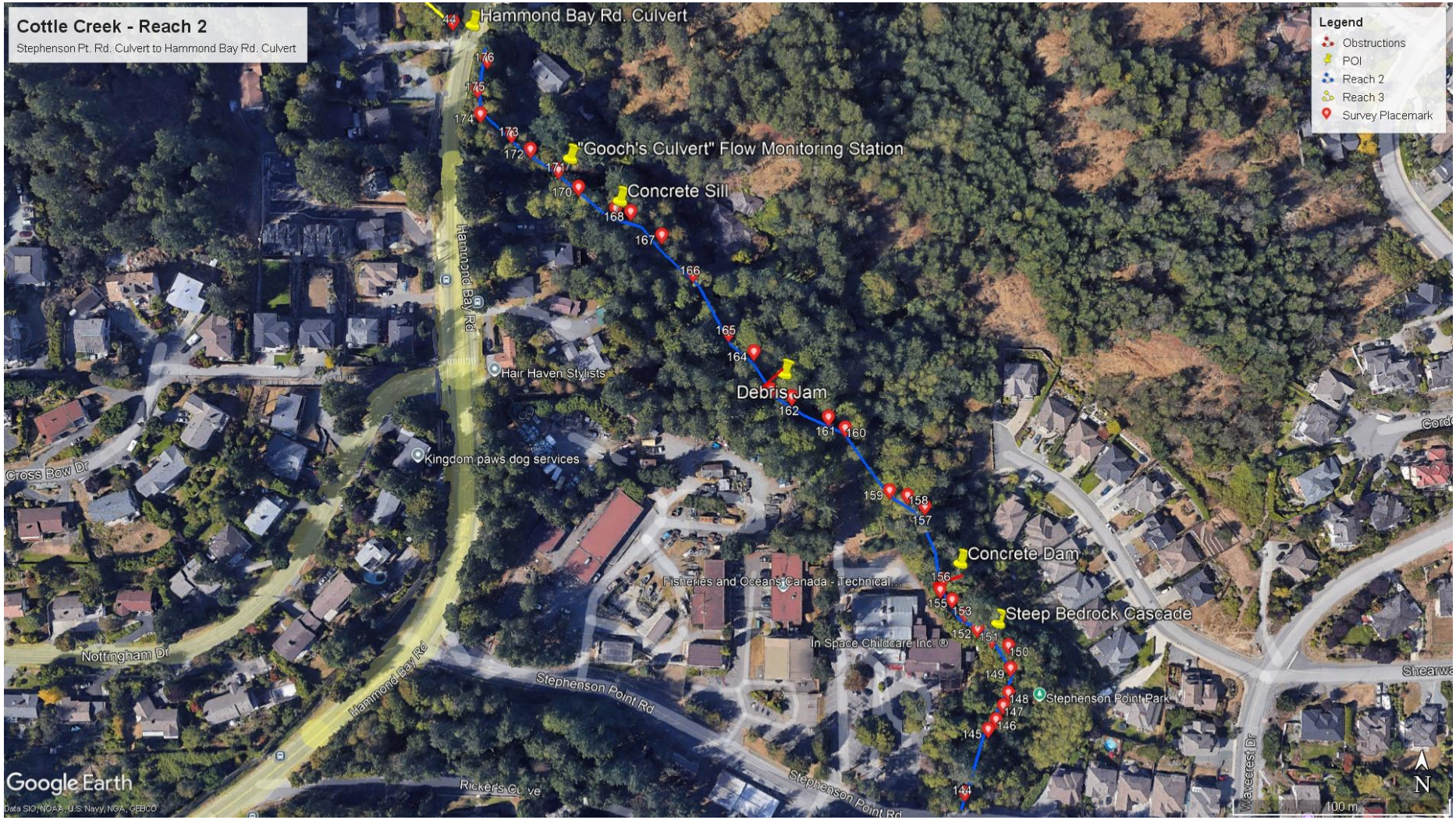

Figure 7. Cottle Creek Reach 2 survey map.

Figure 8. Reach 2 photos.

a) Concrete irrigation dam

b) Channel spanning concrete sill

c) Erosion area near daycare access

d) Driveway culvert used as flow monitoring station

e) Outlet of Hammond Bay Road culvert

f) Riffle in upper portion of Reach 2

Reach 3

Reach 3 runs 658 m from the upstream end of the Hammond Bay Road to the culvert in the vacant lot at 200 Linley Rd. (Fig. 9).

A total of 41 habitat units were recorded in the reach. The gradient of Reach 3 averaged 1.3 % with gravel (50%) and fines (34 %) dominating the substrate. A total of 22 pools were recorded in the reach, with 8 having an average depth >20 cm. Undercut banks and LWD were the dominant cover types in pools (43 % & 40 %, respectively). The average wetted width was 1.98 m and the average bankfull width was 4.61 m.

Directly upstream of Hammond Bay Road the stream runs in a steep, riprap-confined ravine between private properties (Fig. 10a) until opening into a wider floodplain as it flows through Cottle Creek Park. The channel has been ditched for the entire length of the park, leaving a mostly straight channel dominated by low gradient glide habitat (Fig. 10b). This may be remnants of the small farm that was subdivided for housing in 2000 (Aquaterra, 2002). Iron oxidizing bacteria was observed blanketing the stream bed throughout this area. This survey encountered a City of Nanaimo public works project underway to remove sediments from a multiplate culvert at Nottingham Road. Riparian vegetation had been removed in this area to facilitate machinery access for culvert maintenance.

Upstream of Cottle Creek Park, the stream regains its meander as it flows adjacent to private property backyards on Miller Farm Road and Linley Road. This area was historically a cattle farm and signs of alterations associated with the historical land use were observed, such as cement-filled tires used as bank revetments (Fig. 10d), and old fence posts and wire in the riparian zone. A 10 m x 40 m stormwater detention pond on the left bank is present near USHP placemark 66 that was not connected to the stream's surface flow at the time of survey. Surveyors have observed both CCT and pumpkinseed sunfish (*Lepomis gibbosus*) using the pond habitat. Upstream of the backyard at 166 Linley Road, the stream begins to flow through a 17.8-acre undeveloped private lot. Here, the stream and riparian zone are mostly naturalized with some historical sign of disturbance (old gravel pit). A popular trail leading to Cottle Lake Park begins at the end of the road right-of-way (private lot at 200 Linley Road). The pool created by a large cement culvert with wingwalls marks the end of Reach 3.

The concrete culvert at the end of Reach 3 is 1.8 m in diameter, 17.5 m long, and has a 0.5% gradient. At low flows the culvert outlet is perched 0.25 m above the outlet pool. The culvert scored 21 using the rapid assessment method and is likely a fish barrier at all flows (WLRS, 2021).

Habitat rating for Reach 3 ranged from fair to poor (Table 6) and riparian conditions were rated fair (Table 7). Reach 3 was the most altered (19%) of all surveyed reaches, as it was originally channelized for farm lands and remains so today to accommodate residential housing development.

Table 6. Reach 3 fish habitat and water quality results and ratings. Results are an aggregate score calculated from the habitat parameters recorded during this assessment.

Habitat Parameter	Result	Rating	Result
% Pool Area	75	1	Good
Large Woody Debris/Bankfull Channel Width	0.2	5	Poor
% Cover in Pools	10	3	Fair
Average% Boulder Cover	0	5	Poor
Average % Fines	34	5	Poor
Average % Gravel	50	not rated	not rated
% of Reach Eroded	22	5	Poor
Obstructions	2	2	Fair
% of Reach Altered	19	5	Poor
% Wetted Area	43	5	Poor
Dissolved Oxygen	9.13	1	Good
pH	6.58	1	Good

Table 7. Reach 3 riparian results and ratings. Results are an aggregate score calculated from the habitat parameters recorded during this assessment.

Riparian Ratings	Result	Rating	Result
Land Use	143	2	Fair
Riparian Slope	86	1	Good
Bank Stability	196	2	Fair
% Crown Cover	77	1	Good
% of Reach Accessed	8	3	Fair
Average Vegetation Depth	25	5	Poor

Within Reach 3, these habitat characteristics were rated "Good**":**

- **Percent Pool Area**: A total of 22 pools were recorded in Reach 3, making up 75% of the wetted area. The average gradient is 1.3 %, which is the flattest reach of the entire stream. The low gradient explains the dominance of pool/glide habitat.
- **Water Quality**: All water quality parameters recorded were within the British Columbia Approved Water Quality Guidelines for Aquatic Life, Wildlife & Agriculture (WLRS, 2025). Directly upstream and downstream of the Nottingham Drive culvert had little cover from direct sunlight. Elevated water temperatures were recorded here at the time of survey (18-19°C). Groundwater is suspected to enter the creek in this area, providing a doubling of flows during the low flow time period (mid-August to mid-September).
- **Crown Cover**: The riparian canopy is dominated by red alder, red cedar, Douglas fir, and bigleaf Maple.

Within Reach 3, these habitat characteristics were rated "Poor**":**

- **Large Woody Debris:** Historic land use issues and subdivision of lands into housing have limited natural LWD recruitment due to active vegetation management by private property owners and park maintenance. At the time of survey, City of Nanaimo crews were clearing trees from the riparian zone to facilitate machine access for Nottingham Drive culvert maintenance.
- **Boulder Cover & Fines:** Boulders made up 4 % of the substrates in Reach 3. All boulders present were embedded in fines and not able to provide cover for fish.
- **Erosion:** Erosion was noted on both stream banks, often present on the outside of a meander. In many places, bare eroded banks extended 1 to 2 m vertically from the wetted edge, an indication of the intensity of storm flows the creek experiences.
- **Alterations:** Reach 3 was the most heavily altered of all surveyed reaches (19%). Many alterations were attributed to historical land use in the area (cattle farming), such as tractor tires and cement used as bank stabilization, a wooden footbridge, and old fence posts. Alterations (vegetation removal, path construction) made within Cottle Creek Park to facilitate Nottingham Drive culvert maintenance was also noted.
- **Vegetation Depth:** An average vegetation depth of 25 m was recorded in Reach 3, with a maximum depth of 50 m recorded in the area of the 200 Linley Road property. The area directly upstream of the Hammond Bay Road culvert and the majority of the riparian zone in Cottle Creek Park had the lowest riparian depths recorded (0 m to 5 m).

Figure 9. Cottle Creek Reach 3 survey map.

Figure 10. Reach 3 photos.

a) Ravine u/s of Hammond Bay Road culvert

b) Ditched channel in Cottle Creek Park

c) u/s of Nottingham Dr. culvert looking d/s

d) One of multiple cement filled tires in bank

f) Bridge and bank armouring on old Miller Farm property

g) Typical bank erosion observed in Reach 3

h) Culvert pool at 200 Linley Road

Reach 4

Reach 4 of Cottle Creek measures 457 m long and runs from the upstream end of the 200 Linley Road culvert to the first aluminum bridge crossing of the Linley Valley Trail (Fig. 11).

A total of 42 habitat units were recorded in Reach 4. The average gradient was 1.45 % with gravel dominating the substrate (75 %). A total of 19 pools were recorded in Reach 4, with 7 averaging a depth >20 cm. Undercut banks were the dominant cover type in pools at 45 % of all pool cover. The average wetted width was 1.5 m and the average bankfull width was 5.24 m.

The majority of this reach is on private undeveloped land (PID 009-435-034), and ends within the Crown Land District Lot 56 (3519 Robin Hood Drive). The stream and riparian zone in this reach are in a mostly undisturbed condition, except for historical logging (old growth stumps) and the popular Linley Valley recreational trail. The channel is incised and lacks sinuosity for much of the reach, with a nearly vertical left bank 3 to 5 m high (Fig. 12a). In certain locations, the channel downcutting was exposing a "hardpan" clay outcrop on the stream bottom. Wetted habitat at the time of survey was mostly shallow pools and glides, with undercut banks being the dominant cover type. In the upper ~60 m of the reach, stream flow was sub-surface with only a dry gravel-filled channel observed.

The mean habitat rating for Reach 4 was fair (Table 7), and the mean riparian rating was fair (Table 8). Reach 4 stream banks were heavily eroded (32 %) and lack woody debris and boulder cover. The reach was minimally altered (4%), and generally lacked obstructions to fish movement other than the dry section at the upstream end.

Table 7. Reach 4 fish habitat and water quality results and ratings. Results are an aggregate score calculated from the habitat parameters recorded during this assessment.

Habitat Parameter	Result	Rating	Result
% Pool Area	57	1	Good
Large Woody Debris/Bankfull Channel Width	0.3	5	Poor
% Cover in Pools	11	3	Fair
Average% Boulder Cover	0	5	Poor
Average % Fines	13	3	Fair
Average % Gravel	75	not rated	not rated
% of Reach Eroded	32	5	Poor
Obstructions	2	2	Fair
% of Reach Altered	4	1	Good
% Wetted Area	29	5	Poor
Dissolved Oxygen	6.54	3	Fair
pH	6.41	3	Good

Table 8. Reach 4 riparian results and ratings. Results are an aggregate score calculated from the habitat parameters recorded during this assessment.

Riparian Ratings	Result	Rating	Result
Land Use	84	1	Good
Riparian Slope	104	1	Good
Bank Stability	171	2	Fair
% Crown Cover	79	1	Good
% of Reach Accessed	57	5	Poor
Average Vegetation Depth	52	3	Fair

Within Reach 4, these habitat characteristics were rated "Good**":**

- **Pool Area:** A total of 19 pools were measured in Reach 4, making up 57% of the wetted area. These were mostly shallow pools <15 cm deep, with 7 pools identified averaging a depth >20 cm.
- **Water Quality:** All water quality parameters recorded were within the British Columbia Approved Water Quality Guidelines for Aquatic Life, Wildlife & Agriculture (WLRS, 2025). Dissolved oxygen in Reach 4 was the lowest observed in all surveyed reaches, which may be associated with the high densities of algae on substrates in shallow glide and pool habitat.
- **Alterations:** Reach 4 generally lacked major alterations, with the exception of the large culvert at the beginning of the reach and the aluminum bridge crossing of the Linley Valley Trail at the upstream end of the reach.
- **Land Use:** Reach 4 land use was entirely classified as "natural". The land is zoned for residential development; however the delays in proceeding with subdivision and construction (+15 years) have provided time for this large lot to return to an ecologically diverse valley lowland riparian condition.
- **Crown Cover:** Canopy cover averaged nearly 80% with the stream surrounded by the riparian forest. Canopy is a mix of red cedar, bigleaf maple and Douglas fir, offering year-round shade to the stream.

Within Reach 4, these habitat characteristics were rated "Poor**":**

- **Large Woody Debris:** Few LWD pieces were observed in Reach 4 (n=27), mature LWD recruitment from the surrounding forest has been interrupted by historical logging. The lack of LWD complexity has allowed flood flows to experience little resistance in Reach 4, leading to the degree of channel downcutting observed.

- **Boulder Cover:** Boulders were not observed in the substrates of Reach 4. The low average gradient (1.5 %) does not favour the deposition of large substrates, and composition of bank soils also appeared to be lacking in boulders, as they were dominated by clay and organics.
- **Erosion:** Signs of erosion were recorded through the entire reach. Most of this erosion was in areas of channel downcutting, where the banks above the incised channel were vertical walls of bare soil or clay.
- **Access:** Despite the natural setting of Reach 4, its proximity to the popular Linley Valley Trail has allowed for relatively easy access to the stream's left bank for most of the lower half of the reach. Multiple ad hoc access trails were observed off the main walking trail, leaving exposed, loose soil pathways on the stream's left bank.

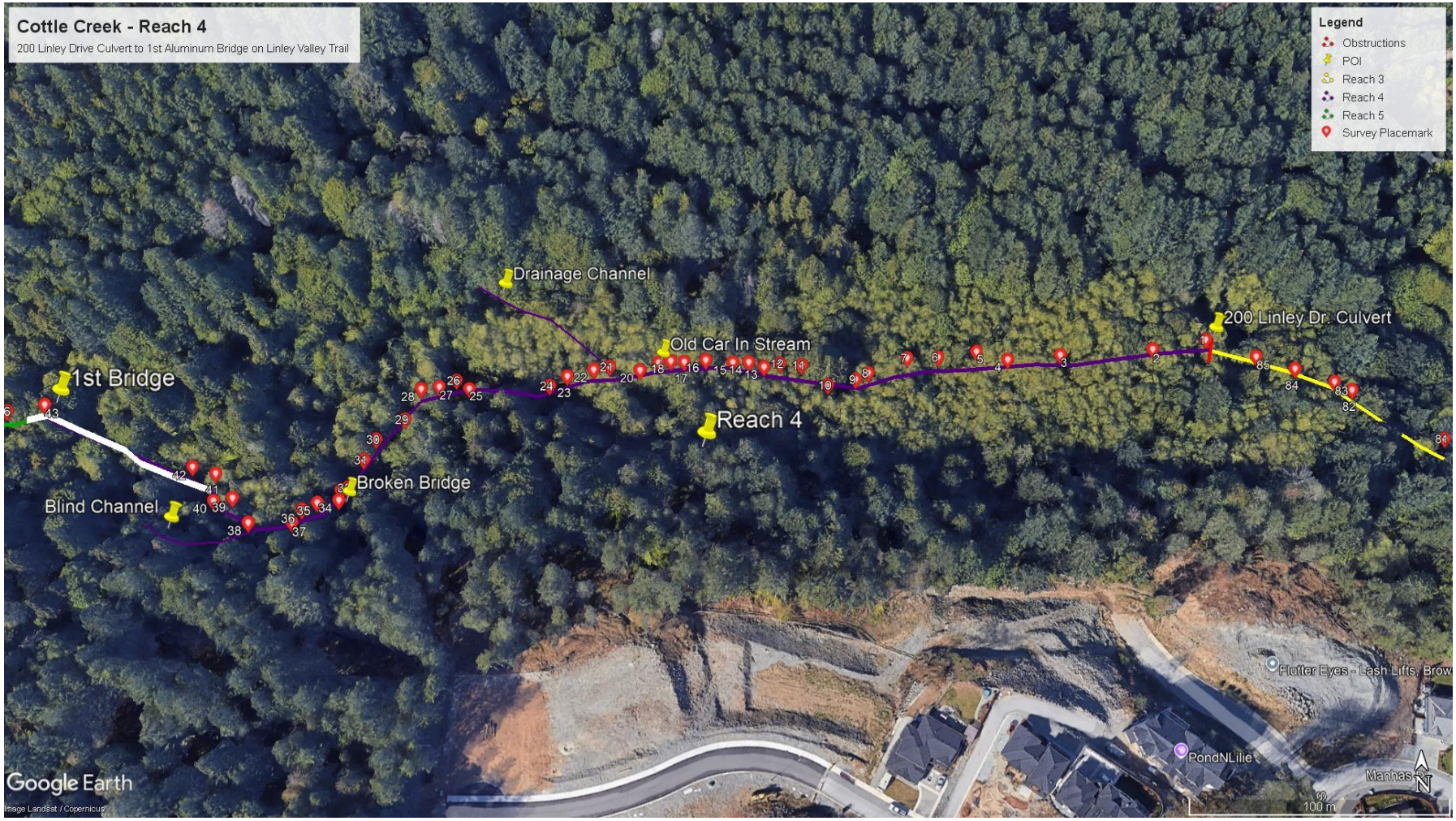

Figure 11. Cottle Creek Reach 4 survey map. White line is area lacking surface flow.

Figure 12. Reach 4 photos.

a) Down-cut channel & eroded banks typical of Reach 4

b) Pool with overhanging Vegetation & LWD

c) 1.5 m deep undercut, the dominant cover type in Reach 4

Reach 5

This reach runs 651 m between the two aluminum pedestrian bridge crossings on the Linley Valley Trail downstream of Cottle Lake (Fig. 13).

A total of 48 habitat units were recorded in the reach. The average gradient in Reach 5 was 1.4 % with gravel as the dominant substrate (38%). A total of 24 pools were recorded with 7 having an average depth >20 cm. LWD was the dominant cover type, making up 76% of all pool cover. The survey recorded the highest average percent cover in pools (13%) for the entire watershed. The average wetted width was 1.5 m and the average bankfull width was 4.65 m.

Reach 5 flows entirely through the forested Crown Land parcel (DL 56). The surrounding forest has largely recovered from historical logging and the Linley Valley Trail runs atop a steep ravine approximately 30 m from the stream on the stream's right bank. This steep ravine limits public access, leaving the riparian area relatively undisturbed. At the time of survey, the first ~75 m of Reach 5 lacked surface flow, except for a stagnant pool at USHP placemark 86, just upstream of the 1st aluminum pedestrian bridge on the Linley Valley Trail. The first ~20 m of Reach 5 has exposed and trampled banks from trail users and their pets. Upstream of USHP placemark 97, the stream is naturally confined to a steep and narrow ravine with an average bank slope of 19 % that often exceeded 50 % in the steepest sections. The riparian habitat has a vigorous understory of sword fern (*Polystichum munitum*), salmonberry (*Rubus spectabilis*) and salal *(Gaultheria shallon*), as well as a mature mixed canopy of Douglas fir, red cedar and bigleaf maple trees (Fig. 14f). Reach 5 had 6 obstructions observed, all of which were gravel/debris deposits, or log jams. Channel downcutting was observed throughout the ravine portion of the reach, with vertical banks often eroded bare 0.5 to 1 m above the wetted edge (Fig. 14c and 14d). Young-of-the-year and older CCT were observed in both riffles and pools throughout the reach.

Reach 5 had a habitat rating of fair (Table 9), and a riparian rating of good and fair (Table 10); these were the best scores for the watershed. Reach 5 was one of the least eroded reaches (29 %) and the least altered. Obstructions (6) due to debris and log jams are a hinderance to fish movement during low flow periods.

Table 9. Reach 5 fish habitat and water quality results and ratings. Results are an aggregate score calculated from the habitat parameters recorded during this assessment.

Habitat Parameter	Result	Rating	Result
% Pool Area	58	1	Good
Large Woody Debris/Bankfull Channel Width	1.0	5	Poor
% Cover in Pools	13	3	Fair
Average% Boulder Cover	0	5	Poor
Average % Fines	28	5	Poor
Average % Gravel	38	not rated	not rated
% of Reach Eroded	29	5	Poor
Obstructions	6	6	Poor
% of Reach Altered	0	1	Good
% Wetted Area	32	5	Poor
Dissolved Oxygen	7.36	1	Good
pH	6.99	1	Good

Table 10. Reach 5 riparian results and ratings. Results are an aggregate score calculated from the habitat parameters recorded during this assessment.

Riparian Ratings	Result	Rating	Result
Land Use	96	1	Good
Riparian Slope	188	2	Fair
Bank Stability	194	2	Fair
% Crown Cover	75	1	Good
% of Reach Accessed	15	3	Fair
Average Vegetation Depth	66	1	Good

Within Reach 5, these habitat characteristics were rated "Good**":**

- **Alterations:** Reach 5 was the least altered of all surveyed reaches. The pedestrian bridge crossings from the Linley Valley Trail at the upstream and downstream reach breaks were the only alterations observed.

- **Water Quality:** All water quality parameters recorded were within the British Columbia Approved Water Quality Guidelines for Aquatic Life, Wildlife & Agriculture (WLRS, 2025).
- **Land Use:** The entirety of Reach 5 is within the undeveloped forested DL56 Crown Land parcel. A popular trail runs adjacent to the creek's right bank, but the steep ravine that runs for most of Reach 5 has largely protected it from impacts associated with recreational trail builders/users.
- **Crown Cover:** Canopy cover often exceeded 85% due to the steep ravine walls and the mature mixed conifer and deciduous surrounding forest.
- **Vegetation Depth:** Riparian conditions (natural setting) are excellent throughout the reach.

Within Reach 5, these habitat characteristics were rated "poor**":**

- **Large Woody Debris:** A total of 139 LWD pieces were observed in Reach 5, which is over four times more than the next highest reach (Reach six). Natural recruitment of wood appears to be intact.
- **Boulder Cover & Fines:** Very few boulders were observed here and none were unembedded enough to provide cover for fish.
- **Erosion:** A moderate amount of bank erosion was present. A few sites in the ravine showed downcutting to bare soil or clay. Areas of significant bank erosion were noted in the raw data as likely point sources of fine sediment.
- **Obstructions:** In total, 6 obstructions were observed in Reach 5, all of which were sediment/debris or log jams. In multiple cases there were large bedload gravel deposits on the upstream end of a log and debris jams that appeared to be stable, as gravel deposits were vegetated with willows/grasses. All of the observed barriers preclude fish movement in low flows.

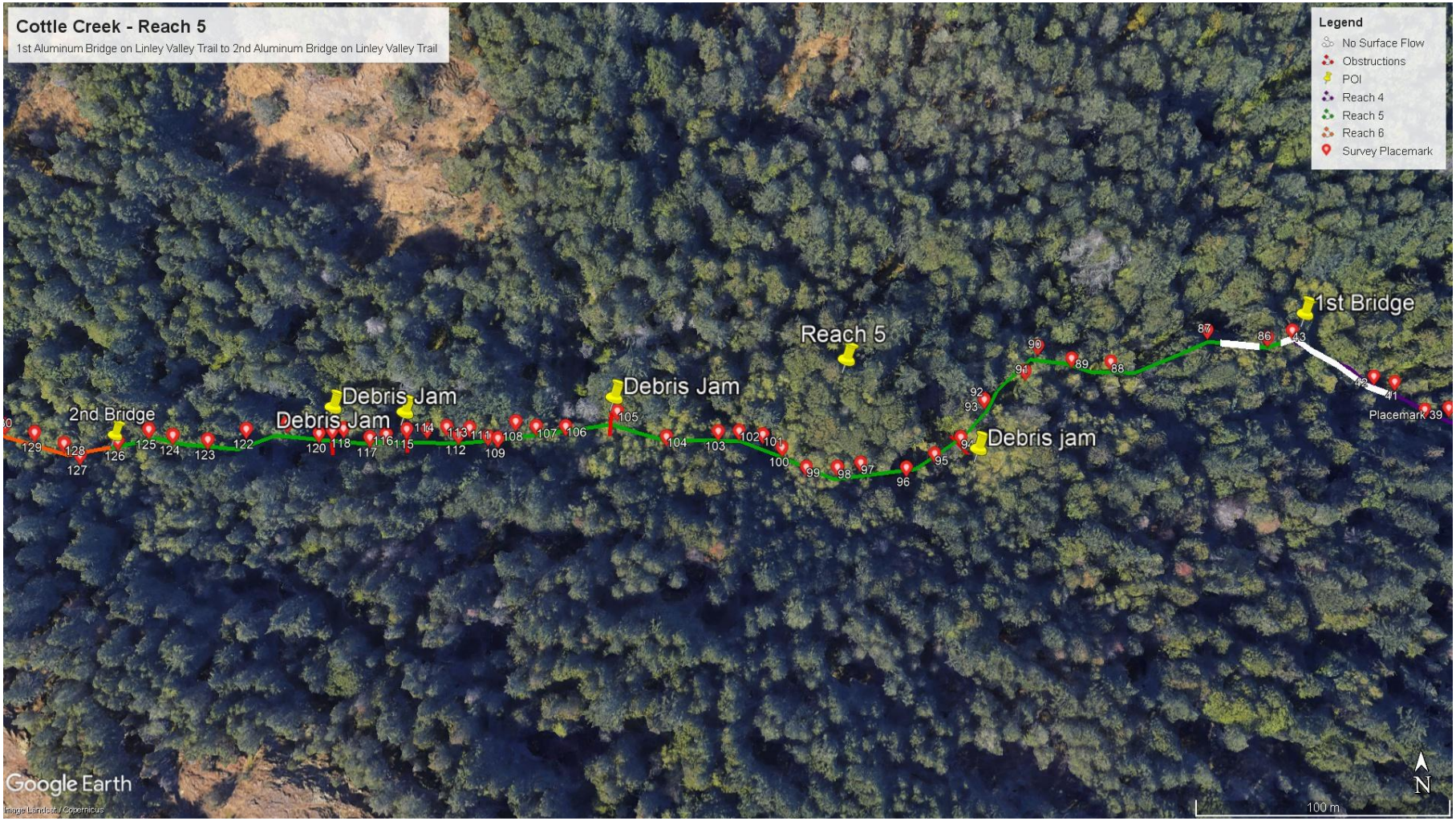

Figure 13. Cottle Creek Reach 5 survey map. White line is area lacking surface flow.

Figure 14. Reach 5 photos.

a) Fine sediment deposit at riffle tail-out

b) Reed canary grass (*Phalaris arundinacea*) on banks

c & d) Areas of significant bank erosion and wasting observed in Reach 5

e) Pool with LWD accumulation

f) Pool/riffle sequence in Reach 5

g) Linley Valley Trail aluminum bridge at u/s end of Reach 5

Reach 6

Reach 6 runs 242 m from the upstream end of the 2nd Linley Valley Trail aluminum bridge upstream to the beaver dam at the outlet of Cottle Lake (Fig. 15).

A total of 12 habitat units were recorded in Reach 6. The average gradient was 1 %, with fines making up the majority of substrate at 53 %. A total of 7 pools were observed, with 3 having an average depth >20 cm. The average wetted width was 2.26 m and the average bankfull width was 5.43 m.

This reach lies entirely within Linley Valley Cottle Lake Park. The Linley Valley Trail parallels the stream's left bank, but is upslope about 50 m. At the outlet of the lake the trail crosses the creek with a small wooden bridge. This reach runs mostly in a shallow ravine, so trails and vegetation impacts are more common. Flooding evidence from the collapse of the beaver dam in mid-December 2024 is still observable in this reach, with freshly eroded banks and flood debris deposited above the channel margins on both banks.

Both pumpkinseed sunfish and CCT were observed in pools throughout.

The riparian area within Reach 6 is diverse and vigorous, with a mature mixed canopy of Douglas fir, red cedar and bigleaf maple trees and a dense understory of sword fern, salmonberry, and salal (Fig. 16a).

Backwatering by a small beaver dam near USHP placemark 134 (Fig. 16c) has caused the upper half of Reach 6 to be dominated by pool and glide habitat. LWD was the only cover type observed in pools.

Erosion of the streambanks in this area is significant and flood impacts from the beaver dam breach is still evident. In total, 62 % of the reach's banks were accessible to the public. Reach 6 was the most eroded (40%) reach in the entire survey. Erosion in Reach 6 is tied to both bank access and flood/debris flows. Trail users and their pets have caused significant impacts to riparian conditions near the lake outlet (Figure 16e).

The average habitat rating for Reach 6 was fair (Table 11), as was the average riparian rating (Table 12). It is important to note that this reach has significant erosion impacts from flooding and ongoing impacts from park users. This reach does contain pool habitats with ample LWD cover.

Table 11. Reach 6 fish habitat and water quality results and ratings. Results are an aggregate score calculated from the habitat parameters recorded during this assessment.

Habitat Parameter	Result	Rating	Result
% Pool Area	93.47	1	Good
Large Woody Debris/Bankfull Channel Width	0.76	5	Poor
% Cover in Pools	9	3	Fair
Average% Boulder Cover	0	5	Poor
Average % Fines	52.50	5	Poor
Average % Gravel	18.33	not rated	not rated
% of Reach Eroded	40	5	Poor
Obstructions	2	2	Fair
% of Reach Altered	4	1	Good
% Wetted Area	41.67	5	Poor
Dissolved Oxygen	7.13	1	Good
pH	7.09	1	Good

Table 12. Reach 6 riparian results and ratings. Results are an aggregate score calculated from the habitat parameters recorded during this assessment.

Riparian Ratings	Result	Rating	Result
Land Use	24	1	Good
Riparian Slope	28	1	Good
Bank Stability	66	3	Fair
% Crown Cover	68.75	3	Fair
% of Reach Accessed	62	5	Poor
Average Vegetation Depth	40	3	Fair

Within Reach 6, these habitat characteristics were rated "Good**":**

- **Pool Area:** Low gradient and lake outlet conditions provide a high percentage of pool and glide habitat.

- **Water Quality:** All water quality parameters recorded were within the British Columbia Approved Water Quality Guidelines for Aquatic Life, Wildlife & Agriculture (WLRS, 2025)
- **Alterations:** The aluminum bridge crossings at the beginning of the reach and the wooden bridge crossing near the upstream end of the reach were the only observed alterations.

Within Reach 6, these habitat characteristics were rated "Poor**":**

- **Large Woody Debris:** Wood makes up the majority of cover in Reach 6 pools, however, many other pieces of woody debris were observed on the banks and floodplain that had been deposited along with other flood debris. The force of the December 2024 flood flows may have altered the functionality of LWD in this reach.
- **Boulder Cover & Fines:** Boulders made up 3% of the substrate here, however, fines dominated at the lake outlet.
- **Erosion:** Reach 6 was the most eroded of all surveyed reaches (40%). Erosion resulted from a mix of bank access trails and bank scouring from flood/debris flows.
- **Access:** Public access to water around the lake outlet's wooden bridge crossing is unimpeded and causing erosion issues.

Figure 15. Cottle Creek Reach 6 survey map.

Figure 16. Reach 6 photos.

a) Reach 6 typical channel and riparian structure

b) Streamkeepers at work in Reach 6

c) Backwatered pool above abandoned beaver dam

d) Failed beaver dam downstream of lake outlet

e) Bank erosion just downstream of lake outlet

f & g) Top of beaver dam at Cottle Lake outlet

Reach 7

Reach 7 is a short reach of North Cottle Creek, as it flows into Cottle Lake near its outlet (Fig. 17). The reason for its inclusion in this assessment is that it has been identified as a "fish-bearing reach", important to the lake's resident trout. FOCC volunteers have observed CCT fry in the gravel bed area of this reach and suspect it may be the only suitable spawning area for resident CCT in Cottle Lake (P. Law, pers. comm., August, 2025).

North Cottle Creek is an ephemeral tributary that flows from Lost Lake into Cottle Lake near Cottle Lake's east end. At the time of this survey, the entirety of North Cottle Creek lacked surface flow. In the late winter and early spring months (February – March), higher lake levels coupled with inlet flows allow for fish access and spawning opportunity.

Reach 7 is only 27 m long. A debris barrier to fish movement exists at the upstream end of the assessed portion of North Cottle Creek that limits fish access beyond. North Cottle Creek flows through the mature coastal Douglas fir forest of Linley Valley Cottle Lake Park, into Cottle Lake. The lowest 15 m of the reach where it flows into Cottle Lake is a flat floodplain dominated by reed canary grass (*Phalaris arundinacea*). The only habitat unit recorded in Reach 7 was a 27 m long pea gravel bed that terminated at a debris jam at USHP placemark 191 (Figure 17). A wooden footbridge on a connector trail from the main Linley Valley Trail crosses over the creek (Fig. 18a).

Habitat ratings for Reach 7 should be interpreted with caution, as the channel was not wetted, so many measurements could not be taken. Only one habitat unit was measured, so ratings are not averaged from multiple data points and do not necessarily represent the average condition of North Cottle Creek. For these reasons, no analysis and interpretation will be included for Reach 7 habitat ratings.

Table 13. Reach 7 fish habitat and water quality results and ratings. Results are an aggregate score calculated from the habitat parameters recorded during this assessment.

Habitat Parameter	Result	Rating	Result
% Pool Area	0.00	5	Good
Large Woody Debris/Bankfull Channel Width	0.00	5	Poor
% Cover in Pools	10	3	Fair
Average% Boulder Cover	0	5	Poor
Average % Fines	10.00	3	Poor
Average % Gravel	80.00	not rated	not rated
% of Reach Eroded	0	1	Poor
Obstructions	1	1	Fair
% of Reach Altered	0	1	Good
% Wetted Area	0.00	5	Poor
Dissolved Oxygen	na	5	Good
pH	na	5	Good

Table 14. Reach 7 riparian results and ratings. Results are an aggregate score calculated from the habitat parameters recorded during this assessment.

Riparian Ratings	Result	Rating	Result
Land Use	2	1	Good
Riparian Slope	2	1	Good
Bank Stability	6	3	Fair
% Crown Cover	90.00	1	Good
% of Reach Accessed	100	5	Poor
Average Vegetation Depth	25	5	Poor

Figure 17. Cottle Creek Reach 7 survey map.

Figure 18. Reach 7 photos.

a) Pea gravel bed in Reach 7 upstream of wooden trail bridge

Reach 8

Reach 8 of Cottle Creek is 380 m long and runs from the wooden footbridge crossing the lake inlet stream up to Landalt Road. At the time of this survey, ~120 m from the wooden bridge to the open water of Cottle Lake was an inaccessible wetland (Fig. 19). In the winter months, rising lake levels can often submerge this wetland portion of the lake.

The survey began in Cottle Lake Park and moved upstream through the private properties of 3669, 3651, and 3629 Rock City Road, and 3340 Landalt Road. Permission to access from the property owners was obtained by the FOCC before the survey date.

The average stream gradient of Reach 8 was 1.2 %, with fines dominating the substrate (Table 15). In total, 5 pools were measured with one having an average depth >20 cm. Native shrubs created overhanging cover in Reach 8 pools. The average wetted width was 1.2 m and average bankfull width was 3.74 m.

At the park footbridge, there is a small beaver dam underneath the bridge (Fig. 20a and b). The riparian zone here is dominated by reed canary grass, which has completely overgrown the channel for ~100 m upstream of the footbridge pool. The riparian area transitions to grass lawn in the backyard of 3669 Rock City Road. It is the understanding of the FOCC that this was historically a sheep farm (P. Law, pers comm., August, 2025). Within the stream channel there is a collapsed roadbed that has two 30 cm diameter culverts, which appear plugged at USHP placemark 181 (Fig. 20c). At the time of survey, this crossing was a complete barrier to surface flow and fish passage. Upstream of the obstruction, there is a backwatered pool that is overgrown completely by reed canary grass. Approximately 50 m upstream, the channel enters a forested area in the private properties of 3651 and 3629 Rock City Road. From this point upstream to Landalt Road, the channel is severely down-cut and confined with steep and eroded banks on both sides (Fig. 20d). Historical land use (prior to 1980's) was likely a hobby farm as the creek's floodplain is wide and flat. The current landowner has allowed the property to naturally revegetate and it is now a well-shaded alder meadow. The owner also confided that the family has been removing all dead or downed trees from the creek channel, as they were concerned about debris causing flooding and erosion (P. Law, pers. comm., August, 2025).

The average habitat rating for Reach 8 was fair/poor (Table 15), and average riparian rating was fair (Table 16).

Table 15. Reach 8 fish habitat and water quality results and ratings. Results are an aggregate score calculated from the habitat parameters recorded during this assessment.

Habitat Parameter	Result	Rating	Result
% Pool Area	15	5	Poor
Large Woody Debris/Bankfull Channel Width	0.2	5	Poor
% Cover in Pools	11	3	Fair
Average% Boulder Cover	0	5	Poor
Average % Fines	49	5	Poor
Average % Gravel	22	not rated	not rated
% of Reach Eroded	77	5	Poor
Obstructions	2	2	Fair
% of Reach Altered	19	5	Poor
% Wetted Area	32	5	Poor
Dissolved Oxygen	9.09	1	Good
pH	6.16	3	Fair

Table 16. Reach 8 riparian results and ratings. Results are an aggregate score calculated from the habitat parameters recorded during this assessment.

Riparian Ratings	Result	Rating	Result
Land Use	36	2	Fair/Good
Riparian Slope	26	1	Good
Bank Stability	87	4	Poor/Fair
% Crown Cover	65	3	Fair
% of Reach Accessed	13	3	Fair
Average Vegetation Depth	49	3	Fair

Within Reach 8, these habitat characteristics were rated "Good**":**

- **Water Quality:** All water quality parameters recorded were within the British Columbia Approved Water Quality Guidelines for Aquatic Life, Wildlife & Agriculture (WLRS, 2025).
- **Land Use:** The stream flows through second growth alder forest on large private properties along Rock City Road and Arrowsmith Road. These properties were once hobby farms, but are slowly naturalizing.

Within Reach 8, these habitat characteristics were rated "Poor**":**

- **Pool Area:** The stream is deeply incised and confined in high alluvial banks. There is a lack of channel complexity (i.e., LWD) to slow velocities, or to scour pools.
- **Large Woody Debris:** Sixteen pieces of LWD were observed, mostly near the Landalt Road end of the reach, where the forest is more dense. It appears that natural LWD recruitment has been interrupted by property owners removing downed trees from the creek due to flood concerns.
- **Boulder Cover & Fines:** Boulders accounted for ~10 % of the substrate in Reach 8, but fines were prominent and no boulders were unembedded enough to provide cover for fish. The Landalt Road culvert has disrupted the supply of gravel bedload that would historically deposit downstream.
- **Erosion:** A very high percentage of this reach's stream banks are heavily eroded, the highest of all surveyed reaches. The deeply incised channel has resulted in vertical banks of bare soil on both sides of the stream.
- **Alterations:** There are crossing structures on the public trail in Linley Valley Cottle Lake Park and on the private property of 3669 Rock City Rd.
- **Bank Stability:** Bank stability was poor for the majority of the reach. Multiple locations of bank collapse were observed.

Figure 19. Cottle Creek Reach 8 survey map. Black line is area not surveyed.

Figure 20. Reach 8 photos.

a & b) Upstream and downstream sides of walking trail bridge with beaver dam bypass pipes

c) Collapsed roadbed on private property

d) Down-cutting and erosion that dominates Reach 8

e) Downstream side of Landalt Road culvert

6. Discussion

Survey Limitations & Efficiency

The Cottle Creek USHP survey covered 2,978 m from Departure Bay to Landalt Road and included all confirmed fish-bearing reaches of the stream. All reaches were surveyed in their entirety with the exception of the steep anadromous barrier section immediately upstream of Departure Bay to 31 m downstream of the Stephenson Point Road culvert (~150 m), for an overall survey efficiency of 95 %. This level of survey efficiency is not strictly required under the USHP assessment procedures (Michalski, Reid & Stewart, 2001), but was deemed necessary in this assessment for the FOCC to achieve their objective of a comprehensive baseline stream habitat inventory.

Comparison of Habitat and Riparian Ratings by Reach

A comparison of the ratings for fish habitat in Cottle Creek indicate that Reaches 2, 3, and 8 had more compromised (impacted) stream habitat conditions, while reaches 4, 5 and 6 were the least compromised (Table 17). The reaches with poor habitat scores were found in areas where adjacent lands have been developed, primarily for housing. The survey found these reaches have higher amounts of bank erosion and down-cutting, alterations (i.e., riprap), obstructions (i.e., culverts, dam), fine sediment deposition, and a lack of instream cover for fish.

Reach 5 was the best scored reach in the watershed for both fish habitat and riparian condition. Much of the stream's habitat in Reach 5 was largely intact with minimal public access or trails that can modify 'healthy' conditions. This reach contained the highest amount of instream cover for fish

of all surveyed reaches, and is the most isolated in the watershed from any land development activities.

The ratings for riparian conditions were fair for a majority of the creek, except Reach 5, which was rated 'good' (Table 17). The 'good' rating for Reach 5 is related to the ecological conditions surrounding this reach and the large area preserved in a natural coastal Douglas fir ecosystem.

Table 17. Cottle Creek average habitat and riparian scores by reach.

Reach	Habitat	Rating	Riparian	Rating
1	2.7	Fair	2.7	Fair
2	4.2	Fair/Poor	2.8	Fair
3	3.5	Fair/Poor	2.4	Fair
4	3.2	Fair	2.2	Fair
5	3.0	Fair	1.7	Good/Fair
6	3.1	Fair	2.7	Fair
7	3.1	Fair	3.0	Fair
8	4.0	Fair/Poor	3.0	Fair
Mean Score	**3.4**	**Fair**	**2.6**	**Fair**

Although there are site-specific impacts to riparian conditions, especially along more developed reaches, the majority of Cottle Creek's riparian areas are healthy and provide positive attributes to the stream.

Restoration Opportunities

As Cottle Creek primarily supports CCT, the restoration opportunities were identified and prioritized with CCT in mind.

Status of Cottle Creek's Coastal Cutthroat Trout Habitat with a View to Prioritizing Restoration Opportunities

Biology and Life History

CCT in Cottle Creek likely evolved above the natural barrier falls near the stream's mouth, following colonization of the watershed when sea levels were much higher, more than 10,000 years ago.

Most CCT in the Cottle Creek watershed are representative of the species' "headwater stream resident ecotype," where population abundance and seasonal growth are limited by food supply and habitat space, largely dictated by extremely low summer flows. These CCT typically mature at a very small size (15 to 20 cm) and at 3 to 5 years of age. Based on small average size at spawning age, it is likely that preferred spawning sites consist primarily of small gravels (75 % less than 25.4 mm in diameter), and contain a high proportion of particles less than 6.35 mm (J.C Wightman, pers. comm., August, 2025).

From nearly two years of stream and lake observations, Cottle Creek CCT likely spawn in late February or early March, with swim-up fry emergence in early May at approximately 530 accumulated thermal units (Tristan Robbins, Hatchery Manager, FFSBC, Duncan, pers. comm., November, 2025). Swim-up fry have been captured in the lower reach of North Cottle Creek (USHP Reach 7), at 20 mm fork length. Following emergence, fry seek shallow water and cover along the stream's margins. As they grow, parr may move farther downstream to slower and deeper water areas, although total movement is often less than 200 m (Badger and Atkinson 2024; Fuss, 1982; June, 1981; Wyatt, 1959).

Young-of-the-year and juvenile CCT strongly associate with glide and pool habitats (Roberge, 2000), especially in the presence of cover. Rosenfeld and Boss (2001) found that juvenile CCT require pool habitat for optimal growth. Ideal residual pool depth for CCT summer rearing is 20 cm, with no significant increase in CCT survival observed in pools exceeding 20 cm average depth (Sheldon & Richardson, 2021). Primary cover used by CCT of all ages includes boulder substrate, large woody debris, undercut banks, and over-hanging riparian vegetation (Roberge, 2000; FOCC member observations). During winter and cold stream temperatures (<7°C), they tend to shift to slower velocity areas, and seek dense cover.

Habitat Limiting Factors

There are several habitat constraints or impairments that likely limit the abundance of CCT in the Cottle Creek watershed. At this point, these largely reflect anecdotal observations and professional experience of FOCC and BCCF members familiar with CCT ecology and urban streams in the Nanaimo area. These constraints are as follows:

1. **Low Stream Flows**

The FOCC have been monitoring stream flows in Cottle Creek since September 2024 as part of BCCF's CFMN (Fig. 21). This streamflow data has facilitated the creation of a water level to discharge relationship (rating curve) for the stream, as well as an estimate of the stream's mean annual discharge (MAD), which is a critical hydrological measurement that provides an average of the stream's natural annual flow, and is tied to the availability of aquatic habitat in the stream.

The threshold for "fair spawning/rearing habitat" for fish in East Coast Vancouver Island streams is 10-20 % of MAD, with any MAD below 5 % classified as "severely degraded spawning/rearing habitat" (Reid, Michalski & Reid, 1999). Summer low flow conditions in Cottle Creek averaged 1.06 % of MAD during the 2025 USHP survey (Fig. 22), which is well below the threshold for severely degraded spawning/rearing habitat.

Using the Cottle Creek USHP survey data, the total amount of aquatic habitat available in Cottle Creek can be linked to the stream discharge present at the time of survey. Approximately 5,429 m^2 of wetted stream area was present in Cottle Creek at the 1.06 % of MAD present during the survey period (Table 18). At this residual level, there were short sections of some reaches where surface flow was absent, or confined to the sub-surface hyporheic zone.

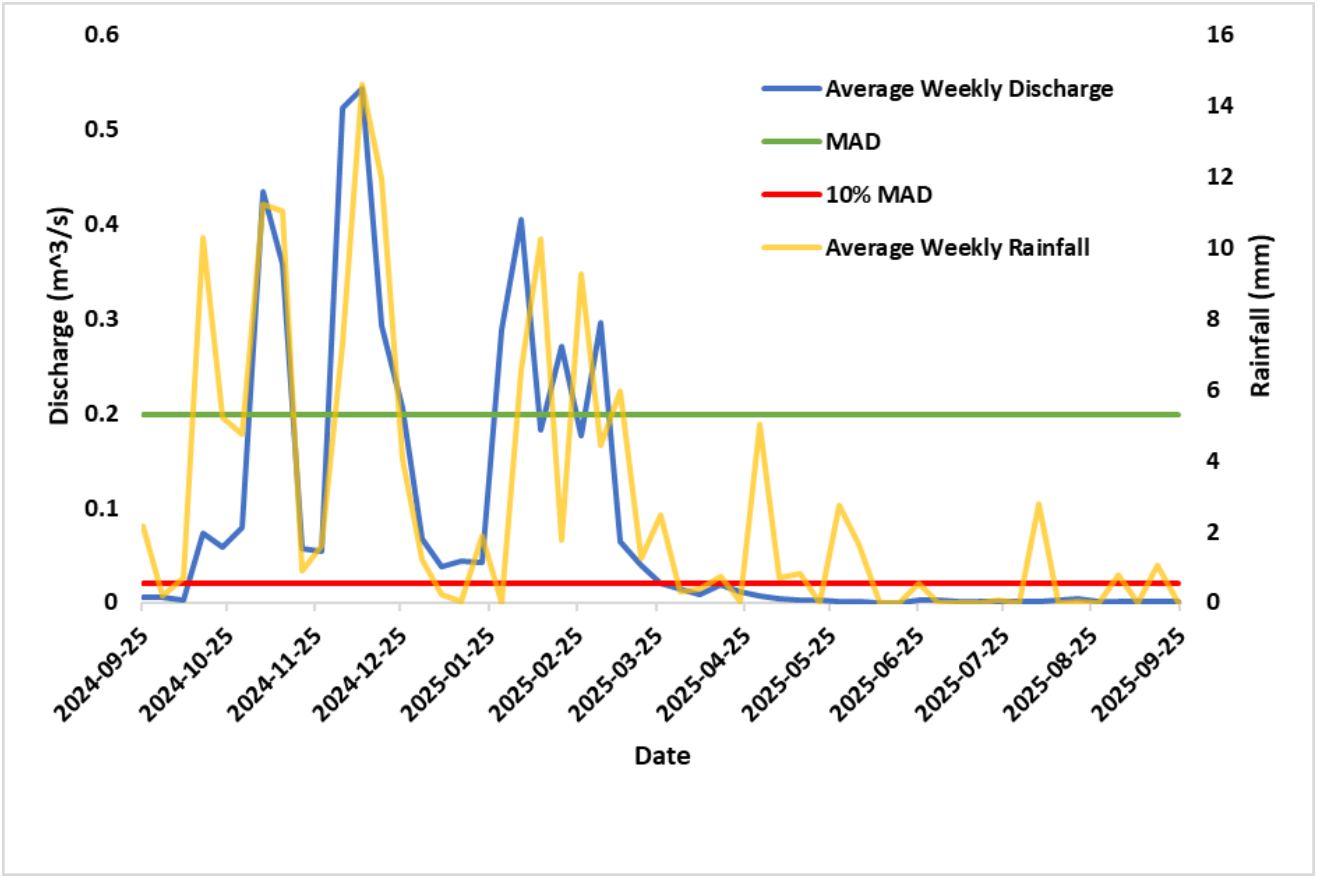

Figure 21. Hydrograph of Cottle Creek average weekly discharge and Nanaimo City Works Yard average weekly rainfall from Sept 24, 2024 to Sept 24, 2025. Green line indicates short term mean annual discharge (MAD) estimate from flow monitoring efforts on Cottle Creek between Sept 24, 2024 to Sept 25, 2025. Red line indicates 10% MAD (minimum threshold for spawning/rearing habitat for fish in ECVI streams) (Reid, Michalski & Reid, 1999).

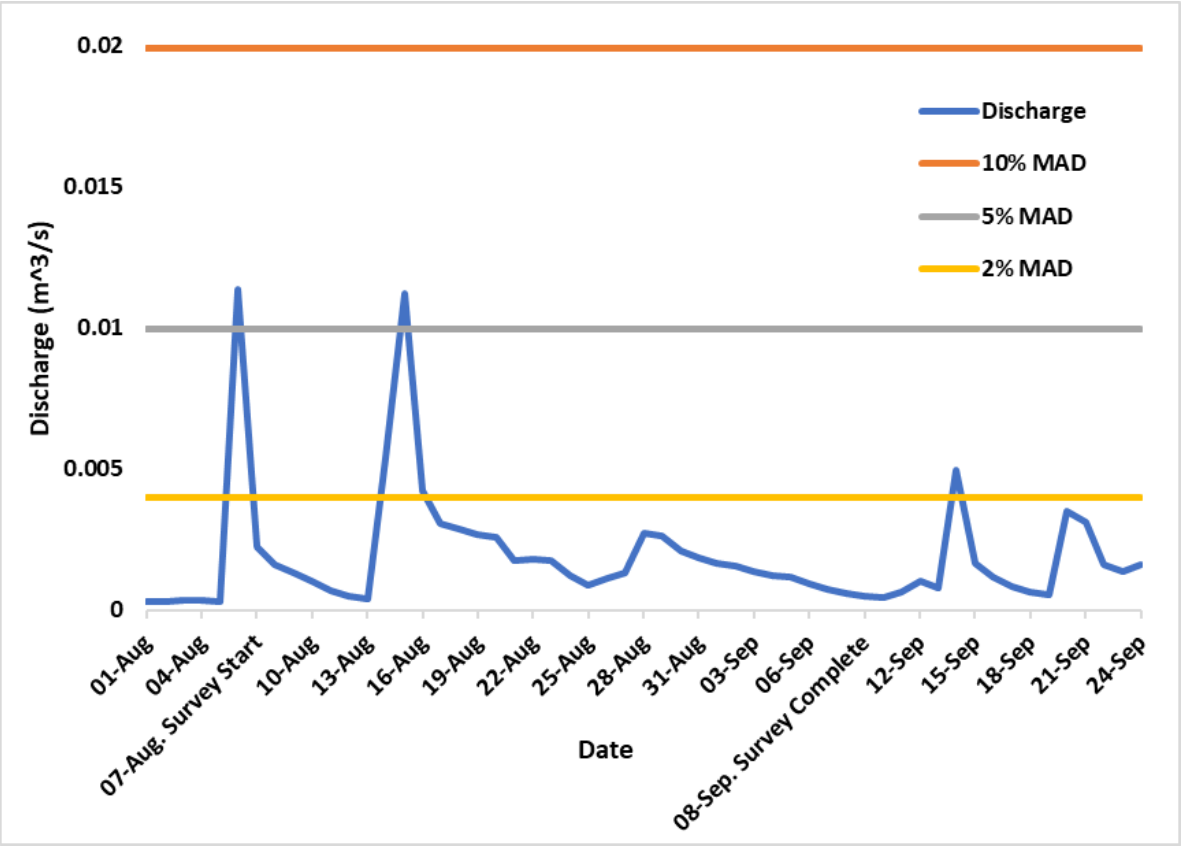

Figure 22. Daily average discharge (m^3/s) on Cottle Creek between Aug 1, 2025 and Sept 24, 2025. USHP survey was completed between Aug 7, 2025 and Sept 8, 2025. Orange line indicates 10% of short term mean annual discharge (MAD) estimate for Cottle Creek and the minimum flow threshold for spawning/rearing habitat for fish in ECVI streams. Grey line indicates 5% of MAD and is the threshold for severely degraded spawning/rearing habitat for fish in ECVI streams. (Reid, Michalski & Reid, 1999). Yellow line indicates 2% of MAD.

Location	Length (m)	Wetted Mesohabitat Area (m^2)		% Area by Habitat Type	Total Wetted Area (m^2)	Pool Cover Type and Area (m^2)		Pools with Cover (#)	Pools >20 cm Avg. Depth (#)	Area of pools >20 cm Avg. Depth (m^2)	Cover Area Within Pools >20 cm Avg. Depth (m^2)	% Area of Pools >20 cm Avg. Depth	% Area of Cover Within Pools >20 cm Avg. Depth
Reach 1	31	pool n=2	48	63%	76	LWD:	Cutbnk: 3	1	2	48	5	63.2%	10.0%
		riffle n=1	28	37%		Bold: 2	Veg:						
Reach 2	535	pool n=16	535	35%	1530	LWD: 8	Cutbnk: 54	16	9	419	54	27.4%	10.1%
		riffle n=17	995	65%		Bold: 7	Veg: 3						
Reach 3	658	pool n=22	980	76%	1295	LWD: 47	Cutbnk: 50	19	8	542	87	41.9%	8.9%
		riffle n=19	315	24%		Bold:	Veg: 19						
Reach 4	457	pool n=19	388	65%	598	LWD: 25	Cutbnk: 27	21	7	131	30	21.9%	7.7%
		riffle n=24	210	35%		Bold:	Veg: 7						
Reach 5	651	pool n=24	560	62%	904	LWD: 78	Cutbnk: 13	23	7	215	41	23.8%	7.3%
		riffle n=24	344	38%		Bold: 2	Veg: 10						
Reach 6	242	pool n=7	512	84%	610	LWD: 56	Cutbnk:	5	3	341	32	55.9%	6.3%
		riffle n=5	98	16%		Bold:	Veg:						
Reach 7	24	pool n=0	0	0%	0	LWD:	Cutbnk:	0	0	0	0	0.0%	0.0%
		riffle n=1	36	0%		Bold:	Veg:						
Reach 8	380	pool n=5	70	17%	416	LWD: 1.5	Cutbnk:	3	1	23	2	5.5%	2.9%
		riffle n=6	346	83%		Bold:	Veg: 6						
Totals	**2978**	**pool n=95**	**3093**	**57%**	**5429**	**LWD: 216**	**Cutbnk: 147**	**88**	**37**	**1719**	**244**	**31%**	**7.9%**
		riffle n=97	**2372**	**43%**		**Bold: 11**	**Veg: 45**						

Table 18. Cottle Creek USHP fish habitat and cover area summary. Calculations were made using the habitat parameters recorded during this assessment.

2. **Lack of LWD and Instream Cover**

CCT in small streams are highly dependent on LWD as escape cover from predators, and as winter refugia from high flows in response to rain. Rosenfeld et al. (2000) found that, "abundance of larger cutthroat parr and pool habitat were positively correlated with large woody debris". The Cottle Creek USHP assessment enumerated a total of 36 pools greater than 20 cm deep over a combined distance of nearly 2.5 km across the main fish bearing reaches (Reaches 1 through 6) of the creek (Table 18). The total pool surface area measured was approximately 3,023 m^2, with only 411 m^2 of combined cover types for CCT. The majority of cover was provided by LWD (214 m^2), but this represented just 4.3 % of the total wetted stream area in reaches below the lake (Table 18). Clearly, under summer base flow conditions, there is a deficit of LWD in the stream channel, impacting this urban stream's ability to successfully rear CCT to maturity and reproductive age. This is likely a long-lasting impact of the watershed's logging history, which systematically removed most old growth conifers right to the stream banks many decades ago.

3. **Human Made Fish Migration Barriers**

The lower reaches of the creek (specifically Reaches 2 and 3) feature four large culverts and an abandoned irrigation dam that are impassable to upstream fish movement. This contributes to fragmented habitats that may not present the diverse range of hydraulic, substrate and cover conditions preferred by CCT for enhanced survival.

4. **Beaver Dam is a Migration Barrier**

The large beaver dam in the outlet of Cottle Lake is likely impassable to upstream fish passage, so there may have been little reproductive exchange between lake and stream resident trout over many years.

5. **Plugged (Private) Culverts**

Upper Cottle Creek, at the west end of the lake, appears impassable to fish due to an old road crossing and under-sized (potentially plugged) culverts on a private property adjacent to the city park boundary. To date (December 2025), no fish have been observed in this lake tributary upstream of the suspected barrier, although more definitive field sampling in 2026 is pending.

6. **Land Use**

Properties around Cottle Lake and Nottingham Drive (Reaches 3 and 8) were once small hobby farms. The natural creek was channelized in many areas to facilitate drainage and irrigation. Over the years, the stream has down-cut, leading to simplified habitat conditions and eroded banks not conducive to trout recruitment. Reaches 4, 5, and 6 are all within Crown Land and city park, which offer a level of protection to the watershed's natural capital; however, the presence of popular

walking and biking trails allows access to the streambanks for the public and their pets and has led to trampling and erosion in riparian areas.

7. Invasive Fish Species

In past years, pumpkinseed sunfish were introduced to the lake and have now established a robust and self-sustaining population. These fish present a significant threat of competition and even predation to the native cutthroat population (Halfmoon Bay Community Association (HBCA) | Pumpkinseed Fish in Trout Lake Taking Over). Sunfish have been sampled downstream of the lake as far as Stephenson Point Road.

8. Invasive Plants in the Riparian Area

Urban and recreational developments over the last 25 or more years have impacted riparian habitats, particularly in Reaches 2 and 3. This has contributed to bank erosion and loss of native riparian plants and shrubs, while creating conditions favourable to invasive species like English holly (*Ilex aquifolium*), spurge laurel (*Daphne laureola*), English ivy (*Hedera helix*) and Himalayan blackberry (*Rubus armeniacus*).

9. Invasive Aquatic Plant Species

Eurasian watermilfoil (*Myriophyllum spicatum*) and reed canary grass (*Phalaris arundinacea*) are now widely present in Cottle Lake, impacting the lake's suitability as trout habitat. Left unchecked, these two invasives will likely accelerate this shallow lake's transition to a wetland ecosystem. Reed canary grass has already established in areas of Cottle Creek with slower moving water, both upstream and downstream, of Cottle Lake.

Site Specific Restoration Opportunities

Based on the findings of this USHP assessment, restoration opportunities have been identified by reach in Table 19 (below). Each restoration opportunity has an associated USHP survey placemark(s) listed, which are tied to a GPS location in the raw USHP data and to the placemarks on the individual reach maps. Each restoration opportunity is tied to one, or multiple of the nine habitat limiting factors listed above.

Table 19. Cottle Creek restoration opportunities by reach. Locations are indicated by reach (R#) and placemark (PM#).

Reach & Placemark #	Habitat Limiting Factor	Description
R1 – PM 179	Human-made migration barriers	The Stephenson Point Road culvert is a fish barrier at all flows; replacement with open-bottom culvert/bridge would restore connectivity to Reach 2.

R1 – PM 179	Invasive plants in the riparian area	Invasive plants (English Ivy, Himalayan Blackberry) are encroaching on both banks downstream of the Stephenson Point Road culvert. Riparian understory health could be improved by removal of invasives followed by planting of native understory plants/shrubs (e.g., sword fern, salmonberry).
R1 – PM 179	Lack of LWD & instream cover	Lack of cover in Reach 1 pools may be addressed with well anchored LWD structures, or by planting of stream-edge vegetation to improve overhead cover for fish.
R2 – PM 160-162	Land Use	Engagement with Nanaimo Parks Department and In Space Child Care are recommended to enhance public education related to accessing and recreating in the riparian zone of the creek. Defining a formal trail within Stephenson Point Park that does not directly access the creek would be valuable to allow bare and erodible soils to vegetate.
R2 – PM 169 & 171	Human-made migration barriers	Both the concrete sill and private driveway culvert are likely fish barriers. Both are located on private land and will require engagement with property owners if removal is desired.
R2 – PM 176	Human-made migration barriers	Hammond Bay Road culvert is a likely fish barrier. Replacement with an open-bottom culvert or bridge will allow for uninterrupted habitat continuity between Reaches 2 and 3.
R3 – PM 55-66	Lack of LWD & instream cover	Well-anchored LWD structures would provide habitat for CCT, as well as promote scouring and deposition processes that are tied to the high amounts of fine sediment observed in Reach 3. The areas directly upstream and downstream of the Nottingham Drive culvert present an opportunity for LWD installations, as the riparian zone has already been cleared for machine access to allow for culvert maintenance.
R3 – PM 55-66	Lack of LWD & instream cover	Boulder structures may be valuable in the riffle/glide areas upstream and downstream of the Nottingham Drive culvert to promote scouring and deposition processes, and generally increase the hydraulic complexity of the previously ditched channel.
R3 – PM 55-66	Land Use & Invasive plants in the riparian area	Re-vegetating the riparian zone around the Nottingham Drive culvert is a priority to stabilize the exposed soils, rebuild canopy cover for the stream and preclude colonization by invasive plant species. The City of Nanaimo is coordinating the planting in 2026.
R3 – PM 44-48	Invasive plants in the riparian area	Steep riparian slopes upstream of the Hammond Bay Road culvert are colonized by invasive plants including spurge laurel and Himalayan blackberry. Restoration of the ravine area beside the 3253 Hammond Bay Road driveway with native understory plants would be valuable for bank stabilization and increase instream cover.
R3 – PM 85	Land Use	Split–rail fencing and/or signage to deter access to the streambanks in the area of the 200 Linley Road culvert pool would be valuable to allow this area to vegetate, and reduce further erosion of the surrounding banks, which is likely contributing to fine sediment deposition downstream.
R3 – PM 85	Human-made migration barriers	200 Linley Drive culvert is a fish barrier at all flows. Removal or replacement with an open-bottom culvert or bridge would restore aquatic habitat connectivity to Reach 4.

R4 – PM 1-25	Lack of LWD & instream cover & Land Use	Addition of boulder clusters and anchored LWD structures would be valuable to increase hydraulic complexity, initiate scouring of new pools, and to activate sediment sorting in the reach, especially the region 0 – 200 m upstream of the 200 Linley Road culvert. Strategic placement of bank structures may also aid in reducing the force of flood flows in erosion sites.
R4 – PM 18	Land Use	Remove rusted vehicle frame near USHP placemark 18.
R4 PM 1-25	Land Use	Limiting public access to the left bank of Reach 4 would be valuable to reduce bank access by both humans and dogs. Split-rail fencing along the Linley Valley Trail may accomplish this, but would require approval of the property owner at 200 Linley Road.
R5 – PM 34	Land Use	Remove broken wooden bridge near USHP placemark 34 to discourage access and use of side-trail.
R5 – PM 86 & 131	Land Use	Limit access to the streambanks from the pedestrian bridges on the Linley Valley Trail at both the upstream and downstream ends of Reach 5, to allow disturbed banks and adjacent riparian understory to recover. Split-rail fencing, signage, and riparian planting may all be possible in partnership with City of Nanaimo Parks Department.
R5 – PM 86-131	Land Use	Stabilizing and/or diverting stream energy away from severely eroded banks with boulder clusters and anchored LWD would be valuable to reduce bank erosion, although access to these areas within the steep ravine section will be a logistical challenge.
R5 – PM 90-93	Invasive plants in the riparian area	Remove reed canary grass that has established in flat floodplain areas upstream of the 1st Linley Valley Trail bridge, downstream of the ravine. Removal of this invasive and replanting with native understory species will increase riparian biodiversity and reduce its further spread downstream.
R6 – PM 132 & 143	Land Use	Limit access to the streambanks from the aluminum bridge at the beginning of the reach, and the wooden pedestrian bridge near the lake outlet to allow disturbed banks and adjacent riparian understory to recover. Split-rail fencing, signage and riparian planting may all be possible in partnership with City of Nanaimo Parks Department.
R6 – PM 132	Lack of LWD & instream cover	Installation of anchored LWD cover structures in the large pool directly upstream of the 2nd Linley Valley Trail bridge in Reach 6. This pool is large (90 m^2) and deep (0.4 m average depth) and would provide excellent CCT habitat with additional cover.
R6 – PM 132-143	Land Use	Areas of bank erosion along Reach 6 are reasonably accessible from the main Linley Valley Trail and may be stabilized using terraced willow wattle structures complemented with native riparian plant species.
R7 – PM 191	Invasive plants in the riparian area	Remove and control reed canary grass at the lake junction of North Cottle Creek to maintain seasonal CCT spawning access.
R7 – PM 191	Land Use	Split-rail fencing and signage to deter trail users and their pets from accessing the gravel bed, especially during winter/spring when the channel is wetted and CCT may be spawning. This may be possible in partnership with City of Nanaimo Parks Department.

R8 – PM 181	Human-made migration barriers	Remove collapsed roadbed and plugged culvert pipes on private property at 3651 Rock City Road.
R8 – PM 182 - 188	Lack of LWD & instream cover	Installation of beaver dam analog (BDA) structures along the property of 3629 Rock City Road in Reach 8 to help slow flows, reduce erosion and create pool habitat to promote sediment deposition and channel incision recovery.
R8 – PM 181	Invasive plants in the riparian area	Remove/suppress reed canary grass near Linley Valley Trail and replant native species.
R8 – PM 181	Invasive plants in the riparian area	Riparian planting of native tree/understory species in lawn area at 3651 Rock City Road to provide shade to the stream and increase bank stability.

What Role Does Local Government Play in Cottle Creek's Future?

Nanaimo's Official Community Plan, entitled, *"City Plan – Nanaimo Reimagined"* (2022) acknowledges the value of healthy watersheds by stating, "The health of the city's streams, lakes, wetlands, and waterfronts depends on the land and plants around them, and on the watersheds that feed them." The Plan lists three key desired outcomes in support of this overarching concern:

- A significant number, and wide array of, biologically diverse freshwater and saltwater ecosystems throughout the city that are preserved for future generations;
- Restoration of areas that have been impacted by erosion related to past development, and
- Thoughtful integration of urban development and built and natural systems that protect and enhance the quality of the city's watersheds, even as the city densifies.

The FOCC suggest the city could adopt CCT as an indicator of watershed health and reflection of whether policies such as C1.4.1 "Support summer base flows in watercourses and limit in-stream or bank erosion related to high stormwater flows and volumes, by addressing the extent and scale of rainwater management infrastructure," are effective over time.

7. Conclusions

The Cottle Creek USHP (2025) will serve as a foundational reference for future monitoring of the watershed's health and success of restoration projects. This assessment of fish habitat at 192 individual habitat units along the stream offers a unique and comprehensive way to quantify the condition of Cottle Creek's aquatic habitat, the functional components necessary to understand how this ecosystem works, and how we can maintain its proper functioning in the long-term.

This assessment has integrated data and projects from multiple partner organizations and projects to highlight the value of Cottle Creek's CCT as a sentinel species of watershed health, and has used the data gathered to describe the current condition of fish habitat in the stream, as well as identify the habitat limiting factors for CCT. Restoration opportunities for fish habitat and riparian health have been identified based on the conditions recorded during this 2025 field assessment.

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9.0 Appendix

Stream Name	*Fish C.*
Reach / pg. #	*R2/pg1*
Habitat Type (P/R)	*P*
Start (m)	*10 m*
End (m)	*20 m*
Wetted Width	*2 m*
Bankfull Width	*3 m*
Average Depth	*0.5 m*
% Bedrock	*20%*
% Boulders	*20%*
% Cobble	*30%*
% Gravel	*20%*
% Fines	*10%*
Instream Cover (type/%)	*C-10% B-2%*
% Crown Cover	*60%*
Gradient	*2%*
# LWD	*10*
A/E/O	*E-10m A-20m*
Off-Channel Habitat	*L/bank 20*2m*
Land Use (L/R)	*N/R*
Vegetation (L/R)	*CF/G*
Vegetation Depth (L/R)	*30+/2*
Riparian Slope (%)(L/R)	*10/15*
Stability (L/R)	*M/L*
Livestock Access (L/R)	*20m/0*
Photos	*1,2,3*
Comments	*1,2*

Habitat and Riparian Card Instructions

1. Measure all habitat parameters at the beginning of the reach and every 200 meters. Measure all parameters twice if the reach is less than 200 meters long;
2. Measure riparian parameters (black boxes) every 100 meters;
3. Measure the start, finish & wetted width for pools only; take data for all other shaded boxes along entire stream length.

Abbreviations and Definitions

A/E/O: Altered sites, Erosion sites, Obstructions

Bankfull Width: the horizontal distance from rooted terrestrial vegetation to rooted terrestrial vegetation.

Crown Cover: streamside vegetation at least 1 meter above water surface that provides shade over the habitat unit.

Gradient: slope of the stream, measured with a clinometer

Habitat Type: P=pool or R=riffle

Instream Cover: B=boulder C=undercut banks LWD=large woody debris O=other V=instream vegetation (includes algae)

Land Use: C=commercial I=industrial EX=exposed L=lawns FC=farms/cattle N=natural FG=farms/grass R=roads or residential GC=golf course

Livestock: note the length, in meters, of the site where any type of livestock have access to the stream.

LWD: deadwood >10cm in diameter and >2m. long and stable in the wetted channel

Obstructions: BD=beaver dam CV=culvert X=log jam D=dam EBB=other F=falls

Off-Channel: includes ponds and lateral channels; note the bank side,[1] channel length and width

Riparian Slope: the slope of the bank above the high water mark to the far end of the riparian vegetation or break in slope; include distance if on floodplain

Stability: H=high; M=medium; L=low

Vegetation: Br=broadleaf forest Mix=mixed Con=coniferous forest Sh=shrub Gr=grasses

Wetted Width: the width of the water surface measured at right angles to the direction of flow

[1] NOTE: Bank side is determined when facing downstream

measure along stream length; note start and end for pools only

measure every 100 meters

Figure 1. USHP field card (Michalski, Reid & Stewart, 2001)

FOCC CCT Sampling Data

Table 1. CCT sampling results from sampling efforts of the FOCC on Cottle Creek between October 2024 – July, 2025

Sampling Date	Site Number (#)	Cutthroat Trout Captured	Fork Length Range (mm)
October 16, 2024	1	4	122-165
October 16, 2024	2	2	74-75
October 25, 2024	3	9	89-125
November 1, 2024	3B	2	97-99
March 26, 2025	3C	2	130-138
October 25, 2024	4	8	79-133
November 16, 2024	5	4	78-116
November 26, 2024	6	1	107
July 16, 2025	7	4	67-84

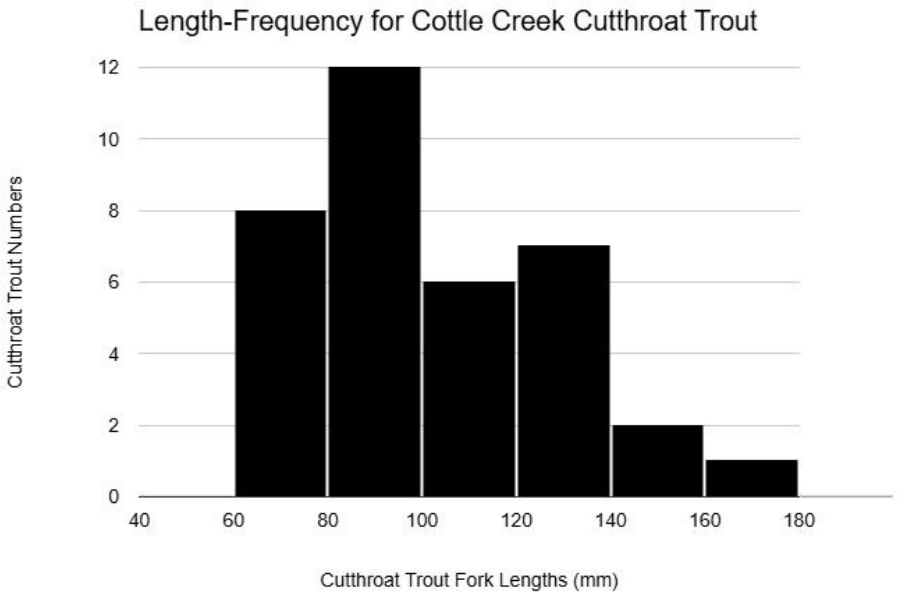

Figure 2. Length-frequency histogram of Cottle Creek CCT sampled by the FOCC between October 2024 – July, 2025.

Summary Tables

Table 2. Reaches 1-6 Habitat Sum & Ratings

Habitat Parameter	Reach 1	Ratings	Reach 2	Ratings	Reach 3	Ratings	Reach 4	Ratings	Reach 5	Ratings	Reach 6	Ratings	Total
% Pool Area	54.84	3	46.71	3	75.12	1	56.50	1	57.58	1	93.47	1	**10**
Large Woody Debris/Bankfull Channel Width	0.17	5	0.29	5	0.20	5	0.31	5	0.99	5	0.76	5	**30**
% Cover in Pools	10	3	10	3	10	3	11	3	13	3	9	3	**18**
Average% Boulder Cover	7	5	2	5	0	5	0	5	0	5	0	5	**30**
Average % Fines	20.00	3	20.30	5	34.02	5	12.98	3	28.13	5	52.50	5	**26**
Average % Gravel	13.33	not rated	16.36	not rated	49.51	not rated	74.64	not rated	37.60	not rated	18.33	not rated	**--**
% of Reach Eroded	0	1	39	5	22	5	32	5	29	5	40	5	**26**
Obstructions	2	2	7	7	2	2	2	2	6	6	2	2	**21**
% of Reach Altered	0	1	17	5	19	5	4	1	0	1	4	1	**14**
% Wetted Area	53.16	5	41.17	5	43.00	5	28.65	5	32.14	5	41.67	5	**30**
Dissolved Oxygen	9.37	1	9.09	1	9.13	1	6.54	3	7.36	1	7.13	1	**8**
pH	7.35	1	6.16	3	6.58	1	6.41	3	6.99	1	7.09	1	**10**
Totals		**30**		**47**		**38**		**36**		**38**		**34**	**223**
Off-Channel Habitat as % of Reach	0	5	0	5	16	3	11	5	2	5	8	5	**28**
Reach Lengths	31	not rated	535	not rated	658	not rated	457	not rated	651	not rated	242	not rated	**2574**

Table 3. Reach 7 & 8 Habitat Sum & Ratings

Habitat Parameter	Reach 7	Ratings	Reach 8	Ratings	Total
% Pool Area	0.00	5	15.28	5	**10**
Large Woody Debris/Bankfull Channel Width	0.00	5	0.16	5	**10**
% Cover in Pools	10	3	11	3	**6**
Average% Boulder Cover	0	5	0	5	**10**
Average % Fines	10.00	3	49.09	5	**8**
Average % Gravel	80.00	not rated	21.82	not rated	**--**
% of Reach Eroded	0	1	77	5	**6**
Obstructions	1	1	2	2	**3**
% of Reach Altered	0	1	19	5	**6**
% Wetted Area	0.00	5	32.24	5	**10**
Dissolved Oxygen	.	1	9.09	1	**2**
pH		5	6.16	3	**8**
Totals		**35**		**44**	**79**

Table 4. Reaches 1-6 Riparian Sum & Ratings

Riparian Ratings													
Reach	**Reach 1**	**Ave. Ratings**	**Reach 2**	**Ave. Ratings**	**Reach 3**	**Ave. Ratings**	**Reach 4**	**Ave. Ratings**	**Reach 5**	**Ave. Ratings**	**Reach 6**	**Ave. Ratings**	**Total**
Land Use	20	3	152	2	143	2	84	1	96	1	24	1	**10**
Riparian Slope	8	1	82	1	86	1	104	1	188	2	28	1	**8**
Bank Stability	14	2	179	3	196	2	171	2	194	2	66	3	**14**
		Ratings		**Ratings**		**Ratings**		**Ratings**		**Ratings**		**Ratings**	**--**
% Crown Cover	76.67	1	76.21	1	76.83	1	79.17	1	75.21	1	68.75	3	**8**
% of Reach Accessed by Livestock	16	3	36	5	8	3	57	5	15	3	62	5	**24**
Average Vegetation Depth	11.66667	5	20	5	25	5	52	3	66	1	40	3	**22**
Totals		**16**		**17**		**14**		**13**		**10**		**16**	**87**

Table 5. Reaches 7 & 8 Riparian Sum & Ratings

Riparian Ratings					
Reach	**Reach 7**	**Ave. Ratings**	**Reach 8**	**Ave. Ratings**	**Total**
Land Use	2	1	36	2	**3**
Riparian Slope	2	1	26	1	**2**
Bank Stability	6	3	87	4	**7**
		Ratings		**Ratings**	**--**
% Crown Cover	90.00	1	64.55	3	**4**
% of Reach Accessed by Livestock	208	5	13	3	**8**
Average Vegetation Depth	25	5	49	3	**8**
Totals		**16**		**16**	**32**

Reach Data

Reach 1

Stream Name	Cottle Creek	Watershed Code	920-401700	Date	Auust 28th, 2025	Reach Name	Reach 1			Discharge Depth #1		Velocity		
Water Quality Information					Field Crew		BCCF, FOCC					T1		Site Length
Dissolved Oxygen	9.37	pH	7.35	Total Dissolved Solids	110.00	Temp C		Chainage at Beginning of Reach	0.00	Discharge Depth #2		T2		
Velocity (m/s)	.	Average Depth (at flow site)		Wetted Width (at flow site)		Discharge (m3/s)		Chainage at End of Reach	31.00	Discharge Depth #3		T3		
Habitat Information (All Pool and Cross Section Data)														

Habitat Type	Start (chainage at start)	Finish (chainage at end)	Unit Length	Wetted Width	Pool Area	Wetted Reach Area	%Pool Area	Habitat unit Depth (m)	Percent Gradient	Bankfull Width(m)	Average Percent Wetted Area	Substrate Percent Bed	Bld	Cob	Grv	Fine
Pool	0.00	7.00	7.00	2.50	17.50			0.35	0.00	4.80		20	30	40	10	0
Riffle	7.00	24.00		1.60	0.00			0.15	4.00	5.40		30	20	30	20	0
Pool	24.00	31.00	7.00	4.30	30.10			0.55	0.00	5.60		10	10	10	10	60
Reach Totals and Averages		31.00	14.00	2.80	47.60	86.80	54.84	0.35	1.33	5.27	53.16	20	20	27	13	20

Habitat Type	Percent Instream Cover Bold	LWD	Cutbk	Veg	Other	PercentCrown Cover	Large Woody Debris	LWD/bank-full channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstructions (number)	Off-Channel Habitat (length)	Off-Channel Habitat (width)	Off-Channel Habitat (bank side)	Land Use Right	Left	Ve Typ
Pool	10	0	0	0	0	70.00	1				1				RS	RS	Mix
Riffle	10	0	0	0	0	80.00	0								RS	RS	Mix
Pool	0	0	10	0	0	80.00	0				1				RS	R	Mix
Reach Totals and Averages	7	0	3	0	0	76.67	1	0.17	0	0	2	0			9	11	

Reach 2

Stream Name	Cottle Creek	Watershed Code	920-401700	Date	45890.00	Reach Name	Reach 2			Discharge Depth #1		Velocity		
Water Quality Information					Field Crew		BCCF, FOCC					T1		Site Length
Dissolved Oxygen	9.09	pH	6.16	Total Dissolved Solids	129.00	Temp C		Chainage at Beginning of Reach	31.00	Discharge Depth #2		T2		
Velocity (m/s)	.	Average Depth (at flow site)		Wetted Width (at flow site)		Discharge (m3/s)		Chainage at End of Reach	566.00	Discharge Depth #3		T3		
Habitat Information (All Pool and Cross Section Data)														

Habitat Type	Start (chainage at start)	Finish (chainage at end)	Unit Length	Wetted Width	Pool Area	Wetted Reach Area	%Pool Area	Habitat unit Depth (m)	Percent Gradient	Bankfull Width(m)	Average Percent Wetted Area	Substrate Percent Bed	Bld	Cob	Grv	Fine	Percent Instream Cover Bold	LWD	Cutbk	Veg	Other	PercentCrown Cover	Large Woody Debris	LWD/bank-full channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstructions (number)	Off-Channel Habitat (length)	Off-Channel Habitat (width)	Off-Channel Habitat (bank side)	Land Use Right	Left
Pool	0.00	6.00	6.00	1.50	9.00			0.15	0.00	3.50		0	0	70	10	20	0	0	10	0	0	60.00	0		0	0	0				Nat	Nat
Riffle	6.00	42.00		1.60	0.00			0.10	3.00	3.50		10	10	40	40	0	0	0	10	0	0	75.00	0		30	0	0				C	Nat
Pool	42.00	47.00	5.00	2.50	12.50			0.15	0.00	5.40		20	10	0	10	60	0	0	0	10	0	90.00	0		0	0	0				C	Nat
Riffle	47.00	56.00		1.70	0.00			0.05	3.00	4.70		20	20	50	10	0	0	0	0	0	0	80.00	0		9	0	0				Nat	Nat
Pool	56.00	80.00	24.00	1.80	43.20			0.20	0.00	4.40		0	10	10	10	70	0	10	0	0	0	90.00	3		24	0	0				C	Nat
Riffle	80.00	102.00		2.50	0.00			0.05	4.00	4.90		20	20	40	20	0	0	0	0	10	0	90.00	0		0	0	0				C	Nat
Pool	102.00	110.00	8.00	2.50	20.00			0.25	0.00	3.20		40	20	0	10	30	0	0	0	10	0	80.00	1		0	0	0				C	RS
Riffle	110.00	118.00		0.25	0.00			0.05	20.00	3.00		90	10	0	0	0	0	0	0	0	0	80.00	0		0	0	1				C	R
Riffle	118.00	131.00		1.70	0.00			0.05	2.00	2.80		10	40	30	20	0	0	0	10	0	0	90.00	0		0	0	0				L	Nat
Pool	131.00	138.00	7.00	2.80	19.60			0.30	0.00	5.40		10	30	20	0	40	20	0	0	0	0	90.00	0		7	0	0				R	Nat
Riffle	138.00	148.00		0.50	0.00			0.05	15.00	5.00		10	50	20	20	0	0	0	0	0	0	90.00	0		0	0	1				R	Nat
Pool	148.00	153.00	5.00	1.70	8.50			0.40	0.00	6.70		20	0	30	30	30	0	0	10	0	0	80.00	0		0	0	0				L	Nat
Riffle	153.00	165.00		1.70	0.00			0.08	15.00	5.70		30	20	50	0	0	10	0	0	0	0	75.00	0		0	2	1				L	Nat
Pool	165.00	208.00	43.00	4.50	193.50			0.35	0.00	9.20		10	0	10	20	60	0	0	15	0	0	75.00	6		25	0	0				C	Nat
Riffle	208.00	216.00		0.50	0.00			0.05	2.00	12.80		0	20	60	20	0	0	0	5	0	0	80.00	0		8	0	0				Nat	Nat
Pool	216.00	231.00	15.00	3.20	48.00			0.35	0.00	6.20		0	30	30	30	10	0	0	10	0	0	60.00	0		0	15	0				C	Nat
Riffle	231.00	265.00		1.50	0.00			0.05	4.00	4.70		0	30	30	30	10	0	10	0	0	0	80.00	1		30	0	0				C	Nat
Pool	265.00	272.00	7.00	2.30	16.10			0.15	0.00	4.30		0	10	20	20	50	0	0	10	0	0	70.00	1		5	0	0				C	Nat
Riffle	272.00	300.00		0.80	0.00			0.05	4.00	8.20		10	10	60	20	0	0	0	0	10	0	50.00	1		0	0	1				C	Nat
Pool	300.00	306.00	6.00	2.00	12.00			0.20	0.00	5.80		10	10	60	20	0	0	0	10	0	0	60.00	0		10	0	0				C	Nat
Riffle	306.00	346.00		1.50	0.00			0.10	5.00	5.20		10	50	30	10	0	0	0	0	5	0	80.00	0		0	0	1				Nat	Nat
Pool	346.00	352.00	6.00	4.20	25.20			0.35	0.00	6.90		30	10	10	10	30	0	15	0	0	0	80.00	3		0	0	0				C	Nat
Riffle	352.00	388.00		1.00	0.00			0.10	10.00	6.30		10	50	20	20	0	0	10	0	0	0	80.00	9		0	5	0				Nat	Nat
Pool	388.00	393.00	5.00	1.80	9.00			0.20	0.00	3.50		10	20	20	20	30	0	0	10	0	0	70.00	0		0	0	0				Nat	Nat
Riffle	393.00	421.00		2.30	0.00			0.10	4.00	3.60		40	20	30	10	0	10	0	0	0	0	60.00	1		15	10	0				RS	Nat
Pool	421.00	433.00	12.00	3.00	36.00			0.30	0.00	3.80		10	20	20	20	30	0	0	10	0	0	60.00	1		0	10	1				RS	L
Riffle	433.00	453.00		3.30	0.00			0.15	3.00	4.50		20	40	20	20	0	10	0	0	0	0	70.00	0		20	10	0				RS	L
Pool	453.00	462.00	9.00	3.60	32.40			0.50	0.00	6.10		0	10	20	20	50	10	0	0	0	0	80.00	0		9	10	0				L	RS
Riffle	462.00	484.00		2.90	0.00			0.05	3.00	5.40		0	20	60	20	0	0	0	0	10	0	80.00	0		0	10	0				L	L
Pool	484.00	491.00	7.00	2.00	14.00			0.20	0.00	4.40		0	0	0	20	80	0	0	30	0	0	90.00	1		6	0	0				L	L
Riffle	491.00	511.00		2.90	0.00			0.10	2.00	5.20		0	20	60	20	0	0	0	0	0	0	60.00	0		0	0	0				RS	L
Pool	511.00	521.00	10.00	3.60	36.00			0.50	0.00	3.60		0	10	10	10	70	0	0	20	0	0	90.00	2		10	0	0				R	R
Riffle	521.00	535.00		1.00	0.00			0.05	5.00	3.70		40	20	40	0	0	10	0	0	0	0	70.00	0		0	20	1				R	L
Reach Totals and Averages		535.00	175.00	2.14	535.00	1145.39	46.71	0.18	3.15	5.20	41.17	15	19	29	16	20	2	1	5	2	0	76.21	30	0.29	39	17	7	0			95	57

Reach 3

Stream Name	Cottle Creek	Watershed Code	920-401700	Date	45880.00	Reach Name	Reach 3			Discharge Depth #1		Velocity			
Water Quality Information					Field Crew		BCCF, FOCC, NALT					T1		Site Length	
Dissolved Oxygen	9.13	pH	6.58	Total Dissolved Solids	118.20	Temp C		Chainage at Beginning of Reach	566.00	Discharge Depth #2		T2			
Velocity (m/s)	.	Average Depth (at flow site)		Wetted Width (at flow site)		Discharge (m3/s)		Chainage at End of Reach	1224.00	Discharge Depth #3		T3			
Habitat Information (All Pool and Cross Section Data)															

Habitat Type	Start (chainage at start)	Finish (chainage at end)	Unit Length	Wetted Width	Pool Area	Wetted Reach Area	%Pool Area	Habitat unit Depth (m)	Percent Gradient	Bankfull Width(m)	Average Percent Wetted Area	Substrate Percent Bed	Bld	Cob	Grv	Fine	Percent Instream Cover Bold	LWD	Cutbk	Veg	Other	PercentCrown Cover	Large Woody Debris	LWD/bank-full channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstructions (number)	Off-Channel Habitat (length)	Off-Channel Habitat (width)	Off-Channel Habitat (bank side)	Land Use Right	Left	V Ty
Riffle	0.00	15.00		1.30	0.00			0.04	1.00	3.80		0	20	10	60	10	0	0	10	0	0	75.00	0		9	0	0	0	0	0	RS	RS	Sh
Pool	15.00	18.00	3.00	1.30	3.90			0.15	0.00	3.80		0	10	0	40	30	0	10	0	0	0	80.00	1		3	0	0	0	0	0	RS	RS	Sh
Riffle	18.00	24.00		1.50	0.00			0.05	2.00	2.80		0	30	60	10	0	0	0	0	0	0	75.00	0		0	0	0	0	0	0	RS	RS	Sh
Pool	24.00	67.00	43.00	2.00	86.00			0.10	1.00	2.20		0	10	60	10	20	0	10	0	0	0	50.00	3		0	0	0	0	0	0	RS	RS	Sh
Riffle	67.00	70.00		0.80	0.00			0.05	2.00	2.20		0	0	0	90	10	0	0	0	10	0	60.00	0		0	0	0	0	0	0	RS	RS	Mi
Pool	70.00	78.00	8.00	1.00	8.00			0.10	0.00	2.30		0	0	0	90	10	0	0	0	10	0	70.00	0		0	0	0	0	0	0	RS	RS	Mi
Riffle	78.00	88.00		0.60	0.00			0.04	3.00	3.80		0	0	0	90	10	0	0	0	10	0	75.00	0		0	0	0	0	0	0	Nat	Nat	Mi
Pool	88.00	112.00	24.00	0.90	21.60			0.13	0.00	4.10		0	0	0	20	80	0	0	10	0	0	80.00	2		10	0	0	0	0	0	Nat	RS	Mi
Riffle	112.00	118.00		1.40	0.00			0.05	3.00	3.20		0	0	0	100	0	0	0	0	5	0	90.00	0		0	0	0	0	0	0	Nat	RS	Mi
Pool	118.00	127.00	9.00	1.90	17.10			0.15	0.00	3.50		0	0	0	30	70	0	0	10	0	0	90.00	0		0	0	0	0	0	0	RS	Nat	Mi
Riffle	127.00	131.00		3.00	0.00			0.02	1.00	4.20		0	0	0	90	10	0	0	0	0	0	80.00	0		0	0	0	0	0	0	Nat	Nat	Mi
Pool	131.00	171.00	40.00	3.00	120.00			0.25	0.00	3.80		0	5	10	10	75	0	0	0	15	0	85.00	1		0	0	0	0	0	0	Nat	RS	Mi
Riffle	171.00	186.00		0.60	0.00			0.02	2.00	4.00		0	0	0	100	0	0	0	0	10	0	75.00	0		0	0	0	0	0	0	Nat	Nat	Mi
Pool	186.00	201.00	15.00	3.80	57.00			0.65	0.00	4.10		0	10	10	10	70	0	20	0	0	0	90.00	2		0	5	0	58	1	R	RS	Nat	Mi
Riffle	201.00	219.00		0.90	0.00			0.02	3.00	4.10		0	0	0	100	0	0	0	0	0	0	95.00	0		18	0	0	0	0	0	Nat	RS	Mi
Pool	219.00	234.00	15.00	2.60	39.00			0.25	0.00	3.60		0	0	0	90	10	0	0	10	0	0	80.00	0		10	10	0	0	0	0	Nat	EX	Mi
Riffle	234.00	240.00		1.70	0.00			0.05	2.00	3.70		0	0	0	90	10	0	0	10	0	0	90.00	0		5	6	0	0	0	0	Nat	Nat	Gr
Pool	240.00	265.00	25.00	2.90	72.50			0.20	0.00	3.90		0	0	10	10	80	0	0	10	0	0	60.00	0		0	0	0	0	0	0	RS	Nat	Gr
Pool	265.00	311.00	46.00	1.00	46.00			0.10	0.00	3.50		0	0	0	10	90	0	10	0	0	0	20.00	3		0	40	0	0	0	0	Nat	Nat	Gr
Pool	311.00	350.00	39.00	3.60	140.40			0.35	0.00	5.40		0	0	10	20	70	0	20	0	0	0	50.00	2		0	30	0	0	0	0	Nat	Nat	Gr
Riffle	350.00	355.00		1.20	0.00			0.05	2.00	5.50		0	0	0	100	0	0	0	0	0	0	40.00	0		0	0	0	0	0	0	Nat	Nat	Mi
Pool	355.00	380.00	25.00	2.90	72.50			0.50	0.00	4.80		0	0	0	20	80	0	20	0	0	0	85.00	1		10	0	0	0	0	0	Nat	RS	Gr
Riffle	380.00	395.00		1.00	0.00			0.10	3.00	6.40		0	10	0	80	10	0	30	0	0	0	85.00	5		15	0	0	45	10	L	Nat	RS	Br
Pool	395.00	422.00	27.00	1.80	48.60			0.20	0.00	4.90		0	0	10	20	70	0	0	10	0	0	80.00	1		0	0	0	0	0	0	Nat	Nat	Mi
Riffle	422.00	427.00		1.10	0.00			0.05	2.00	8.50		0	0	0	100	0	0	0	0	0	0	90.00	0		0	0	0	0	0	0	Nat	Nat	Mi
Pool	427.00	442.00	15.00	2.00	30.00			0.18	0.00	4.80		0	0	10	30	60	0	0	10	0	0	70.00	0		0	5	0	0	0	0	Nat	L	Mi
Riffle	442.00	454.00		1.50	0.00			0.10	3.00	6.00		0	0	0	100	0	0	0	10	0	0	90.00	0		0	0	0	0	0	0	Nat	L	Mi
Pool	454.00	464.00	10.00	3.50	35.00			0.25	0.00	5.20		0	0	0	20	80	0	0	20	0	0	90.00	0		10	0	0	0	0	0	Nat	RS	Mi
Riffle	464.00	476.00		2.10	0.00			0.03	3.00	5.30		0	0	60	40	0	0	0	0	0	0	60.00	0		0	10	0	0	0	0	Nat	L	Mi
Pool	476.00	494.00	18.00	2.20	39.60			0.33	0.00	5.80		0	0	0	20	80	0	0	10	0	0	80.00	0		0	16	0	0	0	0	Nat	L	Mi
Riffle	494.00	502.00		1.20	0.00			0.05	5.00	7.30		0	0	30	70	0	0	10	0	0	0	80.00	2		0	0	0	0	0	0	Nat	L	Mi
Pool	502.00	510.00	8.00	1.70	13.60			0.18	0.00	4.00		0	0	0	60	40	0	0	10	0	0	80.00	0		8	0	0	0	0	0	Nat	Nat	Mi
Pool	521.00	531.00	10.00	3.10	31.00			0.10	0.00	7.20		0	0	0	20	80	0	0	20	0	0	90.00	1		0	0	0	0	0	0	Nat	RS	Mi
Riffle	531.00	559.00		1.50	0.00			0.04	4.00	4.40		0	10	50	40	0	0	10	0	0	0	90.00	2		10	0	0	0	0	0	0	RS	Mi
Pool	559.00	569.00	10.00	2.30	23.00			0.20	0.00	4.70		0	0	0	50	50	0	0	20	0	0	80.00	0		10	0	0	0	0	0	Nat	Nat	Mi
Riffle	569.00	587.00		1.90	0.00			0.10	3.00	4.10		0	20	20	60	0	0	0	0	0	0	90.00	0		0	0	0	0	0	0	Nat	Nat	Mi
Pool	587.00	595.00	8.00	3.00	24.00			0.20	0.00	4.90		0	0	10	10	80	0	0	10	0	0	80.00	1		0	0	0	0	0	0	Nat	Nat	Mi
Riffle	595.00	620.00		1.40	0.00			0.03	3.00	4.40		0	20	50	30	0	0	10	0	0	0	80.00	1		20	0	0	0	0	0	Nat	Nat	Mi
Pool	620.00	627.00	7.00	1.80	12.60			0.10	0.00	4.30		0	0	40	20	40	0	0	10	0	0	80.00	0		5	0	0	0	0	0	Nat	Nat	Mi
Riffle	627.00	652.00		1.87	0.00			0.03	3.00	5.30		0	10	30	60	0	0	0	0	0	0	80.00	0		0	0	1	0	0	0	Nat	Nat	Mi
Pool	652.00	658.00	6.00	6.40	38.40			0.45	0.00	9.20		0	10	10	10	70	0	0	0	0	0	80.00	0		5	0	1	0	0	0	Nat	Nat	Mi
Reach Totals and Averages		658.00	411.00	1.98	979.80	1304.28	75.12	0.15	1.24	4.61	43.00	0	4	12	50	34	0	4	5	1	0	76.83	28	0.20	22	19	2	16			58	85	

Reach 4

Stream Name	Cottle Creek	Watershed Code	920-401700	Date	45876.00	Reach Name	Reach 4			Discharge Depth #1		Velocity		
Water Quality Information					Field Crew		BCCF, FOCC, NALT					T1		Site Length
Dissolved Oxygen	6.54	pH	6.41	Total Dissolved Solids	70.00	Temp C		Chainage at Beginning of Reach	1224.00	Discharge Depth #2		T2		
Velocity (m/s)	.	Average Depth (at flow site)		Wetted Width (at flow site)		Discharge (m3/s)		Chainage at End of Reach	1681.00	Discharge Depth #3		T3		
Habitat Information (All Pool and Cross Section Data)														

Habitat Type	Start (chainage at start)	Finish (chainage at end)	Unit Length	Wetted Width	Pool Area	Wetted Reach Area	%Pool Area	Habitat unit Depth (m)	Percent Gradient	Bankfull Width(m)	Average Percent Wetted Area	Substrate Percent Bed	Bld	Cob	Grv	Fine	Percent Instream Cover Bold	LWD	Cutbk	Veg	Other	PercentCrown Cover	Large Woody Debris	LWD/bank-full channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstructions (number)	Off-Channel Habitat (length)	Off-Channel Habitat (width)	Off-Channel Habitat (bank side)	Land Use Right	Left
Riffle	0.00	11.00		0.60	0.00			0.05	3.00	6.40		0	0	70	20	10	0	0	15	0	0	85.00	0		8	10	0	0	0	0	Nat	Nat
Pool	11.00	21.00	10.00	2.00	20.00			0.05	0.00	6.40		0	0	10	75	15	0	0	0	10	0	95.00	0		0	0	0	0	0	0	Nat	Nat
Riffle	21.00	60.00		1.00	0.00			0.05	2.00	5.40		0	0	0	100	0	0	0	0	10	0	60.00	0		0	0	0	0	0	0	Nat	Nat
Riffle	71.00	85.00		1.80	0.00			0.05	2.00	6.10		0	0	0	95	5	0	0	0	10	0	60.00	0		0	0	0	0	0	0	Nat	Nat
Riffle	85.00	111.00		1.20	0.00			0.04	3.00	4.20		0	0	0	90	10	0	0	0	20	0	75.00	0		0	0	0	0	0	0	Nat	Nat
Pool	111.00	120.00	9.00	1.00	9.00			0.10	0.00	5.50		0	0	0	90	10	0	0	10	0	0	95.00	0		10	0	0	0	0	0	Nat	Nat
Pool	120.00	132.00	12.00	2.50	30.00			0.35	0.00	2.70		0	0	0	75	25	0	0	20	0	0	60.00	0		0	0	0	0	0	0	Nat	Nat
Riffle	132.00	142.00		1.40	0.00			0.40	2.00	4.00		0	0	0	90	10	0	0	0	10	0	60.00	0		0	0	0	0	0	0	Nat	Nat
Pool	142.00	146.00	4.00	1.80	7.20			0.12	0.00	4.70		0	0	0	90	10	0	0	10	0	0	60.00	0		0	0	0	0	0	0	Nat	Nat
Riffle	146.00	151.00		1.30	0.00			0.04	2.00	5.90		0	0	0	95	5	0	0	0	15	0	90.00	0		0	0	0	0	0	0	Nat	Nat
Pool	151.00	162.00	11.00	3.70	40.70			0.07	0.00	5.00		0	0	0	90	10	0	0	10	0	0	90.00	0		10	0	0	0	0	0	Nat	Nat
Riffle	162.00	166.00		0.70	0.00			0.04	2.00	5.75		0	0	0	100	0	0	0	0	0	0	75.00	0		0	0	0	0	0	0	Nat	Nat
Pool	166.00	175.00	9.00	2.70	24.30			0.10	0.00	3.50		0	0	0	90	10	0	15	0	0	0	60.00	2		0	0	0	0	0	0	Nat	Nat
Riffle	175.00	177.00		3.00	0.00			0.03	2.00	3.90		0	0	0	95	5	0	0	0	0	0	70.00	0		0	0	0	0	0	0	Nat	Nat
Pool	177.00	189.00	12.00	1.40	16.80			0.10	0.00	4.00		0	0	0	90	10	0	0	25	0	0	75.00	0		6	0	0	0	0	0	Nat	Nat
Riffle	189.00	193.00		1.15	0.00			0.03	2.00	2.80		0	0	0	100	0	0	0	0	50	0	95.00	0		0	0	0	0	0	0	Nat	Nat
Pool	193.00	203.00	10.00	1.60	16.00			0.10	0.00	2.80		0	0	0	90	10	0	0	10	0	0	90.00	0		8	0	0	0	0	0	Nat	Nat
Riffle	203.00	210.00		1.30	0.00			0.10	3.00	5.70		0	0	5	90	5	0	0	0	0	0	95.00	0		7	0	0	0	0	0	Nat	Nat
Pool	210.00	224.00	14.00	1.50	21.00			0.35	0.00	5.20		0	0	10	80	10	0	40	0	0	0	85.00	2		14	0	0	0	0	0	Nat	Nat
Riffle	224.00	226.00		1.20	0.00			0.02	2.00	3.80		0	0	0	100	0	0	0	0	0	0	95.00	0		2	0	0	0	0	0	Nat	Nat
Pool	226.00	238.00	12.00	1.00	12.00			0.30	0.00	3.50		0	0	0	20	80	0	0	10	0	0	85.00	2		10	0	0	10	1	L	Nat	Nat
Riffle	238.00	246.00		0.80	0.00			0.03	10.00	8.30		0	0	0	90	10	0	0	0	5	0	75.00	1		2	0	0	0	0	0	Nat	Nat
Pool	246.00	272.00	26.00	1.80	46.80			0.20	0.00	4.90		0	0	0	90	10	0	0	0	10	0	90.00	0		0	0	0	0	0	0	Nat	Nat
Riffle	272.00	278.00		0.80	0.00			0.05	1.00	6.50		0	0	0	95	5	0	0	0	10	0	60.00	2		0	0	0	0	0	0	Nat	Nat
Pool	278.00	281.00	3.00	3.20	9.60			0.35	0.00	8.00		0	0	0	30	70	0	10	0	0	0	60.00	5		0	0	0	0	0	0	Nat	Nat
Riffle	281.00	291.00		0.60	0.00			0.05	4.00	10.30		0	0	5	90	5	0	0	0	0	0	75.00	1		0	0	0	0	0	0	Nat	Nat
Pool	291.00	300.00	9.00	2.70	24.30			0.20	0.00	8.20		0	0	0	75	25	0	15	0	0	0	85.00	4		10	0	0	0	0	0	Nat	Nat
Riffle	300.00	311.00		0.70	0.00			0.10	3.00	12.50		0	0	10	90	0	0	0	0	10	0	80.00	0		0	0	1	20	1	L	Nat	Nat
Pool	311.00	328.00	17.00	2.30	39.10			0.20	0.00	3.60		0	0	25	75	0	0	0	10	0	0	85.00	2		2	0	0	0	0	0	Nat	Nat
Riffle	328.00	330.00		1.10	0.00			0.02	1.00	5.40		0	0	10	90	0	0	0	0	10	0	90.00	0		0	0	0	0	0	0	Nat	Nat
Pool	330.00	338.00	8.00	2.00	16.00			0.30	0.00	7.30		0	0	0	60	40	0	0	20	0	0	70.00	1		10	0	0	0	0	0	Nat	Nat
Riffle	338.00	346.00		1.00	0.00			0.07	4.00	4.50		0	0	60	40	0	0	0	0	0	0	75.00	0		10	0	0	0	0	0	Nat	Nat
Pool	346.00	348.00	2.00	1.80	3.60			0.15	0.00	3.00		0	0	0	50	50	0	0	0	10	0	70.00	0		2	10	0	0	0	0	Nat	Nat
Riffle	348.00	353.00		0.60	0.00			0.03	3.00	4.50		0	0	10	90	0	0	0	0	0	0	75.00	0		5	0	0	0	0	0	Nat	Nat
Pool	353.00	357.00	4.00	2.00	8.00			0.20	0.00	4.50		0	0	10	50	40	0	1	0	0	0	80.00	1		2	0	0	0	0	0	Nat	Nat
Riffle	357.00	362.00		1.30	0.00			0.05	3.00	2.90		0	0	60	40	0	0	0	0	0	0	90.00	0		3	0	0	0	0	0	Nat	Nat
Pool	362.00	376.00	14.00	2.00	28.00			0.25	0.00	7.80		0	0	10	40	50	0	30	0	0	0	80.00	4		0	0	0	20	2	R	Nat	Nat
Riffle	376.00	382.00		0.16	0.00			0.12	1.00	6.20		0	0	50	50	0	0	0	0	0	0	75.00	0		6	0	0	0	0	0	Nat	Nat
Riffle	382.00	391.00		1.50	0.00			0.05	3.00	3.50		0	0	50	50	0	0	0	10	0	0	90.00	0		10	0	0	0	0	0	Nat	Nat
Riffle	391.00	400.00		0.30	0.00			0.04	1.00	3.20		0	0	50	50	0	0	0	0	0	0	80.00	0		5	0	0	0	0	0	Nat	Nat
Pool	400.00	406.00	6.00	2.50	15.00			0.30	0.00	3.60		0	0	25	75	0	0	0	10	0	0	95.00	0		6	0	0	0	0	0	Nat	Nat
Riffle	406.00	457.00		0.00	0.00			0.00	2.00	4.00		0	0	50	50	0	0	0	0	0	0	90.00	0		0	0	1	0	0	0	Nat	Nat
Reach Totals and Averages		457.00	192.00	1.50	387.40	685.61	56.50	0.13	1.45	5.24	28.65	0	0	12	75	13	0	3	4	4	0	79.17	27	0.31	32	4	2	11			42	42

Reach 5

Stream Name	Cottle Creek	Watershed Code	920-401700	Date	45888.00	Reach Name	Reach 5			Discharge Depth #1		Velocity	
Water Quality Information					Field Crew		BCCF, FOCC					T1	Site Length
Dissolved Oxygen	7.36	pH	6.99	Total Dissolved Solids	88.80	Temp C		Chainage at Beginning of Reach	1681.00	Discharge Depth #2		T2	
Velocity (m/s)	.	Average Depth (at flow site)		Wetted Width (at flow site)		Discharge (m3/s)		Chainage at End of Reach	2332.00	Discharge Depth #3		T3	

Habitat Information (All Pool and Cross Section Data)

Habitat Type	Start (chainage at start)	Finish (chainage at end)	Unit Length	Wetted Width	Pool Area	Wetted Reach Area	%Pool Area	Habitat unit Depth (m)	Percent Gradient	Bankfull Width(m)	Average Percent Wetted Area	Substrate Percent Bed	Bld	Cob	Grv	Fine	Percent Instream Cover Bold	LWD	Cutbk	Veg	Other	PercentCrown Cover	Large Woody Debris	LWD/bank-full channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstructions (number)	Off-Channel Habitat (length)	Off-Channel Habitat (width)	Off-Channel Habitat (bank side)	Land Use Right	Left	Veg Type
Riffle	0.00	18.00		0.00	0.00			0.00	2.00	3.00		0	0	20	80	0	0	0	0	0	0	70.00	0		0	0	1	0	0	0	Nat	Nat	Mix
Pool	18.00	22.00	4.00	1.70	6.80			0.15	0.00	3.20		0	0	20	0	80	0	20	0	0	0	75.00	1		4	0	0	0	0	0	Nat	Nat	Mix
Riffle	22.00	65.00		0.00	0.00			0.00	2.00	3.00		0	0	30	50	20	0	0	0	0	0	80.00	0		0	0	1	0	0	0	Nat	Nat	Mix
Pool	65.00	94.00	29.00	2.30	66.70			0.20	0.00	3.60		0	0	0	80	20	0	0	10	0	0	85.00	1		5	0	0	0	0	0	Nat	Nat	Mix
Riffle	94.00	123.00		0.95	0.00			0.04	3.00	3.20		0	10	20	70	0	0	20	0	0	0	90.00	9		10	0	0	0	0	0	Nat	Nat	Mix
Pool	123.00	131.00	8.00	1.40	11.20			0.10	0.00	2.90		0	0	20	70	10	0	0	10	0	0	60.00	0		5	0	0	0	0	0	Nat	Nat	Mix
Riffle	131.00	144.00		1.00	0.00			0.05	3.00	8.00		0	0	40	60	0	0	10	0	0	0	75.00	3		0	0	0	0	0	0	Nat	Nat	Mix
Pool	144.00	159.00	15.00	4.90	73.50			0.30	0.00	11.00		0	0	10	10	80	0	20	0	0	0	80.00	14		0	0	0	0	0	0	Nat	Nat	Mix
Riffle	159.00	164.00		1.40	0.00			0.03	1.00	2.40		0	0	70	30	0	0	0	0	0	0	60.00	0		0	0	0	0	0	0	Nat	Nat	Mix
Pool	164.00	175.00	11.00	1.20	13.20			0.15	4.00	4.00		0	0	0	60	40	0	15	0	0	0	70.00	4		8	0	0	0	0	0	Nat	Nat	Mix
Riffle	175.00	187.00		0.30	0.00			0.03	8.00	11.00		0	0	10	90	0	0	10	0	0	0	75.00	18		10	0	1	0	0	0	Nat	Nat	Mix
Pool	187.00	206.00	19.00	1.10	20.90			0.08	0.00	5.00		0	0	0	60	40	0	0	0	10	0	50.00	0		0	0	0	0	0	0	Nat	Nat	Mix
Riffle	206.00	234.00		1.80	0.00			0.03	3.00	4.60		0	0	50	50	0	0	0	0	10	0	80.00	0		10	0	0	0	0	0	Nat	Nat	Mix
Pool	234.00	242.00	8.00	2.50	20.00			0.18	0.00	4.30		0	0	0	40	60	0	10	0	0	0	85.00	3		6	0	0	0	0	0	Nat	Nat	Mix
Riffle	242.00	262.00		1.50	0.00			0.08	3.00	7.50		0	10	30	60	0	0	10	0	0	0	70.00	8		5	0	0	0	0	0	Nat	Nat	Mix
Pool	262.00	274.00	12.00	2.40	28.80			0.25	0.00	5.80		0	0	20	20	60	0	15	0	0	0	80.00	5		0	0	0	0	0	0	Nat	Nat	Mix
Riffle	274.00	292.00		1.50	0.00			0.06	4.00	2.90		0	0	60	30	10	0	10	0	0	0	90.00	2		0	0	0	0	0	0	Nat	Nat	Mix
Pool	292.00	299.00	7.00	1.35	9.45			0.20	0.00	3.60		0	10	30	10	50	0	0	10	0	0	90.00	1		7	0	0	0	0	0	Nat	Nat	Mix
Riffle	299.00	307.00		1.50	0.00			0.04	2.00	3.60		0	0	50	30	20	0	0	10	0	0	80.00	0		7	0	0	0	0	0	Nat	Nat	Mix
Pool	307.00	315.00	8.00	1.50	12.00			0.30	0.00	4.40		0	0	60	10	30	0	0	0	0	0	70.00	0		6	0	0	0	0	0	Nat	Nat	Mix
Riffle	315.00	343.00		1.30	0.00			0.10	4.00	4.90		10	10	30	50	0	0	0	0	10	0	80.00	0		10	0	0	0	0	0	Nat	Nat	Mix
Pool	343.00	354.00	11.00	3.00	33.00			0.30	0.00	9.00		0	0	20	20	60	0	70	0	0	0	70.00	30		0	0	1	0	0	0	Nat	Nat	Mix
Pool	354.00	385.00	31.00	1.30	40.30			0.20	0.00	3.60		10	0	20	50	20	0	10	0	0	0	80.00	3		0	0	0	0	0	0	Nat	Nat	Mix
Riffle	385.00	393.00		0.90	0.00			0.06	3.00	5.90		0	10	70	20	0	0	0	0	10	0	70.00	0		0	0	0	0	0	0	Nat	Nat	Mix
Pool	393.00	401.00	8.00	2.50	20.00			0.20	0.00	4.20		0	10	40	40	10	0	0	10	0	0	70.00	0		7	0	0	0	0	0	Nat	Nat	Mix
Riffle	401.00	409.00		1.20	0.00			0.03	2.00	3.20		0	0	60	40	0	0	0	0	0	0	50.00	0		0	0	0	0	0	0	Nat	Nat	Mix
Pool	409.00	424.00	15.00	1.30	19.50			0.80	0.00	3.80		0	10	10	20	60	0	0	10	0	0	70.00	1		5	0	0	0	0	0	Nat	Nat	Mix
Riffle	424.00	429.00		0.70	0.00			0.05	2.00	8.00		0	0	70	30	0	0	10	0	0	0	70.00	2		0	0	0	0	0	0	Nat	Nat	Mix
Pool	429.00	435.00	6.00	2.80	16.80			0.20	0.00	3.00		0	0	10	10	70	0	10	0	0	0	70.00	1		0	0	0	0	0	0	Nat	Nat	Mix
Riffle	435.00	441.00		0.85	0.00			0.04	1.00	3.50		0	0	70	30	0	0	0	0	0	0	70.00	0		0	0	0	0	0	0	Nat	Nat	Mix
Pool	441.00	451.00	10.00	3.00	30.00			0.27	0.00	5.00		0	10	30	0	60	0	10	0	0	0	80.00	2		0	0	1	0	0	0	Nat	Nat	Mix
Riffle	451.00	460.00		1.10	0.00			0.05	2.00	5.50		0	0	80	20	0	0	0	0	0	0	80.00	2		9	0	0	0	0	0	Nat	Nat	Mix
Pool	460.00	470.00	10.00	1.80	18.00			0.22	0.00	3.40		0	0	25	25	50	0	40	0	0	0	90.00	1		5	0	0	0	0	0	Nat	Nat	Mix
Riffle	470.00	479.00		0.80	0.00			0.08	2.00	3.00		0	0	30	70	0	0	0	0	0	0	80.00	0		0	0	0	0	0	0	Nat	Nat	Mix
Pool	479.00	488.00	9.00	1.80	16.20			0.10	0.00	2.60		0	10	10	10	70	0	10	0	0	0	80.00	2		5	0	0	0	0	0	Nat	Nat	Mix
Riffle	488.00	495.00		0.80	0.00			0.05	0.00	3.80		0	20	40	40	0	0	5	0	0	0	70.00	1		5	0	0	0	0	0	Nat	Nat	Mix
Pool	495.00	499.00	4.00	2.60	10.40			0.10	0.00	5.70		0	10	10	0	80	0	10	0	0	0	75.00	1		4	0	0	0	0	0	Nat	Nat	Mix
Riffle	499.00	519.00		0.60	0.00			0.10	2.00	8.00		0	0	30	70	0	0	0	10	0	0	80.00	1		0	0	1	0	0	0	Nat	Nat	Mix
Pool	519.00	534.00	15.00	1.20	18.00			0.20	0.00	5.00		10	10	20	10	50	10	0	0	0	0	80.00	1		3	0	0	0	0	0	Nat	Nat	Mix
Riffle	534.00	544.00		0.85	0.00			0.07	2.00	4.70		0	10	70	20	0	0	0	0	10	0	90.00	0		5	0	0	0	0	0	Nat	Nat	Mix
Pool	544.00	564.00	20.00	1.77	35.40			0.20	0.00	3.70		0	0	10	10	80	0	0	0	10	0	80.00	1		10	0	0	0	0	0	Nat	Nat	Mix
Riffle	564.00	575.00		1.20	0.00			0.04	2.00	3.40		0	10	50	40	0	0	10	0	0	0	80.00	1		0	0	0	0	0	0	Nat	Nat	Mix
Pool	575.00	587.00	12.00	1.20	14.40			0.12	0.00	3.10		0	0	0	20	80	0	30	0	0	0	70.00	5		0	0	0	0	0	0	Nat	Nat	Mix
Riffle	587.00	602.00		1.20	0.00			0.05	4.00	3.30		0	0	10	90	0	0	0	0	10	0	70.00	2		10	0	0	12	1	L	Nat	Nat	Mix
Pool	602.00	611.00	9.00	2.10	18.90			0.18	0.00	4.20		0	0	10	10	80	0	40	0	0	0	70.00	7		0	0	0	0	0	0	Nat	Nat	Mix
Riffle	611.00	630.00		0.80	0.00			0.04	3.00	4.60		0	0	50	50	0	0	0	0	10	0	70.00	3		10	0	0	0	0	0	Nat	Nat	Sh
Pool	630.00	635.00	5.00	1.40	7.00			0.12	0.00	3.20		0	0	20	20	60	0	0	0	60	0	70.00	0		5	0	0	0	0	0	Nat	Nat	Mix
Riffle	635.00	651.00		1.40	0.00			0.05	3.00	5.00		0	10	10	80	0	0	0	0	10	0	80.00	3		10	0	0	0	0	0	Nat	Nat	Sh
Reach Totals and Averages		651.00	286.00	1.50	560.45	973.38	57.58	0.13	1.40	4.65	32.14	1	3	30	38	28	0	8	1	3	0	75.21	139	0.99	29	0	6	2			48	48	

Reach 6

Stream Name	Cottle Creek	Watershed Code	920-401700	Date	45888.00	Reach Name	Reach 6			Discharge Depth #1		Velocity	
Water Quality Information					Field Crew		BCCF, FOCC					T1	Site Length
Dissolved Oxygen	7.13	pH	7.09	Total Dissolved Solids	93.30	Temp C		Chainage at Beginning of Reach	2332.00	Discharge Depth #2		T2	
Velocity (m/s)	.	Average Depth (at flow site)		Wetted Width (at flow site)		Discharge (m3/s)		Chainage at End of Reach	2574.00	Discharge Depth #3		T3	

Habitat Information (All Pool and Cross Section Data)

Habitat Type	Start (chainage at start)	Finish (chainage at end)	Unit Length	Wetted Width	Pool Area	Wetted Reach Area	%Pool Area	Habitat unit Depth (m)	Percent Gradient	Bankfull Width(m)	Average Percent Wetted Area	Substrate Percent Bed	Bld	Cob	Grv	Fine	Percent Instream Cover Bold	LWD	Cutbk	Veg	Other	PercentCrown Cover	Large Woody Debris	LWD/bank-full channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstructions (number)	Off-Channel Habitat (length)	Off-Channel Habitat (width)	Off-Channel Habitat (bank side)	Land Use Right	Left	Veg Type
Pool	0.00	30.00	30.00	3.00	90.00			0.40	0.00	5.30		0	0	0	10	90	0	15	0	0	0	90.00	9		0	5	0	0	0	0	Nat	Nat	Mix
Riffle	30.00	48.00		1.70	0.00			0.08	2.00	3.10		0	20	0	40	40	0	0	0	0	0	80.00	0		15	0	0	0	0	0	Nat	Nat	Mix
Pool	48.00	76.00	28.00	1.80	50.40			0.20	0.00	3.35		0	10	10	10	70	0	30	0	0	0	85.00	7		20	0	0	0	0	0	Nat	Nat	Mix
Riffle	76.00	86.00		2.00	0.00			0.05	2.00	2.70		0	10	40	50	0	0	0	0	10	0	70.00	0		8	0	0	0	0	0	Nat	Nat	Mix
Pool	86.00	95.00	9.00	2.00	18.00			0.13	0.00	3.80		0	0	10	10	80	0	10	0	0	0	70.00	2		3	0	0	0	0	0	Nat	Nat	Mix
Riffle	95.00	109.00		1.40	0.00			0.06	3.00	4.20		0	0	70	30	0	0	0	10	0	0	80.00	1		10	0	0	0	0	0	Nat	Nat	Mix
Pool	109.00	129.00	20.00	1.70	34.00			0.15	0.00	4.90		0	0	30	10	60	0	20	0	0	0	80.00	9		0	0	1	0	0	0	Nat	Nat	Mix
Pool	129.00	150.00	21.00	3.25	68.25			0.20	0.00	6.00		0	0	100	0	0	0	0	0	0	0	70.00	0		0	0	0	20	2	L	Nat	Nat	Mix
Pool	150.00	200.00	50.00	3.80	190.00			0.25	0.00	8.60		0	0	0	10	90	0	10	0	0	0	60.00	6		0	0	0	0	0	0	Nat	Nat	Mix
Riffle	200.00	220.00		1.00	0.00			0.04	2.00	8.00		0	0	50	50	0	0	0	0	0	0	60.00	0		20	4	0	0	0	0	Nat	Nat	Mix
Pool	220.00	233.00	13.00	4.70	61.10			0.25	0.00	12.20		0	0	0	0	100	0	0	0	0	0	60.00	0		13	0	0	0	0	0	Nat	Nat	Mix
Riffle	233.00	242.00		0.80	0.00			0.03	3.00	3.00		0	0	0	0	100	0	0	0	0	0	20.00	0		9	0	1	0	0	0	Nat	Nat	Mix
Reach Totals and Averages		242.00	171.00	2.26	511.75	547.53	93.47	0.15	1.00	5.43	41.67	0	3	26	18	53	0	7	1	1	0	68.75	34	0.76	40	4	2	8			12	12	

Reach 7

Stream Name	Cottle Creek	Watershed Code	920-401700	Date	45908.00	Reach Name	Reach 7			Discharge Depth #1		Velocity																					
Water Quality Information					Field Crew		FOCC, BCCF					T1		Site Length																			
Dissolved Oxygen	.	pH		Total Dissolved Solids		Temp C		Chainage at Beginning of Reach	0.00	Discharge Depth #2		T2																					
Velocity (m/s)	.	Average Depth (at flow site)		Wetted Width (at flow site)		Discharge (m3/s)		Chainage at End of Reach	24.00	Discharge Depth #3		T3																					

Habitat Information (All Pool and Cross Section Data)

Habitat Type	Start (chainage at start)	Finish (chainage at end)	Unit Length	Wetted Width	Pool Area	Wetted Reach Area	%Pool Area	Habitat unit Depth (m)	Percent Gradient	Bankfull Width(m)	Average Percent Wetted Area	Substrate Percent					Percent Instream Cover					PercentCrown Cover	Large Woody Debris	LWD/bank-full channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstructions (number)	Off-Channel Habitat (length)	Off-Channel Habitat (width)	Off-Channel Habitat (bank side)	Land Use	
												Bed	Bld	Cob	Grv	Fine	Bold	LWD	Cutbk	Veg	Other									Right	Left
Riffle	0.00	24.00		0.00	0.00			0.00	1.00	2.20		0	0	10	80	10	0	0	0	10	0	90.00	0		0	0	1	0	0	0	Nat	Nat
Reach Totals and Averages		24.00	0.00	0.00	0.00	0.00		0.00	1.00	2.20	0.00	0	0	10	80	10	0	0	0	10	0	90.00	0	0.00	0	0	1	0			1	1

Reach 8

Stream Name	Cottle Creek	Watershed Code	920-401700	Date	45908.00	Reach Name	Reach 8			Discharge Depth #1		Velocity																					
Water Quality Information					Field Crew		FOCC, BCCF					T1		Site Length																			
Dissolved Oxygen	9.09	pH	6.16	Total Dissolved Solids	129.00	Temp C		Chainage at Beginning of Reach	0.00	Discharge Depth #2		T2																					
Velocity (m/s)	.	Average Depth (at flow site)		Wetted Width (at flow site)		Discharge (m3/s)		Chainage at End of Reach	380.00	Discharge Depth #3		T3																					

Habitat Information (All Pool and Cross Section Data)

Habitat Type	Start (chainage at start)	Finish (chainage at end)	Unit Length	Wetted Width	Pool Area	Wetted Reach Area	%Pool Area	Habitat unit Depth (m)	Percent Gradient	Bankfull Width(m)	Average Percent Wetted Area	Substrate Percent					Percent Instream Cover					PercentCrown Cover	Large Woody Debris	LWD/bank-full channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstructions (number)	Off-Channel Habitat (length)	Off-Channel Habitat (width)	Off-Channel Habitat (bank side)	Land Use	
												Bed	Bld	Cob	Grv	Fine	Bold	LWD	Cutbk	Veg	Other									Right	Left
Pool	0.00	11.00	11.00	2.10	23.10			0.50	0.00	3.70		10	0	10	10	70	0	0	0	10	0	10.00	0		0	4	0	0	0	0	FG	FG
Riffle	11.00	29.00		2.00	0.00			0.30	1.00	7.50		0	0	10	10	80	0	0	0	10	0	20.00	0		0	8	1	0	0	0	L	L
Riffle	29.00	84.00		2.20	0.00			0.10	1.00	4.50		0	10	30	20	40	0	0	0	10	0	40.00	0		0	10	1	0	0	0	L	Nat
Pool	84.00	90.00	6.00	1.10	6.60			0.10	0.00	2.60		0	0	30	0	70	0	0	0	10	0	70.00	0		6	6	0	0	0	0	FG	Nat
Riffle	90.00	187.00		0.50	0.00			0.08	3.00	5.20		0	10	40	30	20	0	10	0	0	0	80.00	6		90	30	0	0	0	0	Nat	Nat
Pool	187.00	206.00	19.00	0.75	14.25			0.20	0.00	2.80		0	0	0	20	80	0	0	0	10	0	70.00	2		19	15	0	0	0	0	L	Nat
Riffle	206.00	266.00		1.00	0.00			0.05	2.00	3.20		0	10	30	40	20	0	0	0	10	0	85.00	0		60	0	0	0	0	0	Nat	Nat
Pool	266.00	281.00	15.00	0.80	12.00			0.10	0.00	2.60		0	0	20	10	70	0	0	0	10	0	80.00	0		20	0	0	0	0	0	Nat	Nat
Riffle	281.00	333.00		1.10	0.00			0.05	2.00	3.20		0	10	40	40	10	0	0	0	10	0	80.00	3		50	0	0	0	0	0	Nat	Nat
Pool	333.00	347.00	14.00	1.00	14.00			0.15	0.00	2.80		0	0	0	20	80	0	10	0	0	0	85.00	5		14	0	0	0	0	0	Nat	Nat
Riffle	347.00	380.00		0.70	0.00			0.02	4.00	3.00		0	20	40	40	0	0	0	0	20	0	90.00	0		33	0	0	0	0	0	Nat	Nat
Reach Totals and Averages		380.00	65.00	1.20	69.95	457.73	15.28	0.15	1.18	3.74	32.24	1	5	23	22	49	0	2	0	9	0	64.55	16	0.16	77	19	2	0			21	15