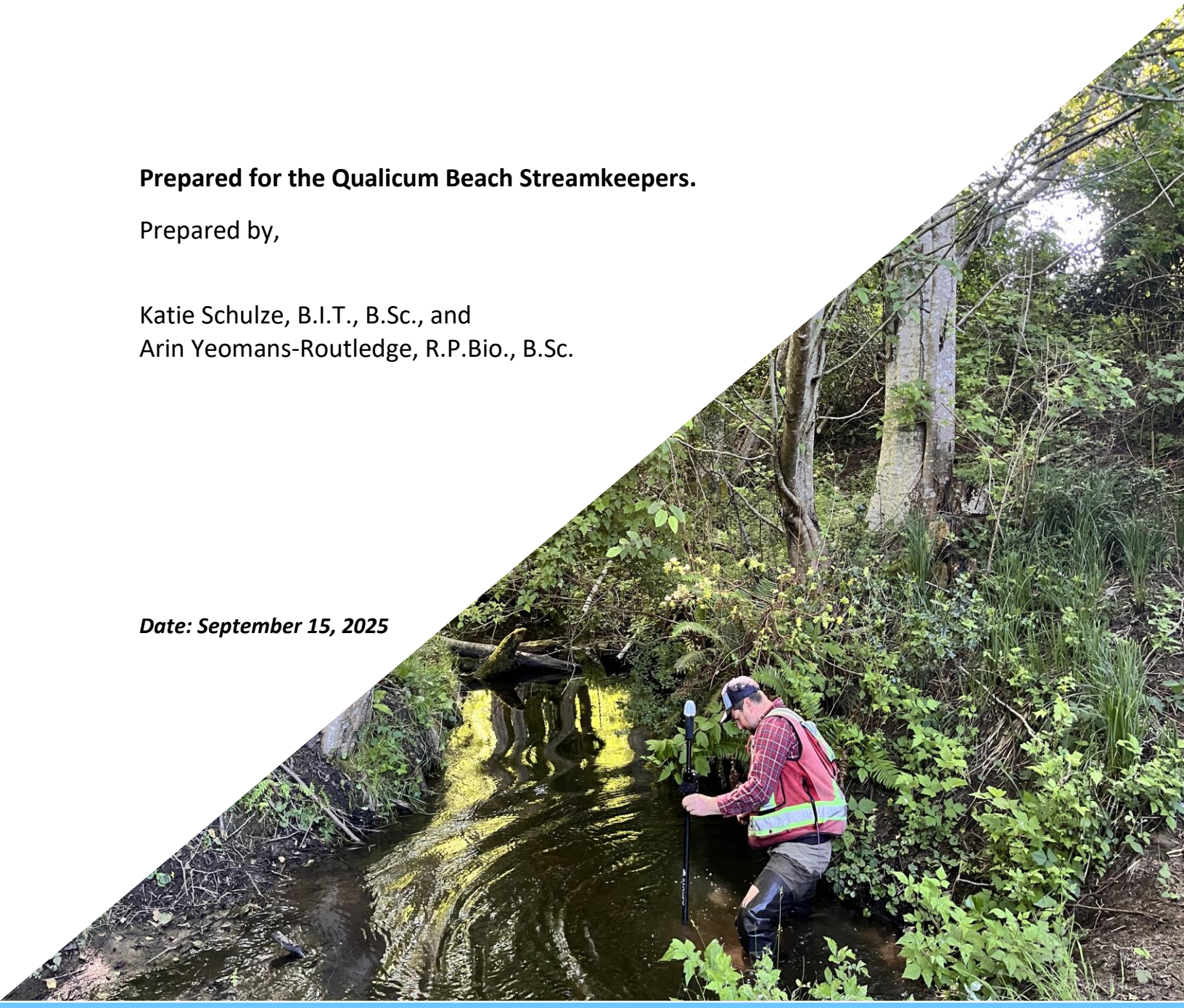
Stream Mapping Results Report

Beach Creek & Grandon Creek 2024-2025



Prepared for the Qualicum Beach Streamkeepers.

Prepared by,

Katie Schulze, B.I.T., B.Sc., and
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Date: September 15, 2025

Executive Summary

Astraea Consulting (Astraea), in collaboration with the Qualicum Beach Streamkeepers (QBS), conducted comprehensive stream mapping and habitat assessment in the Qualicum Beach area between June 2024 and March 2025. This initiative focused on Beach Creek and Grandon Creek, with detailed habitat mapping completed for Beach and Grandon Creeks. The purpose of the project was to enhance the understanding of local aquatic habitats, support fisheries and watershed management, and inform future restoration and planning initiatives.

Key Findings

- Beach Creek: Previously unmapped upstream tributaries and ditches were identified and mapped. The creek flows through residential zones and drains into the ocean, supporting Coho Salmon (*Oncorhynchus kisutch*) and Cutthroat Trout (*Oncorhynchus clarkii).*
- Grandon Creek: Mapping extended from historical headwaters through farmland and residential zones to the estuary. New side channels, off-channel habitats, and fish barriers were documented.
- Both creeks had gaps in publicly available stream data that were corrected through this project, particularly relating to fish-accessible side channels, wetlands, and road crossings (i.e., culverts).
- Updated streamlines were produced and submitted to the Regional District of Nanaimo (RDN) and the Province of British Columbia for integration into iMap BC.
- These updates support improved planning for responsible land-use development, habitat protection, and fish passage restoration.

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Introduction

Astraea Consulting (Astraea) is pleased to provide the Qualicum Beach Streamkeepers (QBS) with a summary of stream mapping works completed between June 2024 and March 2025 in the Qualicum Beach area. Identified local streams of interest by QBS include Beach Creek (Figure 1), Grandon Creek (Figure 2), and Whiskey Creek.

Beach Creek is a ~1,200 m long system that also flows north through residential areas before draining into the ocean. Current mapping for Beach Creek depicts the creek's headwaters originating from within residential areas. No stream channels had been identified above Village Way, prior to this project.

Grandon Creek is a ~5,500 m long system with headwaters originating from historical farm ditching located below Highway 19A. The creek flows north through farmland and residential areas, crossing under Rupert Rd, Hoylake Rd, and Hwy 19A before draining into the ocean near Crescent Rd W.

Works completed include:

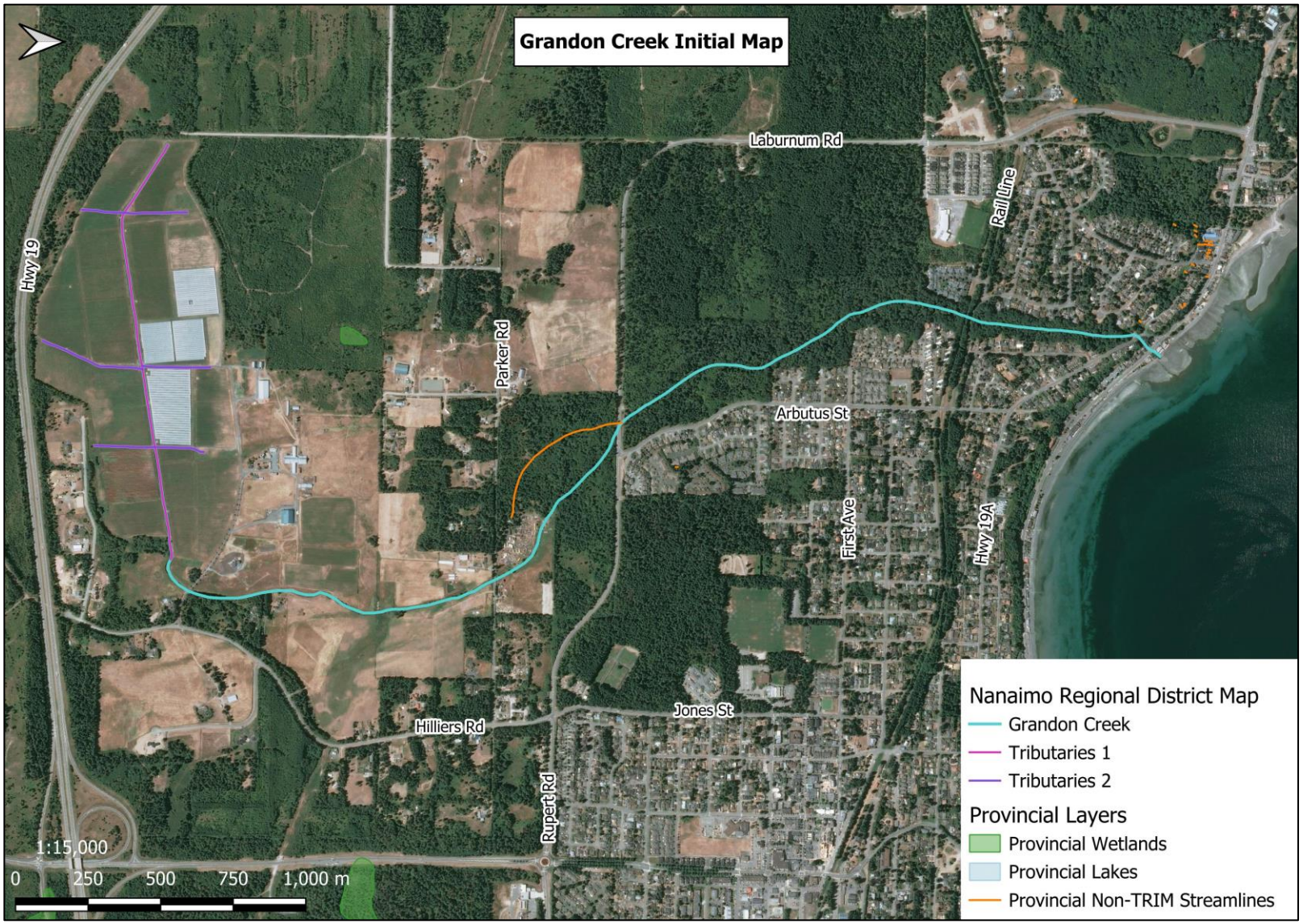
- Identifying previously unidentified tributary streams and ditches that drain into these streams, which would provide seasonal water inputs along with food and nutrients.
- Assessing existing habitat values (spawning habitat, cover, and other instream features).
- Identifying barriers to fish access (culverts, falls, and other obstacles to migration).
- Observing impacted or underperforming riparian habitats.
- Identifying opportunities for future enhancement projects.
- Providing GIS data to the Province and Municipality, thereby enhancing local knowledge of aquatic habitats and making the information accessible to the public. A vital tool for city planners, landowners, and other decision-makers.

Works were conducted jointly by Astraea Biologists and QBS volunteers and included ground-truth mapping of the streams and any previously unmapped tributaries or ditches using high-accuracy GPS tools. Stream segments were defined following the provincial guidelines, as outlined in the Definitions Section below. Key habitat features outlined above were identified, described, and documented with photographs and GPS waypoints. The GPS data collected was then analyzed in the office using GIS software and compiled into updated streamlines and community-facing annotated maps. Updated streamlines were distributed to the RDN and the Province of British Columbia's geomatics departments for integration into publicly accessible online mapping resources (i.e., iMap BC and RDN watershed map; currently in progress). See Methods for more details.

The figures below contain the currently available mapped extents of Beach Creek and Grandon Creek available online via iMap BC and via the RDN web mapper.

Figure 1. Initial Mapped Extent of Beach Creek, Qualicum Beach, BC.

Figure 2. Initial Mapped Extent of Grandon Creek, Qualicum Beach, BC.



Definitions

STREAM

As per the *Water Sustainability Act (WSA)*[1], ***"stream"*** *means*

a) a natural watercourse, including a natural glacier course, or a natural body of water, whether or not the stream channel of the stream has been modified, or
b) a natural source of water supply,

including, without limitation, a lake, pond, river, creek, spring, ravine, gulch, wetland or glacier, whether or not usually containing water, including ice, but does not include an aquifer;"

As per the *Riparian Area Protection Regulation (RAPR)*[2], ***"stream"*** *means*

a) a watercourse or body of water, whether or not usually containing water, and
b) any of the following that is connected by surface flow to a watercourse or body of water referred to in paragraph (a):
i. a ditch, whether or not usually containing water;
ii. a spring, whether or not usually containing water;
iii. a wetland;"

Accordingly, a **"stream"** is any watercourse (natural or man-made) that 1) provides fish habitat, 2) contains water permanently or seasonally, and 3) is scoured by water or contains observable deposits of alluvium. A **"stream"** may not be currently inhabited by fish, but may provide water, food, and nutrients to a fish-bearing stream. Thus, side channels, off-channels, and tributaries are included within the definition of a **"stream"** under WSA and RAPR.

DITCH

As per the *Water Sustainability Act (WSA)*, a **"ditch"** is defined as *"a long, narrow, excavated channel for carrying water, often for drainage".*

A **"ditch"** can still be considered a **"stream"** if it was/still is a natural watercourse or if it is a source of water supply to downstream fish-bearing watercourses, even if it has been modified.

Generally, a **"ditch"** is not considered a **"stream"** under the WSA if

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[1] Government of British Columbia. (2014). *Water Sustainability Act* (SBC 2014, c. 15). Retrieved from https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/14015
[2] Government of British Columbia. (2019). *Riparian Areas Protection Regulation*, B.C. Reg. 178/2019. Retrieved from https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/178_2019/

a) it only carries overland flow or surface runoff (i.e., it has no headwaters or springs),
b) it was constructed as a 'work' under a WSA water licence or use authorization, or
c) it is operated in a manner consistent with a drainage 'exemption' under Section 31-34.1 of the *Water Sustainability Regulation* (e.g., corridor drainage, local government drainage works, agricultural drainage, etc.)[3]

Mapping Methods

Watercourses were ground-truthed by Astraea biologists and QBS volunteers. Mapping was completed to review the existing habitat conditions in Beach Creek and Grandon Creek, with efforts concentrated between the estuary and Hwy 19. The recent mapping utilized the SHIM methodology to delineate the stream centerline and aquatic habitats. The thalweg (deepest point of the stream channel) was surveyed to collect geospatial and elevation data. For wetlands, perimeter points were collected, and vegetation types were recorded to aid in habitat delineation.

To define the different sections of the channel (i.e., natural stream, channelized stream, ditch, and wetlands) that were surveyed, provincial regulatory definitions were applied as outlined above in the Definitions Section. Both the WSA and RAPR define a stream as any watercourse providing fish habitat, natural or human-made, that contains water on a perennial or seasonal basis and is scoured by water or contains observable deposits of mineral alluvium; or has a continuous channel bed including a watercourse that is obscured by overhanging or bridging vegetation or soil mats. A stream may not be currently inhabited by fish, but may provide water, food and nutrients to other streams that do support fish. Side channels, intermittent streams, and seasonally wetted contiguous areas are included in the definition of a stream, which includes active floodplains and wetlands connected to streams. In general, the only watercourses excluded from the definition of stream under the WSA and RAPR are those that do not support fish or drain into a watercourse that supports fish; for example, an isolated wetland that is not connected to a stream system, or a roadside ditch that is not directly connected to a downstream fish-bearing watercourse.

The streamlines were surveyed using either an Emlid Reach RX unit or an iPhone 15 Pro Plus running Avenza Maps. The Emlid Reach RX is a commercial survey unit used for urban and remote land surveying. The Emlid Reach RX utilizes the RTK technique to improve the accuracy of standalone GNSS receivers. The Emlid Reach RX provides accurate points to within one

[3] Government of British Columbia. (2021, December 9). *A User's Guide for Changes In and About a Stream in British Columbia* (Version 2022.01). Ministry of Environment and Climate Change Strategy. https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/working-around-water/wsa-cias-users_guide.pdf

meter. By comparison, traditional GNSS receivers, like those in smartphones, can determine the position with 2–4 meters accuracy. As such, the Emlid was predominantly used unless two teams were working at the same time, with one using the Emlid and one using Avenza Maps on an iPhone.

Collected GPS data was then reviewed using QGIS software by a GIS technician. Differences in the watercourses mapped by Astraea and those available from previous mapping efforts were reviewed and are depicted below. Notable additions to the available Fresh Water Atlas (FWA) streamlines include (1) previously unmapped channels, tributaries, braided channels, and off-channel habitats, including side channels and backwatered channels that provide key refuge habitat during high flow events, (2) wetlands, and (3) road crossings and culverts (sizing and length data were recorded).

Updated streamline maps of Beach Creek (Figure 3), and Grandon Creek (Figure 4) are presented below.

Figure 3. Ground-truthed stream mapping results of Beach Creek, Qualicum Beach, BC. (historic streamlines are depicted in pink).

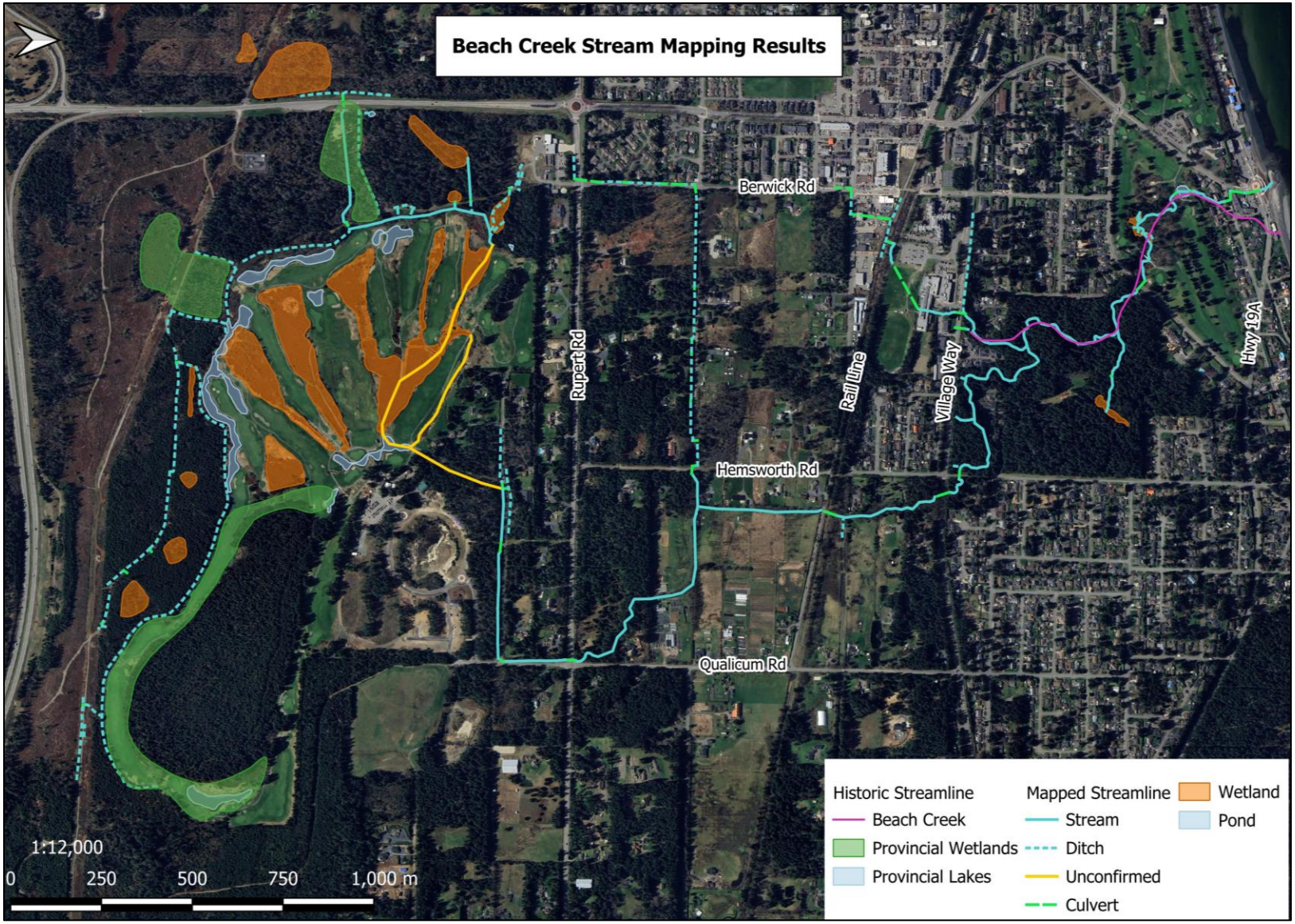
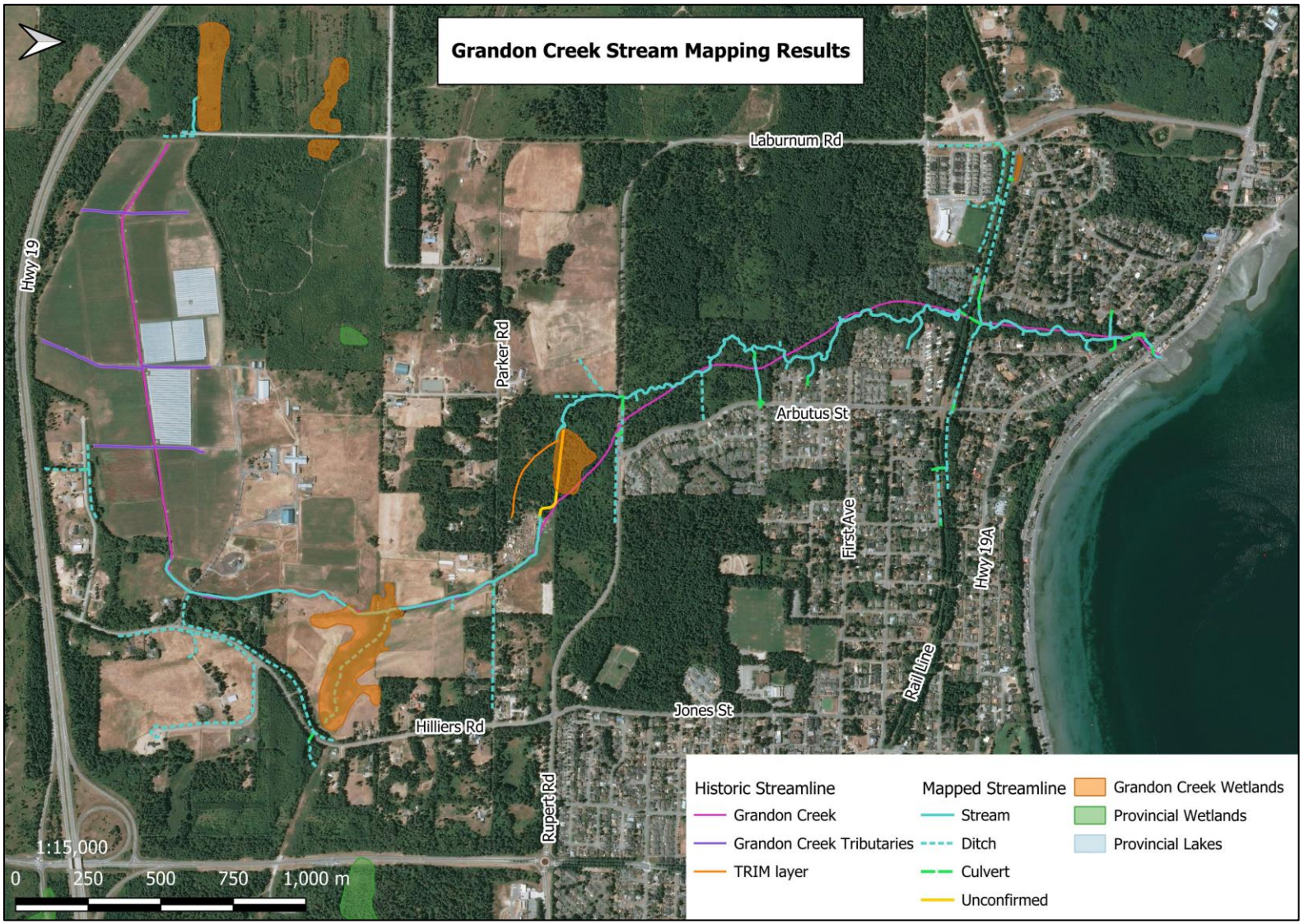


Figure 4. Ground-truthed stream mapping results of Grandon Creek, Qualicum Beach, BC. (historic streamlines are depicted in pink).



Features of Interest

Key features of interest that were identified during the survey are outlined here and presented below in mapped form (Figure 5 and Figure 6) for Beach and Grandon creeks. Photographs of these features are included in Appendices A and B for Beach Creek and Grandon Creek, respectively. Sections of the stream channel have been broken down based on their location within the geographic areas and discussed in this manner below.

Beach Creek

Qualicum Beach Memorial Golf Course

The Qualicum Beach Golf Course has maintained portions of the riparian vegetation within its property. Notable exceptions include the pond ~280 m upstream of the confluence with the ocean, and the recent riparian clearing associated with a private bridge construction project, occurring ~600 m from the confluence with the ocean (Figure 5).

The constructed pond acts as a water feature and is regulated by a small dam. The pond is predominantly void of large trees within the riparian zone; the riparian zone averages 5 m in width and is composed primarily of shrubs and aquatic vegetation (i.e., reeds and sedges). Coho parr were observed near the margins of the pond, where the fish were utilizing overhanging and in-water vegetation for refuge. The outlet from the pond is perched and consists of a ~1.1 m drop over the dam structure. The dam height is controlled by the placement of stop logs (timber boards) that can be removed to enable fish passage upstream during spawning season. QBS team members provided dam operational information regarding fish passage.

The riparian clearing that occurred upstream was to enable the construction of a new pedestrian/golf cart bridge from the top of the ravine banks. Several large trees were removed, and both ravine banks were replanted with riparian vegetation. Silt fencing and straw bales were observed to have been installed to mitigate sediment and erosion concerns. Coho salmon parr/fry were observed just upstream of this area at the culvert under Crescent Rd E.

Heritage Forest

The Heritage Forest supports a well established riparian habitat within the ravined banks, which is further surrounded by a mature stand of conifers. QBS volunteers have completed several riparian restoration efforts within the Heritage Forest to encourage this excellent habitat to persist. These activities have included the removal of invasive plant species and the planting of native riparian vegetation within disturbed areas. Observations of Coho salmon fry, parr, and adults within this reach indicate that the Heritage Forest provides key habitat for this species. The upper extent of the spawning area is unknown; however, Coho spawner pairs (40 total individuals) were observed up to the rail line between Hemsworth Rd and Qualicum Rd during the survey (December 2024).

School Creek River Left Tributary

A river left tributary of Beach Creek, known as School Creek, was identified and ground truth-mapped in June 2024. Source waters for this tributary originate from City of Qualicum Beach stormwater culverts along Berwick Rd and the Rail line. Waters are directed east along the rail ditch before entering a ~160 m long culvert running under the sports field behind Kwalicum Secondary School. The sports field culvert outflow then travels under the school via a modified streambed (i.e., cobbles set in concrete) for ~100 m. Flows then converge with roadside ditching along Village Way after crossing Village Way via another culvert. The culvert outflow is perched 3.2 m above the streambed and is thus a definitive barrier to fish passage (Figure 5). The natural stream channel flows north for ~230 m before converging with the mainstem of Beach Creek within the Heritage Forest. This lower reach of the tributary is ravined, with good riparian vegetation and good gravel conditions. A second perched culvert (2.6 m drop) draining roadside ditching flows from along Village Way, enters the channel 50 m downstream from the first culvert.

Channelized Stream Above Rail Line

The habitat upstream of the rail line is highly channelized between Mant Rd and Rupert Rd. This includes the river left tributary ditch flowing east along the south side of Garden Rd, as well as the mainstem, which flows east along Nenzel Rd and north along Qualicum Rd before being channeled along property lines north towards Mant Rd (Figure 5). A ~300 m long section north of Rupert Rd is naturalized through a forested property before becoming channelized again. The mainstem contained the majority of flows (>30 cm depth) during the survey (December 2024). The river left tributary along Garden Rd is sourced primarily from the City of Qualicum Beach stormwater infrastructure along Berwick Rd S. This tributary contributes moderate flows (<20 cm depth) as observed during the survey (December 2024).

Pheasant Glen Golf Course

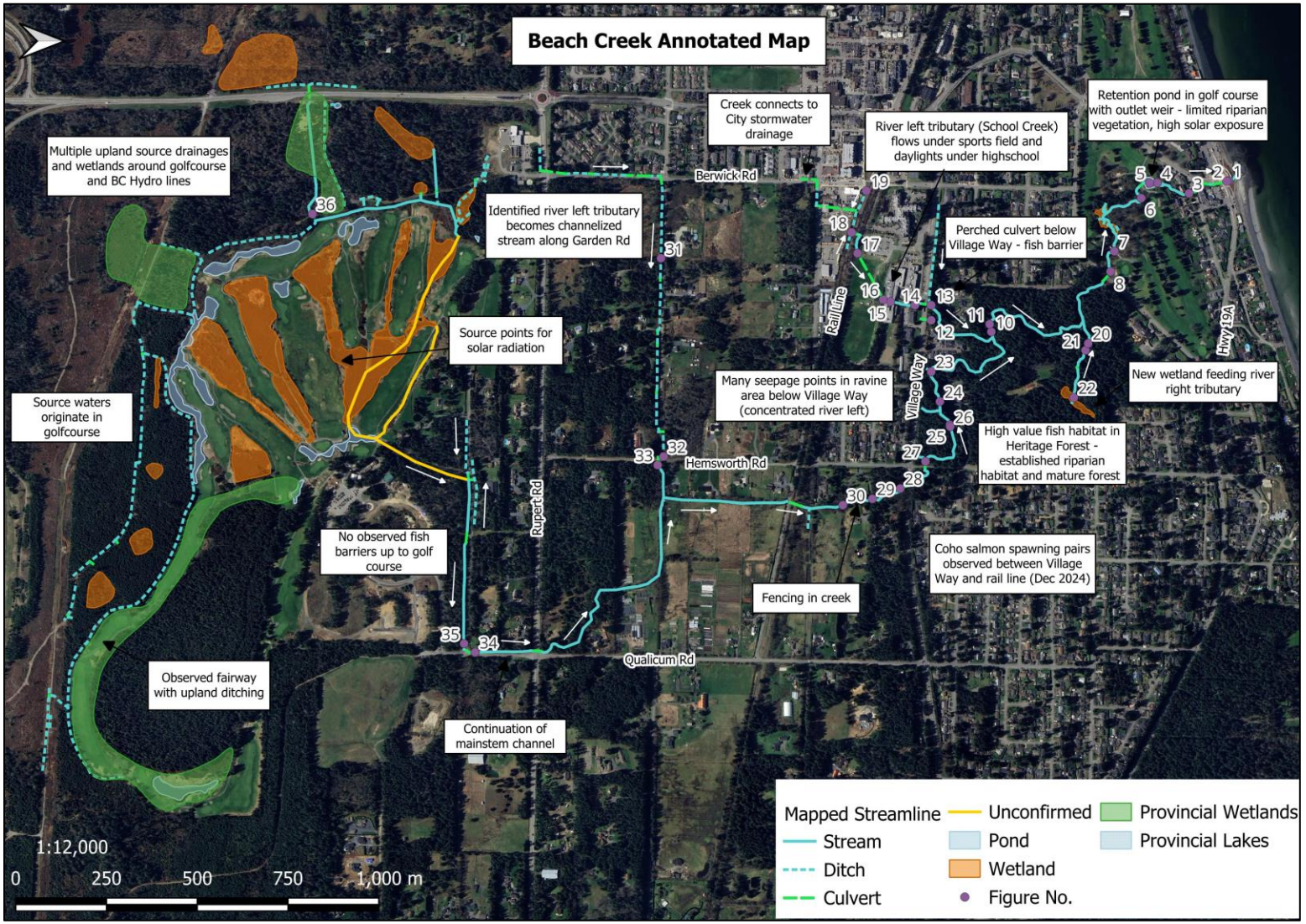
Multiple source drainages (headwaters) to Beach Creek were identified to the south and west of the Pheasant Glen Golf Course. These drainages were observed to feed into a large ditching network located upland of the golf course. Flows then entered the golf source through multiple channels/excavated ponds before connecting into the Beach Creek mainstem along Nenzel Rd. At the time of the survey, access to the golf course had not been obtained, and for reasons of safety concern, the stream sections within the golf course were not assessed.

Areas around the golf course were characterized as wetland habitat. Previous wetlands had been identified within the area. During the survey, the historic provincially mapped wetlands (three) were examined, and newly observed wetland areas were delineated (Figure 5). The two historic wetland areas on the southern and western sides were observed to be intact, while the wetland area to the east was observed to be composed of a maintained fairway within the golf

course. Several other pocket wetlands with connectivity to Beach Creek were mapped, including the excavated ponds/wetlands within the golf course that are fed by upstream sources. These pond/wetlands were characterized by the dense hardhack (*Spiraea douglasii*) and red osier dogwood (*Cornus sericea*) that lined their banks.

There were no observed fish barriers along the Beach Creek mainstem up to or past the Pheasant Glen Golf Course. It is recommended that fish sampling above and below the golf course be completed to confirm if this is a fish-bearing reach.

Figure 5. Annotated features of interest map for Beach Creek, Qualicum Beach, BC. (See Appendix A for corresponding site photographs.)



Grandon Creek

Grandon Creek Trail Park and Fish Passage

The stream channel within the Grandon Creek Trail Park has a well-established riparian zone from the top of the ravine bank down to the natural stream boundary. However, many homes have been built along the top of the ravine bank, and many invasive plant species (e.g., English ivy, *Hedera helix*) spread downslope from these properties between Crescent Rd and Hoylake Rd. In addition, numerous stormwater drain pipes, both private and public, were observed to traverse down the steep banks and enter the channel. The intent is to minimize erosion and help stabilize the banks. Riparian planting works completed by the Qualicum Beach Streamkeepers (QBS) along the trail were observed and are recommended to be monitored to ensure success.

There were no observed fish barriers within this section of the mainstem of Grandon Creek. There are concrete fish ladders at the confluence with the ocean below Hwy 19A, and there are ~85 m of daylighted culverts between Hwy 19A and Crescent Rd to encourage fish passage upstream into Grandon Creek Trail Park. These improvements downstream of Grandon Creek Trail Park appears to be effective in allowing the anadromous migration upstream, as supported by Coho fry observations upstream during the survey (February 2025). In addition, the Qualicum Beach Streamkeepers (QBS) and the City of Qualicum Beach have completed other restoration works within the park in recent years (i.e., pool construction, LWD placement, and spawning gravel placement).

Hoylake Rd Tributary

A river right tributary ditch along Hoylake Rd was identified. The tributary is composed of a constructed channel which flows for ~730 m parallel to the walking path before passing under Arbutus St and continuing along Hoylake Rd. The tributary then cascades down a bedrock chute into Grandon Creek from the top of the ravine bank underneath a small pedestrian bridge. The tributary input into Grandon Creek is a barrier to fish passage due to the step gradient (>20 % grade). The tributary is sourced from the City of Qualicum Beach's stormwater infrastructure near the corner of Harlech Rd and Alder St.

In addition, a river left tributary ditch flowing east from Laburnum Rd was identified. The ditches run along both sides of the walking path west of Hoylake Rd for ~600 m and convey surface flows from along Laburnum Rd into Grandon Creek. The culvert outlet feeds into the Grandon Creek ravine and cascades down a bedrock chute into Grandon Creek. This tributary is also a barrier to fish passage due to the steep gradient (>20 % grade) and that the culvert outlet is perched (~30 cm drop).

The mainstem of Grandon Creek flows through a long 1,100 mm diameter culvert set into a concrete headwall under Hoylake Rd and the rail line. This culvert has been assessed as a barrier

to fish passage in the past due to its length (~88 m), a change in direction leaving no visible exit, and a midpoint change in elevation. However, Coho salmon fry were observed upstream of Hoylake Rd during this assessment (February 2025). As such, we would classify the culvert as an obstacle to migration rather than an anadromous barrier. Passage concerns have been referred to DFO's Centre of Expertise (Peter Dekoning).

Multiple tributaries/drainage inputs

Above Hoylake Rd in the Nature's Garden Forest Park, there are multiple point-source drainage inputs into Grandon Creek. Many of these inputs are directed into the creek via long PVC pipes from residential properties, in addition to those sourced from the City stormwater system. These long pipes reduce negative impacts by directing runoff away from soft slopes, thus reducing erosion of the ravine banks and limiting fine sediment inputs into the creek.

The habitat within the park is excellent, with stands of mature forest and well-established riparian vegetation. Instream features such as rearing and spawning habitat were observed to be excellent within this reach.

Agriculture Riparian Concerns

Above Rupert Rd, Grandon Creek becomes modified as a result of historic agricultural activities. Immediately upstream of Rupert Rd, the creek is channelized along a property line for ~120 m. Above this, the channel enters a wetland area to the east (i.e., becoming undefined and highly vegetated). The creek becomes channelized again as it travels east-south-east for ~280 m through a neighbouring property along Parker Rd. The riparian zone is highly degraded through this area (i.e., limited vegetation with no mature trees and dense Himalayan blackberry, *Rubus armeniacus,* presence). Mapping of this area was limited as access to this property had not been obtained prior to works commencing, and the channel was too overgrown to traverse. To address this, satellite imagery was reviewed to map the stream channel. During the review of aerial imagery, a large number of parked vehicles located next to the creek were observed. These were identified as an item of concern with regard to potential leakages of oils or fuels from these vehicles entering the creek and impacting the aquatic habitat.

Upstream of Parker Rd (~380 m), Grandon Creek remains channelized, and the riparian zone continues to be highly degraded by invasive plant species (i.e., Himalayan blackberry, *Rubus armeniacus,* and reed canary grass, *Phalaris arundinacea*) and the lack of mature trees needed to provide shading. In addition, livestock are free to enter the riparian zone, which results in increased sediment through bank disturbances and animal waste inputs into the creek. Engagement with one of the property owners during the survey was encouraging, as they were eager to learn how to improve fish habitat within their property. We encourage QBS and others to help support local farmers and other landowners to undertake riparian improvements.

Riparian vegetation is a key part in maintaining cool water temperatures during summer periods and reducing sediment inputs during rain events.

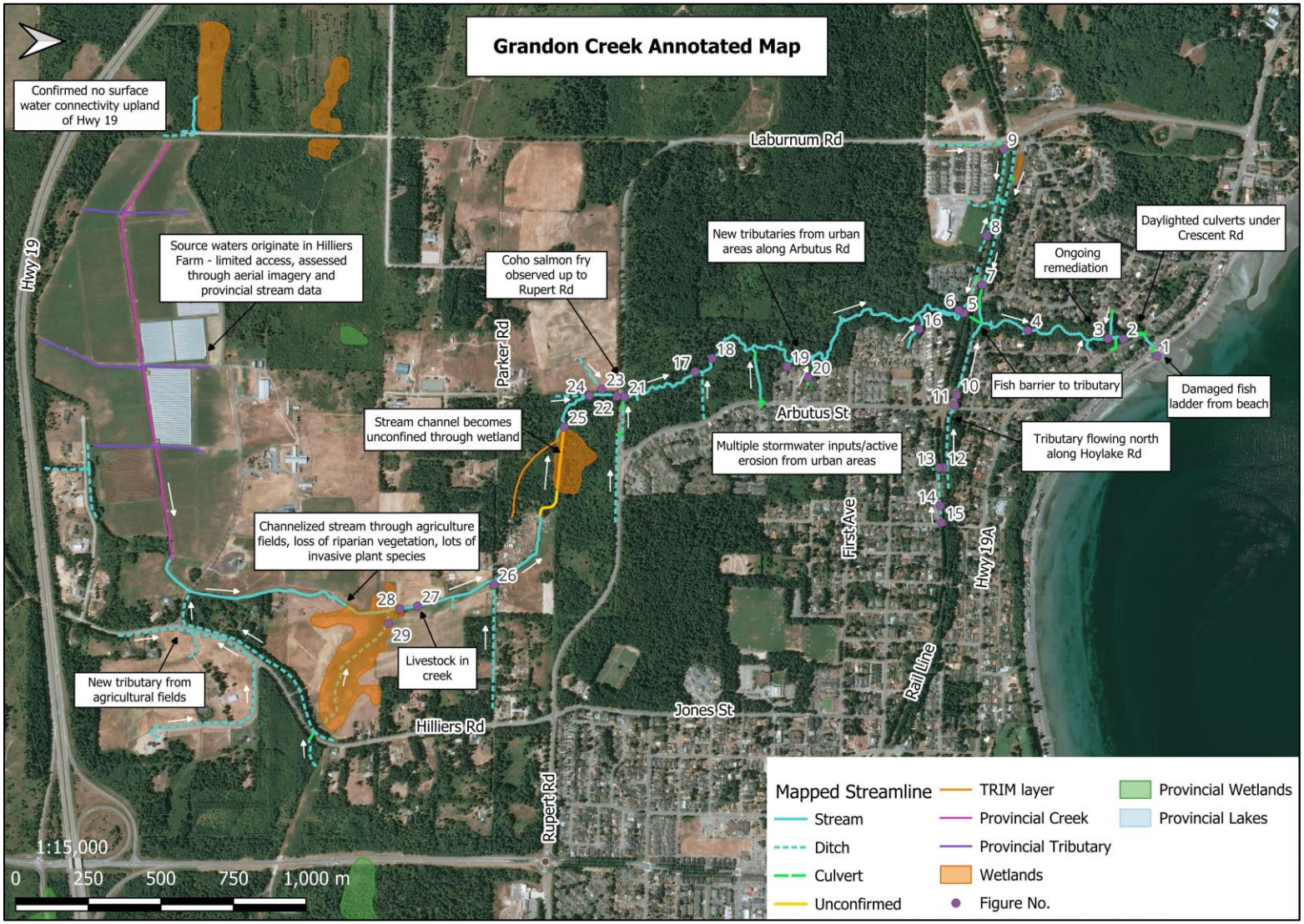
A large wetland complex feeds into Grandon Creek west of Hilliers Rd. The wetland is primarily underneath BC Hydro lines and is dominated by hardhack (*Spiraea douglasii*) and reed canary grass (*Phalaris arundinacea*). The mainstem of Grandon Creek upstream of this wetland complex (~800 m) continues to be channelized, with a limited riparian zone. Ditching conveying surface flows from Hilliers Rd and Monte Vista Dr converge with the Creek at Turner Meadow Rd.

Hilliers Farm

The source waters for Grandon Creek originate within the Hilliers Farm property (upstream of Turner Meadow Road). This area was not ground-truth surveyed as permission had not been obtained during the time of the survey. A small wetland was identified east of Laburnum Rd, with limited downstream connectivity into the Hilliers Farm property due to constructed berms along the fence line. As such, it was defined as isolated but is likely to have groundwater connectivity. No additional source waters were observed upland of Hillier's farm above Hwy 19.

No other barriers or obstacles to migration were observed between the Hoylake Road culvert and Hillers Farm. It is recommended that fish sampling be undertaken within the upper reaches of this watercourse to determine fish distribution.

Figure 6. Annotated features of interest map for Grandon Creek, Qualicum Beach, BC. (See Appendix B for corresponding site photographs.)



Recommendations

Remediation opportunities

We encourage continued riparian remediation efforts, including planting native vegetation and removal of invasive plant species. Observed invasive plant species include reed canary grass, English ivy, and Himalayan blackberry. Working with private land owners to develop strategies to improve fish habitat in the upper reaches is also encouraged (i.e., increase riparian buffers, apply reed canary grass treatment, install fencing to keep livestock out of riparian zones).

Fish Passage Improvements

It is recommended to update the barrier assessment of the Hoylake Road culvert to determine fish passage limitations. Further engagement with DFO's Centre of Expertise is also encouraged to determine if fish passage within the existing culvert can be improved through the placement of baffles within the culvert or a ladder below.

A ranked list of all identified culverts based on their barrier severity (e.g., perched, undersized, high-velocity flow), habitat gain potential upstream, and feasibility of replacement or retrofit can be provided.

Whiskey Creek Mapping

Ground-truth mapping of Whiskey Creek began in Spring 2025 and will resume in the Fall 2025 (as funds allow). An updated report or a separate report shall be issued upon the completion of the mapping works.

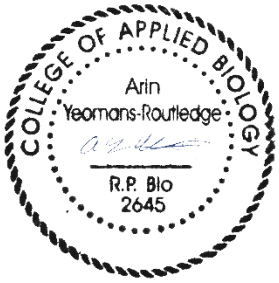
Closure

The stream mapping project conducted by Astraea Biologists in partnership with the Qualicum Beach Streamkeepers has greatly improved the understanding of aquatic habitat for Beach Creek and Grandon Creek. Through ground-truthed, GPS-based habitat mapping techniques, the project identified critical features, including unmapped tributaries, fish barriers, riparian degradation, and key spawning and refuge habitats. The resulting data is to be integrated into the Provincial (iMapBC) and the Nanaimo Regional District's online mapping platforms, which will support informed decision-making and conservation planning. Looking ahead, targeted efforts of invasive species management, riparian restoration, and fish passage improvements are recommended to enhance the ecological function, improve habitat connectivity, and support the long-term health of these local streams and the aquatic life they support.

Sincerely,

Katie Schulze, B.I.T., B.Sc., and

Arin Yeomans-Routledge, R.P.Bio., B.Sc.,



Arin Yeomans-Routledge, R.P.Bio. (2645), B.Sc., QEP.

Appendices

Appendix A - Beach Creek: Photo Appendices

Appendix B - Grandon Creek: Photo Appendices

Appendix A

Beach Creek: Photo Appendices

Figure 1. Pedestrian crossing at Hwy 19A. Arrow indicates flow direction. Photograph collected June 7, 2024.

Figure 2. Outlet of Beach Creek under Hwy 19A, including fish-passable weirs. Arrow indicates flow direction. Photograph collected June 7, 2024.

Figure 3. Inlet of Beach Creek under Elizabeth Avenue. Arrow indicates flow direction. Photograph collected June 7, 2024.

Figure 4. Outlet from Golf Course pond beneath foot bridge: drop of ~1 m, though the drop is reduced to 0.8 m with boards removed (fish-passable). Arrow indicates flow direction. Photograph collected June 7, 2024.

Figure 5. View of the Qualicum Memorial Golf Course pond with increased solar radiation and minimal riparian vegetation to provide shading. Coho fry observed. Photograph collected June 7, 2024.

Figure 6. Excellent habitat and riparian vegetation maintained in Qualicum Beach Memorial Golf Course. Arrow indicates flow direction. Photograph collected June 7, 2024.

Figure 7. Disturbed area for construction of new pedestrian/cart bridge at the Qualicum Beach Memorial Golf Course. Erosion and Sediment control concerns. Arrow indicates flow direction. Photograph collected June 7, 2024.

Figure 8. Outlet of culvert under Crescent Road E. Riparian remediation planting and sediment and erosion control measures in place. Arrow indicates flow direction. Photograph collected June 7, 2024.

Figure 9. View of Coho salmon parr at the Crescent Road E culvert outlet (circled). Arrow indicates flow direction. Photograph collected June 7, 2024.

Figure 10. Representative view of the riparian habitat within the Heritage Forest. Arrow indicates flow direction. Photograph collected June 7, 2024.

Figure 11. Representative view of gravel habitat in the creek bed within the Heritage Forest. Arrow indicates flow direction. Photograph collected June 7, 2024.

Figure 12. Perched culvert from Village Way roadside ditching. Culvert drop is 2.6 m (fish barrier). Arrow indicates flow direction. Photograph collected June 7, 2024.

Figure 13. Perched culvert under Village Way from School Creek tributary. Culvert drop is 3.2 m (fish barrier). Arrow indicates flow direction. Photograph collected June 7, 2024.

Figure 14. Representative view erosion concerns in School Creek tributary upstream of Village Way. Arrow indicates flow direction. Photograph collected June 7, 2024.

Figure 15. Representative view of the modified School Creek tributary that flows under Kwalikum Secondary School. Arrow indicates flow direction. Photograph collected June 7, 2024.

Figure 16. Representative view of School Creek tributary outflow from beneath Kwalicum Secondary School sports fields. Arrow indicates flow direction. Photograph collected June 7, 2024.

Figure 17. Representative view of the culvert inflow of School Creek tributary beneath the Kwalicum Secondary School sports fields. Arrow indicates flow direction. Photograph collected June 7, 2024.

Figure 18. Representative view of the culvert inflow beneath the rail line. Arrows indicate flow direction. Photograph collected June 7, 2024.

Figure 19. Representative view of the culvert inflow into railway ditching from the City of Qualicum Beach Stormwater system at the corner of Second Avenue E and Berwick Road S. Arrow indicates flow direction. Photograph collected June 7, 2024.

Figure 20. Newly identified river right tributary. Streambed mostly organics and fines, little gravel, likely ephemeral. Arrow indicates flow direction. Photograph collected December 2, 2024.

Figure 21. Historic culvert with weirs in river right tributary. Connects to City Stormwater (red algae abundant). Arrow indicates flow direction. Photograph collected December 2, 2024.

Figure 22. Wetland at top of newly identified river right tributary. With an abundance of sedges and other hydrophilic vegetation. Photograph collected December 2, 2024.

Figure 23. Example view of multiple identified river left seeps from Village Way into the mainstem of Beach Creek (erosion concerns). Arrow indicates flow direction. Photograph collected December 2, 2024.

Figure 24. Representative view of Beach Creek mainstem. Gravel very suitable for Coho spawning. Arrow indicates flow direction. Photograph collected December 2, 2024.

Figure 25. Representative view of multiple Coho Redds (circled). Several were identified in the Heritage Forest to above Village Way. Arrow indicates flow direction. Photograph collected December 2, 2024.

Figure 26. Example of Coho salmon spawning pairs observed in mainstem from Heritage Forest to above Village Way (circled). Arrow indicates flow direction. Photograph collected December 2, 2024.

Figure 27. Culvert outlet under Hemsworth Road. Arrow indicates flow direction. Photograph collected December 2, 2024.

Figure 28. Culvert inlet under Village Way. Arrow indicates flow direction. Photograph collected December 2, 2024.

Figure 29. Culvert outlets under driveways. Arrow indicates flow direction. Photograph collected December 2, 2024.

Figure 30. Fencing in Beach Creek. Photograph collected December 2, 2024.

Figure 31. Beach Creek river left tributary along south side of Garden Road. Arrow indicates flow direction. Photograph collected December 2, 2024.

Figure 32. View of the culvert under Garden Road at the intersection with Hemsworth Rd. Arrow indicates flow direction. Photograph collected December 2, 2024.

Figure 33. View of the culvert outflow under Hemsworth Road. Tributary continues through forested section before converging with the mainstem. Arrow indicates flow direction. Photograph collected December 2, 2024.

Figure 34. View downstream from Nenzel Road of the channelized portion of Beach Creek mainstem. Arrow indicates flow direction. Photograph collected December 2, 2024.

Figure 35. View upstream from the intersection of Nenzel Road and Qualicum Road of the Beach Creek mainstem. Arrow indicates flow direction. Photograph collected December 2, 2024.

Figure 36. Example view of drainage upland of the Pheasent Glen Golf Course. Arrow indicates flow direction. Photograph collected December 2, 2024.

Appendix B

Grandon Creek: Photo Appendices

Figure 1. Constructed concrete weirs below Hwy 19A (fish passage). Arrow indicates flow direction. Photograph collected February 12, 2025.

Figure 2. Inlet of culverts (including daylighting system) under Crescent Road at Grandon Creek Trail Park (culvert with grate accommodates high flows). Arrow indicates flow direction. Photograph collected February 12, 2025.

Figure 3. Example of large woody debris features throughout Grandon Creek Trail Park. Arrow indicates flow direction. Photograph collected February 12, 2025.

Figure 4. Representative view of the streambed habitat of boulder-cobble-gravel within Grandon Creek Trail Park. Arrow indicates flow direction. Photograph collected February 12, 2025.

Figure 5. View upstream of the culvert inflow at Hoylake Road. Arrow indicates flow direction. Photograph collected February 13, 2025.

Figure 6. View downstream of the culvert under Hoylake Road. Arrow indicates flow direction. Photograph collected February 13, 2025.

Figure 7. River left tributary culvert inflow under Hoylake Road. Arrow indicates flow direction. Photograph collected February 12, 2025.

Figure 8. River left tributary ditching along rail trail. Photograph collected February 26, 2025.

Figure 9. River left tributary ditching looking towards Laburnum Road. Arrow indicates flow direction. Photograph collected February 26, 2025.

Figure 10. River right tributary along Hoylake Road. Arrow indicates flow direction. Photograph collected February 12, 2025.

Figure 11. River right tributary culvert under Arbutus Street. Arrow indicates flow direction. Photograph collected February 12, 2025

Figure 12. River right tributary culvert outflow under rail line. Arrow indicates flow direction. Photograph collected February 12, 2025

Figure 13. River right tributary culvert inflow under rail line. Arrow indicates flow direction. Photograph collected February 12, 2025

Figure 14. River right tributary along Harlech Road. Arrow indicates flow direction. Photograph collected February 12, 2025

Figure 15. River right tributary along Hoylake Road sourced from City of Qualicum Beach stormwater at Harlech Road and Alder Street. Arrow indicates flow direction. Photograph collected February 12, 2025.

Figure 16. Small river right tributary near Claymore Road in a steep gully. Arrow indicates flow direction. Photograph collected February 12, 2025

Figure 17. Representative view of the riparian habitat of Grandon Creek within Nature's Garden Park. Arrow indicates flow direction. Photograph collected February 12, 2025.

Figure 18. Volunteers assisting with stream mapping efforts in Nature's Garden Park. Photograph collected February 12, 2025.

Figure 19. City stormwater outflow into Grandon Creek. Arrow indicates flow direction. Photograph collected February 12, 2025.

Figure 20. Example of piped rainwater runoff from residential areas into Grandon Creek. Arrow indicates flow direction. Photograph collected February 12, 2025.

Figure 21. Rupert Road bot culvert outflow. Arrow indicates flow direction. Photograph collected February 12, 2025.

Figure 22. Rupert Road box culvert inflow. Arrow indicates flow direction. Photograph collected February 26, 2025.

Figure 23. Ditch from agricultural field river left, upstream of Rupert Road. Arrow indicates flow direction. Photograph collected February 26, 2025.

Figure 24. Channelized stream along property line looking north towards Rupert Road. Arrow indicates flow direction. Photograph collected February 26, 2025.

Figure 25. Wetland habitat between Rupert Road and Parker Road. The stream channel becomes unconfined through hardhack and sedges. Arrow indicates flow direction. Photograph collected February 26, 2025.

Figure 26. Tributary ditch along Parker Road. Arrow indicates flow direction. Photograph collected February 12, 2025.

Figure 27. Channelized stream through agricultural field upstream of Parker Road with reduced riparian buffer and increased reed canary grass presence. Arrow indicates flow direction. Photograph collected February 26, 2025.

Figure 28. Channelized stream through agricultural field upstream of Parker Road with reed canary grass and livestock trampling. Arrow indicates flow direction. Photograph collected February 26, 2025.

Figure 29. Beginning of wetland complex through agricultural land. Presence of reed canary grass and hardhack. Arrow indicates flow direction. Photograph collected February 26, 2025.