Airpark Lagoon Breach Project:

Phase 2

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Executive Summary

Along the right bank of the K'omoks estuary where the river meets the mudflats lies the Courtney Airpark Lagoon. It's a destination for residents and visitors; a place where people of all ages gather to play, get exercise, and enjoy nature. Its position in the estuary is close to the limit of salt water intrusion, where brackish waters support an abundance of plankton that provide a foundation for larger forms of life. Young salmon use the lagoon to feed and grow or as a short stopover as they migrate out to sea. In the late summer and fall, adult salmon can be found swimming in the shallows, awaiting high tide to proceed with their journey upstream. A diversity of shore and diving birds are regulars here, particularly during the winter and spring when they take refuge from stormy seas. Mammals small and large feed off the bounty found in the salt marshes and mudflats, including small rodents, deer, and even bear.

It wasn't always this way. Behind the lagoon's aesthetic appeal is a history of dredging, channelization and diking. These activities radically changed this part of the estuary from a dynamic system with branches feeding estuarine mudflats to a single channel diverted by a dike. By severing contact between the upper mudflats and the river channel, a key process that fed a thriving ecosystem was degraded.

A Short History

The 2ha lagoon was built in the 1950's to treat the City's sewage waste until operations ceased in the early 1980's. A decade later, the dike encircling the lagoon was breached at the lower end where it met the estuary mudflats and park amenities were added. While the area was partially restored with native plantings and the re-introduction of tidal flows, it remains highly modified. As it provides important social and aesthetic public services, it is not likely to be returned to a natural state. However, there is an opportunity to greatly improve ecosystem functions for fish and wildlife while maintaining, and likely enhancing, its use as a public park.

Vision

Information collected since 2010 identifies that a second breach is a viable solution to partially restore important ecosystem processes. A second breach will connect the river with the upper lagoon, introducing cool, fresh water and improving flushing and access for fish. Water from the uppermost layer of river will enter this breach during mid to high tides and storm flows at an elevation slightly above the lower breach. Water introduced will be fresher than from the lower breach, further enhancing habitat where fish can access and adapt to changing salinities. As the tide recedes, water will also leave by this breach as it will through the lower breach.

Project

The 2013 study, and the subject of this report, affirmed that a second breach will provide a great benefit for fish and fish habitat in the K'omoks estuary. It involved the mapping of vegetation, the analysis of fish and bird use of the lagoon and area, water and sediment monitoring, analysis using hydrologic models, and project planning. These activities have placed this project in a ready state for project implementation. There is now important baseline information for comparison after the breach is constructed, regulatory requirements have been clarified, and there is a project design and budget in

place. Further, there is a knowledge base that supports project implementation and the expected benefits to the K'omoks estuary.

The vegetation mapping will aid in restoration after breach construction and in subsequent monitoring. The bird and fish studies also provide baseline information for future monitoring, and identify suitable project timing to minimize disturbance. The fish monitoring further supports previous data that indicated the lagoon is underutilized during July and August. Water temperature data between the lagoon, river and the Dyke Slough reference site suggest that high summer temperatures help explain why young salmon don't use the lagoon during these months.

Sediments at the proposed breach location were tested for contamination associated with municipal sewage sludge. The samples did not exceed Contaminated Sites Regulation criteria for sensitive marine and estuarine environments. Mercury and copper concentrations did exceed the more conservative CCME[1] Probable Effects Levels (PEL)[2] for freshwater but not for marine or estuarine environments. A Contaminated Sites Approved Professional provided an Opinion Letter that identified methods and parameters tested were appropriate, and that sludge excavated for the project was suitable for on-site disposal. The Land Remediation Section of the Ministry for the Environment reviewed all available information, including the Opinion Letter, and agreed that the project was low-risk and not a concern under the Contaminated Sites Regulation.

Hydraulic modeling of tidal flow cycles in and out of the lagoon compared the current single breach to the proposed second breach. A TELEMAC-2D model applied a theoretical dye tracer to observe the time for the lagoon to completely dilute. With a second breach the tracer dye diluted by 70% within 10 hours compared to 34 hours without the breach, and >80% after 34 hours compared to 59 hours without. This is significant considering that turbulence upon mixing is responsible for distributing life-supporting oxygen carried by the cool, fresh riverine water.

The project feasibility was further assessed through investigation of structural options for a breach and a consideration of costs and benefits. A 2.4 meter-wide concrete box culvert was chosen, as it provided sufficient mixing without the potentially debilitating costs associated with the other designs and a larger-sized culvert. Further the design and placement of the culvert was such that erosion would be minimal and changes to water levels negligible even during storm flows/high tide conditions.

This project also had a strong communications component. Experts and stakeholders were consulted through letters, phone calls, emails, meetings, and presentations. Stakeholders included representative of the City of Courtenay, the K'omoks First Nation, the Tsolum River Restoration Society, Courtenay Fish and Game Protective Association, Comox Valley Naturalists, Comox Valley Environmental Council, Fisheries and Oceans Canada, and the Courtenay Air Park Association. The City of Courtenay is the crown land lease holder for the Airpark Lagoon, and was supportive of the project given conditions of obvious environmental and public benefits, sound design and construction and public safety. The K'omoks First Nation holds territorial rights over the area, and has an interest in estuarine protection and restoration, as described in a Memorandum of Agreement with Project Watershed[3] . Government

[1] Canadian Council for Ministers of the Environment
[2] PEL refers to the level above which adverse effects are expected to occur frequently.
[3] In 2011 the K'omoks First Nation and PW signed a Memorandum of Agreement to work together to protect and preserve the Courtenay River Estuary.

stakeholders were valuable in providing advice on regulatory requirements and process. The Courtenay Airpark Club's support is crucial as they utilize the runway adjacent to the project site, which is the most feasible access point for construction. The Comox Valley Naturalists Society have been actively restoring the Airpark with native plantings for over 20 years, and participated in the bird monitoring for this project. Other stewardship groups also have a vested interested in protecting the lagoon for the health of fish and wildlife.

Moving Forward

This project has provided a framework towards a project management plan, including associated Environmental Protection Plans/Best Practices, a safety plan, and a monitoring plan. Recommendations to proceed cover the areas of planning, communications, timing, implementation, project management, and outreach. Further, monitoring considerations are outlined, along with key outcomes and indicators to evaluate the success of this project in future years.

It is expected this project can be implemented in the summer of 2014. Project Watershed will continue as the lead proponent with the assistance and cooperation of many stakeholders. Funding has been applied for through BC Hydro's FWCP for implementation and monitoring. Regardless of funding approval, the activities in 2013 have laid the foundation on which to proceed. We are confident this project is needed, and an essential step in the rehabilitation of the K'omoks estuary.

Contents

Tables and Figures

Introduction

The Comox Valley Project Watershed Society (PW) has identified the K'omoks estuary (Figures 1 and 2) as a key area for restoration and enhancement so that ecosystems that support fish, birds and other wildlife may thrive once again. Historical human activity has damaged the estuary, resulting in the cutting off of floodplains and reduced functioning of key ecosystems. The Airpark lagoon has been identified as a restoration priority to address a limiting factor to fish productivity in the estuary (wetland off-channel habitat: Hamilton et al 2008; Hamilton et al, 2002; Jenkins et al, 2001; Morris et al, 1979; Tryon, 2011). It is expected that improving access between the river and the lagoon with a second breach will help return the K'omoks estuary to a functioning state. Lake Trail Environmental Consulting was contracted by PW to provide project management and biological services for this project.

Figure 1: K'omoks estuary in relation to Vancouver Island, British Columbia.

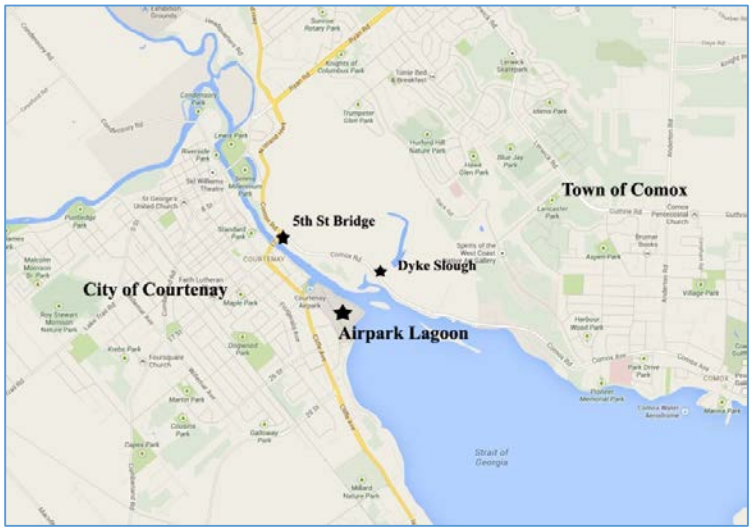

Figure 2: Location of the Airpark Lagoon and other landmarks in the K'omoks estuary.

Study Area

The Courtenay Airpark Lagoon is located in the City of Courtenay on the east coast of Vancouver Island, British Columbia. It is a 2 hectare salt marsh/pond complex in the Courtenay River estuary with a downstream opening to the estuary mudflats. The lagoon is separated from the Courtenay River by a dike. The lagoon site was historically a large tidal channel leading from the river to the estuary mudflats (Figures 3 and 4a). In the 1950's a dike was built to isolate it so it could receive sewage from the City of Courtenay (Figure 4b). It operated as a sewage lagoon for approximately thirty years, then sat unused for another decade until 1992 when it was converted to a public park. This conversion involved breaching the lagoon on the southeast side next to the mudflats to open it up to flows, and the enhancement of the lagoon to a salt marsh/pond complex (Figure 4c). The fringe of the lagoon was benched and planted with *Carex lyngbyii* and *Juncus spp.* which have since established. The lagoon is part of the Courtenay Riverway Park trail system and is now one of the most popular recreation areas in the City of Courtenay with hundreds of visitors each day.

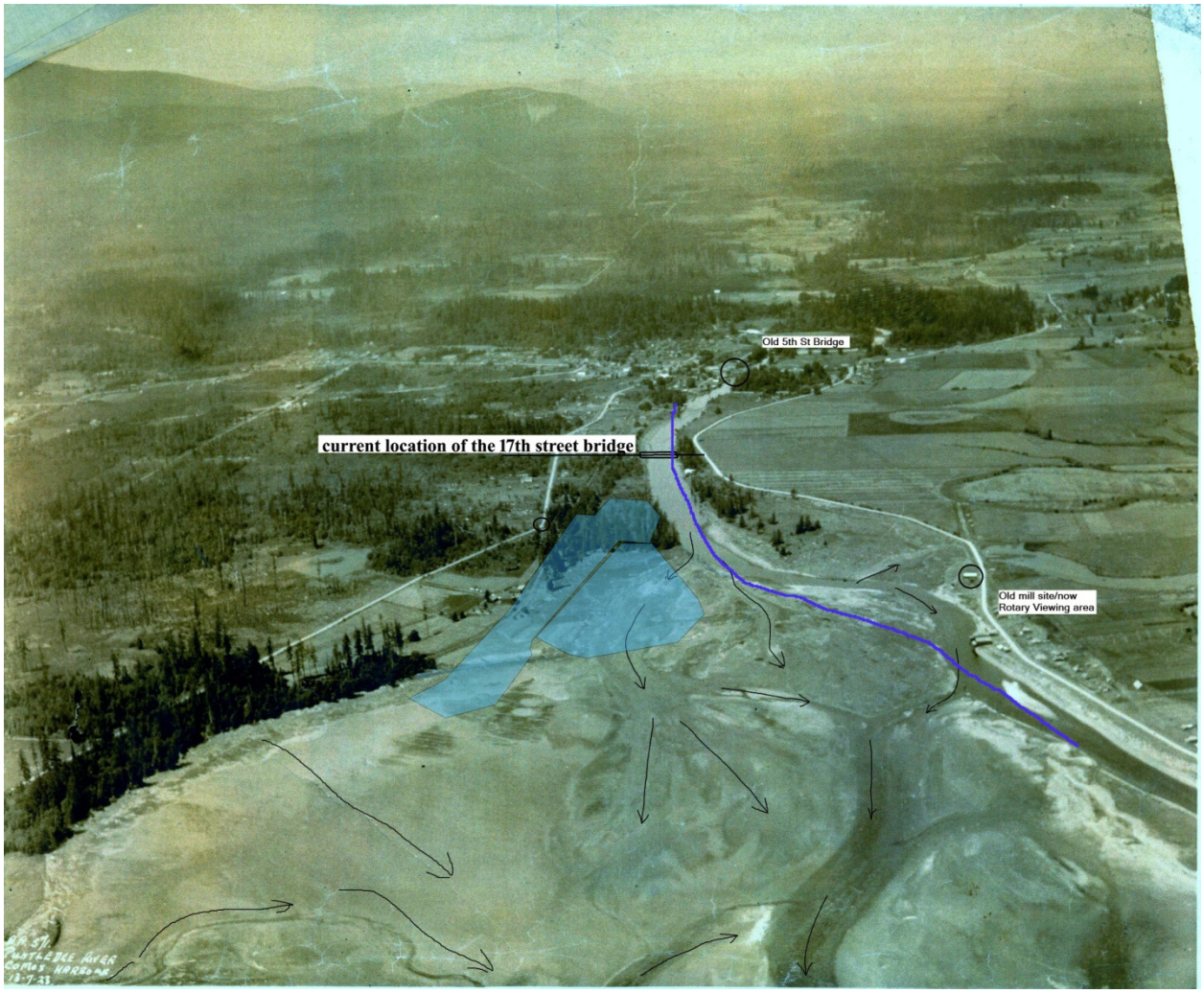

Figure 3: A 1923 oblique view aerial photograph of the project area. Arrows indicate historical flow dynamics, blue line indicates current river alignment according to 2012 Google Earth imagery, and the shaded blue indicate the areas now covered by the runway and the airpark lagoon dike.

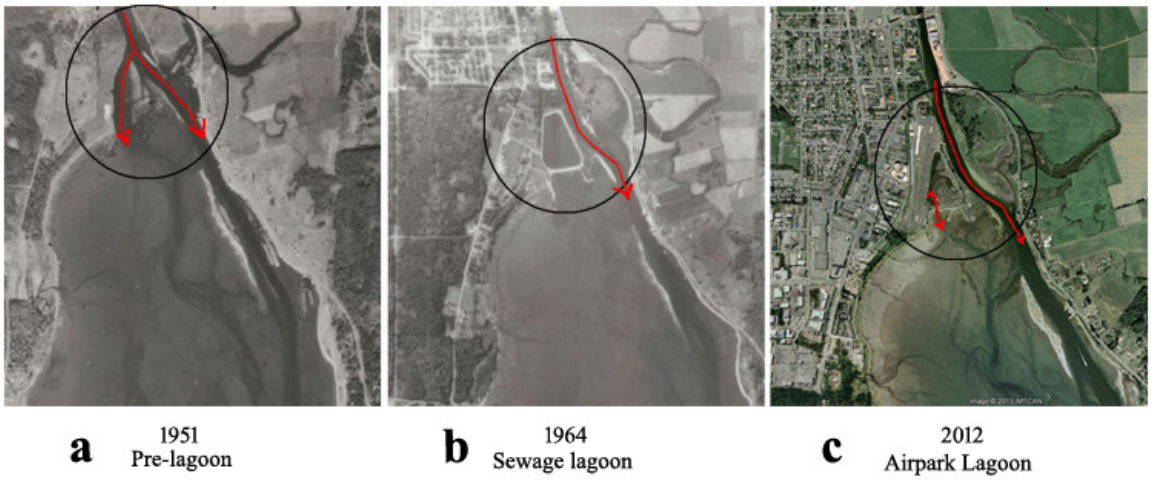

Figure 4: Timeline of modifications to the current Airpark lagoon. Red arrows indicate flow and direction.

Background

The idea of a second breach at the top end of the lagoon came about from observations of poor summer water quality and declined fish use during a study in 2010 (Tryon, 2011). Salmonids frequented the lower end of the lagoon in the early spring, though avoided the upper end (furthest from the existing breach). Further, fish captures declined rapidly throughout the month of June while they remained relatively high in habitat across the river from the lagoon (Dyke Slough tide gate pool); also a transition area between river and mudflat. Comparison of water temperatures between the two sites indicate that lagoon temperatures exceeded 20°C well before the Dyke Slough pool and may be a major factor to declined fish use. Young salmon will avoid water temperatures once they exceed 23°C as their ability to feed and swim becomes compromised. Further, temperatures that exceed 25°C can be lethal to salmonids (Bjornn & Reiser, 1991).

While the breach at the low end of the lagoon is an improvement over the closed system, it appears to be beneficial only to the lower end; the upper end remains relatively stagnant as indicated by high growth of algae and relatively thick sediments. In addition, prior to entering the lagoon in the summer months, water is first warmed over the mudflats baked in the sun during the daytime low tides. It was hypothesized that a second breach at the upper end to introduced riverine surface flows during mid-high tide/flow events would increase circulation and reduce summer temperatures in the lagoon, to the benefit of fish and other wildlife.

Restoration plans involve a simple breach at the top end of the lagoon opposite the current outlet (Figure 5). The second breach will be in the form of a 2.3m concrete box culvert of 20m in length and set at an elevation slightly greater than the outlet to allow water flows from the river into the lagoon at high tides and river discharge. Salvaged salt marsh vegetation will be replanted over the boulder aprons topped by fines and gravels. The project will be monitored for success through ongoing studies of fish and bird use and water quality.

Figure 5: Proposed location of second breach and existing outlet in the Courtenay Airpark lagoon.

Project Description

This project was done to assess baseline conditions and evaluate the benefits and risks of improving habitat in the lagoon for fish and wildlife through the installation of a second breach in the lagoon. It is the 2nd part of a phased approach to investigate, plan and implement actions to restore and monitor the lagoon for fish and wildlife with a second breach. Phase 1 was carried out in 2010 and involved a preliminary feasibility analysis for salt marsh restoration and the breach concept, including a survey of the proposed breach area and adjacent river cross-section as well as the compilation of pertinent background documents. Phase 3, planned for 2014, will involve the construction of the second breach, and Phase 4 the post-breach monitoring of the plants, birds, fish and water conditions. The 2013 study, and the subject of this report, involved the Phase 2 monitoring of fish and bird use, vegetation mapping and soil analysis, hydrological modeling, and preliminary planning activities.

Goals and Objectives

The overall goal of the phased breach project is to improve the health and functioning of the K'omoks estuary through key restoration actions that will address limiting factors to fish habitat. The Airpark lagoon has been identified as a restoration priority by the Comox Valley Project Watershed Society (PW) to address wetland off-channel habitat as a limiting factor to fish productivity. It is expected that improving access between the river and the lagoon with a second breach will help return the K'omoks estuary to a functioning state.

The key objectives for 2013 activities were to assess the risks and benefits of installing a second breach in the upper end of the Courtenay Airpark Lagoon and to collect baseline information to aid in construction planning and to ensure future evaluation of breach success.

The following activities and their associated purposes are outlined below:

- Vegetation/Habitat Survey:
  - Map vegetation communities in different areas of the lagoon, including the proposed breach location and nearby foreshore to identify Species at Risk and habitats that may be impacted by the project, and to provide baseline information for post-breach analysis
- Fish Monitoring
  - Monitor spring and summer fish use of the lagoon to assess if fish will benefit through increased circulation and decreased temperatures in the lagoon, and to provide baseline information for post-breach analysis. The second breach is expected to benefit juvenile salmon by providing improved access to the lagoon over time and space. Fish information will also help to identify construction work windows.
- Bird Monitoring
  - Bird use of the lagoon and adjacent foreshore will provide an indicator for benefits to wildlife from the second breach. It is anticipated that improved mixing and cooler temperatures resulting from a second breach will increase bird diversity in lagoon and surrounding foreshore. Bird information will also help to identify construction work windows.
- Water Monitoring
  - Water temperatures will be compared between the lagoon, river and a reference site. Temperatures will also be compared to fish captures to examine temperature thresholds that correspond to use. It will be used in the future to compare to post-breach conditions.
  - Water level monitoring provides information to assess the timing and duration of tidal inundation of the lagoon prior to post breach construction, and to verify the hydrological flow model.
- Soil Monitoring
  - Although file searches at the City of Courtenay and McElhanney Engineering revealed that the sewage sludge in the area was largely removed during park construction, there is the potential for lagoon sediments to be contaminated to some degree by remaining sludge. Soil monitoring was done to address this risk, and to inform decisions by regulatory authorities on permitting and approvals.
- Hydrological Modeling
  - Hydrologic modeling provides an opportunity to visualize the effects of a second breach, to estimate if flushing will be improved in the lagoon, and to what degree, and to predict potential problems with the breach due to erosion. This was also an important tool to design a breach that is both functional and cost-effective.
- Project Planning
  - Planning is an essential component, not only to breach construction and success, but also for the early identification of potential barriers and challenges to project

implementation. Activities involved communications with regulatory authorities and stakeholders and construction cost estimates for two breach options.

Methods

This phase involved hydraulic model development to test the technical feasibility of a lagoon breach, and data collection on water levels, fish and bird use, and sediment and water quality. The hydraulic modeling was done by Northwest Hydraulic Consultants (NHC), who incorporated 2012 LiDAR and bathymetry data from the City of Courtenay, detailed lagoon bathymetry collected by Bob Foster and Project Watershed, Canadian Hydrographic Services tide chart predictions, and Water Survey of Canada and PW flow and stage data. Hydraulic modeling involved the use of Telemac-2D software to model flushing and flows of different breach scenarios. From this a concept plan including CAD drawings of a 2.4m concrete culvert was designed. Meetings were held with stakeholders, including the City of Courtenay and watershed groups in the Comox Valley. Others who could not make the meetings were consulted via phone and email, including DFO, the Comox Valley Airpark Club and the K'omoks First Nation.

Vegetation Mapping

The collection of vegetation habitats in the lagoon area involved a step-wise process that resulted in a map for communication and presentation purposes, a comprehensive list of species encountered, and site specific community information for baseline reference. Complementing the information collected in 2013 was a vegetation habitat assessment carried out by Mimulus Biological Consultants in 2010 in the area bordering the Courtenay River adjacent to the lagoon.

Steps in vegetation mapping included the following:

1. Identification of polygons and transects to be assessed based on visual aerial analysis (Figure 6)
2. Field analysis of polygons and transects
3. Compilation of information to excel spreadsheets
4. Translation of field notes into GIS attribute table for mapping
5. Preparation of a map that combined 2010 and 2013 data

Polygon boundaries were defined using aerial photo interpretation refined with ground-truthing, which was carried out by Michele Jones, R.P.Bio, of Mimulus Biological Consultants. To obtain fine-scale information seven transects were assessed from July 22 to 24th, 2013 for banding patterns, including one (Transect 4) that was immediately southeast of the proposed breach. The transects were referenced in the field with measure tape and bisected an area from the riparian zone just above high water to the water's edge; inside the lagoon this was at a chart datum of ~2m, outside it was at ~0m. Transects were assessed using a Trimble GPS to mark the transition between vegetation bands, and bands were characterized based on species present, including dominant and sub-dominant vegetation (expressed as % coverage), other species present, invasive plants, and Species at Risk. All vegetation observations were categorized based on their structure using the system in Table 1. Photos of each site were taken at the time of the assessment and georeferenced. Results were transferred to excel spreadsheet organized by site and zonal banding. Information on dominate species and substrates were applied to an attribute

table and the results were mapped along with the results of the 2010 vegetation mapping in the adjacent area. Finally a list of species encountered at each site was compiled.

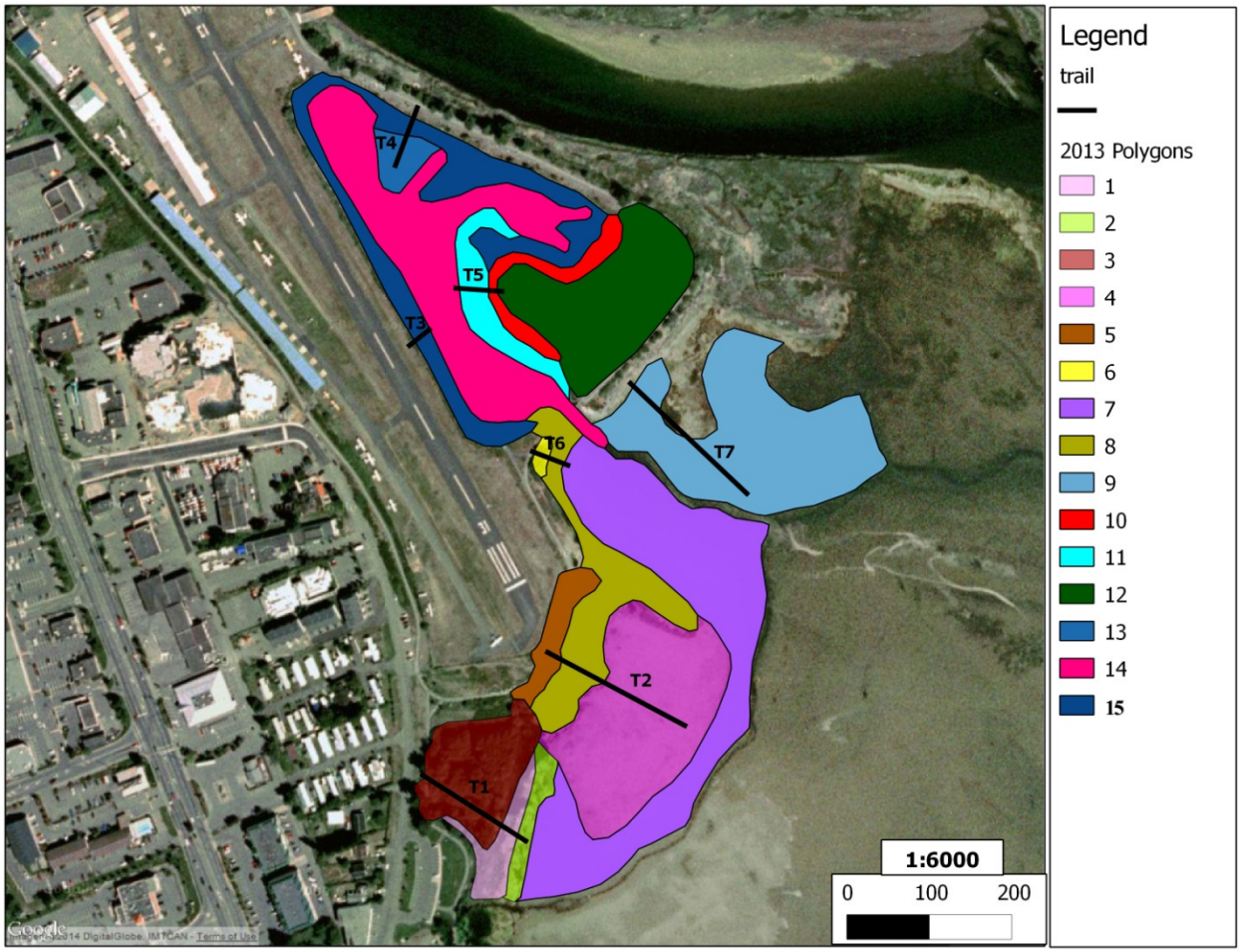

Figure 6: 2013 vegetation assessment polygon and transect (T) locations.

Table 1: Vegetation community structure codes and descriptions used in field assessment.

Structure Code	A	B1	B2	C	D
Description	Tree and shrubs >10m in height	Woody species 2-10m in height	Woody species <2m in height	Herbaceous species	Bryoids, algae and similar

Fish Monitoring

Fish monitoring involved the review of background information from 2010 captures, and the collection of new fish capture information in 2013. Fish monitoring in 2013 was carried out on a monthly basis during times when the tide was <2m. Sampling involved two beach seine sets at three locations sampled once per month from May to August, 2013. The beach seine was deployed by row boat with at least two

shore crew to retrieve it. The beach seine was fitted with floats and a lead line and made up of three panels of varied mesh sizes: the outside panels were of 3/8" mesh, the inside panel, or bunt, was of 1/8" mesh. The length of the seine was 14m, and the depth at the bunt end was 3m. Attempts were taken at each site to sample the same area, which was approximated at 65m2. Sample site locations are provided in Figure 7.

Figure 7: 2013 beach seine sites.

The CPUE (Catch Per Unit Effort) of fish was determined and compared to 2010 data. Fish sampling in 2010 started in May and ended in August, and involved approximate monthly sampling using beach seine methods (see Tryon, 2011).

Bird Monitoring

Bird use in this study was measured by counts and species observations from May to November[4]. Bird counts were undertaken twice per month during high tide morning cycles when tide heights were between 3.4 and 4.9m. Bird counts were carried out by two volunteers experienced in bird identification. The volunteers remained consistent with each count, and were equipped with binoculars and a spotting scope. They walked the shoreline of the lagoon and adjacent mudflat foreshore between the northwest end of the lagoon and the southeast end of the airpark runway, taking approximately

[4] Bird monitoring has continued since November and is ongoing as of this report.

one hour during each visit. Bird counts, species and location (lagoon or foreshore) were documented. Figure 8 shows the areas where lagoon and foreshore observations were taken.

Figure 8: Bird assessment areas 1 (Lagoon) and 2 (Foreshore). Map scale is 1:8000.

Water Monitoring

Water level loggers were installed in the lower end of the lagoon and in the river on the left shoreline (facing downstream) just south of the Field Sawmill site. The river logger is expected to reflect conditions that are most relevant to the water that will be introduced into the lagoon through the proposed breach. A third logger station collected temperature information in 2013 for a separate project immediately upstream of the Dyke Slough tide gates, and was shared by Esther Guimond for this project. The temperatures from the Dyke Slough logger and those of the lagoon were compared for differences between the two sites, and to estimate the temperature benefits that might be realized with a second breach. The Dyke Slough is considered a suitable reference site as it is located along a similar tidal gradient as the lagoon (transition between river and mudflats), it is also blocked off from the main river by a constriction (the tide gates and downstream channel), and it provides conditions for fish that appear very favorable and are thus strived for in the lagoon project (Tryon 2011).

Water level and temperature data for 2013 were available from April 25th to October 3rd for the lagoon site and from July 27th to October 3rd for the river site. Dyke Slough temperature data between April 27th to September 24th were used in the analysis. The lagoon and river loggers collected data at 10 minute intervals, and the Dyke Slough at 15 minute intervals. Sensor depth alternated with the tides, though always remained submerged below the surface. The lagoon logger sensor was set at a geodetic

elevation of -0.271m, the river at -1.192m and the Dyke Slough logger at -0.882m. A map indicating the locations of the three loggers is provided in Figure 9.

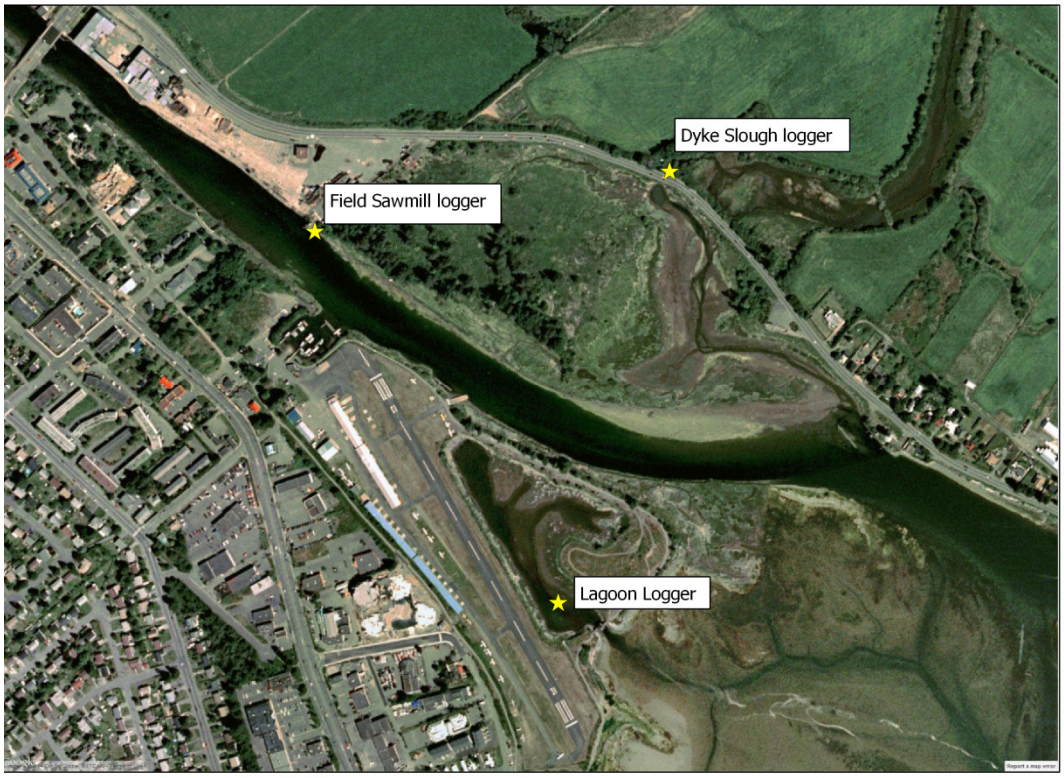

Figure 9: Locations of loggers in the lagoon, river and Dyke Slough (scale 1:9000).

Average daily temperatures were compared between the three sites. Water level data was input to a hydraulic model for analysis (see section on Hydraulic Model Development, this report).

Soil Sampling

Soil sampling of lagoon sediments was done on August 21st, 2013 at12:45pm during a low tide. Two sediment samples were collected approximately 35m apart within the area of the proposed breach. One sample was taken at the north side of the proposed breach location, the other at the south side (Figure 10). The north sample was taken from a mud substrate with limited vegetation located just above the water line (~2m elevation). The second sample was taken from slightly higher up in elevation on a shallow bench on the south side of the proposed breach location where there was denser growth of salt marsh vegetation. The sampler wore sterilized disposable gloves and used a clean stainless steel trowel to excavate the samples. Soils were collected from a depth of 10-15cm and each sample filled two sterilized 1L amber glass bottles supplied by North Island Labs. Large rocks and vegetation were removed prior to sample collection. Samples were immediately stored in a cooler with icepacks and delivered to North Island Labs within two hours of collection. The samples were then shipped by North Island Labs to their contract lab Exova for analysis.

Figure 10: Sediment sampling sites north and south of breach location (scale 1:3000).

Sediment samples were tested for metals, organo-chlorine pesticides, penta-chloro phenols, and Polycyclic Aromatic Hydrocarbons (PAH's). Results were compared to thresholds for the Contaminated Sites Regulation (CSR) (B.C. Reg. 375/96), Canadian Council for Ministers of the Environment Criteria Interim Sediment Guidelines and Probable Effects Levels for the protection of marine/estuarine aquatic Life (CCME), and the Disposal At Sea Regulations (SOR/2001-275).

Hydrological Model Development

Three scenarios, existing conditions without a breach and 2.44m and 4.27m culverts, were modeled using the TELEMAK-2D. Details on how this model is ran is provided in Consortium (n.d.). The model boundaries extended from the 5th Street Bridge to a line from the Trent River to just outside of Goose Spit (Figure 11). Model inputs included:

- City of Courtenay 2012 LiDAR (Laser Imaging, Detection and Ranging) data
- City of Courtenay river bathymetry data
- PW lagoon bathymetry and topographic survey
- Canadian Hydrographic Services chart for Comox (station ID: 7965)
- Water Survey of Canada and PW stage data

Bathymetry information for the lagoon was not included in the LiDAR data, therefore this was collected by Project Watershed (PW), who contracted Bob Foster to collect the data using a Total Station. Data on

the surrounding topography as well as the river banks where the breach is planned was also utilized, which was collected by Total Station in 2010. Stage information for the lagoon and river were collected with a logger, described in the Water Monitoring section of this report.

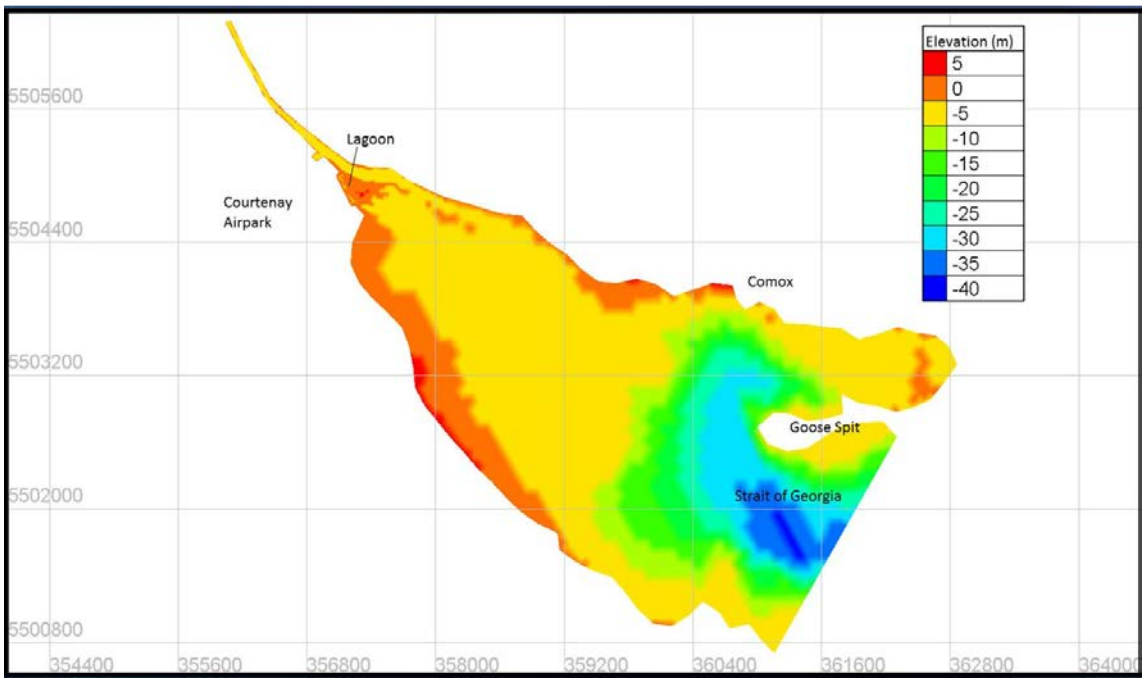

Figure 11: The extents of the TELEMAK 2D model for the lagoon breach project and associated elevations. Map courtesy of Northwest Hydraulic Consultants.

The TELEMAC-2D model predicted velocities in the lagoon based on summer and winter conditions representing low, stable flows and peak discharge events, respectively. Hydraulic input for summer conditions came from data collected during average low flow summer conditions that occurred from July 1-7, 2010. Peak discharge conditions utilized data during a period of high flows coinciding with high tide events from January 1-7, 2010 (~400cms river discharge and 5m tides (relative to chart datum). Baseline summer and winter discharges from these periods are provided in Figure 12 and Figure 13, respectively.

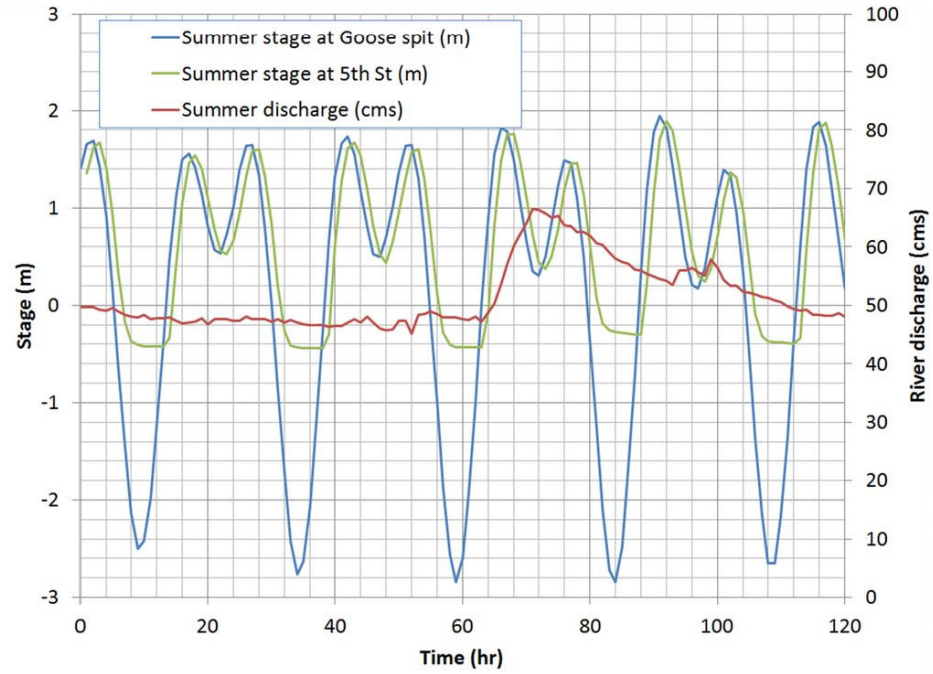

Figure 12: Summer baseline flows from July 1-7th, 2010 used in hydraulic model development. Figure courtesy of Graham Hill of NHC.

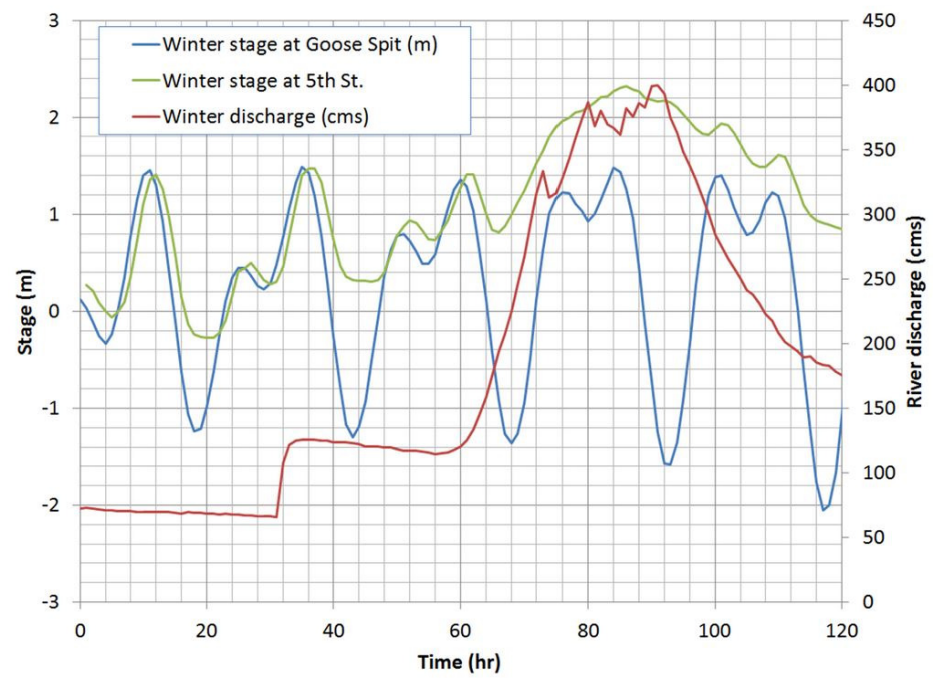

Figure 13: Winter baseline flows from Jan 1-7th, 2010 used in hydraulic model development. Figure courtesy of Graham Hill of NHC.

The model compared velocities in the lagoon during summer and winter conditions between existing conditions and with a second breach (2.44m culvert). A dye test was also run, where the model predicted the rate of dilution of a hypothetical dye introduced into the lagoon over a period of 120

hours given existing and 2.4m breach scenarios and over winter and summer conditions. Culvert discharges and lagoon water levels were modeled for two different sized culverts (2.4 and 4.3m) during winter conditions and an extreme flood condition where river discharge exceeded 400cms.

Project Planning

Project planning involved communicating with regulatory authorities and stakeholders, a detailed engineering design of a breach, and cost estimates of two breach options. Information to support project planning included the hydraulic model and the results from the vegetation, fish, bird, and water temperature analyses. These were applied to assess the requirements for permitting and to engage stakeholders and elicit their feedback.

Both on-site and in-office meetings were held with the City of Courtenay, and stakeholders were given two opportunities to attend presentations[5]. Those who could not attend were invited to discuss the project in person or via email/telephone. All stakeholders were provided with a short description of the project and were invited to provide comment and to support the project with a Letter of Support.

Results

Figures and tables associated with this section are included in Appendix 1, "Monitoring Results".

Vegetation

Vegetation mapping took place in late July 2013 and covered lagoon area inside of the dike, and the outside foreshore on either side of the existing breach. This information was used in combination with the vegetation assessment in 2010 that covered the area northeast of the dike (on the river side).

Overall Area Description

Salt marsh communities dominated the vegetation in and around the lagoon. Other habitats included riparian areas, submerged lagoon and exposed mudflats. Substrates in the area ranged from sand and gravel to mud; courser substrates were limited to rip-rap that bordered the dike between the river, the lagoon and the mudflats. Areas with riprap were typically associated with eroded soils, especially along the outer south east edge of the dike where it was exposed to wave action during high tides.

The vegetation in the area was highly influenced by past dredging and the dike. Course sand and gravels met the riverside, supporting thick growths of sedges (*Carex spp*) and rushes (*Juncus spp*). Midway along the path beside the river, the shoreline flattened out and was pocketed with pools and a small mid-tide channel that snaked its way toward the mudflats. This channel eventually spread out and pooled where it met a rise associated with past dredging spoils. Next to the river clumps of salt marsh vegetation appeared to fracture off and root systems were exposed at low water; evidence of a slowly eroding shoreline.

Inside the lagoon, saltmarsh vegetation included Lyngbye's sedge *(Carex lyngbyei*), along with grasses (Poaceae) and exotics such as the Reed Canary Grass (*Phalaris arundinacea*) and Bird's Foot Tre-foil (*Lotus corniculatus*). The lagoon was shaped with three lobes extending to the northeast, northwest and

[5] The presentations are posted at http://projectwatershed.ca/plan-improved-habitat-air-park-lagoon/

east at the upper end, and a "foot" that expanded then narrowed into a channel at it passed through the lower breach of the lagoon. In the permanently submerged waters of the lagoon grew the native eelgrass *Zostera marina*, and the Japanese eelgrass, *Z. japonica*.

Following the tidal channel from the breach to the mudflats, another channel sourced from an urban outfall 600m away joined it from the south. Westward of the tidal channels the land slowly rose, supporting a variety of first sparse then dense salt marsh vegetation interspersed with woody debris cast there during higher tides. There was a small forest of red alder (A*lnus rubra*) and Red-osier dogwood (*Cornus stolonifera*) located adjacent to the south-western foreshore. The area along this shoreline is known to experience the erosive effects of waves originating from southeasterly winds common to the area.

Proposed Breach Location

The area of the proposed breach was characterized by salt marsh vegetation on either side of the dike. On the river side, Lyngbye's sedge and *Juncus spp*. dominated. The other side of the dike had a short stretch of sedge salt marsh ~5m before it transitioned to unvegetated mud that bordered the low tidal waters of the lagoon. Along the edges of the path in the vicinity of the proposed breach (but not necessarily in its path) were established large bushes and small trees, including willow (*Salix spp.)* and red alder. Smaller bushes in the area included Pacific Ninebark (*Physocarpus capitatus*), Oceanspray (*Holodiscus discolor*) and invasive Himalayan blackberry (*Rubus armeniacus*).

Species at Risk

The 2013 assessment did not reveal any Species at Risk. However, in 2010, sparse growth of the provincially blue-listed Henderson's Checkered Mallow (*Sidalcea hendersonii*) was found in salt marsh habitat outside of the dike next to the river.

Figure 14 provides the vegetation community map. Table 2 provides the results of Transect 4, which is located immediately south of the proposed breach location. Photos of Transect 4 near the proposed breach location are provided in Figure 15. A complete list of species and common names encountered during the assessment is provided in Table 3.

Fish

During the monthly fish sampling period of May to August in 2010, salmonids were found in the lagoon up to June 3 for Coho salmon and June 23rd for Chinook salmon. In the period from May to August, 2013, salmon captures extended only to June 5 when 1 Chinook was captured, though most were captured in the first sampling session, May 22. Juvenile Coho and chum salmon were also captured on May 22. Other species observed throughout the sampling period included flounder, gunnel, perch, pipefish, sculpin, shrimp and stickleback. Figure 16, Appendix 1 provides a summary of Coho and Chinook captures in 2010 compared to other sites sampled at the time. Figure 17 provides an overall capture of all fish species in the lagoon during the summer 2013 sampling period.

Birds

The foreshore area had more bird observations than the lagoon over the 2013 May to November assessment period. Bird use in both areas was generally low through the summer months (Figure 18). More waterfowl were observed in the lagoon than the foreshore in the summer, though numbers in the

foreshore increased dramatically in the fall (Table 4). Gulls and terns were frequent in the foreshore and sparse in the lagoon. Shorebirds numbers were low, which is expected due to the limited shoreline area exposed during the high tide assessments

Temperatures

Of the three temperature stations, the lagoon recorded the highest summer temperatures. The Dyke Slough and the lagoon had similar temperatures until June, when the lagoon temperatures exceeded the Dyke Slough with increasing differences that were the largest in late July/early August. In mid-August, the gap in temperatures between the two sites began to close and by September, the temperatures were once again similar. River temperatures weren't recorded until mid-July; these were similar to the temperatures in the Dyke Slough. Some of the temperature differences may be explained by the difference in the depth of the temperature sensors. To rectify this, a temperature sensor that is not always submerged will be required to capture surface temperatures at the river and slough sites during high tides.

Water temperatures in the lagoon increased beyond the preferred temperature threshold of 16°C for most salmonids[6] in June, though July had the highest overall temperatures and stayed above 20° for the entire month. Temperatures cooled to below 20°C in September.

Water temperature at all three stations is displayed in Figure 19 for April to October, and a close-up of June to September temperatures is in Figure 20. A box plot of this same period for all sites is in Figure 21, and the relative frequency of lagoon temperatures for each month is in Figure 22.

Soil

Results from the lagoon soil analysis did not exceed the Contaminated Sites Regulation (CSR) or the Ocean Dumping Criteria for both senstiive aquatic habitats and for general protection of aquatic life. Comparison to other criteria found an exceedance of Phenanthrene at the south lagoon breach site under the CCME Interim Sediment Quality Guidelines (ISQG) for freshwater systems, but not for marine/estuarine systems, nor did it exceed the probably effects levels (PEL) for freshwater or marine systems. Copper and Mercury levels were also above the limits for CCME ISQG for freshwater and marine/estuarine systems, and exceeded the PEL for freshwater but not for marine/estuarine.

Table 5 provides the results from the sediment sampling compared to the CSR, CCME, and Ocean Dumping Criteria.

Hydraulic Model

The hydraulic model indicated that a 2.4m breach would increase flushing rates, with the redirecting of <1 cms during high flow conditions from the river through the culvert (Figure 28).

A visual map of the dye test indicated a 2.4m breach will have substantial improvements in flushing rates after only 3 hours compared with the existing single breach (Figure 23). Given summer baseline conditions, the 2.4m culvert is projected to flush >70% of the lagoon in 10 hours compared to 34 hours without the breach, and >80% after 34 hours compared to 59 hours without (Figure 25). A map of

[6] Preferred temperature thresholds according to Bjornn and Reiser, 1991.

velocity vectors also indicated a greater concentration of surface water movement through the lagoon with the 2.4m culvert (Figure 26).

A comparison of winter and extreme discharge flows through the two culvert scenarios found the maximum baseline winter culvert discharge of ~0.83cms in the 4.3m culvert was approximately twice that of the 2.4m culvert. Given these discharges, issues from erosion around the culverts were considered minimal by the engineer. Water levels differences were not large between the two culvert scenarios or from existing conditions: the maximum water level increase over existing conditions that could be expected during extreme flood conditions (river discharge 400cms) with either culvert size was approximately 30cm during a low tide, and no difference during a high tide (Figure 30).

Project Planning

Communications

Input was gathered regarding project specifics via telephone and email.

Sediment Concerns

- Email correspondence between PW (via Wayne White and Lora McAuley) and regulatory agencies (DFO- Nick Leone and MOE-various) led to an outlining of DFO's concerns and advice regarding information and permitting requirements by MOE. In general, DFO was concerned about potential impacts from toxic sediments in consideration of the historical use of the lagoon as a sewage treatment pond, and required assurance that sediment and water quality were within provincial guidelines (Compendium of Working Water Quality Guidelines for BC).
- Communications with the Land Remediation Section of the BC Ministry of Environment lead towards the hiring of a Contaminated Sites Approved Professional (Allan Morrison, AMEC) for this project to provide an Opinion Letter on the results of the sediment and analysis and the potential impacts of the proposed breach construction (Appendix 3: Opinion Letter).
- The results of the sediment analysis, AEC's Opinion Letter, historical data and communications between PW and MOE requesting request for clarification on permitting requirements an email was produced by Colm Condom (Manager with Risk Assessment and Remediation for the Land Remediation Section of MOE) who indicated the project presented a low risk activity from a Contaminated Sites Regulation point of view, and therefore he did not have concerns with it (for his email communication see Appendix 1).
- Several factors lead to the decision not to undertake water quality analysis in the lagoon as part of project planning: inactivity as a sewage lagoon since the 1980's, remediation actions in the 1992 via dredging, indications that water is suitable for life via fish activity, and advise from MOE and other experts that water quality analysis was not required.

Permitting

- Brian Epps, Source Water Protection Specialists with the Water Protection Division of the Ministry of Forest, Lands & Natural Resource Operations (FLRNO), informed PW that the project does not require a Section 9 Water Act Authorization, and that the project is not expected to impact existing water license holders. (see email communication Appendix 1)

- John Baldwin, Water Stewardship Officer with Water Protection Branch, FLRNO, advised that Under the BC Dike Maintenance Act (DMA) this work does NOT require approval with the understanding that the landowner is in agreement and there is no increased risk to the Airport.

Stakeholder Involvement

Project Stakeholders included in the project were:

- City of Courtenay – crown lease holder of the Courtenay Airpark lands. In the summer, PW Lagoon project committee met with engineering and planning staff at the CoC, and subsequently had an on-site meeting to discuss issues, opportunities and concerns. In the fall of 2013 PW delivered a presentation to the City of Courtenay Mayor and Council on the project and requested support for the project.
- K'omoks First Nation – territorial claim on land and partner with Project Watershed MOA on Estuary Stewardship. Was informed of the project and invited to participate in stakeholder meetings but was unable to attend. Provided a Letter of Support for FWCP finding.
- Fisheries and Oceans Canada (Nick Leone and Dave Davies)- DFO Community Advisor sat on the project steering committee, Nick Leone (Resource Restoration Biologist, Salmon Enhancement Program) regarding project review requirements and feedback. Nick Leone provided a letter of conditional support. Conditions were related to sediment and water quality, demonstration of physical process and biological feasibility, and full support of regulatory partners. A copy of the letter is provided in Appendix 3.
- Comox Valley Airpark Club – lands of the airpark runway crucial for project access. The airpark club met and discussed the project and provided a letter of support for it.
- Comox Valley Naturalists – have been restoring riparian habitat in the area since the early 1990's. Their involvement is anticipated in the riparian restoration component through planting advice and volunteer support. They are currently providing ongoing volunteer support in the bird monitoring component.
- TSSR – Wayne White on Airpark Breach planning committee, and interest in estuary health to help restore salmon runs impacted in the Tsolum from historical mine development.
- Courtenay Fish and Game Protective Association, whose conservation interests extend to salmon and their habitats in the Comox Valley
- Comox Valley Environmental Council, whose conservation interests extend to salmon and their habitats in the Comox Valley

All stakeholders were informed of the project and requested to provide feedback or letters of support for the FWCP funding application.

Project Funding

- An application to FWCP for the implementation stage, Phase 3 of this project in the 2014/2015 period was submitted.

Public Outreach

- Project details were communicated to the public through the PW 2013 Keeping It Living Campaign[7] , which involved a media release published in the Comox Valley Record and Tidechange, and posted on the PW website. It was also disseminated in handouts and announced at 2 public events.

Engineering Design and Project Costing

Graham Hill of NHC provided the detailed design and cost estimates for the breach options. Different breach designs were considered, including a bridge, rounded culvert, and concrete box culvert. A concrete box culvert was chosen for both durability against corrosive seawater and its larger capacity compared to a similar-diameter rounded culvert. Options for a 2.4m vs 4.3m wide concrete box culvert were compared using a cost benefit approach. While the 4.3m culvert had approximately twice the discharge of the 2.4m culvert, it also cost approximately twice as much. Considering the benefits provided in the 2.4m culvert were already substantial, and the higher cost of a 4.3m culvert could result in insufficient funding, the lower cost culvert was decided upon. If more funds become available in the future, a third culvert could be considered.

The engineer design drawing is provided in Figure 30. The project specifications involve a culvert of 2.4m width by 2m height and 20m length. The total footprint of the culvert and associated rock apron is estimated at 180m2, including ~15m2 of trail surface. The difference, 165m2 includes the riparian and mid to high intertidal regions. The intertidal region will also have rock groins to protect the culvert ends. As the project will impact environmentally sensitive areas, including riparian and fish-bearing wetland areas, it will require an environmental protection plan for implementation, along with environmental monitoring during project implementation. The culvert grade will be 0% and set at a geodetic datum of 0.2m, which equates to a mid-tide level and an elevation slightly higher than the existing breach.

There is expected to be a slow incremental increase in sediment load to the lagoon, as suspended particulates from the river enter through the second breach. This is considered a benefit rather than a liability as sediment is part of an important process that helps to build estuarine salt marsh habitat where it accretes.

Discussion

The 2013 study affirmed that a second breach will provide a great benefit for fish and fish habitat in the K'omoks estuary. Fish and temperature sampling supported the idea that greater flushing and cooler temperatures will result in an increase in salmon use, and the hydraulic modeling confirmed flushing will likely occur with a second breach.

This project presents a relatively simple approach with long lasting benefits. A second breach will allow river water to be introduced to the top, or blind end of the lagoon where fresh, cool water is most needed. Issues from erosion and sedimentation are negligible. The area is high profile, and provides a public education opportunity. Easy access for construction is available from the airpark runway. Landowner consent is not complicated; the land is crown land leased by the City of Courtenay, who is

[7] See http://www.refbc.com/comox-valley-project-watershed-society-1 for details on the Campaign

supportive of the project. The leaseholder, MOE, is aware of the project and has provided input from a sediment perspective without concerns as it is planned. DFO is aware and involved and has provided important guidance and support. Multiple stewardship groups area aware and supportive of the project. The project is cost effective and will create meaningful volunteer opportunities in both restoration and monitoring components.

The activities to date have identified a preferred breach design option and information necessary for effective planning. A 2.4m culvert at the top end of the lagoon will provide the most cost-effective breach option with meaningful results for fish. Vegetation, fish and bird sampling have outlined environmental aspects that must be considered to ensure effective restoration of the immediate area, and provide a baseline of information for future monitoring. Communications with stakeholders have identified the permitting that will be necessary to commence with the project, people who will be involved, and concerns that must be addressed. For example, while a Section 9 Water Act Authorization is not required, a Project Review by DFO will be required. Also, the lagoon dike does not require permits to modify as it is not considered a dike under the Dike Maintenance Act. Another concern regarding public safety can be addressed with racks to prevent access to the culvert after installation.

As the lagoon was once a destination for municipal sewage, the potential for sediment contamination was scrutinized for this project. Culvert installation will involve the excavation of intertidal lagoon materials, and their disturbance and disposal required planning with consideration of potential contamination. In consideration of communications with regulators and experts, and in sediment sample results that were below Contaminated Sites Criteria thresholds, it was decided that excavated sediments could be safely returned on site in the breach area, ensuring care so that they do not smother existing habitat and that they do not become suspended in the water column. Most of the materials will be used to cover the rock groins and re-vegetated with salvaged salt marsh plants. Only trail materials such as the concrete and underlying support materials that cannot be re-used will be disposed off off-site. Suspension of sediments in the water column during construction will be avoided using appropriate timing windows. Concerns of erosion are minimal, as discharge through culvert is not expected to exceed 1cms even during high flows.

Hydraulic modeling revealed obvious benefits associated with flushing from a second breach. The upper end of the lagoon will receive better mixing than it does currently. There are also expected to be benefits not picked up by the model, including 3-dimensional mixing, improved water quality from cool, fresh river water, and improved access for fish between the river and the lagoon.

Overall, the benefits and risks have been identified as follows:

Benefits

- Adult and juvenile fish will find improved access to the lagoon, where they can feed and hide from predators.
- Juvenile fish that use the lagoon as a nursery for part of their lives as they prepare for their ocean journey will find it remains cooler longer due to influx of cool river water at high tides. Currently, summer conditions warm the mudflats below the lagoon outlet, which in turn warms water entering the lagoon during a flood tide.

- Adult salmon currently enter the lagoon through the outlet and become trapped at low tides. A second breach will increase opportunities for escape on the receding tide.
- Well-oxygenated brackish water in the lagoon will support an abundance of important microscopic food items suitable for salmon.
- Project design will work with the City of Courtenay's current infrastructure and ongoing access requirements.
- Community benefits will come about through the high profile of the restoration site combined with media releases and educational signage, increased presence of salmon and associated wildlife, and volunteer opportunities associated with the monitoring phase.

Risks

The risks and mitigation details are below:

- Consultation with the City of Courtenay (CoC) brought up concerns regarding maintenance. There is the potential for woody debris to accumulate on the lagoon side of the breach and block it off. The option of installing a rack was discussed, and may be required by the CoC for this project to go ahead.
- Project Watershed and CoC have discussed public safety concerns, including the potential for children and kayakers to access the breach culvert. Solutions include rack installation (which will also prevent woody debris accumulation) and strategic planting of thick, thorny vegetation to prevent pedestrian access from the trail. Further, except during low tide/extreme flood events, water levels in the culvert will only rise with the tide, otherwise it will have less than 1 cms running through it, and then only when the public is not likely to attempt access (i.e. extreme winter flow conditions). This potential risk can be further addressed through signage.
- The risk for fish stranding in the culvert was also considered; to prevent this, the culvert will have a smooth bottom and placed along a level surface.
- Lagoon sediment sampling in 2013 did not reveal contaminants above Contaminated Sites Criteria thresholds. Care will be taken to not disturb sediments in the water column through appropriate timing windows, and materials will be disposed of on-site.

Recommendations

Below are recommendations for implementing Phase 3 of the Airpark Breach Project: Breach Installation. This provides a brief summary of important points and highlights to consider to make this a successful project.

Prior Planning

- This project requires a "Request for Project Review" form to be submitted to DFO.
- A construction plan should be prepared and reviewed by the project engineer and monitor prior to start up. The plan should include Environmental Protection Measures and Best Management Practices tailored to working in this sensitive estuarine environment. It should also include measures to ensure public safety that are reviewed and acceptable by the City of Courtenay

- A safety plan that will outline all hazards, safety measures, and emergency response and communication procedures is required. It should include signage and personnel to ensure public safety procedures to avoid aviation conflicts with project equipment.

Ongoing communications with stakeholders

- Meetings with stakeholders as required, and at a minimum 2 months prior and two month post-construction to provide information on planning and results.

Timing

- To avoid disturbance of salmonids and birds, undertake project in July during a low tide cycle.

Implementation

- Prior to implementation, salvage vegetation that will be disturbed for later re-planting over the rock groin. A vegetation restoration plan should identify salvage methods, plant storage criteria, and replanting considerations (eg planting at suitable elevations, soil stockpiling and re-use, invasive plant disposal).
- Further care should be taken to investigate the area for the blue listed Henderson's Checkered Mallow when it is in bloom, and salvage any plants that might be disturbed by construction. This species has been observed to bloom in the area in July.
- Stockpiles of material are to be stored onsite, and returned to the lagoon either directly over the rock groin area or spread out in adjacent areas in a manner without smothering vegetation. Materials (other than concrete and underlying gravels from the existing trail) must not be transported off-site as it will trigger onerous and time consuming requirements for sediment sampling under the Contaminated Sites Regulation.
- Safety and Environmental tailboards should be conducted each day with all work crew.

Project Management

- Hire a competent project manager that will coordinate construction aspects of the project, including equipment access, material delivery, timing, etc.

Outreach

- Maintain project communications with the public via signage, radio, and news releases. Highlight the importance of the project for fish and wildlife, safety concerns, and project partners.

Monitoring

- Environmental monitoring of construction activities will ensure the Environmental Protection Plan is adhered to, and will ensure an environmental professional is onsite to provide advice as required.

- Project monitoring will also involve continued monitoring of birds and fish use of the lagoon, as well as water levels and temperatures. Bird monitoring is ongoing, fish monitoring will commence again in April and continue into September.
- Success will be evaluated based on the key objectives to increase fish access to the lagoon and to improve the function of lagoon habitat for fish and wildlife. Table 6 provides a list of assessment endpoints that describe the expected outcomes and the indicators used in monitoring.

It is anticipated this project will be approved for funding and implementation in 2014. If not, Project Watershed will continue to source the financial assistance and support necessary to make this very important project a reality.

Acknowledgements

This project came about from ideas formulated during discussions of the Project Watershed's Estuary Working Group many years ago. It was brought to the forefront of important projects for the estuary following Project Watershed's comprehensive estuary assessment in 2010. Since then, Wayne White, Tsolum River Restoration Society, and Dave Davies, DFO Community Advisor, have carried the torch for this project through to its present status. They have attended meetings, helped with project proposals, caught fish, collected sediments and instigated and maintained important communications with regulatory authorities and experts. The rest of the Lagoon Committee included Dan Bowen and Bill Heidrick, both Project Watershed Directors, and Caila Holbrook, Estuary Coordinator. Caila has also been a crucial support for communications and liaison with various government and non-profit agencies involved with this project. The keen eyes of Bill Heidrick, Art Martell and Dan Bowen have picked out the variety of bird life in the area, and provide important ongoing volunteer support in this area. Graham Hill, the project engineer with Northwest Hydraulic Consultants ran the model, prepared the design drawings, and formed the budget.

Many others helped with this project in various capacities. Planners and engineers from the City of Courtenay provided important advice and data essential for the project. Bob Foster did the surveying for the lagoon breach and area. Dave Radford volunteered regularly doing fish sampling and helping with installing the leveloggers. Wendy Kotilla and her youth at Youth and Ecological Restoration helped with the fish sampling. Other stewardship groups, identified in the stakeholders list, attended meetings on the project and shared their knowledge and support. Nick Leone, DFO, provided helpful advice and guidance. Ministry of Environment staff provided important regulatory advice. Michele Jones of Mimulus carried out the vegetation survey. Mark Shroeder and the Project Watershed Mapping Centre prepared the vegetation map. Esther Guimond shared temperature data from the nearby Dyke Sough. Allan Morrison with AMEC provided professional advice on sediments. Norma Morton provided important background information and historical photos of the lagoon. This project was made possible with financial support of the BC Hydro Fish and Wildlife Compensation Program.

The combined efforts of all involved have brought us to a level of organization that readies us for implementation, and all this effort is greatly appreciated.

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Limitations

Lake Trail Environmental prepared this report for Comox Valley Project Watershed Society. Any use a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of those third parties. Lake Trail Environmental accepts no responsibility for damages, if any, suffered as a result of decisions made or actions based on this report.

Appendices

1. Monitoring Results
2. Hydraulic Model
3. Project Planning Documents

Attached Separately for BC Hydro-FWC Reporting Requirements:

4. Financial Statement (Statement of income and expenditures-form attached)
5. Performance Measures-Actual Outcomes
6. Confirmation of FWCP Recognition

Appendix 1 Monitoring Results

Vegetation

Figure 14: Results of vegetation community mapping.

Table 2: Transect 4 raw data, located immediately south of proposed breach location (beginning above upper intertidal).

Transect 4
Bearing: 200°

			Structure Code and % range coverage							
Latin Name (invasive spp in bold)	**Common Name**	**Code**	**A**	**B1**	**B2**	**C**	**D**	**Band/Wp**	**Photo #**	**Transect 4 Notes: July 23, 2013**
Salix sp.	Willow	SALIX		5 - 25				1	**43-45**	Dom = grasses with willow being sub-dominant
Alnus rubra	red alder	ALNURUB		5 - 25				1		
Physocarpus capitatus	Pacific ninebark	PHYSCAP			5 - 25			1		
Holodiscus discolor	oceanspray	HOLODIC			1 - 5			1		
Rubus armeniacus	Himalayan blackberry	RUBUARM			1 - 5			1		
Rosa nutkana	Nootka rose	ROSANUT			1 - 5			1		
Symphoricarpos albus	common snowberry	SYMPALB			1 - 5			1		
Crataegus douglasii	black hawthorn	CRATDOU			1 - 5			1		
Malus pumila	cultivated apple	MALUPUM			1 - 5			1		Planted
Amelanchier alnifolia	saskatoon	AMELALN			+			1		Planted
Salix sitchensis	Sitka willow	SALISIT			+			1		Planted
Rhamnus purshiana	cascara	RHAMPUR			+			1		Planted
Poaceae	Grasses	POACEAE				25-50		1		Includes Poa, fescues, and others
Phalaris arundinacea	reed canarygrass	PHALARU				5 - 25		1		
Lotus corniculatus	birds-foot trefoil	LOTUCOR				5 - 25		1		
Daucus carota	wild carrot	DAUCCAR				5 - 25		1		
Leymus mollis	dune wildrye	LEYMMOL				5 - 25		1		
Hypericum perforatum	common St. John's-wort	HYPEPER				1 - 5		1		
Agrostis exarata	spike bentgrass	AGROEXA				1 - 5		1		
Rumex crispus	curled dock	RUMECRI				1 - 5		1		
Dactylis glomerata	orchard-grass	DACTGLO				1 - 5		1		
Plantago lanceolata	ribwort plantain	PLANLAN				1 - 5		1		
Bolboschoenus maritimus	seacoast bulrush	BOLBSCH				25-50		2	**46-48**	Dom = BOLBSCH and SCHOPUN, Carex sub-dom
Schoenoplectus pungens	American bulrush	SCHOPUN				25-50		2		
Carex lyngbyei	Lingbye's sedge	CARELYN				5 - 25		2		
Spergularia canadensis var. canadensis	Canadian sand-spurry	SPERCAN1				5 - 25		2		
Eleocharis parvula	small spike-rush	ELEOPAR				5 - 25		2		
Potentilla anserina	common silverweed	POTEANS				1 - 5		2		
Achillea millefolium	yarrow	ACHIMIL				1 - 5		2		
Lotus corniculatus	birds-foot trefoil	LOTUCOR				1 - 5		2		
Triglochin maritima	seaside arrow-grass	TRIGMAR				1 - 5		2		
Typha latifolia	common cattail	TYPHLAT				1 - 5		2		
Symphyotrichum subspicatum	Douglas' aster	SYMPSUB				1 - 5		2		
Schoenoplectus tabernaemontani	soft-stemmed bulrush	SCHOTAB				1 - 5		2		
Distichlis spicata	seashore saltgrass	DISTSPI				1 - 5		2		
Festuca rubra	red fescue	FESTRUB				1 - 5		2		
Deschampsia cespitosa	tufted hairgrass	DESCCES				+		2		
Cotula coronopifolia	brass buttons	COTUCOR				+		2		
Spergularia canadensis var. canadensis	Canadian sand-spurry	SPERCAN1				50-75		3	**49**	SPERCAN dom, ELEOPAR sub-dom
Eleocharis parvula	small spike-rush	ELEOPAR				25-50		3		
Bolboschoenus maritimus	seacoast bulrush	BOLBSCH				1 - 5		3	**50**	Photo of Transect 3 from Band 3
Cotula coronopifolia	brass buttons	COTUCOR				1 - 5		3		
Bolboschoenus maritimus	seacoast bulrush	BOLBSCH				50-75		4	**49, 51**	Band 4 only about 5 meters wide, very similar to low side of Band 2).
Schoenoplectus pungens	American bulrush	SCHOPUN				25-50		4		
Eleocharis parvula	small spike-rush	ELEOPAR				1 - 5		4		Submerged, very small
Spergularia canadensis var. canadensis	Canadian sand-spurry	SPERCAN1				1 - 5		4		

Photo 43. Transect 4: Facing south.

Photo 44. Transect 4: Facing north.

Photo 45. Transect 4: Facing south along Polygon 15 interface.

Photo 46. Transect 4: Polygon 15, facing north.

Photo 47. Transect 4: Polygon 15, facing west towards Polygon 13.	**Photo 48.** Transect 4: Polygon 15, facing southeast.
	
Photo 49. Transect 4: Polygons 13 (foreground) and 14 (distance).	**Photo 51.** Transect 4: Polygon 14 west of Polygon 13 near water's edge.
	
Photo 50. Transect 4, facing upslope (east) from Polygon 13.	

Figure 15: Photo Plate of pictures taken along Transect 4 immediately south of proposed breach location.

Table 3: Species list of plant observations in 2010 and 2013 assessments of the Airpark Lagoon.

A	B	C	D	
Tree and shrub species >10 m in height	**Woody species <10m**	**Herbaceous species**	**Bryoids, algae etc.**	**Exotic Plants**
Acer macrophyllum	Abies grandis	Achillea millefolium	Enteromorpha sp.	Atriplex patula
Alnus rubra	Acer glabrum	Agrostis exarata	Fucus sp.	Calystegia sepium
Picea sitchensis	Acer macrophyllum	Ambrosia chamissonis	Ulva lactuca	Cirsium vulgare
	Alnus rubra		Ulva sp.	Convolvulus arvensis
Populus balsamifera ssp. trichocar	Amelanchier alnifolia	Atriplex patula		Cytisus scoparius
Pseudotsuga menziesii var. menzie	Cornus stolonifera	Bolboschoenus maritimus		Dactylis glomerata
Salix sp.	Crataegus douglasii	Brassica juncea		Dactylis glomerata
	Cytisus scoparius	Calystegia sepium ssp. sepium		Daucus carota
	Hedera helix	Carex lyngbyei		Daucus carota
	Holodiscus discolor	Cirsium arvense		Hedera helix
	Mahonia aquifolium	Cotula coronopifolia		Lotus corniculatus
	Malus fusca	Dactylis glomerata		Lotus corniculatus
	Malus pumila	Daucus carota		Melilotus alba
	Physocarpus capitatus	Deschampsia cespitosa		Phalaris arundinacea
	Populus balsamifera ssp. trichocar	Distichlis spicata		Phalaris arundinacea
	Prunus emarginata	Eleocharis obtusa		Phalaris arundinacea
	Rhamnus purshiana	Eleocharis parvula		Ranunculus repens
	Ribes sanguineum	Eleocharis sp.		Rubus armeniacus
	Rosa nutkana	Elymus repens		Rubus armeniacus
	Rosa sp.	Epilobium ciliatum		Rumex crispus
	Rubus armeniacus	Festuca rubra		Symphytum officinale
	Rubus spectabilis	Galium aparine		Symphytum officinale
	Rubus ursinus	Glaux maritima		
	Salix sitchensis	Grindelia integrifolia		
	Salix sp.	Hypericum perforatum		
	Salix sp.	Juncus arcticus		
	Sambucus racemosa var. arboresc	Juncus breweri		
	Sorbus sitchensis	Juncus sp.		
	Symphoricarpos albus	Lathyrus japonicus		
	Thuja plicata	Leymus mollis		
		Lotus corniculatus		
		Mimulus moschatus		
		Persicaria amphibia		
		Phalaris arundinacea		
		Phleum pratense		
		Plantago lanceolata		
		Plantago major		
		Plantago maritima		
		Poaceae		
		Potentilla anserina		
		Rumex acetosella		
		Rumex crispus		
		Rumex sp.		
		Schoenoplectus pungens		
		Schoenoplectus tabernaemontani		
		Sidalcea hendersonii		
		Sonchus asper		
		Spergularia canadensis var. canadensis		
		Symphyotrichum subspicatum		
		Symphytum officinale		
		Tanacetum vulgare		
		Trifolium spp.		
		Trifolium wormskioldii		
		Triglochin maritima		
		Typha latifolia		
		Vicia cracca		
		Zostera marina		

Fish

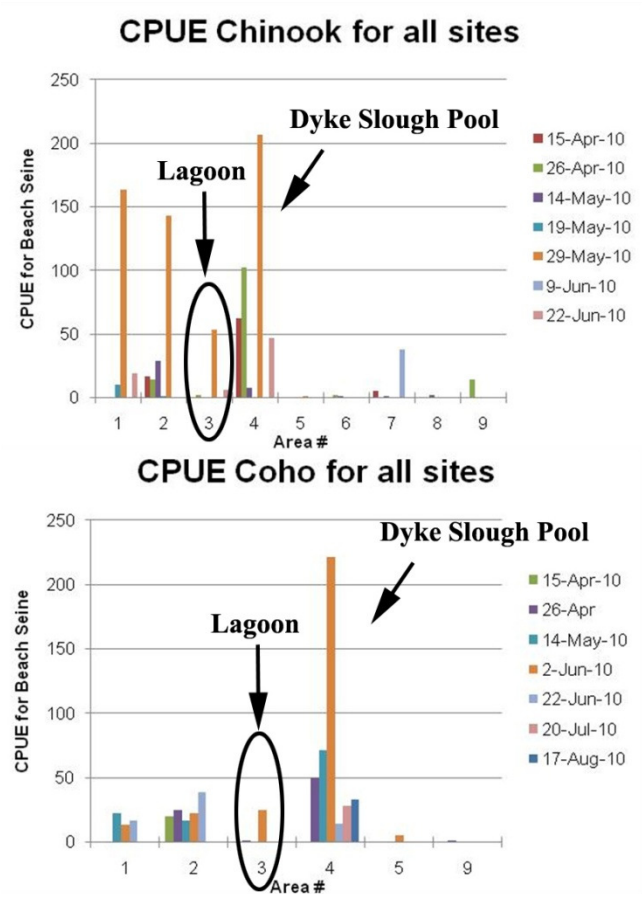

Figure 16: Catch per Unit Effort CPUE for 2010 Chinook and Coho, comparing the Lagoon to the Dyke Slough pool (downstream of Comox Ave. tide gates).

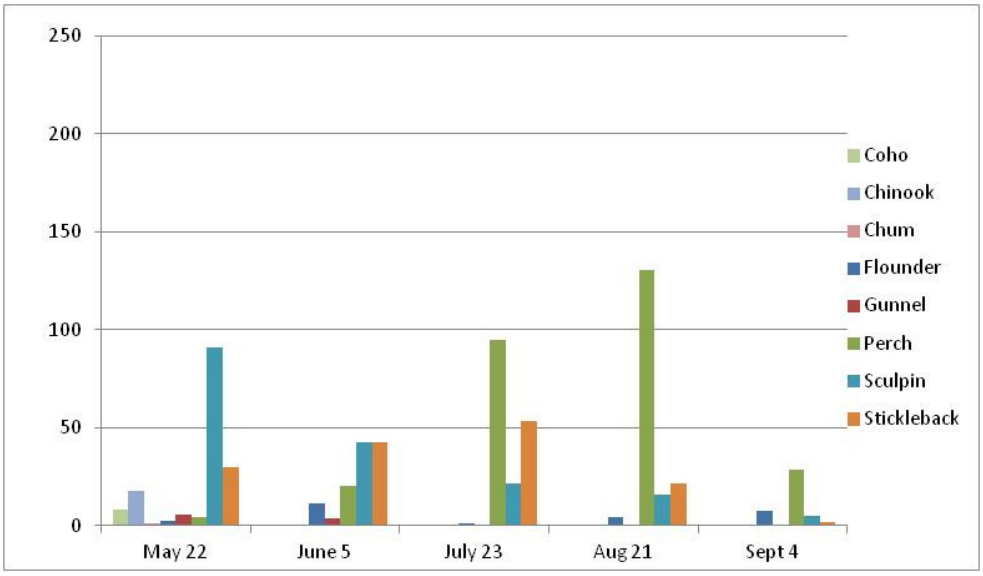

Figure 17: CPUE for all fish species captured in the lagoon in 2013.

Birds

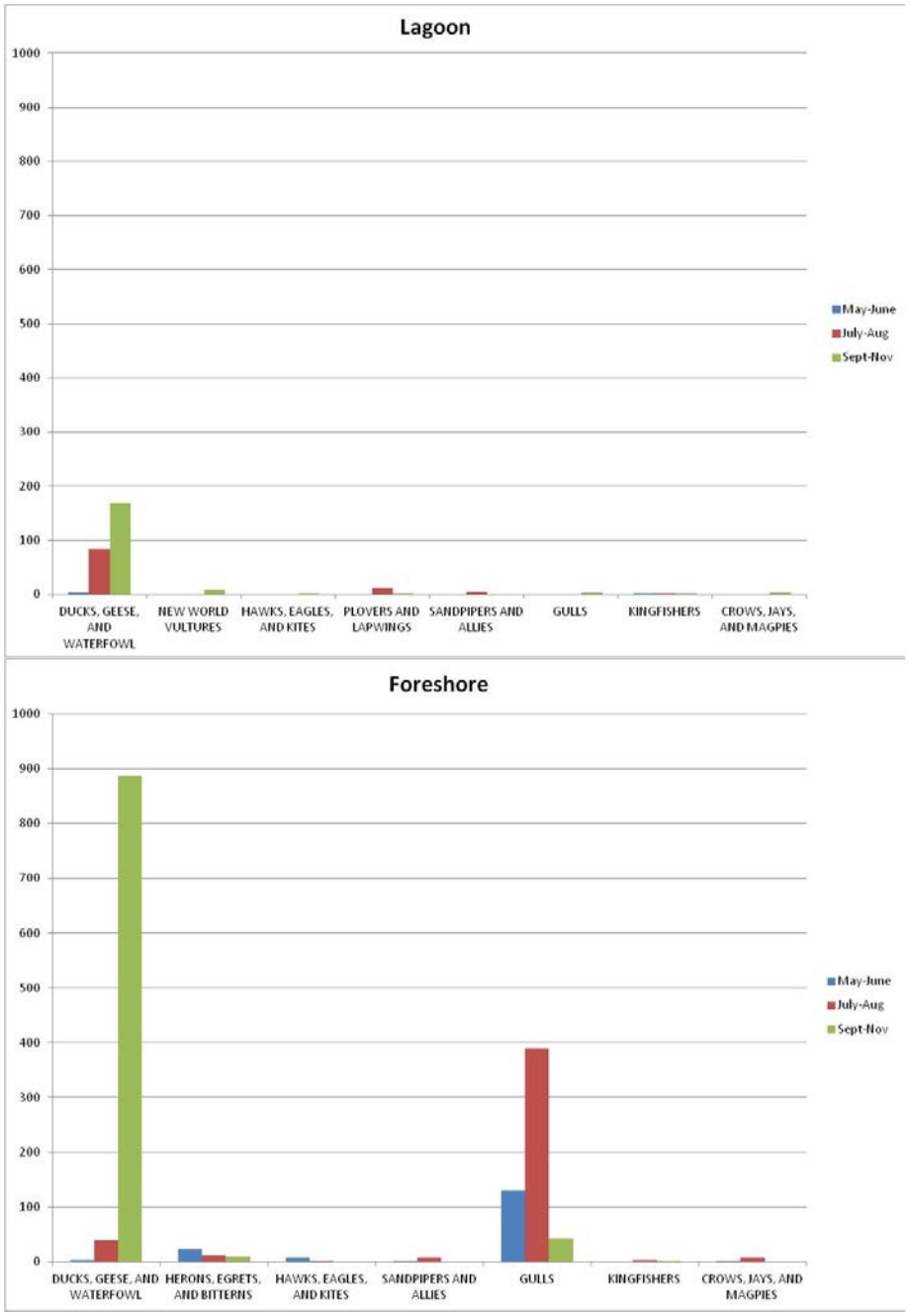

Figure 18: Comparison of bird counts in the lagoon and foreshore over the spring (blue), summer (red) and fall (green).

Table 4: Species list of bird observations from April to November in the Lagoon and Foreshore Areas.

Assessment Area	Ducks, Gees and Waterfowl	Herons, Egrets, and Bitterns	New World Vultures	Hawks, Eagles and Kites	Plovers and Lapwings	Sandpipers and Allies	Gulls	Kingfishers	Crows, Jays and Magpies
Lagoon	American Wigeon Mallard Northern Shoveler Northern Pintail Green-winged Teal Lesser Scaup Hooded Merganser	Great Blue Heron	Turkey Vulture	Bald Eagle	Killdeer	Least Sandpiper Long-billed Dowitcher	Ring-billed Gull Glaucous-winged Gull	Belted Kingfisher	Northwestern Crow
Foreshore	American Wigeon Bufflehead Canada Goose Common Merganser Green-winged Teal Mallard Northern Pintail	Great Blue Heron		Bald Eagle		Greater Yellowlegs Unidentified Peeps	Bonaparte's Gull California Gull Caspian Tern Glaucous-winged Gull Mew Gull Ring-billed Gull	Belted Kingfisher	Northwestern Crow

Temperatures

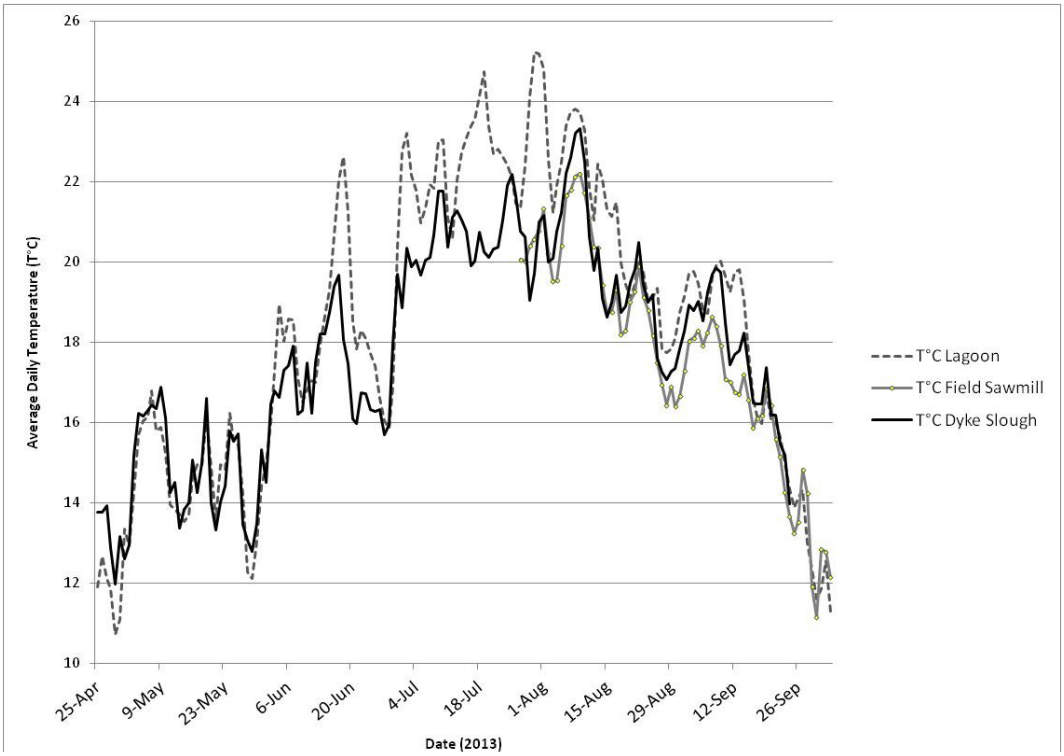

Figure 19: Average daily temperatures from spring to fall for the lagoon and Dyke Sough, and from summer to fall in the river.

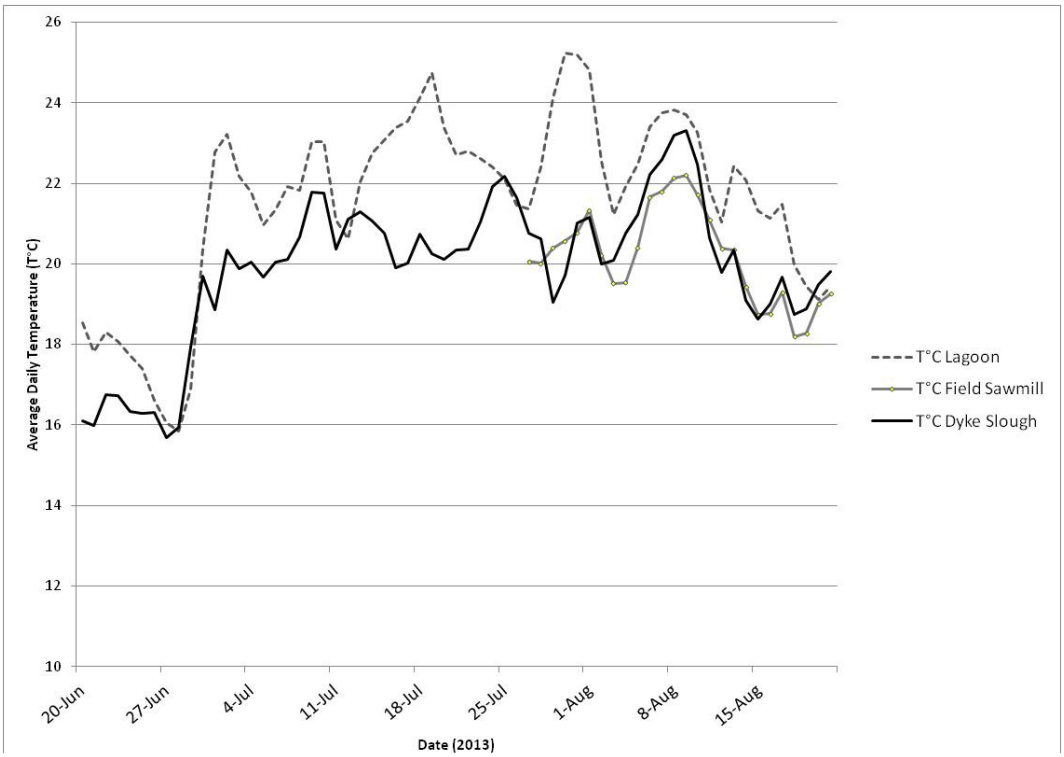

Figure 20: A close up of average daily temperatures in the lagoon, river and Dyke Slough for the summer months.

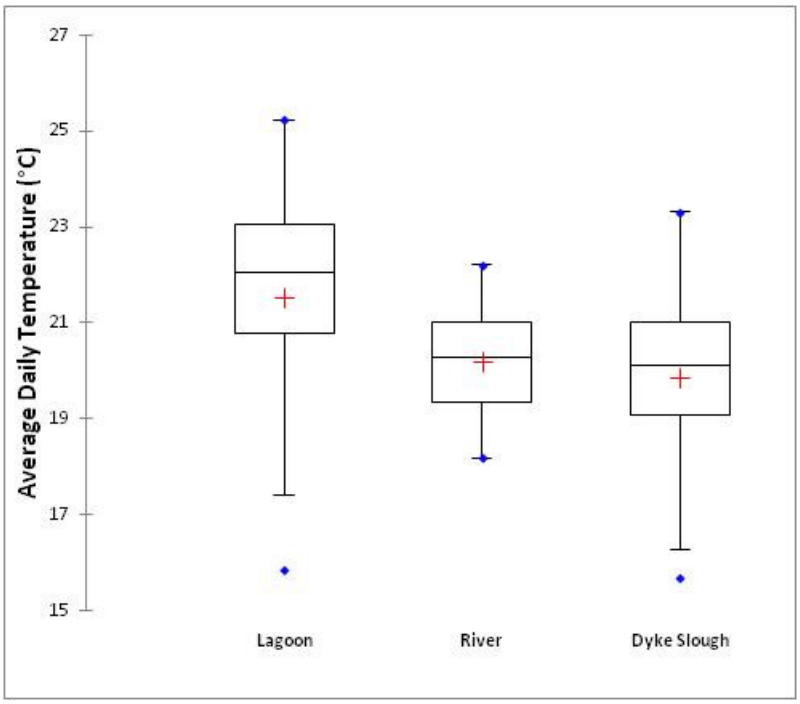

Figure 21: Boxplot of average daily temperatures in lagoon, river and Dyke Slough from June 20th to August 21st, 2013. The box boundaries indicate the upper and lower 25% quartiles. The whiskers indicate the maximum and minimum values, the blue rhombuses indicate the outliers, and the red cross the mean values. The line bisecting each box indicates median values.

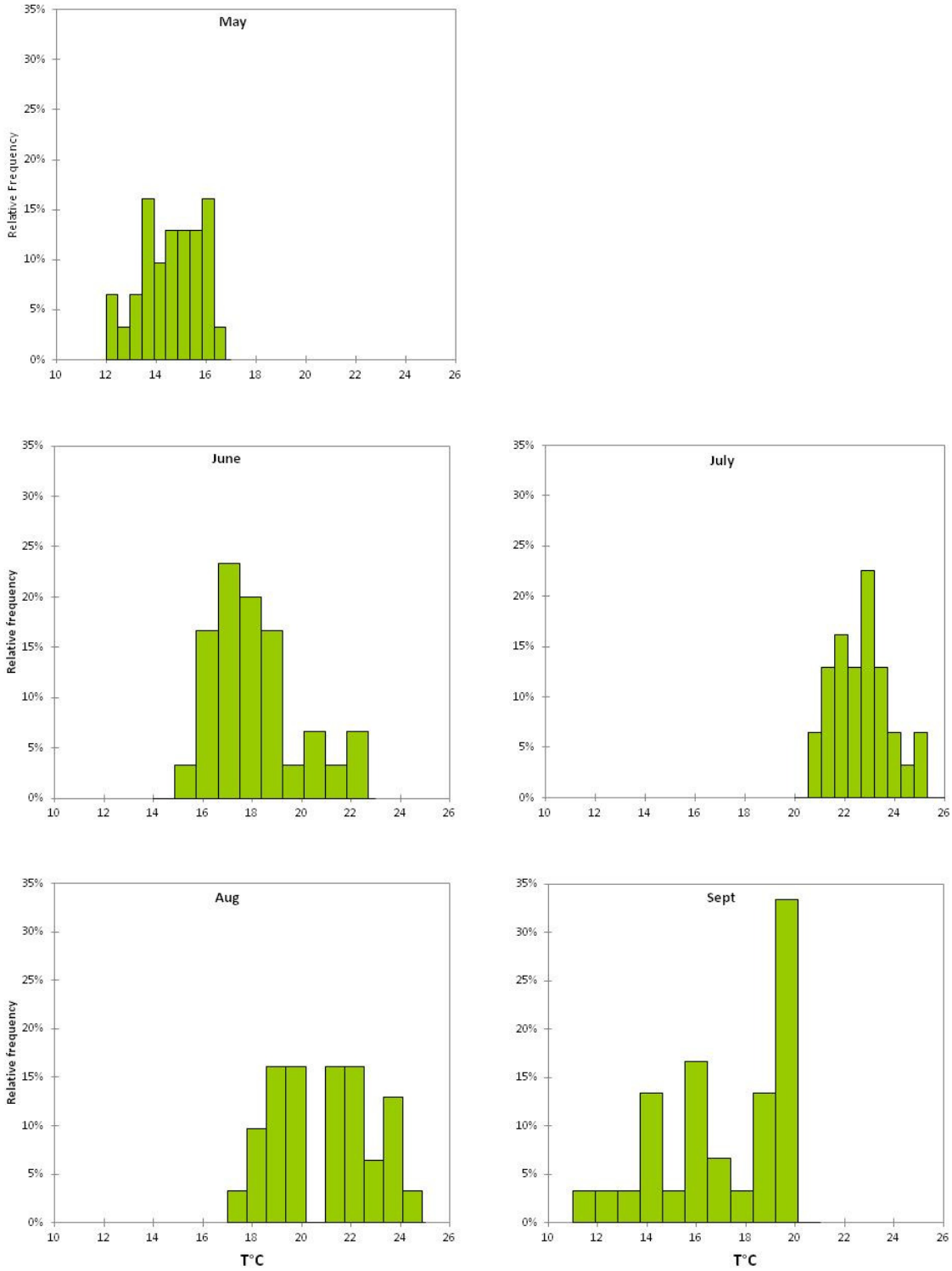

Figure 22: Histogram showing the range in water temperatures in the lagoon, and their relative frequencies throughout each month from May to September.

Sediments

Table 5: Sediment results for the North and South breach sediment sample locations. Exceedances are highlighted in grey.

exceedances highlighted in grey			Citeria											
	Results		**Contaminated Sites Regulation (CSR)**				**CCME**						**Ocean Dumping at Sea**	**Ocean Dumping at Sea**
	Results (ug/g dry weight)		Marine & estuarine sediment (ug/g)		CCME WQGL-sediment (ISQG)		Interim Sediment Quality Guidelines		CCME WQGL-sediment (PEL)		Probable effects level (ug/g)		ug/kg	(ug/g dry weight)
PAH's Above D.L.	**Breach N**	**Breach S**	**sensitive***	**typical****	**fw**	**marine**	**fresh water**	**marine/ estuarine**	**fw**	**marine/ estuarine**	**freshwater**	**marine/ estuarine**		**marine**
Anthracene		0.007	0.15	0.29	46.9	46.9	0.0469	0.0469	245	245	0.245	0.245		
Benzo(a)anthracene		0.02	0.43	0.83	31.7	74.8	0.0317	0.0748	385	693	0.385	0.693		
Fluoranthene		0.05	0.93	1.8	111	113	0.111	0.113	2355	1494	2.355	1.494		
Naphthalene		0.026	0.24	0.47	34.6	34.6	0.0346	0.0346	391	391	0.391	0.391		
Phenanthrene	0.01	0.07	0.34	0.65	41.9	86.7	0.0419	0.0867	515	544	0.515	0.544		
Pyrene		0.05	0.87	1.7	53	153	0.053	0.153	875	1398	0.875	1.398		
PAH's total	0.01	0.223	10	20									2500	2.5
Metals														
Arsenic	<0.20	5.59	26	50	5900	7240	5.9	7.24	17000	41600	7.24	41.6		
Cadmium	0.09	0.36	2.6	5	600	700	0.6	0.7	3500	4200	0.7	4.2		0.6
Chromium	30.5	30.3	99	190	37300	52300	37.3	52.3	90000	160000	52.3	160		
Copper	45.9	56.7	67	130	35700	18700	35.7	18.7	197000	108000	18.7	108		
Lead	4	12.8	69	130	35000	30200	35	30.2	91300	112000	30.2	112		
Mercury	0.038	0.3	0.43	0.84	170	130	0.17	0.13	486	700	0.13	0.7		0.75
Zinc	45.3	67.6	170	330	123000	124000	123	124	315000	271000	124	271		

*a site with sensitive aquatic habitat and for which sensitive sediment management objectives apply
**Criteria to protect marine and/or estuarine aquatic life.

Appendix 2 Hydraulic Model

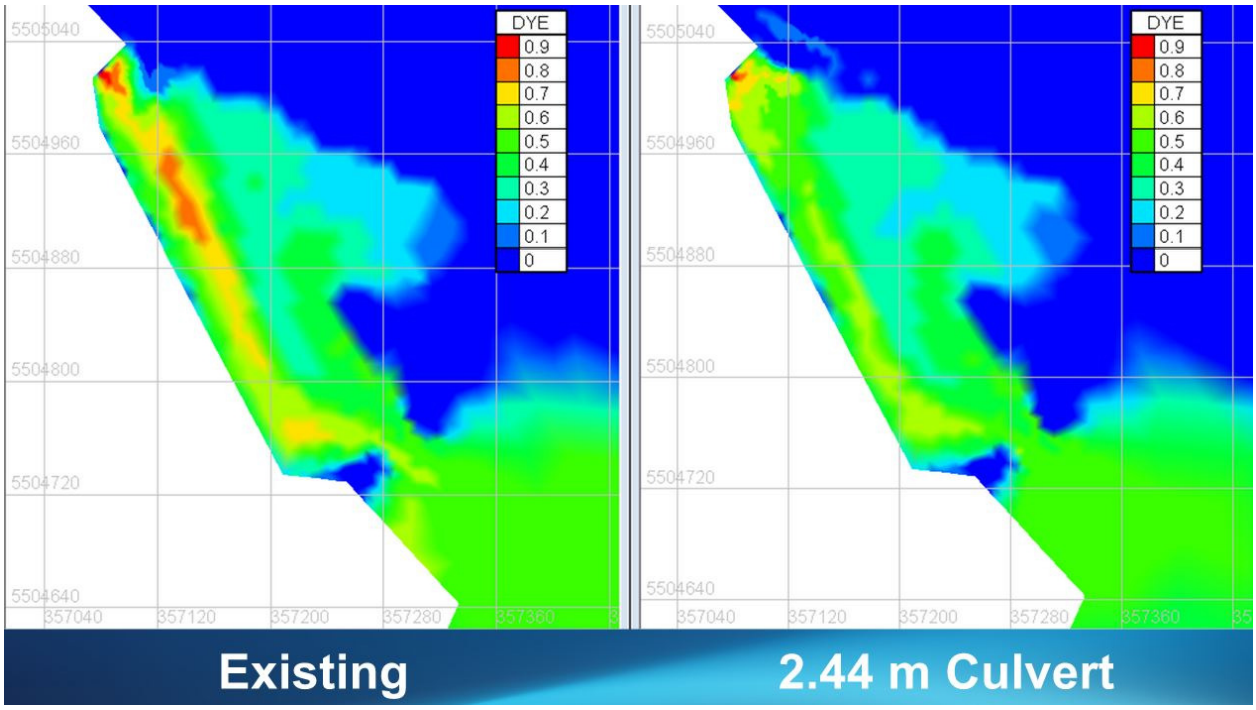

Figure 23: Dye test comparing dilution after 3 hours of existing lagoon conditions and the addition of a 2.4m culvert breach. Figure courtesy of Graham Hill of NHC.

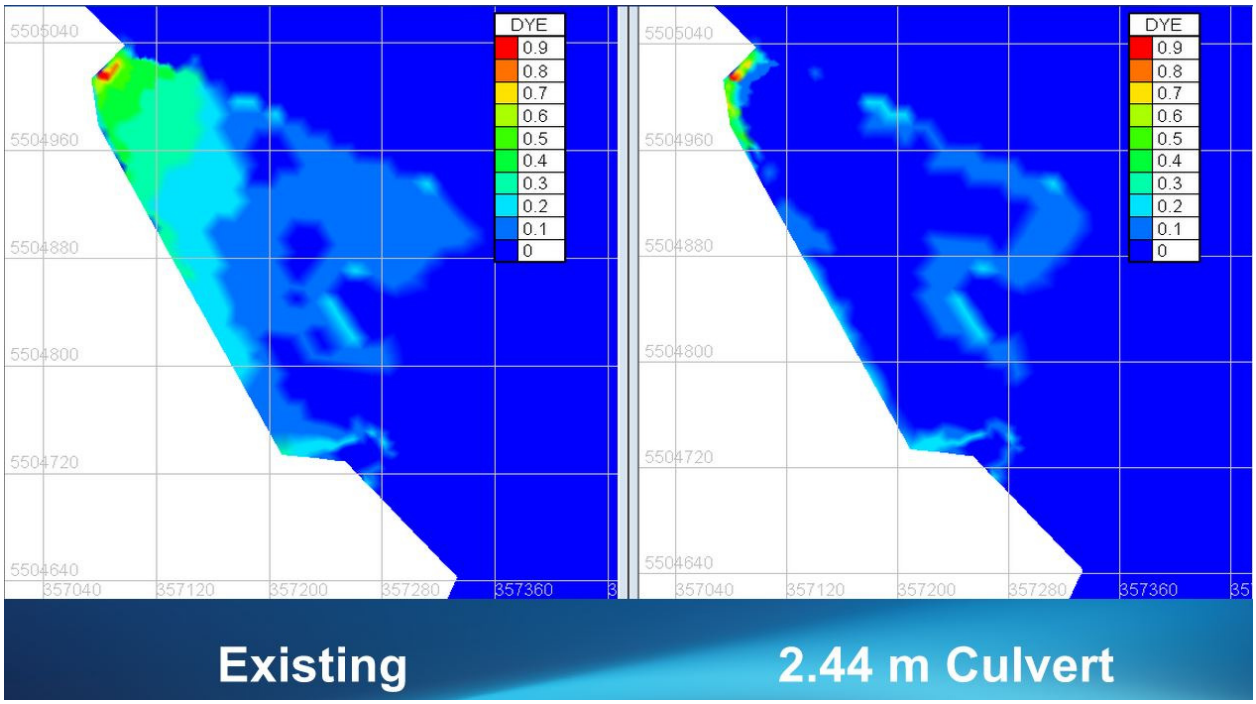

Figure 24: Dye test comparing dilution after 48 hours of existing lagoon conditions and the addition of a 2.4m culvert breach. Figure courtesy of Graham Hill of NHC.

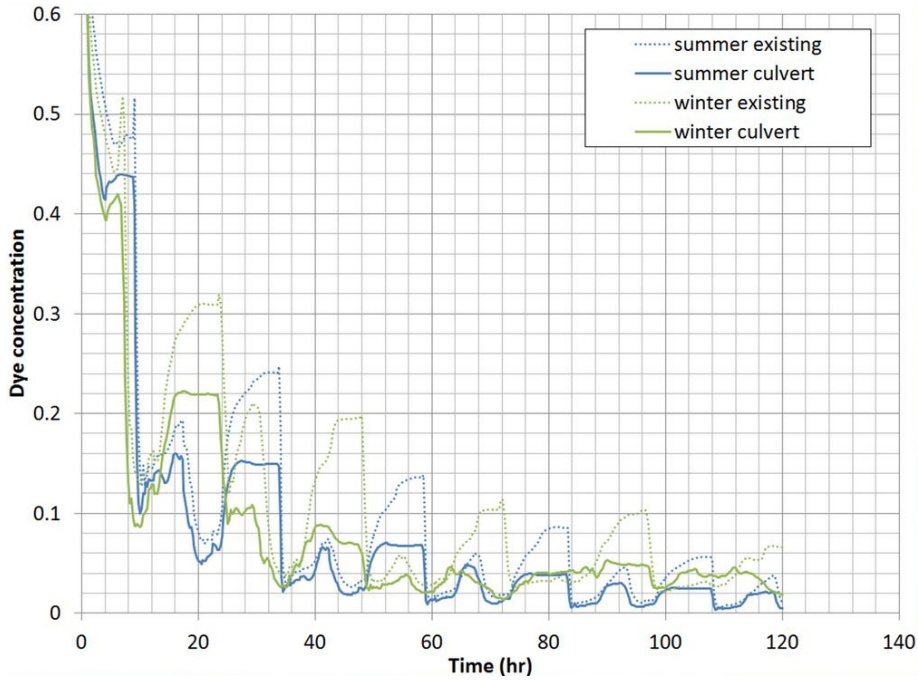

Figure 25: Dye test comparing dilution over time of existing lagoon conditions and the addition of a 2.4m culvert breach over winter and summer baseline flows. Figure courtesy of Graham Hill of NHC.

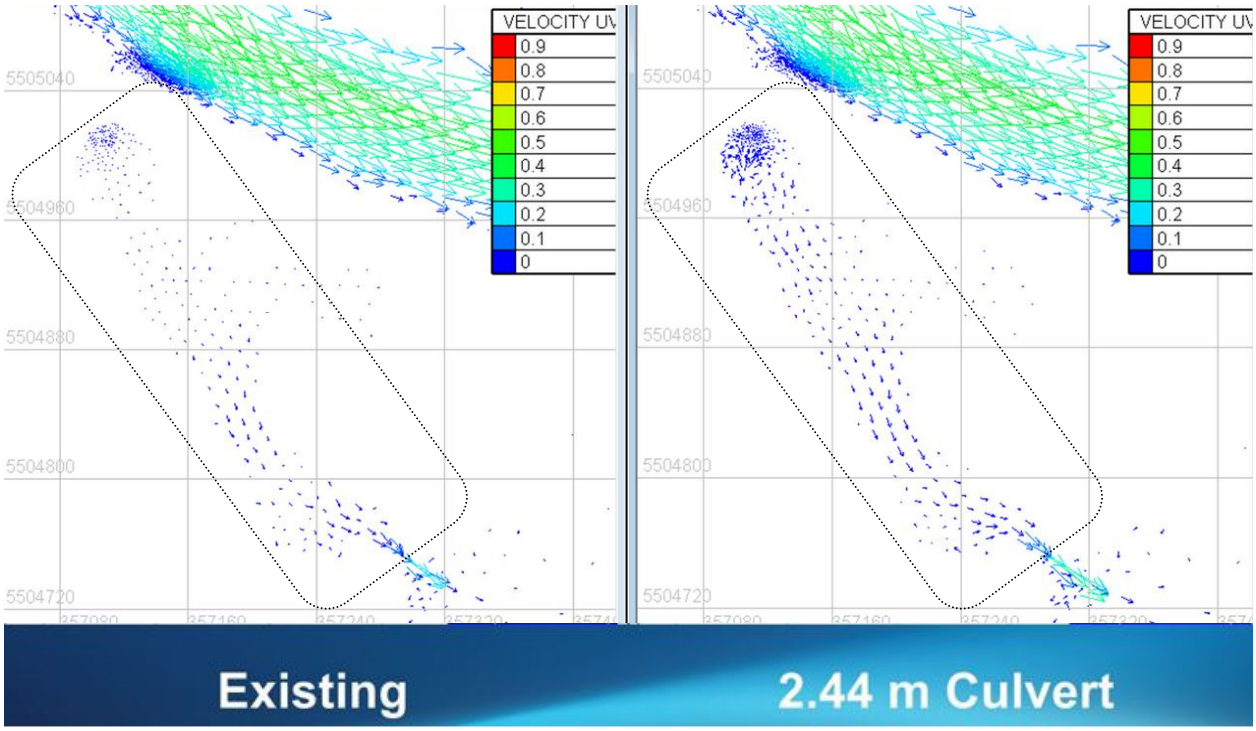

Figure 26: Velocity comparison of 2.4m culvert and exiting single breach in lagoon during a low tide and baseline summer flows. Area inside rectangles indicate lagoon location, adjacent area is river channel. Figure courtesy of Graham Hill of NHC.

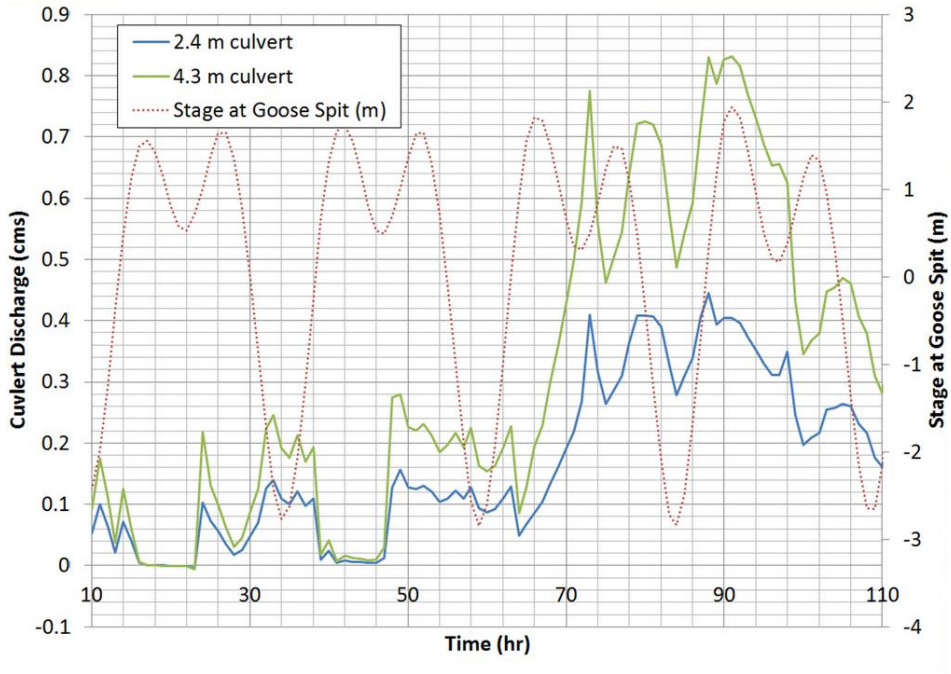

Figure 27: Comparison of culvert discharge through 2.4 and 4.3 culvert options for proposed breach given winter baseline flows. Figure courtesy of Graham Hill of NHC.

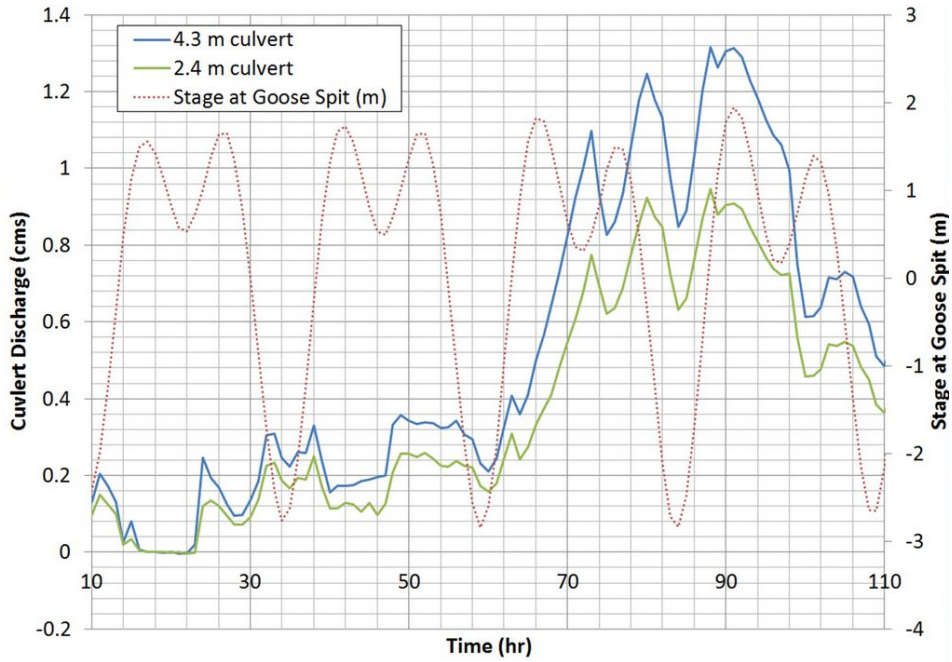

Figure 28: Comparison of culvert discharge through 2.4 and 4.3 culvert options for proposed breach during high flow conditions. Figure courtesy of Graham Hill of NHC.

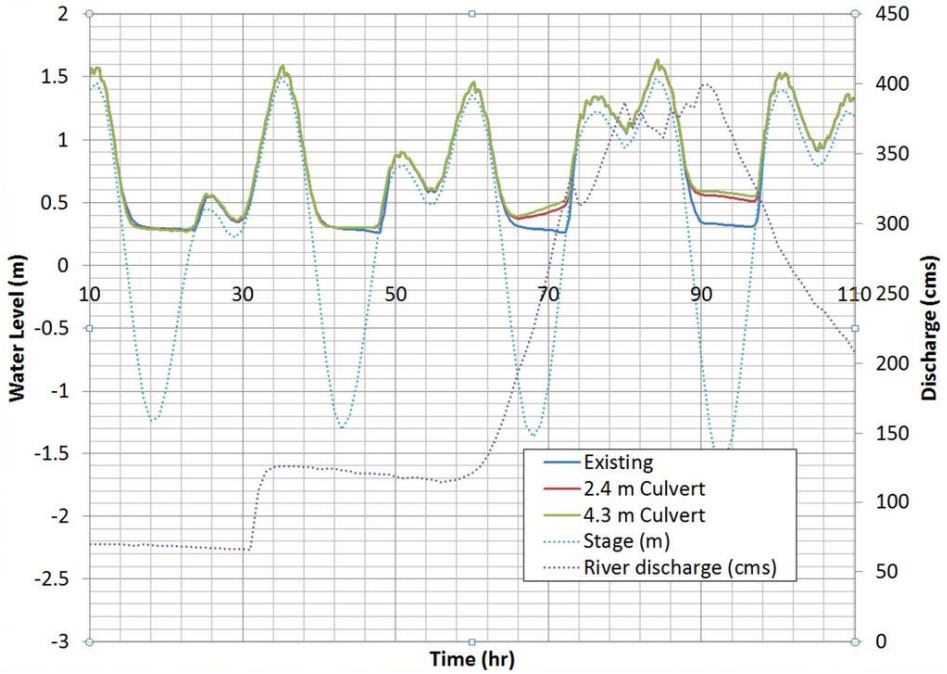

Figure 29: Comparison of water levels and discharge in lagoon with existing, 2.4 and 4.3m culvert options for proposed breach given winter baseline flows. Figure courtesy of Graham Hill of NHC.

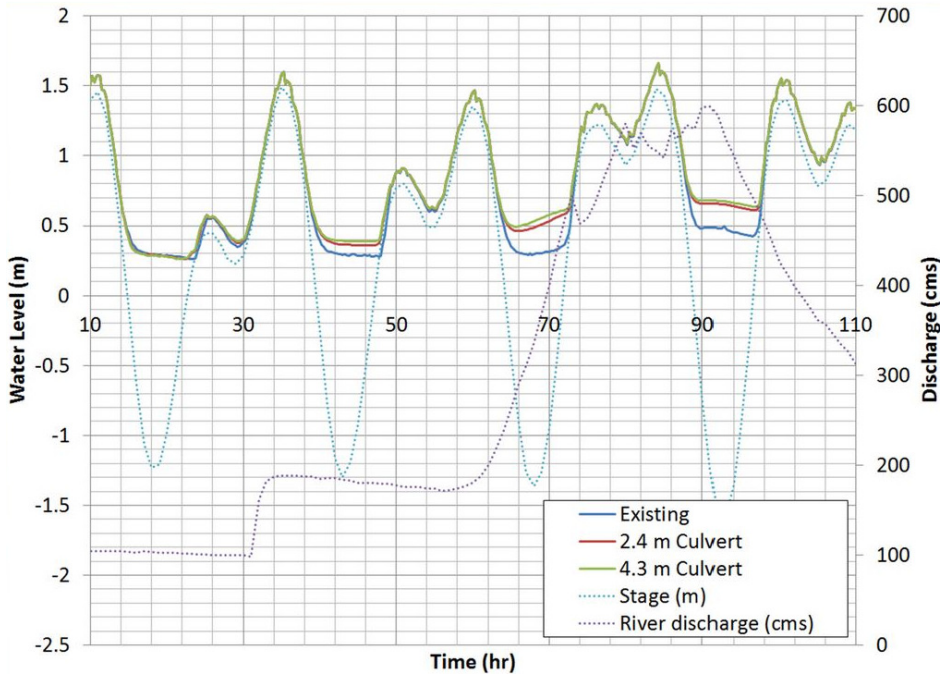

Figure 30: Comparison of water levels and discharge in lagoon with existing, 2.4 and 4.3m culvert options for proposed breach given extreme flow conditions. Figure courtesy of Graham Hill of NHC.

Table 6: Assessment endpoints, indicators and details to evaluate project success.

Assessment Endpoint	Indicator	Timing/Frequency	Notes
Improved Water Quality	temperature	April to Sept, 10 min. intervals (logger), 2014-16	Logger installed in lagoon at ~0.5m depth. Results compared to 20° and 25° thresholds for salmon success (Bjornn and Reiser 1991).
Improved juvenile salmon access to the lagoon	Presence/ Absence	April to Aug, 1x per month, 2014-16	Baseline years = 2010 and 2013. Success indicated by longer residence in lagoon through July-Aug. CPUE also collected.
Increased bird diversity in lagoon and surrounding foreshore	Relative frequency of use by different species	Seasonal: Spring, Summer, Fall Winter 2014-16	Baseline for summer 2013, data collection ongoing (2013-2014). Success based on increase in bird use and diversity.
Increased use of estuary during salmon migration	Sr signature in otoliths	Fall collection of Coho salmon otoliths from Puntledge River hatchery adults 2017	Baseline available for adult Coho in PUN. Success based on longer residence time in estuary of spawning salmon. See Sea Grant (2011) for example.

Appendix 3 Project Planning Documents

Email correspondence[8]

26/1/2014 RE Airpark Lagoon Sampling.htm

From: Condon, Colm ENV:EX [Colm.Condon@gov.bc.ca]
Sent: Wednesday, November 27, 2013 4:25 PM
To: 'Lora Tryon'; Brooke, Julia A ENV:EX; 'wgwhite'; 'Dan Bowen'
Subject: RE: Airpark Lagoon Sampling

Hi Lora,

Julia asked me to address your email below.

Based on the concentrations measured from the limited data collected and the information you've provided about the historical use and management of sediment in the area, the proposed breach appears to be a low risk activity from a Contaminated Sites Regulation point of view, and thus I have no concerns with the activity at this point.

That said, please contact me or my Director, Mike Macfarlane (mike.macfarlane@gov.bc.ca) if, during breach construction, material is encountered which you suspect may be contaminated.

Thank you,
Colm

Colm Condon, MRM, RPBio
Manager, Risk Assessment and Remediation
Land Remediation Section
BC Ministry of Environment
PO Box 9342 Stn Prov Govt
Victoria BC V8W 9M1

W: 250.953.3855
C: 250.360.7477
F: 250.387.8897
E: colm.condon@gov.bc.ca

[8] Lora McAuley is referred to as Lora Tryon in some emails.

DFO Letter of Support

Fisheries and Oceans Canada | Pêches et Océans Canada

Resource Restoration Unit
South Coast Area
1965 Island Diesel Way
Nanaimo, BC V9S 5W8

November 1, 2013

Our file *Notre référence*
BCH-FWCP-CVPWS-14.PUN.02

Allister McLean
Program Manager
BC Hydro's Fish and Wildlife Compensation Program
Coastal Region
6911 Southpoint Drive
Burnaby, B.C. V3N 4X8

Attn: **Allister McLean**

Subject: Letter of Support: BC Hydro FWCP Application, Courtenay Air Park Lagoon Breach Project

In fulfilment of the requirements for Partnership and Regulatory support for project funding applications under the BC Hydro Fish and Wildlife Compensation Program (FWCP), the Department of Fisheries and Oceans (DFO) Resource Restoration Division (South Coast Area) herein provides its endorsement for the *Courtenay Air Park Lagoon Breach Project* under submission from the Comox Valley Project Watershed Society (and supporting partners).

The DFO's endorsement of this project is based on identified and anticipated benefits to salmon resources of the Strait of Georgia (SoG), and specifically in support of Departmental enhancement efforts of its Puntledge River Hatchery – summer Chinook, in addition to fall Chinook, Coho, pink & chum populations, as well as other species utilizing both the Puntledge and Tsolum River systems. Furthermore, the projected benefits of this project are consistent with the Goals and Objectives as defined within the *Courtenay River Estuary Management Plan* (CREMP) – which provides strategic vision for the restoration and integrated management of the K'omoks Estuary, of which DFO is an active partner, along with other government, First Nations, community & stakeholder interests. Additionally, this initiative is supportive of on-going species assessment and enhancement efforts as part of the BC Hydro Puntledge River Water Use Plan (WUP) monitoring program, and consistent with providing improvements in marine nearshore survival of SoG juvenile salmon; a more recently identified, and potentially critical limiting factor.

Through its Community Involvement Program and Salmon Enhancement operations, DFO has established excellent working relations and technical confidence with the CVPWS and its

.../2

Canada

- 2 -

affiliated partners in supporting community conservation efforts focused on salmon enhancement and integrated ecosystems restoration.

In view of the potential benefits to system fisheries productivity and survival linked to marine nearshore habitat restoration; DFO provides conditional support for this initiative subject to confirmation of the following (consistent with stated objectives/outcomes from Phase 1 and 2 projects):

1. Water, soils and sediment quality parameters are within current Provincial WQ/CSR guidelines (*Compendium of Working Water Quality Guidelines for British Columbia*) and confirmation of Provincial approval under the BC-CSR for Qualified Professional assessment of sampling results;
2. Results of the assessment Phase 1 & 2 (2012-13) projects that demonstrate both physical-process (flow-tidal flux) and biological feasibility (habitat suitability/species use) in meeting defined objectives and,
3. Full support from regulatory partners in respect of their mandates and area of jurisdiction, including security/certainty on issues around land tenure, liability and maintenance – all of which have influence on the proper function, sustainability and ultimate success of the project.

In recent discussions with Project Consultant, Lora McAuley (Lake Trail Environmental Consulting) DFO has been advised that these conditions either have or are anticipated to be met in support and in advance of dike construction/Phase-3.

We trust, that this letter provides the appropriate scope for support of the proposed project; however should you require clarification or any additional information, please feel free to contact the undersigned or our local Community Advisor, Mr. Dave Davies (250.330.0431) for assistance.

Yours Respectfully,

Nick Leone, R.P.Bio.
Restoration Biologist
Resource Restoration Division
South Coast Area
Fisheries & Oceans Canada

Cc: Tom Rutherford, DFO, CIP-RRD Section Head
Dave Davies, DFO, CIP-CA
Caila Holbrook, Coord. CVPWS

Sediment Opinion Letter

October 28, 2013

AMEC PROJECT: NX13015

Project Watershed
2356a Rosewall Crescent
Courtenay BC V9N 8R9

Attention: **Dan Bowen, Technical Director**

Subject: **Opinion Letter of Sediment Sampling Results for the Proposed Dike Breach at the Courtenay Airpark Lagoon**

AMEC Environment & Infrastructure Limited (AMEC) was retained by Project Watershed to provide an opinion as to whether sediment at the Courtenay Airpark Lagoon (the Site) is in compliance with the standards applicable to the Site. AMEC understands that Project Watershed is proposing to create a breach in the dike at the Site in order to create additional aquatic habitat at the mouth of the Courtenay River.

The Site was used as a sewage lagoon by the City of Courtenay from approximately 1962 to 1984. It was converted to a salt marsh/pond and park land complex in 1992 with a breach of the dike on the southeast side of the lagoon. The majority of the sludge contained in the lagoon was removed during the redevelopment but some was left around the fringes of the lagoon adjacent to the dike. The proposed breach is intended to increase the water circulation in the lagoon and improve the aquatic habitat. The excavation of the proposed breach will involve movement of sludge within the Site but no off-site removal is anticipated. The hydraulic design of the proposed breach is intended to minimize any movement of the remaining in-situ sludge within or off the Site.

The following information was provided by Project Watershed and reviewed as part of this assessment:

- Email correspondence detailing the Airpark Lagoon sampling protocol used (attached);
- Diagram of Airpark Lagoon sampling points (attached);
- Courtenay Airpark Lagoon Dike Breach Planning, Application for Funding 2013/2014 to the BC Hydro Fish and Wildlife Compensation Program;
- Certificate of Analysis for Sediment Samples prepared by North Island Laboratories dated 21 August 2013 (attached);
- Lagoon Bottom Grading Details, Courtenay Lagoon Park, drawing prepared by McElhanny Engineering Services Ltd. dated 9 July 1991; and,

AMEC Project: NX13015
Opinion Letter
Courtenay Airpark Lagoon Sediment Sampling
October 28, 2013

- Technical Review (Major), Cancellation of PE-258, prepared by the Ministry of Environment dated April 24, 1991.

Review of the sampling protocol and sampling locations indicates that the two samples obtained are representative of the in-situ sludge in the proposed breach area. The sampling method appears to conform to the cross contamination precautions that would be employed by AMEC under similar conditions and Chain of Custody protocol for transport and analysis has been followed. The analytical results indicate subcontracted analysis through Exova Laboratories which is accredited by the Standards Council of Canada.

The applicable standards for sediment at the Site are contained in the *Contaminated Sites Regulation* (CSR), B.C. Regulation 6/2013, Schedule 9, Generic Numerical Sediment Criteria. The Site is a sensitive estuarine environment and therefore the standards in Column IV apply.

Review of the sampling results indicate that the two samples obtained were analyzed for metals, including mercury, total and speciated polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), pentachlorophenol (PCP) and common pesticides/herbicides. These parameters appear to be appropriate for municipal sewage sludge and also accounts for potential PCP sediment contamination due to the former Field's Sawmill site located approximately 400 metres up the Courtenay River. Dioxins and Furans were not analyzed but would only be necessary if high levels of chlorinated compounds such as PCP were identified.

Review of the analytical results indicates that all of the analyzed parameters are below the CSR Schedule 9, Column IV standards. The majority of the parameters, aside from metals and select PAHs, are indicated as below the laboratory detection limits. AMEC concludes that the sludge, when excavated, is suitable as fill material at the Site. Any off-site disposal of the sludge would require further evaluation to assess the need for a Contaminated Soil Relocation Agreement (CSRA) under the CSR. It is recommended that measures be taken to minimize entrainment of the sludge sediment in the water column during excavation and placement on other areas of the Site.

This letter was prepared for the exclusive use of Project Watershed and the BC Ministry of Environment. Any use which a Third Party makes of this letter, or any reliance on or decisions to be made based on it, are the responsibility of the Third party. Should additional parties require reliance on this report, written authorization from AMEC will be required. With respect to third parties, AMEC has no liability or responsibility for losses of any kind whatsoever, including direct or consequential financial effects on transactions or property values, or requirements for follow-up actions and costs.

AMEC Environmental & Infrastructure
4385 Boban Drive
Nanaimo BC V9T 5V9
PH: 250.758.1887
FX: 250.758.1887

AMEC Project: NX13015
Opinion Letter
Courtenay Airpark Lagoon Sediment Sampling
October 28, 2013

In evaluating the Site, AMEC has relied in good faith on information provided by Project Watershed. AMEC has assumed that the information provided is factual and accurate. AMEC accepts no responsibility for any deficiency, misstatement or inaccuracy contained in this letter as a result of omissions, misinterpretations or fraudulent acts.

Please contact the undersigned at 250-758-1887 if you have any questions concerning the work performed.

Respectfully Submitted,

AMEC Environment & Infrastructure
a division of AMEC Americas Limited

Allan Morrison, P.Eng., CSAP
Associate Environmental Engineer

Attachments: Sampling Protocol Email
Diagram of Airpark Lagoon Sampling Points
Certificate of Analysis

AMEC Environmental & Infrastructure
4385 Boban Drive
Nanaimo BC V9T 5V9
PH: 250.758.1887
FX: 250.758.1887

Culvert Design Drawing