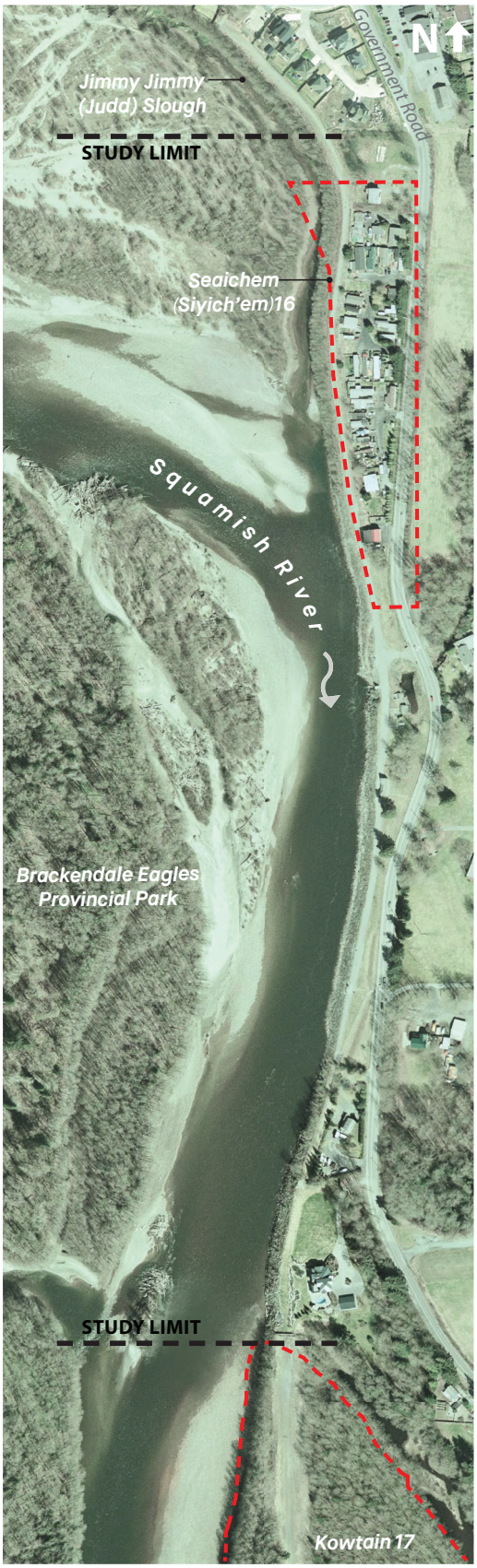
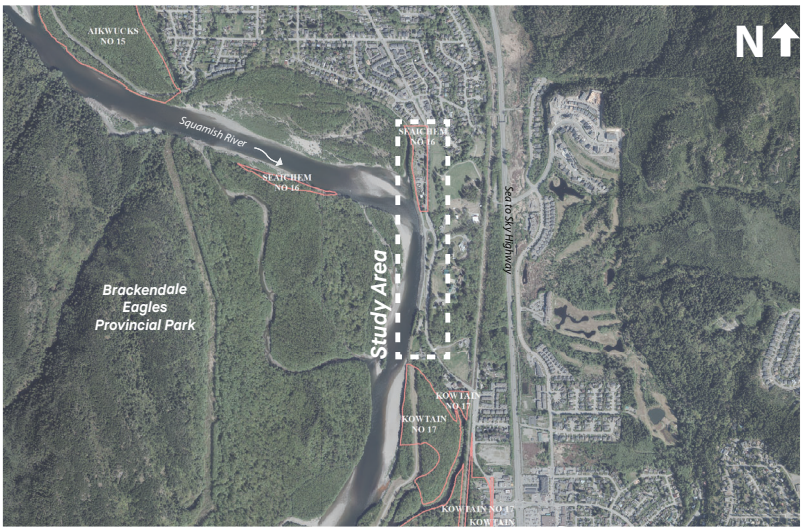
SIYICH'EM RESERVE AND EAGLE VIEWING AREA
PROJECT OVERVIEW

AERIAL OF STUDY AREA



AERIAL OF STUDY AREA WITH CONTEXT



PROJECT OVERVIEW

The project focuses on the area of the Squamish River dike between the northern end of Siyích'em I.R. No. 16 and the northern end of Kowtain I.R. No. 17.

This project assesses options for upgrading the dike protecting Brackendale and the rest of Squamish in accordance with the recently completed Squamish Integrated Flood Hazard Management Plan (IFHMP). The project also considers non-flood protection challenges and opportunities of the area.

The project will consider possible dike alignments and other flood protection options for the area. The aim is to develop a plan which accommodates a number of considerations, including:

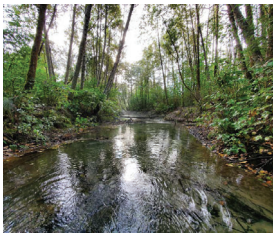
- shared jurisdiction between the District and Nation;
- infrastructure on, through, and next to the dike;
- encroaching development;
- private property challenges;
- impinging river flows and debris impact;
- sensitive environmental habitat areas; and
- tourism and recreational use.

This project does not involve implementation, i.e. no dike construction. A future project or projects will implement the plan and will provide further opportunities for input. The master plan project is funded by the federal and provincial government.

SIYICH'EM RESERVE

EAGLE WATCHING

HABITAT



GOVERNMENT ROAD

PATH ALONG DIKE

PUMP STATION

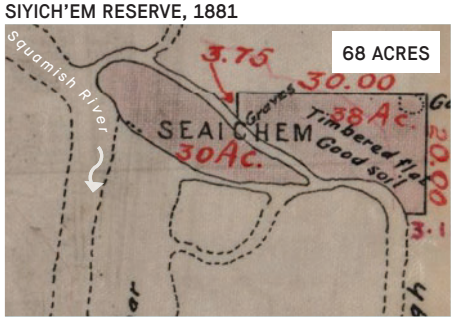
SIYICH'EM RESERVE AND EAGLE VIEWING AREA
RESERVE LAND HISTORY

SIYICH'EM RESERVE LOSS OF LAND

A Government of Canada survey map of the Siyich'em reserve dated 1881 shows that the reserve comprises an island in the river and a mainland parcel on the west side of Government Road. The 1881 survey shows a total area of 68 acres (30 acres on the island and 38 acres on the mainland parcel). The 1881 survey also shows the main Squamish River channel located to the west of the island parcel.

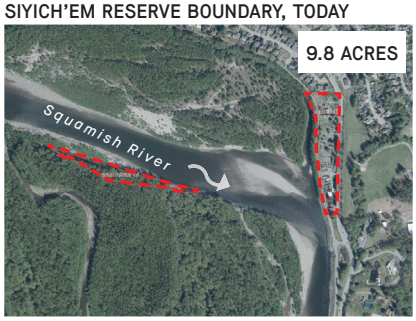
The current Government of Canada mapping of the Siyich'em reserve defines a much smaller area (only 9.8 acres) as the Siyich'em reserve, comprising a 6.6 acre remnant of the mainland parcel and a 3.2 acre remnant of the original island parcel. There are many factors that may have contributed to the physical and mapped loss of land on Siyich'em reserve, including historical diking and river engineering decisions and works, logging practices and logjams, river erosion and alignment change.

SIYICH'EM RESERVE, 1881



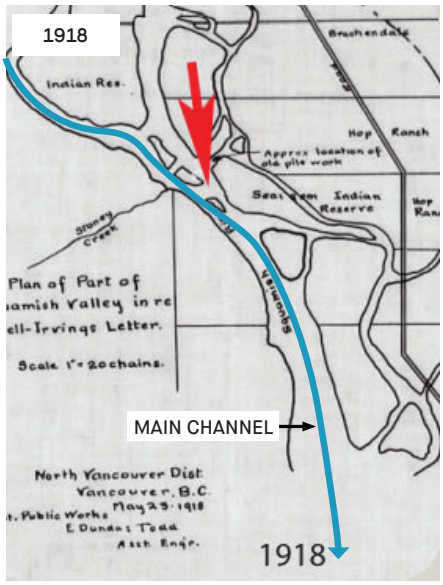
1881 E. Mohun survey provided by Government of Canada

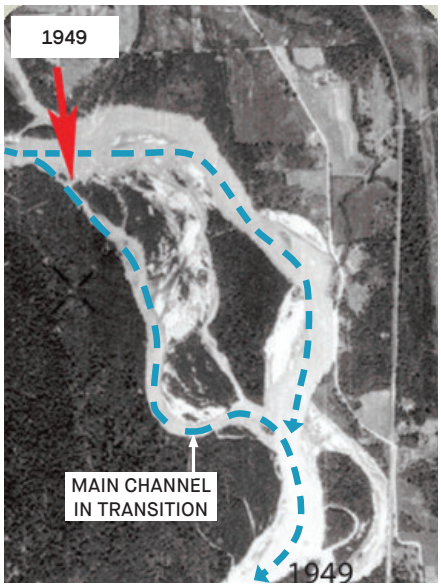
SIYICH'EM RESERVE BOUNDARY, TODAY



RIVER EROSION AND CHANNEL MIGRATION

This panel of historical airphotos shows changes in the Squamish River main channel alignment since the 1900's. The red arrow on each photo is a reference that points to the same approximate location in all three photos. Comparing the 1918 photo (bottom left) to the 2008 photo (bottom right), we can see that the main river channel was located on the west (left) side of the red arrow in 1918 and is now located on the east (right) side of the red arrow. The main channel in 1918 is now a side channel that can be seen on the 2008 photo.





CURRENT CONDITIONS

Homes and structures on the Siyich'em reserve are located immediately adjacent to and below the existing dike.

Forested floodplain areas provide riparian habitat and potential eagle nesting trees.

The south end of the Siyich'em reserve. The Watershed Grill patio is attached to the existing dike crest.

SIYICH'EM RESERVE AND EAGLE VIEWING AREA
HISTORY OF FLOODS AND FLOOD PROTECTION NEEDS

MAJOR FLOODS IN STUDY AREA

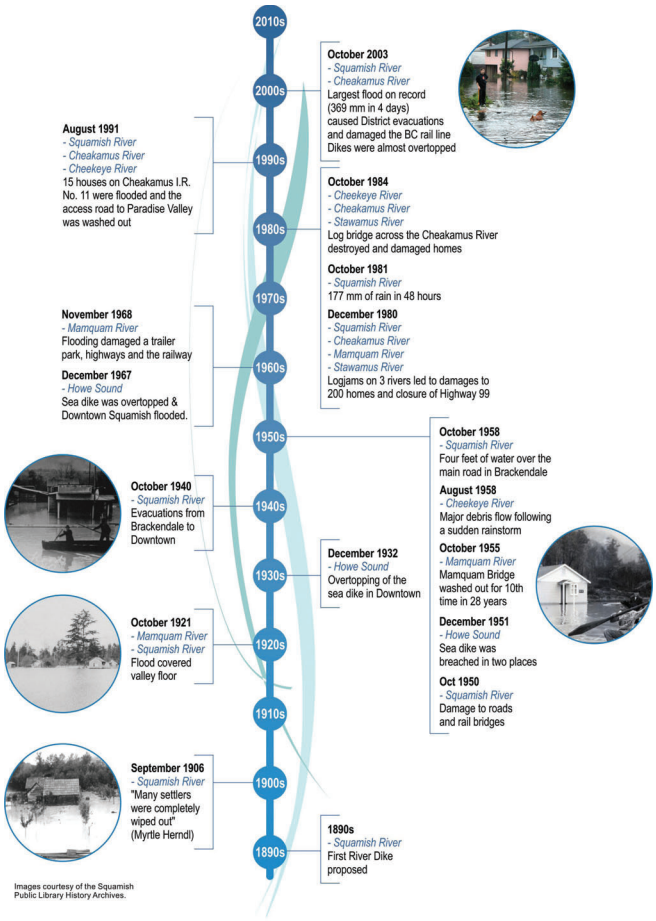
The Squamish valley has a long unrecorded and recorded history of flooding from different rivers and also from Howe Sound. The recent history of floods timeline (right) was created as part of the recent Squamish Integrated Flood Hazard Management Plan (IFHMP) project and shows some of the most notable recorded flood events.

The Siyich'em and Brackendale communities have lived through many Squamish River floods. The photos below recall two of the more notable floods; a major flood in the 1930s and the October 2003 flood, which is the largest Squamish River flood since measurements were formally recorded.

LEVEL OF PROTECTION

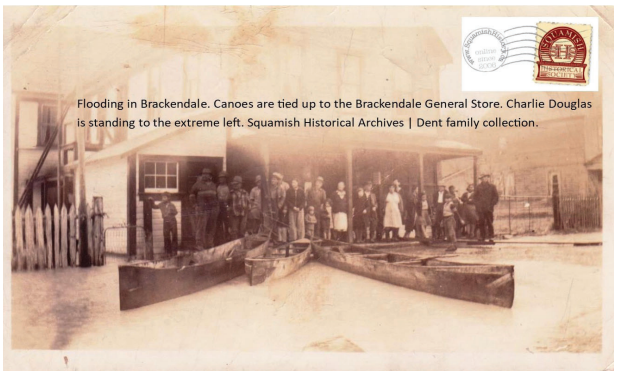
The IFHMP recommends a '500-year return period' level of protection for Squamish River dikes. A 500-year return period flood can happen in any year, but it has a very low probability (0.2% per year).

RECENT HISTORY OF FLOODS IN SQUAMISH

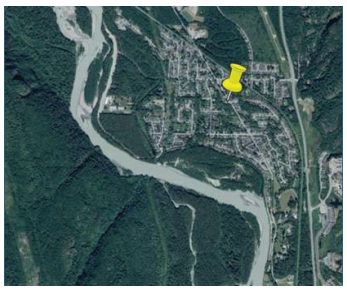


Images courtesy of the Squamish Public Library History Archives.

1930s BRACKENDALE GENERAL STORE



Flooding in Brackendale. Canoes are tied up to the Brackendale General Store. Charlie Douglas is standing to the extreme left. Squamish Historical Archives | Dent family collection.



(Above) Canoes tied up at the Brackendale General Store during a major flood in the 1930s. Photo provided by the Squamish Historical Society.

(Left) Brackendale General Store is located approximately 0.5 miles (850 metres) from the current Squamish River Channel.

2003 FLOOD

Floodwaters lapping at the Squamish River dike at Dyrden Creek pump station within the study area during the October 2003 flood. Records indicate that the river level reached within 0.3 m (1 foot) of the dike crest. Major seepage* and piping* (sand boil) issues were observed raising concerns about dike stability – fortunately, the dike did not breach and floodwaters receded.

SEEPAGE FLOODING IN SIYICH'EM DURING OCTOBER 2003 FLOOD

Seepage* through the dike caused ponding and shallow flooding in Siyich'em reserve during the October 2003 flood. Seepage flooding is experienced regularly on the Siyich'em reserve during large Squamish River floods.

* **Seepage**: The flow of water through the dike.

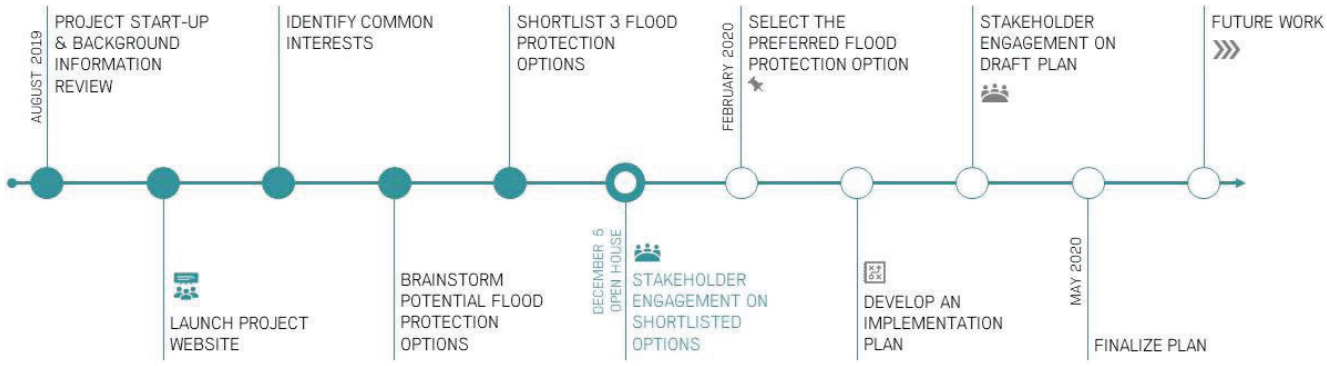
* **Piping:** The loss of fine sediments through the dike resulting in the formation of a pipe gap.

SIYICH'EM RESERVE AND EAGLE VIEWING AREA
DIKE MASTER PLAN PROCESS

WHAT IS A DIKE MASTER PLAN?

The dike master plan will be a document that expresses the preferred vision and concept for upgrading flood protection within the study area while acknowledging and addressing non-flood protection related issues that are related to the study area. The master plan will guide future detailed design and construction projects that will implement the plan. The master plan development is led by a project steering committee comprising District, Nation, and Government of Canada representatives, supported by a consulting team of engineers, biologists, and landscape architects. The project timeline is presented below. The project timeline is governed by the funding grant deadline of Spring 2020. Engagement with the Squamish Nation and community stakeholders is an important component of the project and is also described below.

PROJECT TIMELINE



NATION AND DISTRICT COMMON INTERESTS FOR OPTIONS DEVELOPMENT

The project steering committee developed the following 7 common interests to guide the identification, development, and evaluation of flood protection options. These interests span flood protection, land tenure, environmental, social/cultural, recreational and financial factors.

- ADDRESS FLOOD RISK AND PUBLIC SAFETY
- RECAPTURE SQUAMISH NATION LAND AND ENABLE BENEFICIAL USE
- OPTIMIZE PROJECT COSTS
- MINIMIZE IMPACTS TO THE ENVIRONMENT
- ADDRESS IMMEDIATE FLOOD RISK, WHILE ENABLING LONG TERM APPROACHES
- ACKNOWLEDGE AND REFLECT SITE HISTORY AND CULTURE IN DESIGN AND IMPLEMENTATION
- ENABLE FUTURE COLLABORATION ON RESOLVING DIKE/PATH ACCESS ISSUES

HOW AND WHEN CAN I PARTICIPATE?

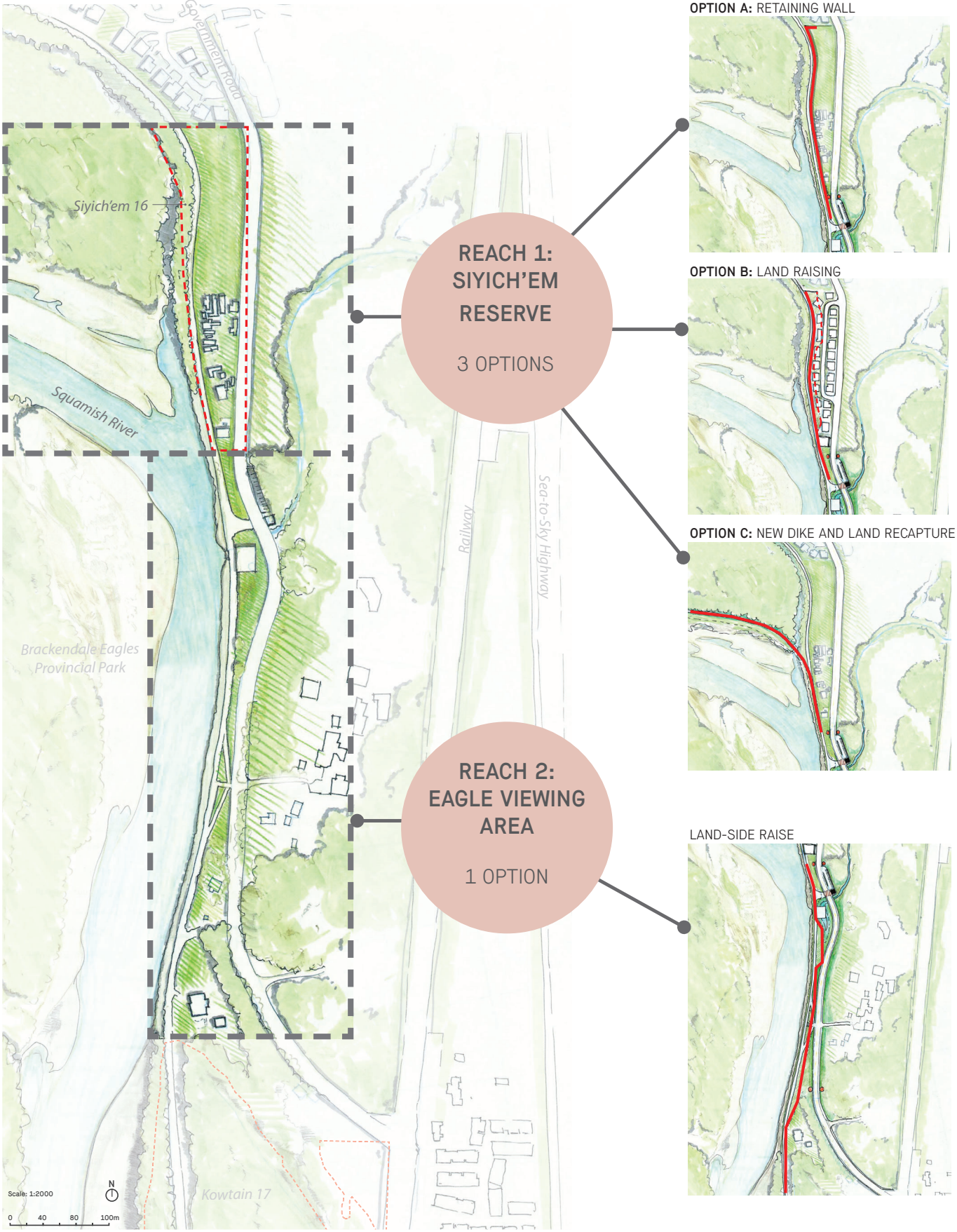
Stakeholder participation is important to the success of the project, and input is sought for the following tasks:

- Gathering values and concerns related to the site;
- Review of options shortlisted by the District and Nation now; and
- Review of the draft master plan.

THE ENGAGEMENT PROCESS INCLUDES THE FOLLOWING FORMATS / VALUES:

- Online survey on values and concerns related to the site (on-going);
- Targeted stakeholder workshops to gather feedback on shortlisted options (complete);
- Public open house and online survey to gather feedback on shortlisted options (December 5, 2019);
- Targeted workshops to gather feedback on the draft master plan (Spring 2020); and
- Public open house and online survey to gather feedback on the draft master plan (Spring 2020).

SIYICH'EM RESERVE AND EAGLE VIEWING AREA
REACH BOUNDARIES AND SHORTLISTED OPTIONS



REACH 1: SIYICH'EM RESERVE
OPTION A: RETAINING WALL

DESCRIPTION:

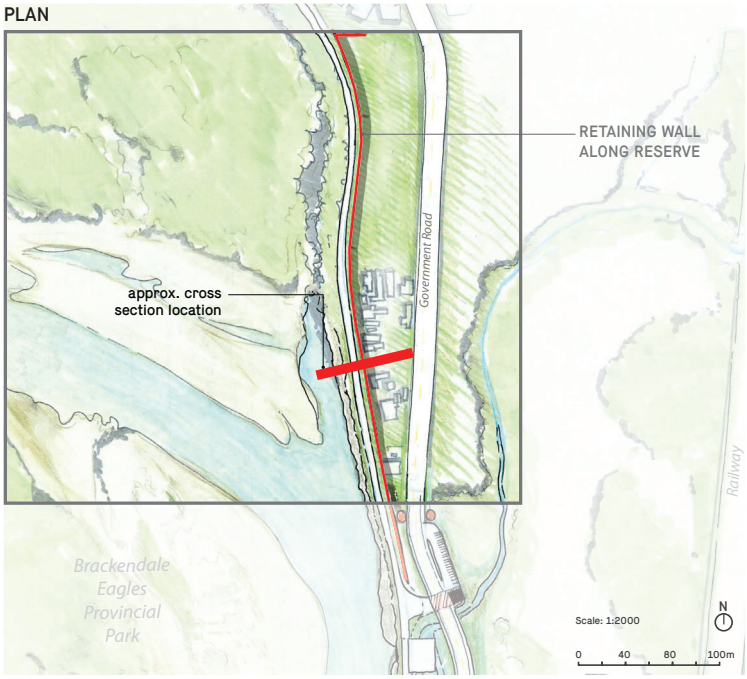
This option involves raising the existing dike crest by approximately 1.5m while limiting the dike footprint to the existing footprint by using retaining walls to contain the raised dike. The total retaining wall height will be 5m or more, and the wall would disrupt views for existing structures on the reserve. This approach aims to prevent any further dike encroachment onto Siyich'em land, however the Watershed Grill structure attached to the existing dike would need to be removed.

A deep cutoff wall would be incorporated into the dike for seepage control, but it may not be fully effective at reducing seasonal seepage volumes through the reserve given the low-lying elevation of the reserve.

Existing riprap bank protection may need to be upgraded which could involve limited work in the Squamish River to provide adequate protection against river scour. Ground improvement measures may be required to improve seismic performance of the proposed dike upgrade.

Land tenure for dike maintenance (e.g. a right-of-way) does not currently exist and the preferred right-of-way width including extending 7.5m from the dike toe would not be possible given the location of existing structures on Siyich'em.

PLAN

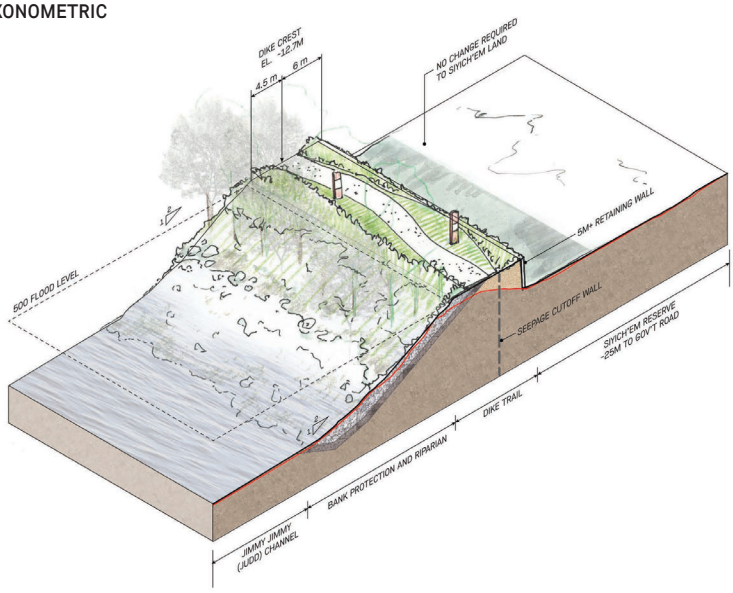


PRECEDENTS

APPROX. 5M+ HIGH RETAINING WALL

RETAINING WALL ADJACENT TO HOMES

AXONOMETRIC



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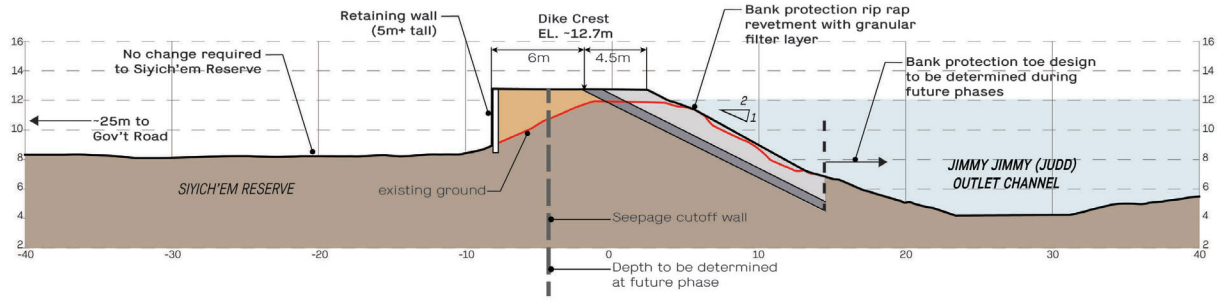


REACH 1: SIYICH'EM RESERVE
OPTION B: LAND RAISING

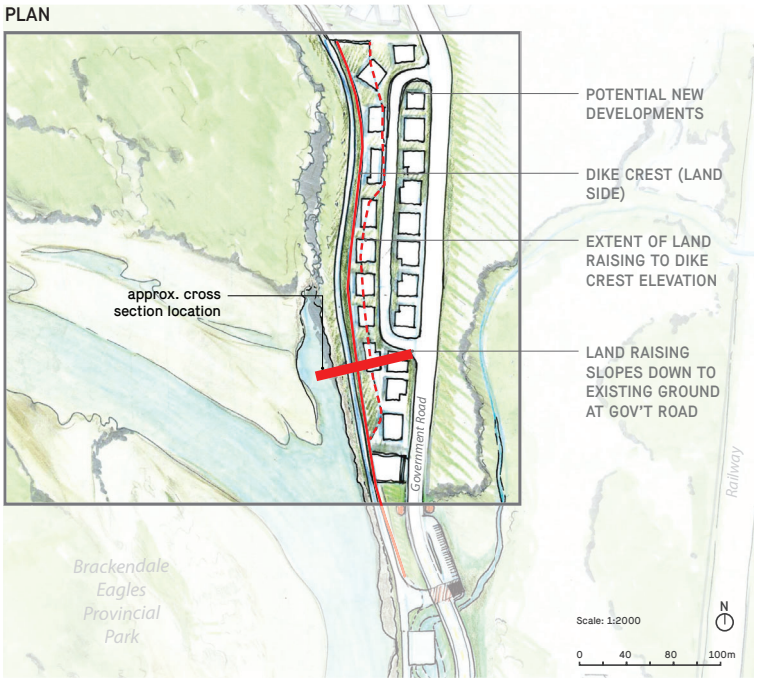
DESCRIPTION:

This option involves raising Siyich'em land up to the proposed dike crest elevation (approximately 1.5m above the current dike crest). This approach would require removal and replacement of the existing structures and services on the reserve but would benefit the reserve as the replacement structures (and future development) would be significantly more protected from seasonal seepage issues and afforded a better vantage over the river. The raised land would slope down to meet Government Road with the potential use of short height (~1 m) retaining walls.

The land raising would negate the need for a deep cutoff wall within the dike for seepage control. Existing riprap bank protection may need to be upgraded which could involve limited work in Squamish River to provide an adequate protection against river scour. Ground improvement measures may be required to improve seismic performance of proposed dike upgrade.

Land tenure for dike maintenance (e.g. a right-of-way) does not currently exist. Under this approach, the regulated dike would be a 6 m wide portion of the raised land along the river bank(plus the riprap bank protection). The conventional right-of-way extending 7.5m from the dike toe could be negated given the area of raised land acting as part of the dike.

PLAN

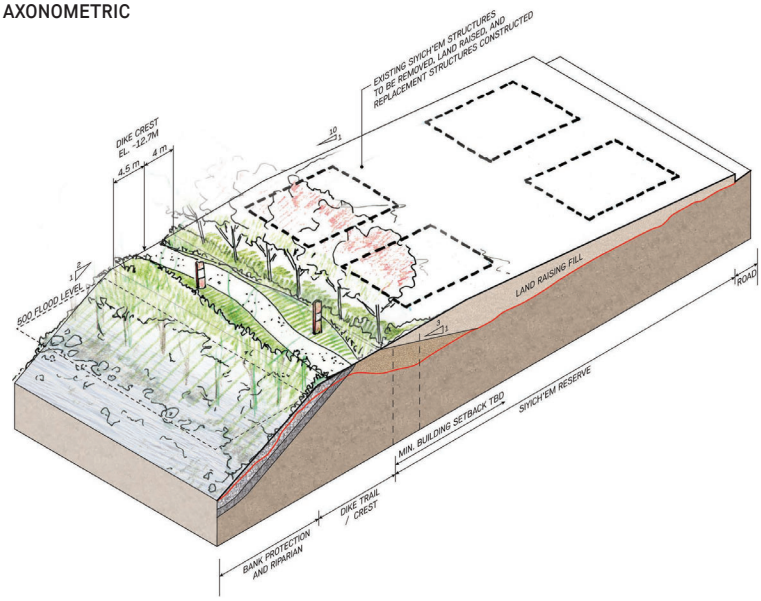


PRECEDENTS

HOMES WITH RETAINING WALLS TO MANAGE GRADES

TERRACED/ BUILDING ON SLOPE

AXONOMETRIC



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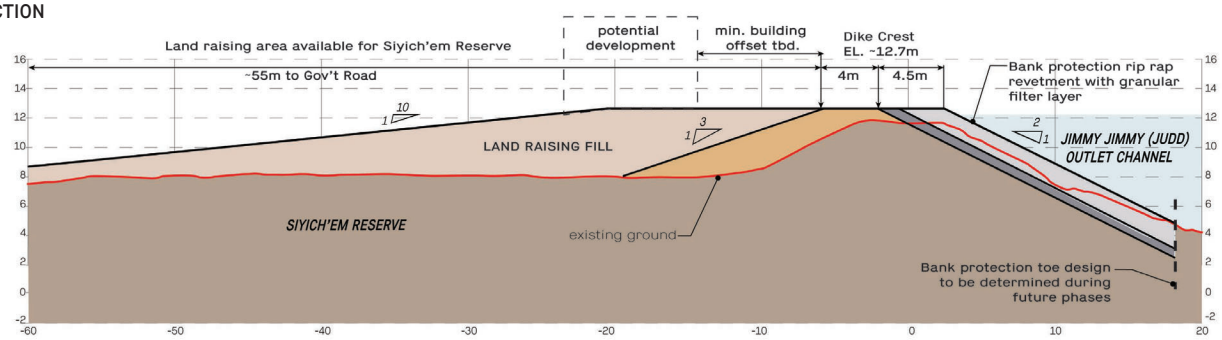


REACH 1: SIYICH'EM RESERVE
OPTION C: NEW DIKE AND LAND RECAPTURE

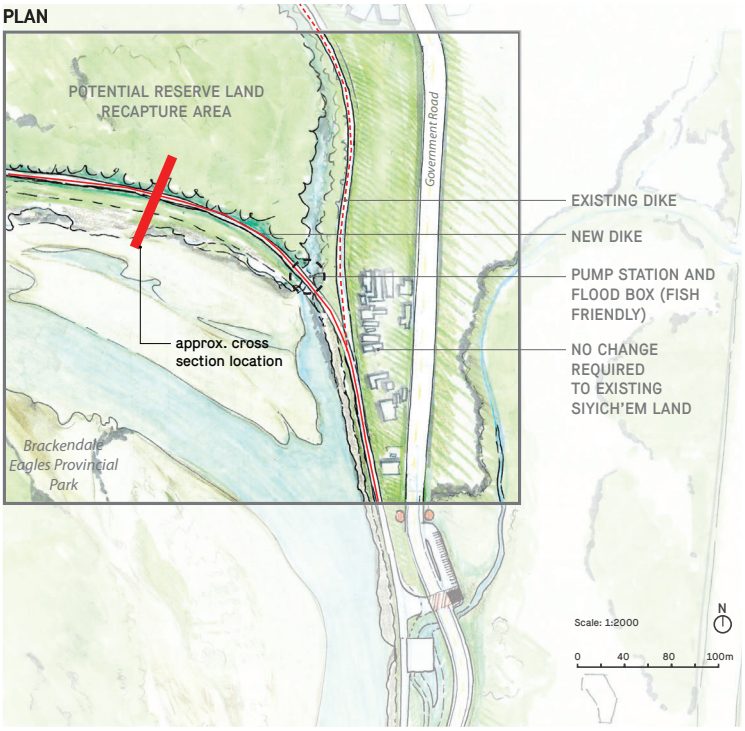
DESCRIPTION:

This option involves constructing a dike on a new alignment heading north-west from Siyich'em reserve along and setback from the active Squamish River bank and connecting to the existing dike at Fisherman's Park. This approach would enable the recapture and beneficial use of lost reserve lands for the Squamish Nation. It may also be possible to use the general approach of a new dike alignment to further reduce flood risk by providing additional internal floodway capacity (where floodwaters could safely be conveyed following an upstream dike breach). However, additional technical work would be required to study this and it may require significant modifications to the concept presented here.

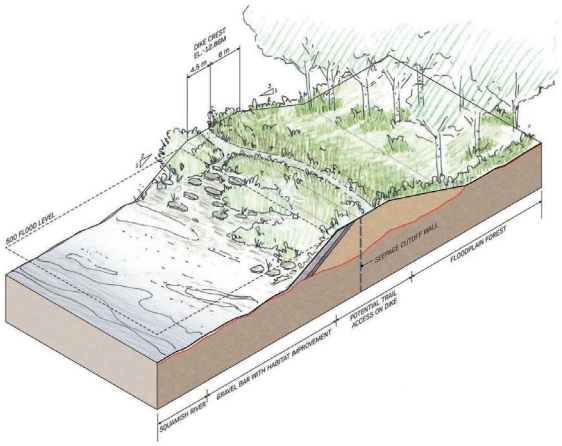
The new dike alignment would partially disconnect a large, forested gravel bar island from the Squamish River. Partial connection could be maintained via a fish-friendly pump station at the outlet of Jimmy Jimmy (Judd) Slough. The dike alignment would be set back from the active river channel by 30m or more, except for the connection points at Fisherman's Park and at the existing dike near the south edge of Siyich'em reserve. The potential impact on flood levels should be investigated for potential transfer of risk and/or additional dike upgrading requirements upstream.

The dike alignment would replace the existing Squamish River dike located along Eagle Run Drive and the cost of future upgrades for the Eagle Run Drive dike should be discounted from the cost of the proposed dike alignment.

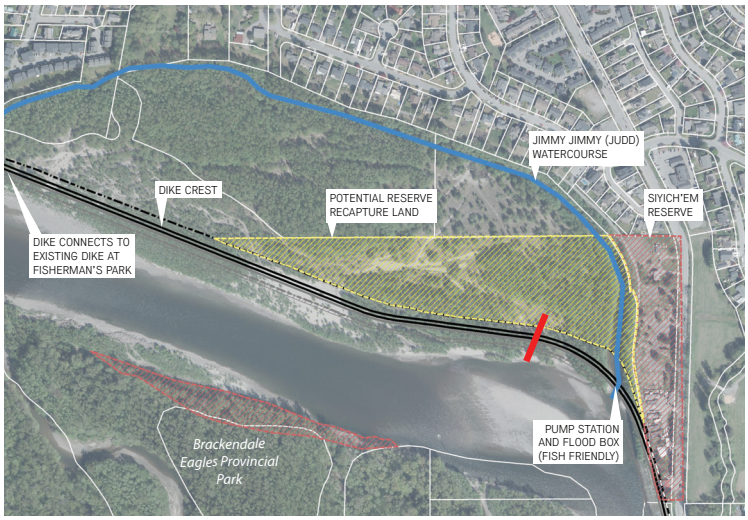
PLAN



AXONOMETRIC



PLAN SHOWING EXTENT OF LAND RECAPTURE AND NEW DIKE



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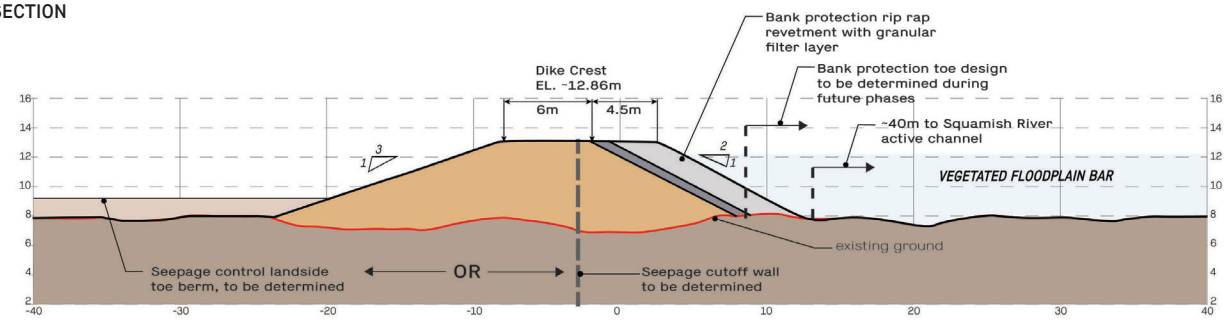


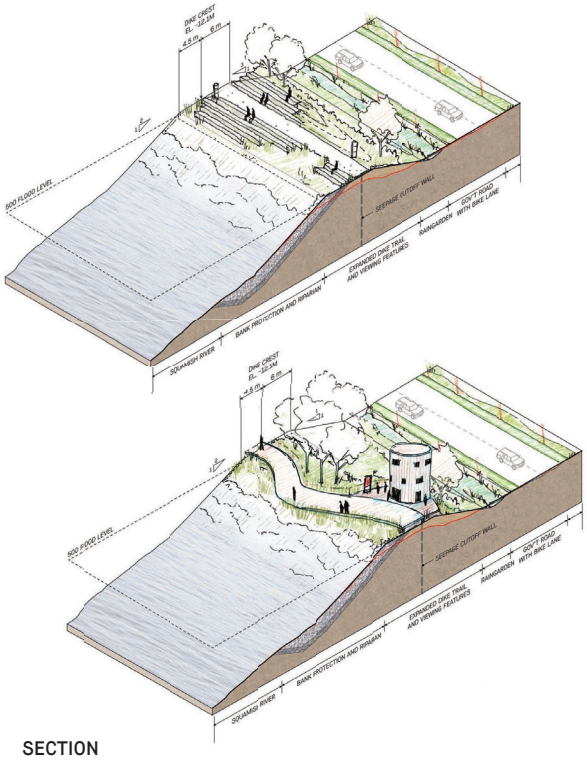
REACH 2: EAGLE VIEWING AREA
LAND-SIDE RAISE

DESCRIPTION:

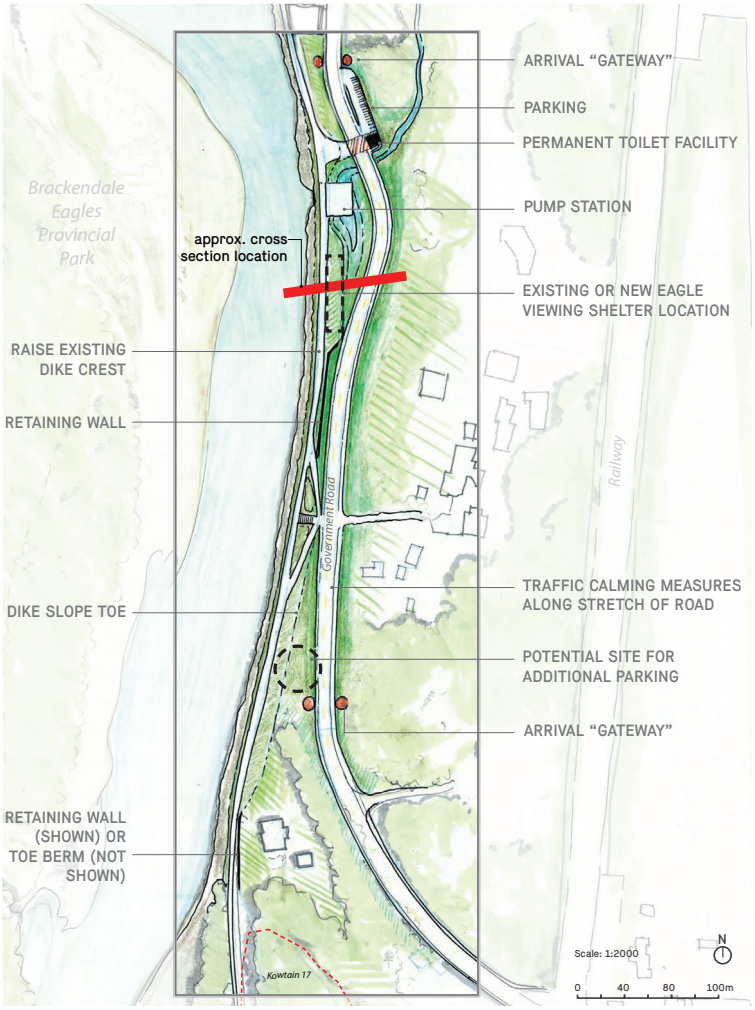
This option involves raising the existing dike crest by approximately 1.5 m between Dryden Creek pump station and the north boundary of Kowtain I.R. 17.

In general, the dike footprint would be expanded towards the land (east) with a vegetated slope at a gradient of 3 horizontal to 1 vertical. Retaining walls would be used to limit the footprint in areas with limited space due to existing infrastructure and/or structures. Existing riprap bank protection may need to be upgraded which could involve limited work in the Squamish River to provide adequate protection against river scour. Seepage control would be provided using either an internal, deep seepage cut-off wall or a land-side toe berm (approximately 15 m wide, 1.5 m thick). If a toe berm is selected, it may conflict with Government Road which could be addressed by localized raising of Government Road. Ground improvement measures may be required to improve seismic performance of the proposed dike upgrade.

Existing eagle viewing facilities (shelter, interpretative signage, etc.) and benches would be removed and replaced/ upgraded. Dike upgrades at Dryden Creek pump station may trigger pump station upgrades.



PLAN



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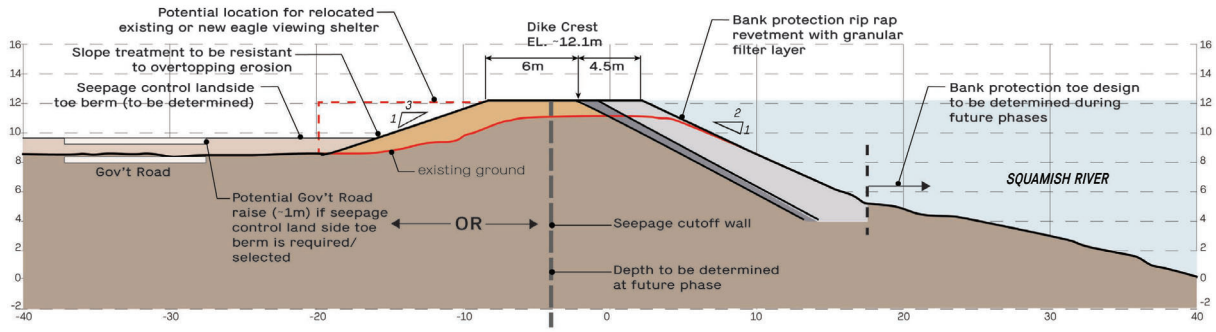


REACH 2: EAGLE VIEWING AREA
PUBLIC AMENITY CONCEPTS

CURRENT CONDITIONS

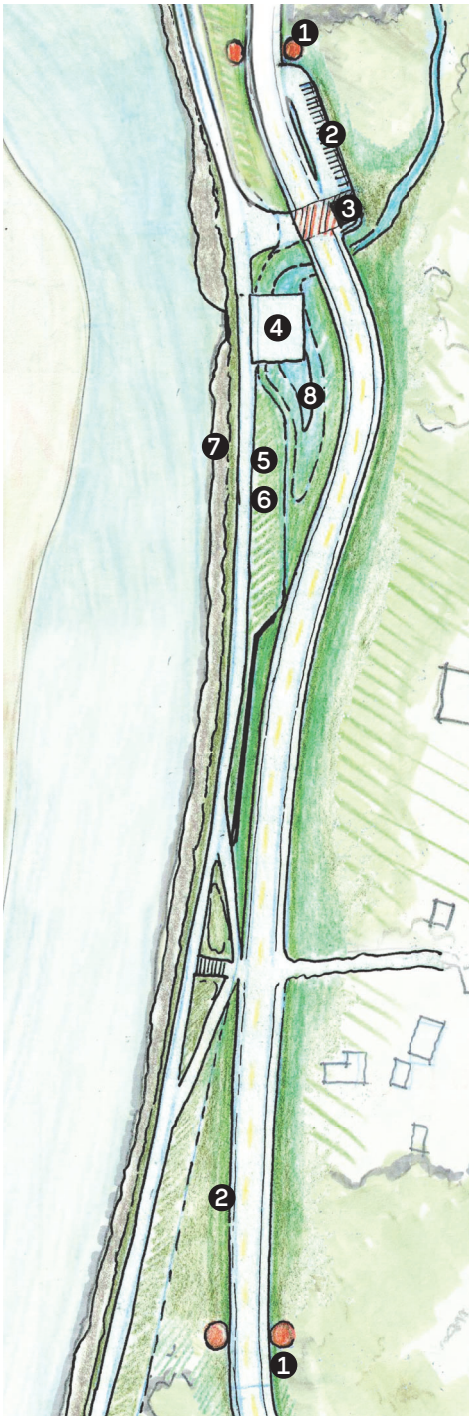
PARKING LOT

DRYDEN CREEK PUMP STATION

PORTABLE TOILETS

EAGLE WATCH PROGRAM

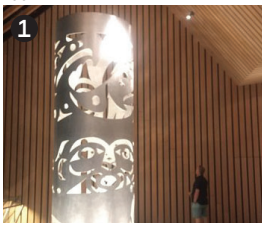
DIKE TRAIL WITH BENCHES



ARRIVAL AND WAYFINDING

GATEWAY

LOCAL ART



Rick Harry

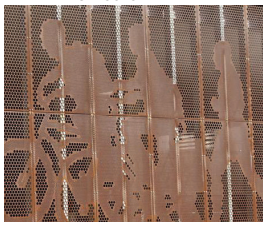
TRAIL WAYFINDING

VISITOR FACILITIES

FORMALIZED/ EXPANDED PARKING

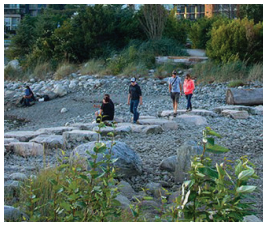
PERMANENT WASHROOMS

BIKE INFRASTRUCTURE



RECREATION AND EDUCATION

OUTDOOR CLASSROOM

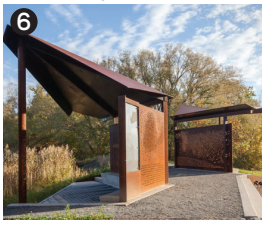


SOCIAL SEATING

COMBINE PUMP STATION UPGRADE WITH VIEWING STRUCTURE

VIEWING STRUCTURES

INTERPRETIVE SHELTER



ACCESS THE WATER

PLANTING AND HABITAT IMPROVEMENTS

WETLAND HABITAT

ENHANCED NATIVE PLANTING

BOARDWALK OVER PLANTING

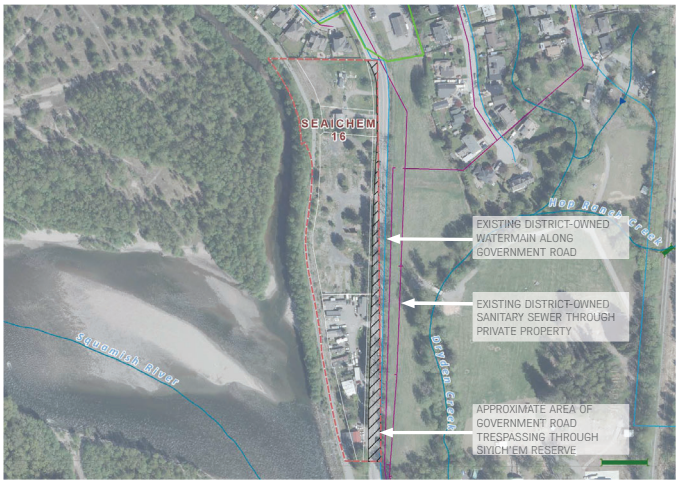
SIYICH'EM RESERVE AND EAGLE VIEWING AREA
OTHER CONCEPTS (NOT DIRECTLY RELATED TO FLOOD PROTECTION)

OTHER CONCEPTS

The dike master plan focuses on options to address immediate structural flood protection needs, i.e. diking to keep floodwaters out. However, the steering committee acknowledges, through the expression of the common interests presented on an earlier board, that there are other issues (not directly related to flood protection) that could be addressed as part of the master plan. Some of these issues are proposed to be addressed directly through the shortlisted diking options. Two additional concepts (not directly related to flood protection) have also been identified to be acknowledged and incorporated into the master plan.

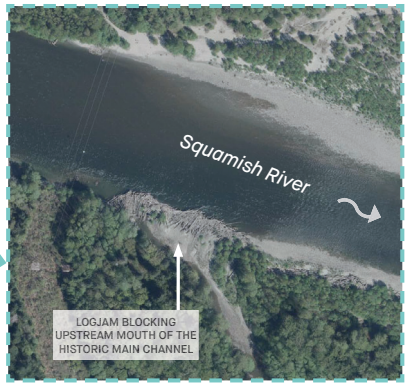
RELOCATING GOVERNMENT ROAD OFF OF SIYICH'EM

Government Road runs through the Siyich'em reserve without legal land tenure. The District and Nation are interested in exploring realigning a portion of Government Road to eliminate the historic trespass. Technical work is underway to develop a conceptual realignment and estimate the associated construction costs. To re-align the road off of the reserve, the road would have to go through a portion of the private properties located along the west side of Government Road. Incidentally, there is already a District-owned sanitary sewer pipe located east of the road through private property. The master plan project does involve detailed design of the realignment and the District would engage directly with the private property owners prior to advancing the work.



RE-ACTIVATE HISTORIC RIVER CHANNEL

The steering committee and consultant team have heard clearly from Squamish Nation members and community members that there is interest in re-activating the historic main channel of the Squamish River (indicated on the airphoto below – left) to relocate the main channel away from the existing dike to the historic main channel. The interest in this concept is primarily based on the desire to recapture historic reserve land and to reduce river erosion hazards which threaten the existing dike. This concept by itself would not directly address immediate flood risk as relocating the river would not necessarily lower water levels and a dike upgrade would still be required. Additionally, this concept would involve large river engineering works to re-activate the historic main channel and would likely require on-going maintenance to encourage the development of the historic main channel. This concept requires extensive technical and environmental studies to advance before a decision can be made about it; these are not possible within the limited schedule of the dike master plan dictated by the provincial and federal funding grant. Accordingly, the dike master plan is being developed in a way that diking options will be generally compatible with a potential future river re-alignment project, if such a project is advanced and approved. This is reflected in one of the District and Nation common interests presented on an earlier board: "Address immediate flood risk, while enabling long-term approaches".



(Above) Close-up of the logjam blocking the upstream mouth of the historic main channel.

(Left) 2019 airphoto of the Squamish River near Brackendale. The narrow side channel located west of the current Squamish River main channel was historically the main channel of the river. There is Squamish Nation and community interest in re-activating the historic main channel.

SIYICH'EM RESERVE AND EAGLE VIEWING AREA
SHARE YOUR COMMENTS VIA STICKY NOTES

Your input is valued and will be used to inform the steering committee in its review, refinement, and evaluation of the shortlisted diking options and the overall plan development. Please write down your comments on the provided sticky notes and place them on the board under the following categories: general comments, Siyich'em reach comments, and eagle viewing area comments.

In addition, we invite you to provide additional input through an online survey which can be accessed at: **https://www.surveymonkey.com/r/siyichem_publicsurvey2** or via the QR code.

Paper copies are also available from the project representatives at the open house.

GENERAL COMMENTS

SIYICH'EM REACH COMMENTS

EAGLE VIEWING AREA REACH COMMENTS