SURREY COASTAL FLOOD ADAPTATION STRATEGY (CFAS)

Climate change is driving some big changes on Surrey's coastline. In the short-term, we can expect more frequent and severe flooding from sea level rise and storm surges, while over the longer-term we can expect even greater challenges.

CFAS | CITY OF SURREY

To help prepare Surrey for a changing climate and help our coastal communities become more resilient, we are developing a Coastal Flood Adaptation Strategy (CFAS).

To be developed over the next year-and-a-half years, the final strategy will identify the current and potential impacts of climate change on Surrey's coastline, and the long-term adaptation options available to address the impacts and adapt to the changes climate change will bring in the future.

THE CFAS PROJECT

Launched last fall, CFAS builds on recent and ongoing work in the area, including the recent Crescent Beach Coastal Flooding Charrette Series. The project is taking a participatory planning approach and engaging residents, stakeholders, and other partners, including First Nations, community and environmental organizations, business associations and groups, senior governments, farmers and agricultural community, and neighbouring jurisdictions in the project.

The CFAS project is broken into five general phases that will be completed over the next three years. Right now, we are in Phase 1 where we want to find out what matters most to residents and stakeholders and who is most affected by climate change-driven coastal flooding.

WHO'S WORKING ON IT?

Surrey is working with an experienced consultant team led by NHC (Northwest Hydraulic Consultants) and including EcoPlan (engagement, community planning), Thurber Engineering (geotechnical), K&M Consulting (agrology), and Diamond Head Consulting (environmental planning).

PHASE 1: Summer 2016-Spring 2017
WHAT MATTERS MOST AND WHO IS AFFECTED?
Education, awareness building, and community values

PHASE 2: Spring 2017-Summer 2017
WHAT CAN WE DO?
Exploring adaptation options

PHASE 3: Summer 2017-Fall 2017
WHAT IS ACCEPTABLE?
Developing adaptation strategies

PHASE 4: Fall 2017-Spring 2018
HOW WILL WE DO IT?
Detailing preferred strategies

PHASE 5: Spring 2018
REPORTING BACK
Final reporting

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CLIMATE CHANGE, CLIMATE HAZARDS AND COASTAL FLOODING

As with many coastal floodplains around the world, the two principal causes of increased flooding in Surrey's coastal floodplain are sea level rise and increased magnitude and intensity of rain. The effects of sea level rise are greater than those of rainfall in Surrey's coastal floodplain.

SEA LEVEL RISE

Global sea level is rising. This is a result of increasing temperatures throughout the world that are melting glaciers and polar ice caps, and that are also increasing the average temperature of ocean waters causing them to expand. The Province of British Columbia advises municipalities to plan for 1 metre of sea level rise over the next 80 years, and 2 metres by 2200.

INCREASED RAINFALL

With the changing climate, we can expect more extreme weather conditions. For example, in Surrey, winters are expected to have fewer wet days, but on the wet days the rainfall amounts will be much greater than in the past. This will result in increased flooding, as more runoff flows into the Nicomekl, Serpentine and Campbell Rivers during these storm events. The frequency and intensity of storm events with heavy precipitation are also expected to increase.

Projected impacts for Surrey's coastal area include higher sea levels, increased frequency and intensity of storms and storm surges (when water is pushed ashore by wind and waves), more erosion of the coastline, impacts on infrastructure, loss of beaches and coastal ecosystems, soil salinization, and groundwater pooling.

COASTAL AND RIVER FLOODING

1870 1880 1890 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010 2020 2030 2040 2050 2060 2070 2080 2090 2100 2100

Major Coastal and River Flood Events

1 Metre

100 cm
80 cm
60 cm
40 cm
20 cm
0 cm

Sea Level Rise

TODAY

A Changing Shoreline

In 1890, dyking of Mud Bay begins. Shortly afterwards, dyking and damming of the Serpentine and Nicomekl Rivers begins.
By 1953, a timber sea wall at Crescent Beach is constructed.

Since then, residents of Surrey's Coastal Floodplain have relied on a system of dykes and sea dams to protect themselves from ocean and river flooding.

An Evolving Future

As our climate continues to change and sea levels continue to rise over the coming years, it is anticipated that the frequency and intensity of major coastal and river floods will also increase.

The Province has directed municipalities to plan for at least 1m sea level rise by 2100. In Surrey, and elsewhere in the Lower Mainland, most drainage systems are not designed for projected changes.

SURREY'S COASTAL FLOODPLAIN

What's keeping us dry today?

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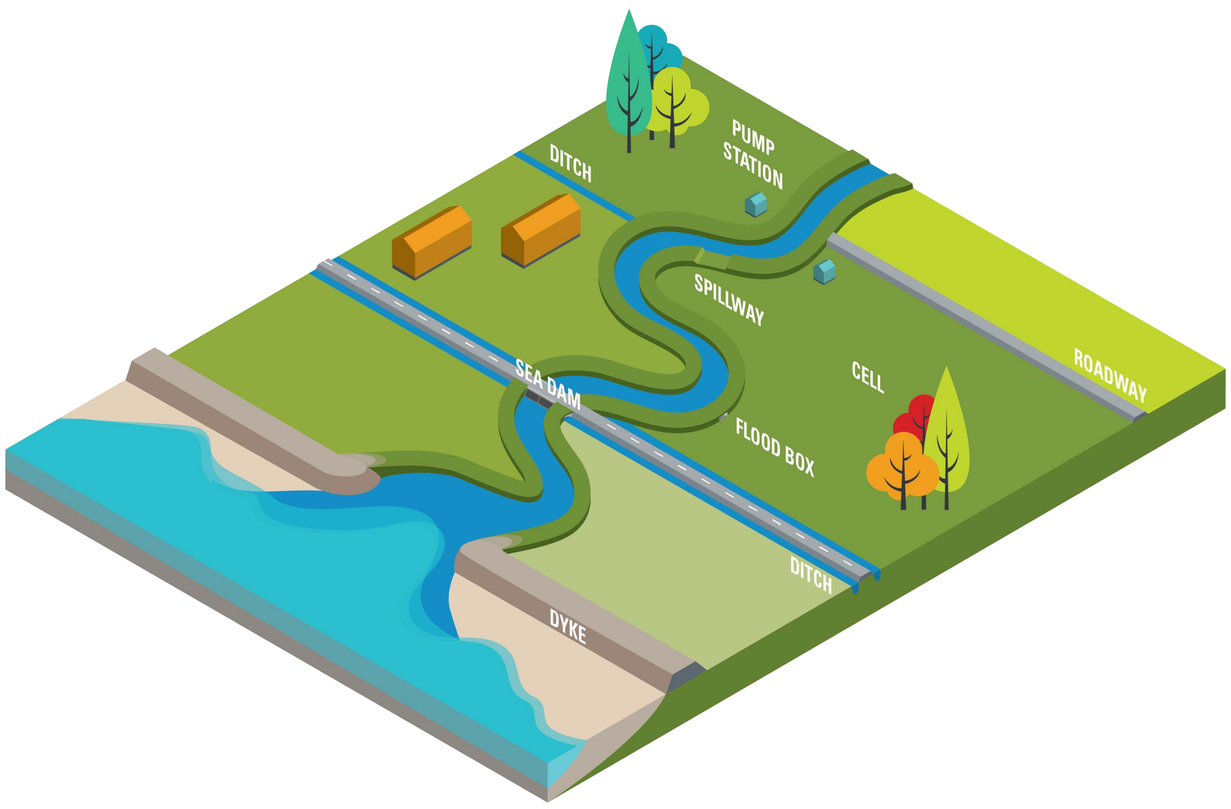
European settlement in the 1890's saw the first dykes and drainage ditches being created to reclaim land for farming. Since then, Surrey has developed a complex network of river and sea dykes along the coast and along the Serpentine and Nicomekl Rivers. Working with the dykes are a system of drainage ditches, spillways and pumps that help move water from behind dykes.

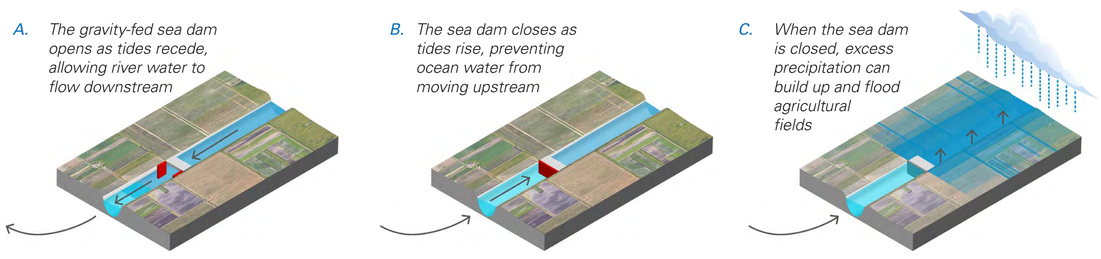
DYKES

A sea dyke is a long wall or embankment built to prevent flooding from the sea. A river dyke is an embankment built to prevent river flooding along the Nicomekl and Serpentine Rivers. Most of Surrey's floodplain, both coastal and inland sections, are protected by dykes. Many dykes in Surrey are also popular walking trails and bicycle routes.

SEA DAMS

Sea dams are constructed along tidal rivers, like the Nicomekl and Serpentine Rivers, to keep salty ocean water from moving upstream where it could have detrimental effects on agricultural irrigation. Sea dams are tidally influenced and gravity-fed, with the incoming tide pushing their gates closed and the river pushing them open once the tide moves out. The Nicomekl and Serpentine sea dams were first built in 1912 and 1913.





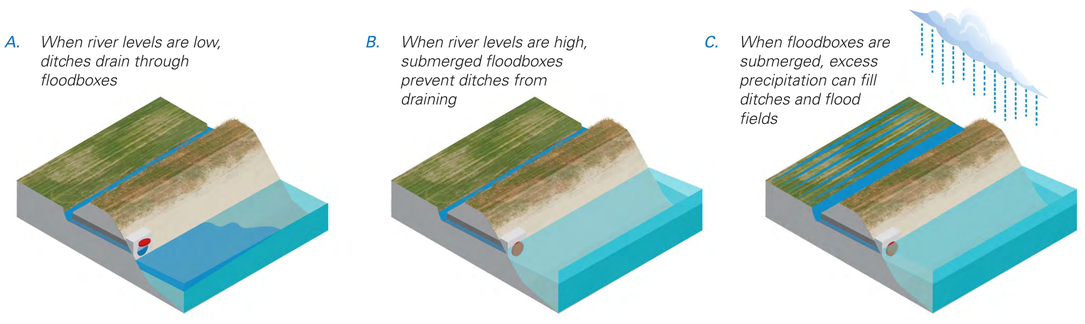
A. The gravity-fed sea dam opens as tides recede, allowing river water to flow downstream

B. The sea dam closes as tides rise, preventing ocean water from moving upstream

C. When the sea dam is closed, excess precipitation can build up and flood agricultural fields

DITCHES, FLOODBOXES AND PUMPS

Surface water flows into drainage ditches which then direct water through floodboxes located along the river. During low tides and when the river water is low enough, the water drains into the river by gravity-fed flap gates (A). When river levels are higher the flood boxes are submerged and their gates are closed (B). During high tides or when sea dams are closed, electrically powered pumps, like the Maple Pump Station in Crescent Beach, are used to help push the water into the rivers.



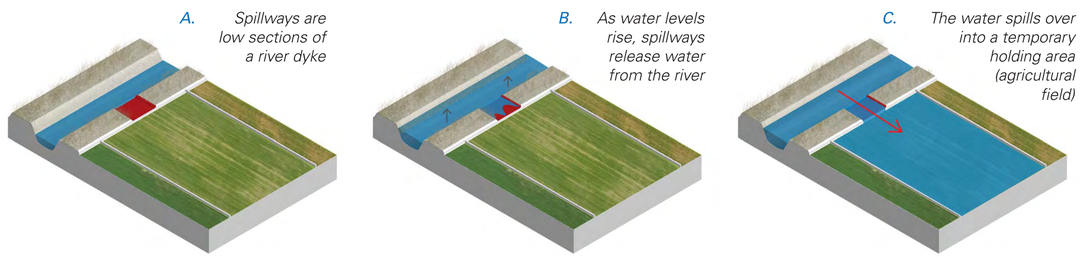
A. When river levels are low, ditches drain through floodboxes

B. When river levels are high, submerged floodboxes prevent ditches from draining

C. When floodboxes are submerged, excess precipitation can fill ditches and flood fields

SPILLWAYS

A spillway is a low section of a river dike (A) where, during floods, water can spill over into a holding area called a cell (B,). These cells are located on agricultural fields and typically only used in winter months when the fields are fallow (C). Once the flood event has ended and river level returns to normal, water stored in the cells will drain back into the river through floodboxes or with the assistance of pumps.



A. Spillways are low sections of a river dyke

B. As water levels rise, spillways release water from the river

C. The water spills over into a temporary holding area (agricultural field)

The changing climate means that the historic controls that have been put in place will likely not perform well in the future with rising sea levels, more frequent storm surges, and increased precipitation. With sea level rise, the duration that rivers can freely drain will be shorter.

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FLOODING HAZARDS

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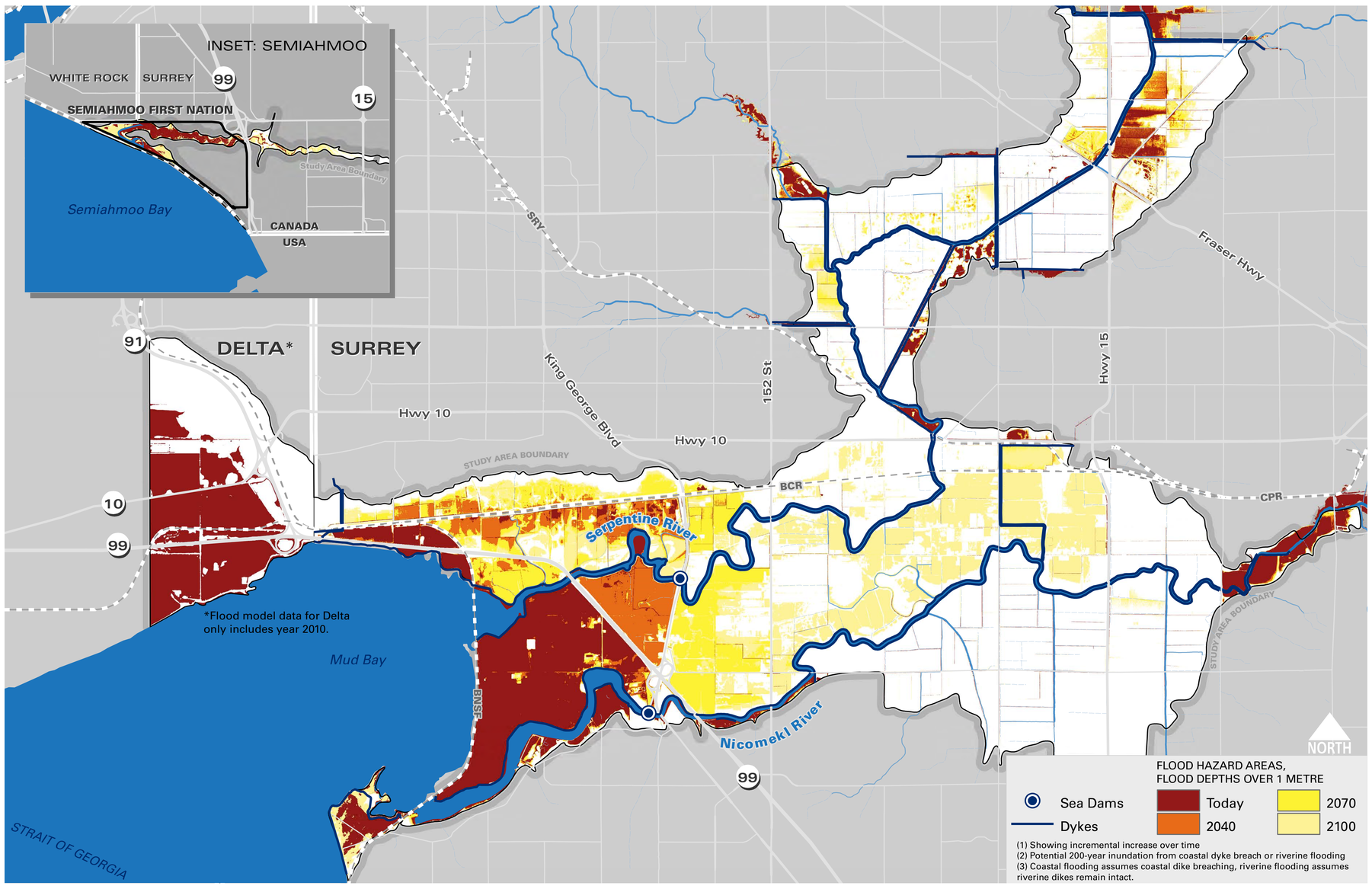
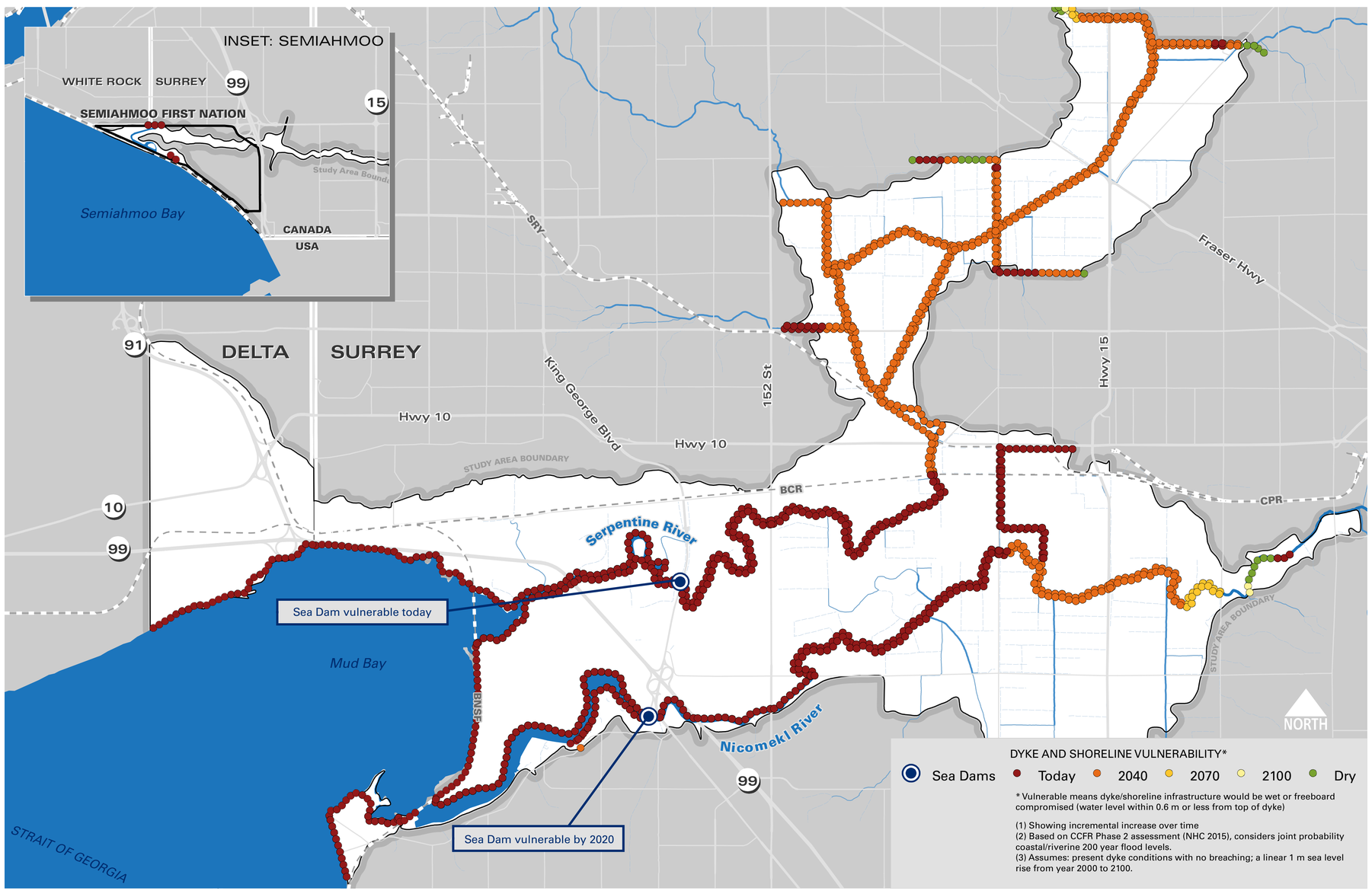
OUR NEED TO PREPARE

Our changing climate means that the historic controls that have been put in place to limit flood damages will not work in future as sea levels rise. The map illustrates the extent of flooding that could be expected today and in the future if no improvements are made to the existing system.



OUR VULNERABLE DYKES AND SHORELINE

Surrey maintains the largest dyking network in BC. Sea level rise is forecast to significantly increase dyke vulnerability and expose low-lying infrastructure along the shoreline to flooding. This map shows that the impacts of sea level rise are greatest closet to the ocean. By 2040, dyke infrastructure nearly 10km inland is expected to become vulnerable.



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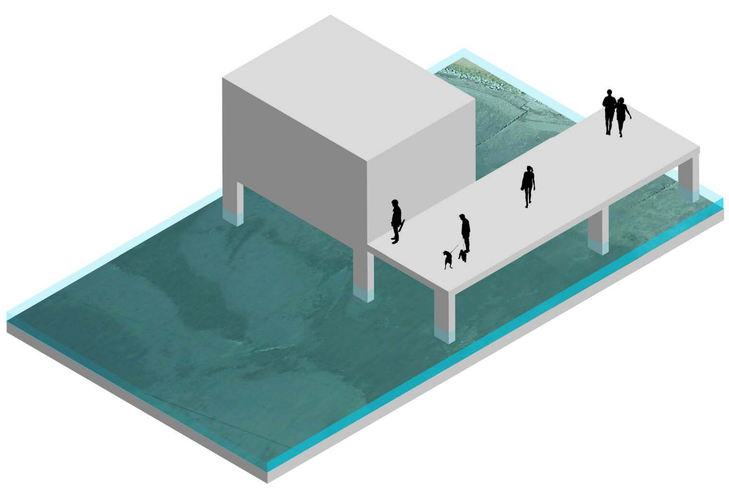
OPTIONS AND ADAPTATION APPROACHES

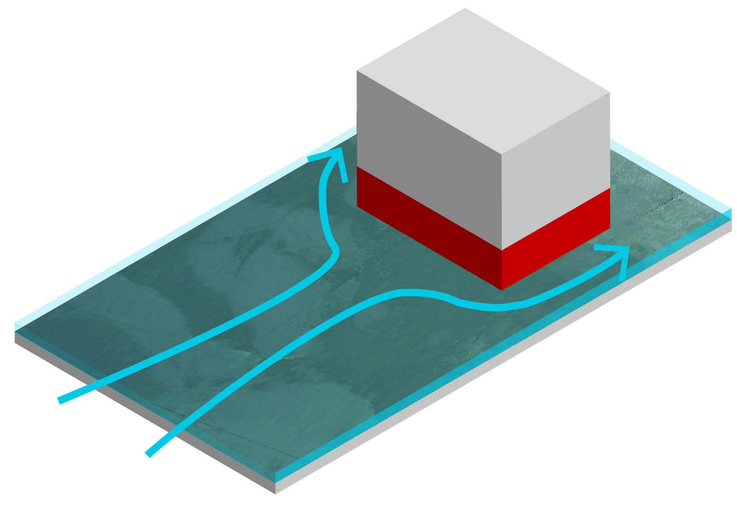
The next phase of work will explore adaptation options for sea level rise and increased flooding in Surrey's coastal floodplain. There are three general adaptation approaches that will be explored and evaluated using the feedback collected from residents, stakeholders and partners. A fourth adaptation approach would use a combination of approaches.

ACCOMMODATE

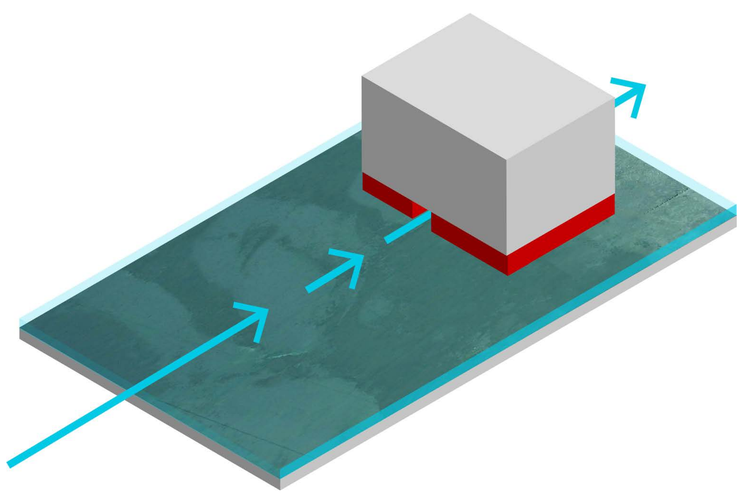
Make changes to human activities and/or buildings and infrastructure to improve resilience to increased flooding.



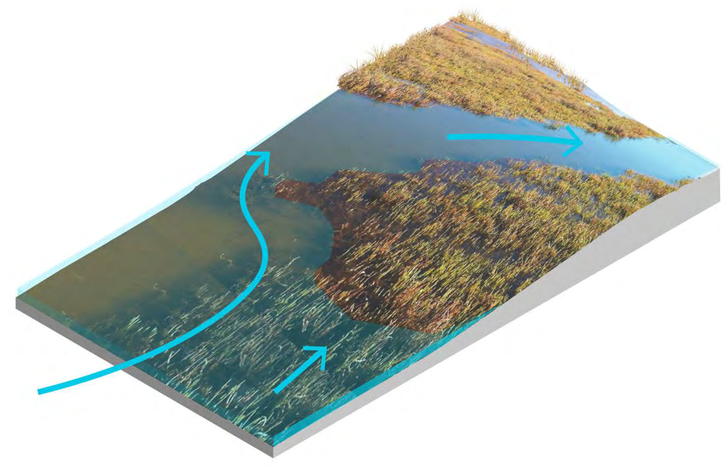
Raised structures: Building structures and homes on pilings so flood water can safely flow underneath.



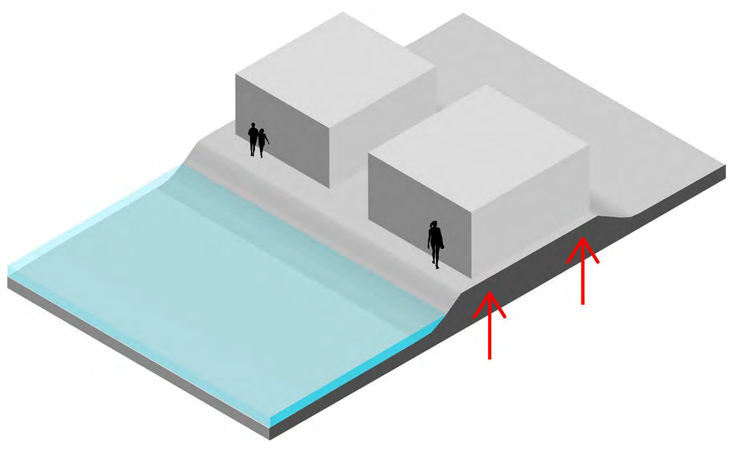
Dry proofing: Building structures and homes on pilings so flood water can safely flow around them.



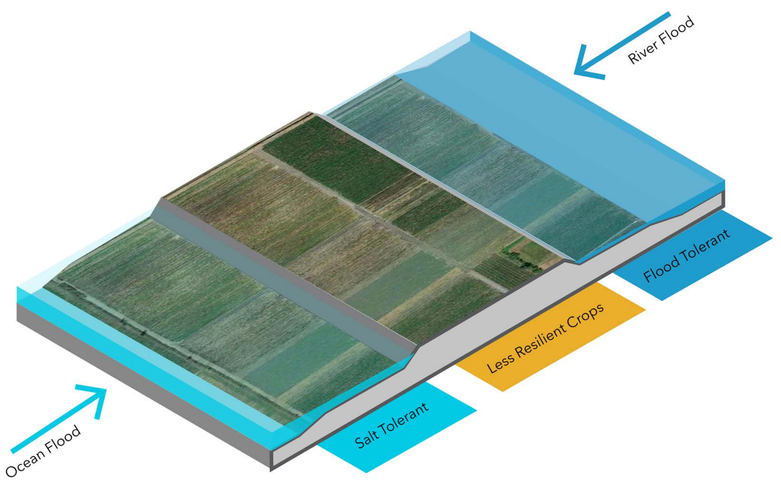
Wet proofing: Building structures and homes that allow flood water can safely flow through.



Wetland restoration: Restoring wetlands to reduce storm surges and wave action.



Building on fill: Building structures and homes on fill so they are above the flood plain.



Crop reorganization: Reorganizing crops so that saltwater tolerant and more flood tolerant crops are planted in more flood prone areas.

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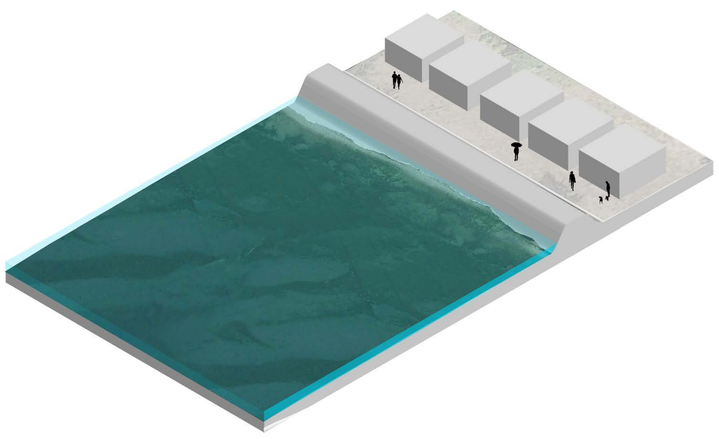
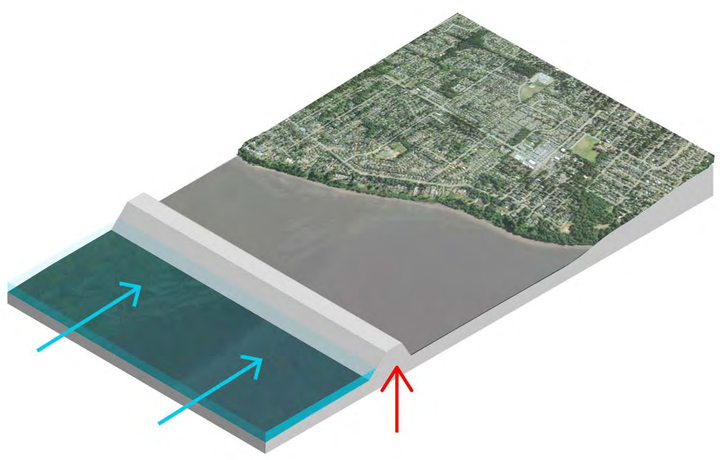
PROTECT

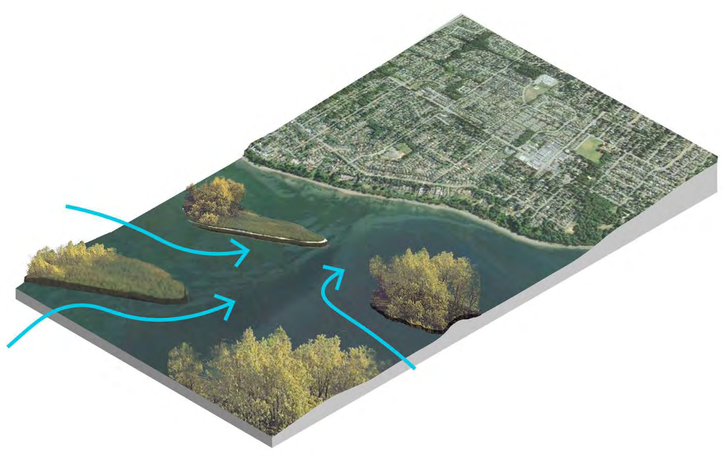
Protect people, property, infrastructure and habitat areas from more frequent and severe flooding and sea level rise.



Raise coastal and river dykes: See the wall map to learn how high and wide dykes would have to be to meet 2100 flood and sea level standards.



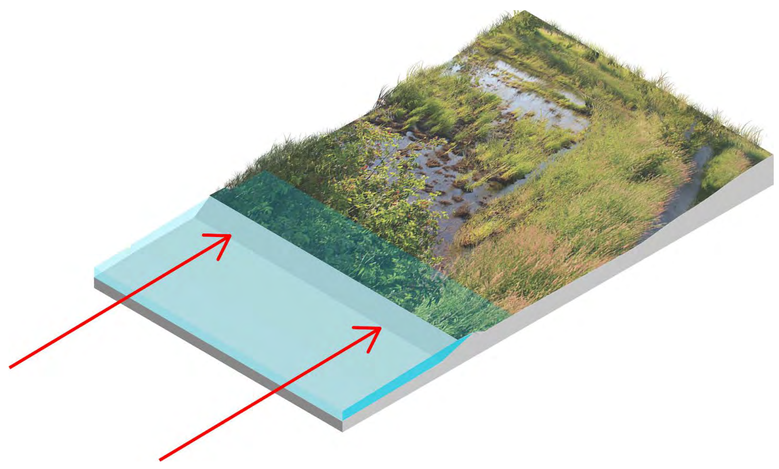
Offshore sea barrier: A constructed sea wall built offshore. Such an option here would stretch across Mud Bay.



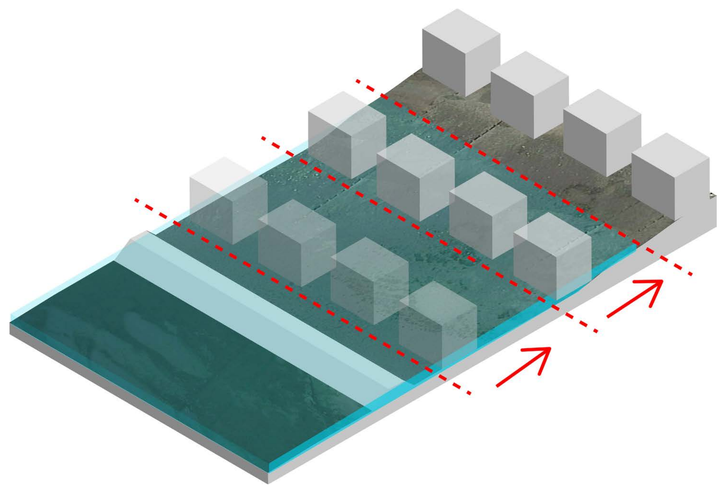
Offshore barrier islands: Constructed island that help reduce wave action and wind-generated waves on shore.

RETREAT

Discourage development in areas subject to flooding and plan for the eventual relocation of buildings and infrastructure to areas with lesser risk.



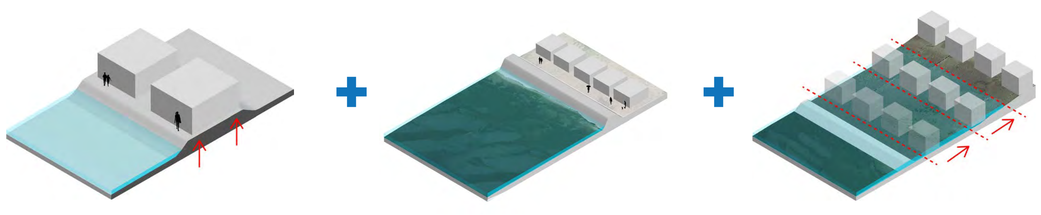
Complete retreat: Moving all activities and people out of the floodplain.



Managed retreat: Moving all activities and people out of designated area and behind new flood protection systems (e.g., building up dykes at King George Boulevard)

COMBINATION

Utilize a combination of adaptation approaches.



INSET: SEMIAHMOO

WHITE ROCK

SURREY

99

15

SEMIAHMOO FIRST NATION

Study Area Boundary

Semiahmoo Bay

CANADA

USA

88 Ave

Fraser Hwy

91

DELTA

SURREY

King George Blvd

152 St

Hwy 15

Hwy 10

STUDY AREA BOUNDARY

BCR

CPR

10

99

Serpentine River

Mud Bay

BNSF

Nicomekl River

99

STRAIT OF GEORGIA

STUDY AREA BOUNDARY

NORTH

TRANSPORTATION AND INFRASTRUCTURE

Infrastructure Asset Managers, Operator and Emergency Services
Flood Vulnerability Assessment

66 participants came together representing 28 organizations to assess flood risk to infrastructure in Mud Bay. All types of infrastructure were evaluated and the key infrastructure components found to be at high risk are summarized below.

Risk Profile	low risk	Risks requiring minimal action
	medium risk	Risks that may require future action
	high risk	Risks that require action

Infrastructure	Flood Scenarios Current	Flood Scenarios Future
Regional / International Transportation Infrastructure		
4 km of four-lane arterial roadway		
7 km section of Highway 99 linking Peace Arch Border		
Highway 91 and 99 Interchange		
4 km section of Highway 91		
Local Government Arterial and Collector Roads		
King George Boulevard (City of Surrey)		
152nd Street (City of Surrey)		
Ladner Trunk Road (Corporation of Delta)		
Class 1 Railways Originating at Port Metro Vancouver		
Burlington Northern Santa Fe (BNSF) Nicomekl Swing Bridge and Trestles		
6 km of Burlington Northern Santa Fe (BNSF) Railway		
Roberts Bank Railway Corridor		
Connection to Southern Railway of British Columbia		
Sanitary Lift Stations		
City of Surrey: Stewart Farm, South Port		
Metro Vancouver: Crescent Beach		
Underground infrastructure		
5 km of Metro Vancouver 750 mm diameter Water Transmission Main		
Overhead Utility Infrastructure		
BC Hydro Twin 500kV bulk transmission line between BC Hydro and Bonneville Power		
BC Hydro local overhead distribution lines		
Flood Control Infrastructure		
City of Surrey Sea Dams (2)		
15 km of dyking, including ditches and floodboxes		
City of Surrey: Colebrook Pump Station, Maple Pump Station		
Corporation of Delta: Oliver Pump Station		
Farming		
Private dairy facilities for over 1,000 head of Cattle		

COMMUNITY AND RESIDENTIAL

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Impacts and Concerns

While the study area is largely agricultural, it is still home to several smaller residential developments and the larger, historic community of Crescent Beach.

Beginning as cottage community, Crescent Beach is one of Surrey's best known and best loved neighbourhoods. Home to about 1,200 people and 400 homes, the community is also home to several commercial businesses and restaurants, Alexandra Neighbourhood House and the Crescent Beach Swim Club. There are also three strata developments in the study area - Nico Wynd, SouthPort, and Anderson Walk – which together include about 250 residences.

The Campbell River area is home to Semiahmoo First Nation, whose main reserve is on the mouth of the river. Semiahmoo First Nation is home to about 50 members.

CLIMATE CHANGE IMPACTS

Here are the community and residential impacts CFAS partners and stakeholders reported being most concerned about. The feedback was collected at three focus groups held during the winter and collected from previous outreach activities.

Please review the coastal flooding impacts below. Take a strip of sticky dots and use them in any combination to prioritize the impacts that are most important to you. Please use a sticky note if you have any comments or want to tell us why you voted the way you did. If an impact was missed, please use a sticky note and place it in one of the blank spaces provided.

COASTAL FLOODING IMPACT	PRIORITY	NOTES
Adverse impacts to Semiahmoo First Nation (impact to community, damage to/loss of cultural and sacred sites)		
People permanently displaced due to flooding		
People temporarily displaced due to flooding		
Damage to homes from flooding		
Loss of property value		
At 'risk' people adversely impacted (e.g., seniors)		
Public safety (e.g., loss of life or injury from flooding)		
Emergency service disruption (because of flooding and road closures)		
Adverse impacts to heritage buildings, historic sites, and streetscapes		
Well water adversely impacted (there are over 900 wells in the study area)		

AGRICULTURE AND FARMING

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Impacts and Concerns

Agriculture and farming sector plays a significant role in Surrey's economy. With over 1/3 of Surrey's land base in the provincial Agricultural Land Reserve (a provincial zone in which agriculture is recognized as the priority use), the sector generates about a quarter of total gross annual farm receipts in Metro Vancouver, or about $170 million in 2010. The sector also employs hundreds, including farm families and seasonal workers.

The project study area is a large and an important part of Surrey's agricultural sector with diversified crops and production, including dairy, berries, field crops, and mushrooms.

CLIMATE CHANGE IMPACTS

Here are the agriculture and farming impacts CFAS partners and stakeholders reported being concerned about. The feedback was collected at three focus groups held during the winter and other meetings with agriculture stakeholders (e.g., South Nicomekl Irrigation District).

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COASTAL FLOODING IMPACT	PRIORITY	NOTES
Permanent loss of agriculture land		
Loos of agricultural productivity (soil salinization)		
Damage to agriculture assets (buildings, machinery, inventory, animals, plants)		
Impacts of flooding on crops		
Impacts of flooding on livestock		
Impacts to local and regional food security		
Loss of family livelihoods (e.g., loss of ability to farm, loss of intergenerational knowledge)		

ENVIRONMENTAL AND RECREATION

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Impacts and Concerns

Surrey's coastal floodplain and the CFAS study is home to several popular Surrey and Metro Vancouver parks that include several kilometres of shoreline trails with incredible views of Boundary Bay. Diverse wildlife habitats, including eelgrass meadows, mud flats, salt marsh and old fields, make it one of the best wildlife viewing areas in Surrey. It is also home to provincially and federally protected wildlife areas, as thousands of migratory birds use Mud Bay and the larger area as a rest stop as they travel along the Pacific Flyway, which is a 'highway in the sky' stretching from Alaska and the Canadian Arctic to Central and South America. The area is also home to several Red Listed and Blue Listed species at risk, including birds, animals, fish and plants.

CLIMATE CHANGE IMPACTS

Here are the environmental and recreation impacts CFAS partners and stakeholders reported being most concerned about. The feedback was collected at three focus groups held during the winter and other meetings with agriculture stakeholders (e.g., South Nicomekl Irrigation District).

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COASTAL FLOODING IMPACT	PRIORITY	NOTES
Impacts to intertidal & freshwater habitat (mud flat, estuarine marsh, freshwater river, freshwater lake)		
Impacts to terrestrial habitats, including forests, meadow habitats, and wetlands (e.g., Serpentine Fen)		
Impacts to biodiversity (i.e., damage to habit, loss of habitat)		
Contaminants released into environment from flooding		
Reduced fish passage through the sea dams (sea dams are staying closed for longer periods because of sea level rise)		
Adverse impacts to parks & open spaces (e.g., loss of access, flood damage)		
Loss of access to trail network		
Loss of access to water (river and ocean)		
Impacts to beach area		
Damage to recreational facilities (marina, swim club, etc.)		

TRANSPORTATION AND INFRASTRUCTURE

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Impacts and Concerns

Major infrastructure, including rail lines, highways and utility corridors, all pass through the CFAS project area including over 10km of Provincial Highways, over 30km of railway (BNSF freight and Amtrak passenger), regional utilities (Metro Vancouver water supply and sewage lines), and international utility corridors (BC Hydro, Fortis).

CLIMATE CHANGE IMPACTS

Here are the transportation and infrastructure impacts CFAS partners and stakeholders reported being most concerned about. The feedback was collected at three focus groups held during the winter and a special workshop with infrastructure operators and owners.

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COASTAL FLOODING IMPACT	PRIORITY	NOTES
Damage to services infrastructure (water, sewer, power)		
Damage to transportation infrastructure (roads, railways)		
Disruptions to transportation from flooding		
Disruptions of services from flooding		
Recovery time of transportation corridors		
Recovery time of services		

DID YOU KNOW?
Surrey has embarked upon a $15 million project with support from the Province to upgrade and raise about 8km of dyke along Colebrook Road from King George Boulevard to Delta and along Mud Bay. The area is considered one of the Surrey's most vulnerable areas for flooding because of its sinking soils, low-level dykes, wind and wave action, and king tides. The dykes will be raised to current BC standards.

LOCAL AND REGIONAL ECONOMY

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#SurreyCoastal

Impacts and Concerns

Surrey's coastal flood plain plays an important role in Surrey's local economy and the larger, regional economy. In addition to the many small, local businesses and home-based businesses in the study area, the larger area also produces about $100 million in annual farm gate revenue (or about 60% of Surrey's total farm gate revenue). From a regional perspective, over 200,000 vehicle trips a day pass through the area and almost $25 billion annual truck and rail freight traffic passes through the study area.

CLIMATE CHANGE IMPACTS

Here are the local and regional economic impacts CFAS partners and stakeholders reported being most concerned about. The feedback was collected at three focus groups held during the winter and a special workshop with infrastructure operators and owners.

Please review the coastal flooding impacts below. Take a strip of sticky dots and use them in any combination to prioritize the impacts that are most important to you. Please use a sticky note if you have any comments or want to tell us why you voted the way you did. If an impact was missed, please use a sticky note and place it in one of the blank spaces provided.

COASTAL FLOODING IMPACT	PRIORITY	NOTES
Economic losses to the agricultural sector		
Adverse employment impacts		
Permanent loss of businesses		
Business interruptions		
Damages to business assets (buildings, inventory, etc.)		
Disruption of goods movement		
Disruption of regional services		
Disruption of international services (electricity sold to USA)		
Regional and provincial economic losses (indirect & multiplier)		

CHOICES AND PRIORITIES

www.surrey.ca/coastal
#SurreyCoastal

Areas of Concern

Coastal flooding will impact Surrey in many ways. What are the general areas of concern that are most important to you?

Take a strip of sticky dots and use them in any combination to prioritize the areas of concern that are most important to you. Please use a sticky note if you have any comments or want to tell us why you voted the way you did. If you feel an area of concern was missed, please use a sticky note and place it in one of the blank spaces provided.

COASTAL FLOODING IMPACT	PRIORITY	NOTES
Community and Residential		
Agriculture and Farming		
Environmental and Recreation		
Transportation and Infrastructure		
Local and Regional Economy		

Royal HaskoningDHV
Enhancing Society Together

Coastal Protection Strategy Tacloban & Palo, Philippines

CLIENT: RVO (Netherlands Enterprise Agency

LOCATION: Tacloban & Palo
Philippines

PROJECT START-END DATES: 10/2015 - 07/2016

Every year 20 typhoons hit the Philippines. November 2013 the largest typhoon ever recorded Yolanda hit the low-lying areas of Tacloban and Palo, with some residential areas completely washed away. The pressure on the area is continuously increasing, as the sea level rises and climate change leads to an increase in severe tropical cyclones. Since October 2015, the project team (RHDHV, Red Cross, Rebel Group, Van Oord, Arcadis, Wetlands International and Deltares) has been working on the coastal protection strategy. The strategy includes a lifecycle (100 year) approach to adaptive and attractive integrated solutions providing flood safety and economic value for the people of Tacloban and Palo. Mitigation measures to reduce flood risk are based on the Dutch multi level safety approach. 1) We propose only hard measures where necessary, soft where possible; creating healthy eco-systems and protective landscapes and embracing the Building with Nature philosophy. 2) New developments are to be built outside danger zones. Existing developments are to be protected with a level of protection of 1/100 year return period. 3) Emergency response, early flood warning system and evacuation measures to be in place on the very short term. From project kick-off onwards, stakeholder participation forms the backbone of our approach in vision formation and the identification of protection possibilities. More than 2500 household surveys were done in the field. Last week numerous stakeholders discussed the proposed coastal protection strategy in four groups. Their contributions will be incorporated in the final strategy, which are to be present in the final seminar on national and local level in the Philippines end of May 2016.

BD8597

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Restricted

Royal HaskoningDHV
Enhancing Society Together

CLIENT:
Hoogheemraadschap Hollands Noorderkwartier

LOCATION:
Amsterdam-Edam
Netherlands

PROJECT START-END DATES:
2008 - 2018

VALUE (€):
> 2M

Dike Enforcement Edam-Amsterdam

CONTACT: Martijn Karelse

The Challenge
The dike section Edam - Amsterdam is part of a ring of defenses that protects the province of North Holland, north of the North Sea Canal. According to current standards under extreme conditions, such as prolonged high water on Lake Markermeer, the stability of the embankment can no longer be guaranteed. It is necessary to strengthen the dike (about 16 km) in order to protect the population and the land permanently from flooding. The dike reinforcement is to be realized in an area with very weak subsoil (peat), protected villages, EHS, Natura 2000, intensive recreation and somewhat reduced accessibility options

The solution
The dike strengthening of the dike section has to guarantee the safety for at least 50 years. The goal is to achieve a secure, future-proof barrier that suits its surroundings. Existing features and valuable elements will have to be preserved as much as possible and opportunities for its enhancement exploited. In addition to the content elaboration, Royal HaskoningDHV plays an important role in the project- and process management, internal and external communications and vision development in the project.

The result
Royal HaskoningDHV is responsible for making the starting note, some substantive additional studies, environmental impact assessment and associated studies and the dike improvement plan. In these reports, several solutions have been inventoried and assessed. This includes innovative concepts such as the Oeverdijk and the study Dikes on Peat integrated has been integrated as much as possible. Partly based on this and on the basis of a description of the current spatial quality of the dike, defined design principles variants have been drawn up per dike section. In the dike improvement plan the design of the preferred alternative identified will be elaborated per dike section .
RHDHV will also be involved in the market approach, tendering- and award phase and implementation supervision.

Royal HaskoningDHV
Enhancing Society Together

CLIENT:
Rijkswaterstaat Water, Verkeer en Leefomgeving (RWS-WVL)

LOCATION:
Utrecht
Netherlands

PROJECT START-END DATES:
2008 - 2014

VALUE (€):
> 2M

Veiligheid Nederland in Kaart (VNK)

CONTACT: Ronny Vergouwe

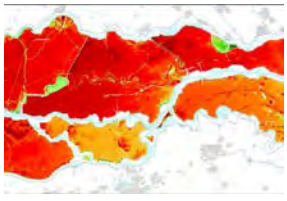
SERVICES:

- Product & Technology Delivery
- Detailed Engineering

The Challenge
In the Netherlands nearly 9 million people live in areas protected by dikes and dunes along the coast, the main rivers and lakes. Roughly 65% of the GNP is generated here. Flood risk management is a pressing issue right now and will only become more urgent as the sea level continues to rise and river discharges increase on the one hand, while on the other hand the population grows and assets that need protection increase in value. Therefore the current policy on protection against flooding is outdated and will be replaced by a risk based approach in which the probabilities of flooding are being linked to the consequences of flooding. To assist risk-informed decision-making the Flood Risk in the Netherlands (FLORIS) project is initiated in which the current flood risks in the Netherlands are analyzed.

Our Solution
This project has mapped the probabilities of flooding and flood risks for 58 dike-ring areas in the Netherlands. Using an innovative method, probabilities of failure of flood defences are being linked to the consequences of flooding expressed in terms of economic damage and casualty numbers. Combining the probabilities of failure and the consequences of flooding (damages and casualties), provides a picture of the flood risk.

The Outcome
The insights produced in the project will help authorities take targeted, cost-effective measures to further reduce flood risk in the Netherlands. The project also provides answers to questions such as: Where is the risk of flooding high or low? What are the most vulnerable areas? What mechanisms are most likely to play a role in a levee breach? How can we effectively reduce the risk of flooding?




Royal HaskoningDHV
Enhancing Society Together

Room for the River Waal

CLIENT: Municipality of Nijmegen

LOCATION: Nijmegen
Netherlands

PROJECT START-END DATES: 2009 - 2016

The Challenge

Our climate is changing, causing an increasing amount of water to flow through our rivers. After river flood events in 1993 and 1995, in order to prevent flooding, the Central Government of The Netherlands decided to create more space for rivers at 40 locations. One of the main locations is in the centre of the city of Nijmegen, where The Netherlands' largest river has a narrow bend. For Nijmegen this means replacing the dike at the village of Lent and constructing a secondary channel in the flood plains of the river Waal. This will result in a new river island and a unique river park in the heart of Nijmegen with room for living, recreation, culture and nature. The municipality was supported by a consortium led by Royal HaskoningDHV in developing a plan for the Room for the River Waal project.

Our Solution

RHDHV has taken on the task of developing several variations on how to utilise the land that is newly created by the dike replacement.

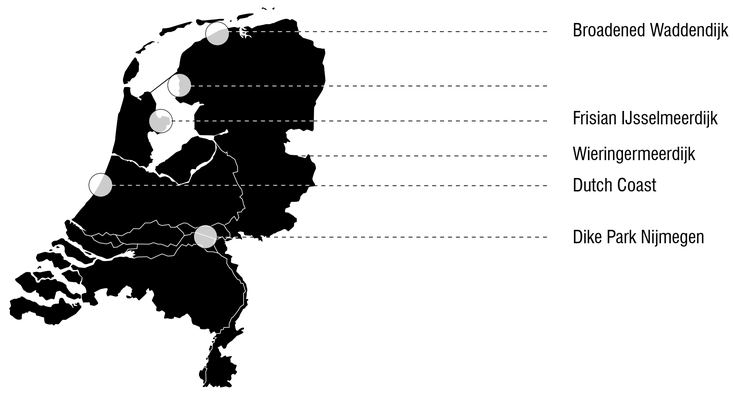
The Outcome

The activities included developing and designing several alternatives for the plan, an Environmental Impact Assessment, a dike replacement plan and a zoning plan and preparing and obtaining the necessary permits.
A team of 250 enthusiastic experts has taken up the challenge to realise this project. Both the analyses and alternatives were finalised at the end of 2010. The outcome will have a profound impact and it will also be sustainable. Safety and the improvement of spatial quality are the key objectives. The dike replacement is scheduled to be completed in 2016.
The Room for the River Waal plan was winner of the Top Honour Award of the 'Excellence on the Waterfront' competition in New York City in October 2011. The plan's scale, the complex multidisciplinary approach and the

LINT
landscape interventions

COASTAL FLOOD PROJECTS

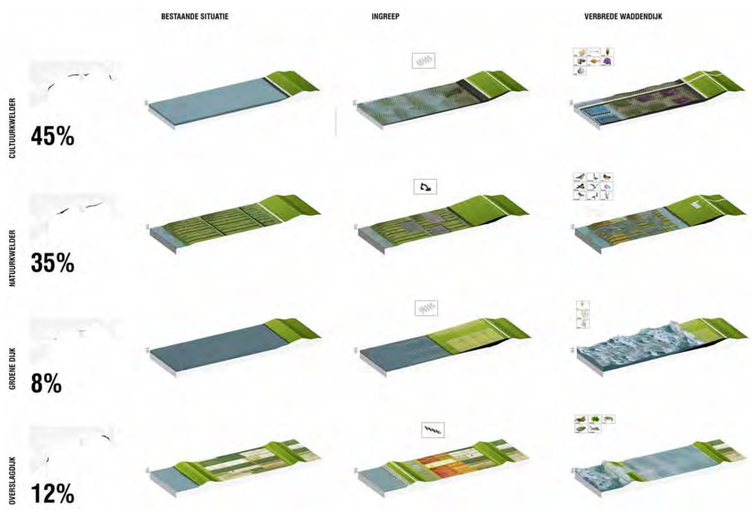
Global warming caused the sea level to rise and the amount of water from the rivers to increase. This is a serious problem for the Netherlands, as a big part of the country lies beneath sea level. Therefore, it is necessary to adjust the dikes and coastal zones in the Netherlands within the coming decades. LINT has extensive experience on projects related to dike reinforcement and coastal reinforcement, varying from the large rivers, the Wadden coast, the North Sea coast, the IJsselmeer and the Soutwestern delta. These projects show that there are great opportunities to combine reinforcement tasks with challenges related to recreation, agriculture and nature development.



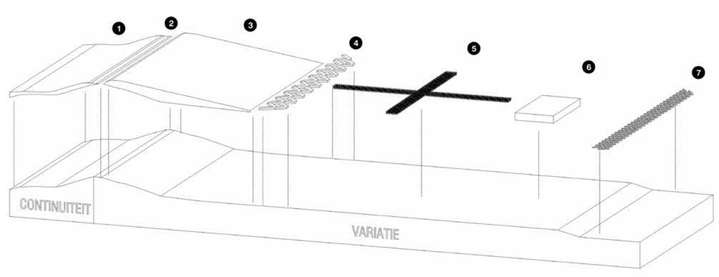
BROADENED WADDENDIJK

Groningen and Friesland / dike reinforcement and nature development / commissioned by the State Architect for Landscape and Water / 2014

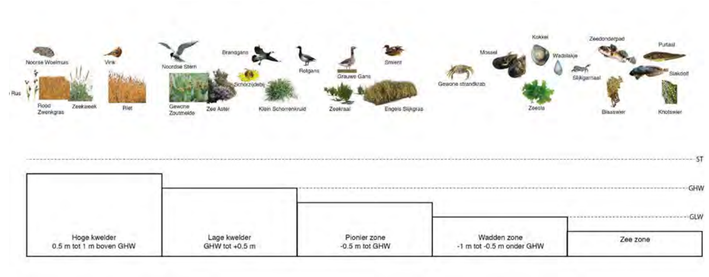
In recent centuries in Northern Netherlands, land reclamation has taken place by the use of kwelders. These kwelders determine the character of the Wadden coast. The purpose for making land and the technique by which kwelders were made have always changed, therefore each time period generated a different landscape. In the current situation, most of the kwelders have disappeared. This vision pleads for expanding the surface of kwelders outside of the existing dike. The new kwelders function as reinforcement of the dike and at the same time give an ecological impulse to the area. The combination of the existing dike and the kwelders results in a new flood landscape: the broadened Waddendijk. On the Wadden side, the different interventions create interesting variations in the landscape. On the land side, the dike structure provides continuity and recognizibility of the Wadden dike as a whole. The broadened Wadden dike also has an important recreational function with its extensive network of bike and walking trails.



Dike typologies and suitable interventions



Continuity and variation of the broadened Waddendijk



Ecological sequence of the kwelder landscapes

Impression Broadened Waddendijk

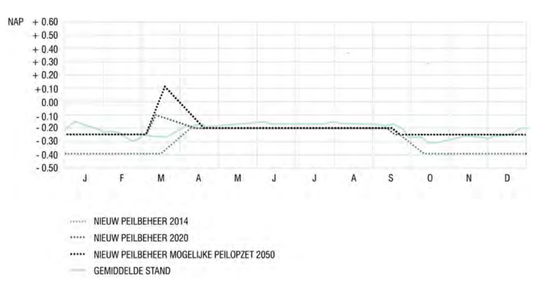
Impression Broadened Waddendijk

Impression Broadened Waddendijk

FRISIAN IJSSELMEERDIJK

IJsselmeer / regional design coastal zone / commissioned by Atelier Making Projects & Ministry of Infrastructure and Environment / i.c.m. Deltares / 2014

In the context of the Deltaprogramma IJsselmeergebied a new flexible water level for the IJsselmeer lake will be proposed, in which the water will be raised to a level of 10 cm below NAP. Because of this new water level, mitigating actions have to be executed to prevent the Friesian IJsselmeer Coast from (further) erosion. The Friesian IJsselmeer Coast is characterized by it's dynamics and valuable nature areas. After the construction of the Afsluitdijk the sandbanks in front of the coast were turned form saltwater into freshwater areas and colonized by reed, willows, industry and recreation. Because of these developments the coastal zone is spatially compacted, which has changed the relationship of the villages with the water and has a big impact on the sight lines and the clarity of the landscape. Sedimental Scenes uses the introduction of the new water level to restore and reinforce the spatial relationship between the dike, villages and natural areas. By stimulating new dynamic nature, waves will be less powerful and the openness of the coast is ensured. New wetlands behind the dikes are connected with the areas on the lakeside and new connections between the villages and the lake are established. The different interventions create a recognizable coast and enhance the connection between the IJsselmeer and inland.

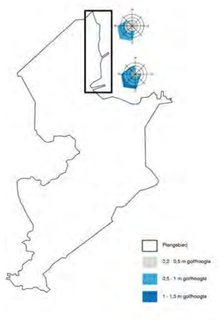


New flexible water levels IJsselmeer

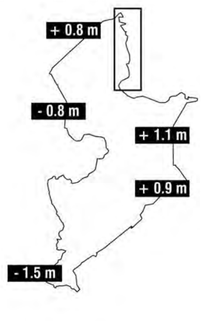
Impression Sedimental Scenes Makkumerwaard

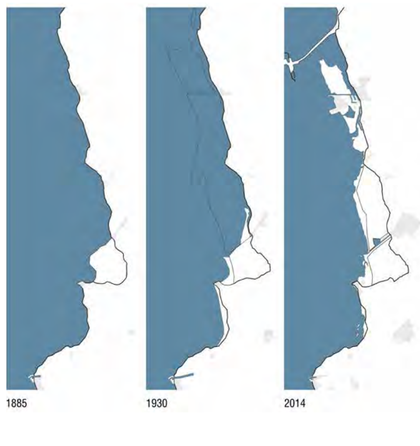
Impression Sedimental Scenes Workum

Impression Sedimental Scenes Hindeloopen



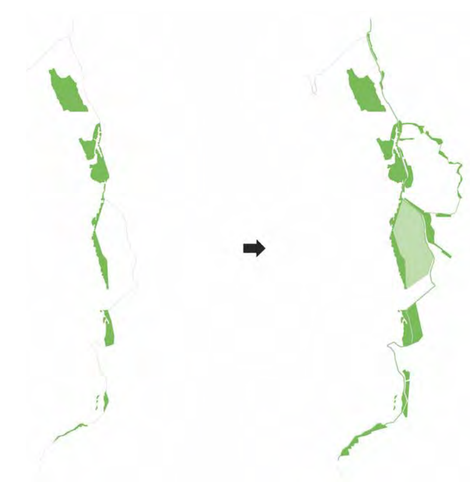
Analysis IJsselmeer coast





Historical development of the IJsselmeer coast

Dike as a recognizable element in the landscape



Stimulating new dynamic nature

LARGE WATERS

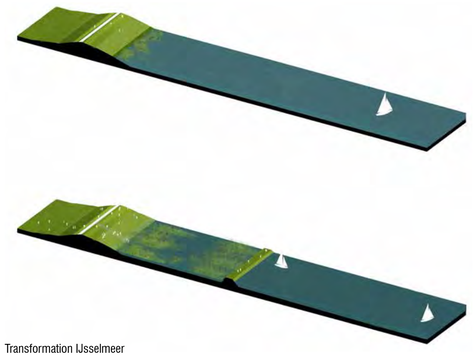
IJsselmeer / Large Rivers, Wadden Coast, North Sea Coast, North Sea and Southwestern Delta / contribution to a vision for 2050-2100 / commissioned by the Ministry of Economic Affairs / 2014

In the most recent forecast of the KNMI, four scenarios were developed concerning climate change (G, G+, W and W+). In all scenarios, the temperature will rise, the sea level will rise and the amount of (peak)rainfall will increase every year. In the scenario W+, even the airflow patterns will change. As a result, winters will be wetter and the summers will be drier. The effects of climate change will have a direct impact on natural ecosystems, because they affect growth rates and biological soil processes. Furthermore, climate change demands changes in water management in the Netherlands, which will also have an impact on nature.'The Nature Ambition of Large Waters 2050-2100' is a vision on nature in the large waters of the Netherlands, in which the effects of climate change are taken into account. In this vision, natural processes have a crucial role in creating new synergies between various tasks, such as flood protection, nature conservation and recreation. The vision shows a resilient and robust nature: giving space to the rivers, creating tidal and fresh-salt transitions in the western Delta, intensifying dynamic coastal management and the construction of more gradual transitions from land to water in the IJsselmeer.

Impression transformation Southwestern Delta

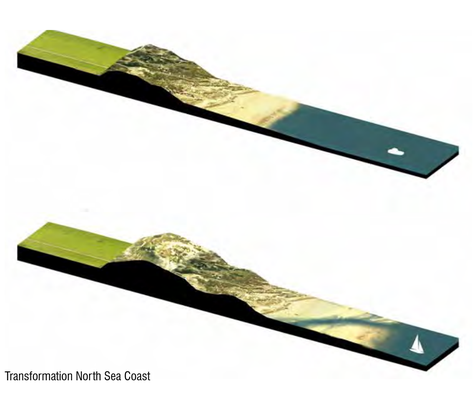
Impression transformation Large Rivers

Impression transformation North Sea Coast



Transformation IJsselmeer

Transformation Southwestern Delta



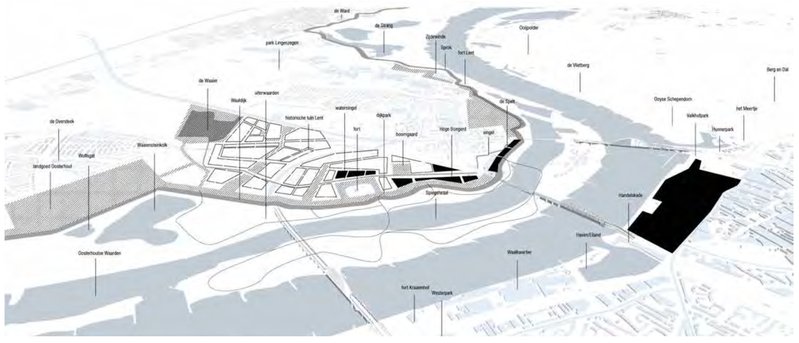
Transformation North Sea Coast

Transformation Wadden Coast

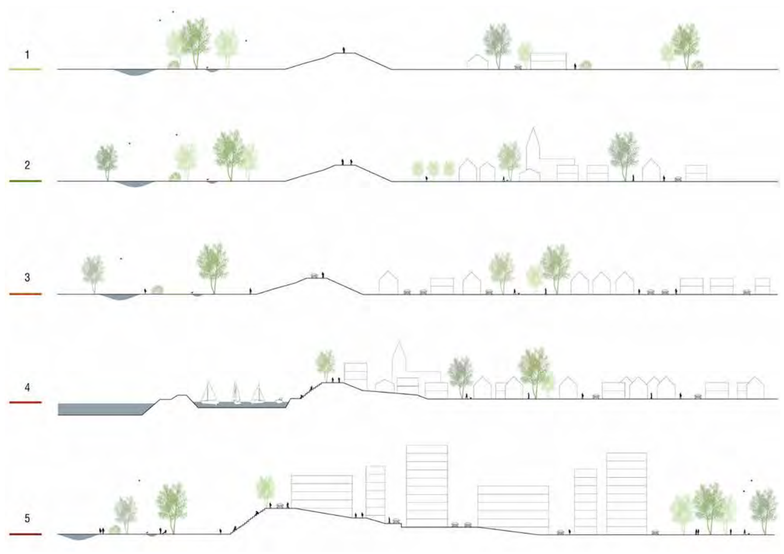
DIKE PARK NIJMEGEN

Nijmegen / dike park / commissioned by O team, Gemeente Nijmegen and Waterschap Rivierenland / 2017

The Waaldijk near Nijmegen will have to be reinforced in the future. Besides elevating the dike with 1 meter in 2050, there are problems with seepage behind the dike and there is a risk of piping and instability. From a technical point of view, the elevation of the dike demands a certain distance between the dike and the houses. However, the municipality of Nijmegen has the ambition to expand the city towards the dike, mainly because of possible revenues from the land. LINT has analysed the Waaldijk and the way different villages, neighbourhoods and cities are located in relation to the dike. The main conclusion was that the dike forms an important linear structure in the area and is recognizable in the landscape except for the most urban parts. To ensure that the dike can be experienced as a separate spatial element and that the landscape is optimally intertwined with the city of Nijmegen, LINT proposes to transform the area directly behind the Waaldijk into a dike park. The park consists of a multitude of functions with public and productive qualities, such as orchards, vegetable gardens and wetland nature. At some locations, there is space for innovative housing development. LINT chooses for a strategy in which the park can be developed in different phases and in which choices for further urbanization can be made in the future.



Bird's-eye view Nijmegen



Dike typologies

Analysis Waaldijk Gorinchem to Nijmegen

Section Dike Park Nijmegen

THE DUTCH COAST

Noordwijk-, Egmond- en Katwijk aan Zee / commissioned by Atelier Kustkwaliteit / i.c.m. XML architecture / 2012

The Dutch Government appointed the Sustainable Coastal Development Committee, with the mandate to formulate a vision and come up with recommendations on the long-term protection of the Dutch coast. The Committee argues that the current standards of flood protection are not being met everywhere. Therefore the coast has to be enforced with sand supplements. By depositing extra sand, the coastal system will grow naturally and will therefore be enforced. Some crucial locations will be enforced by enlarging the existing dunes. The main coastal villages located along the Hollandse Kustboog that are confronted with this task are Katwijk-, Noordwijk- and Egmond aan Zee. A significant part of these villages is outdated in their urbanistic and architectural setup. LINT proposes to use the process of coastal improvement to transform these villages by smart urban interventions and to rethink and improve the connection between city and sea. For each village the specific relationship between the sea and its hinterland is analyzed and used to implement specific interventions that use existing qualities. Possible combinations with other urgent problems and developments around the coastal villages were investigated.

Impression parking dune Egmond aan Zee

Impression dune bridge Noordwijk aan Zee

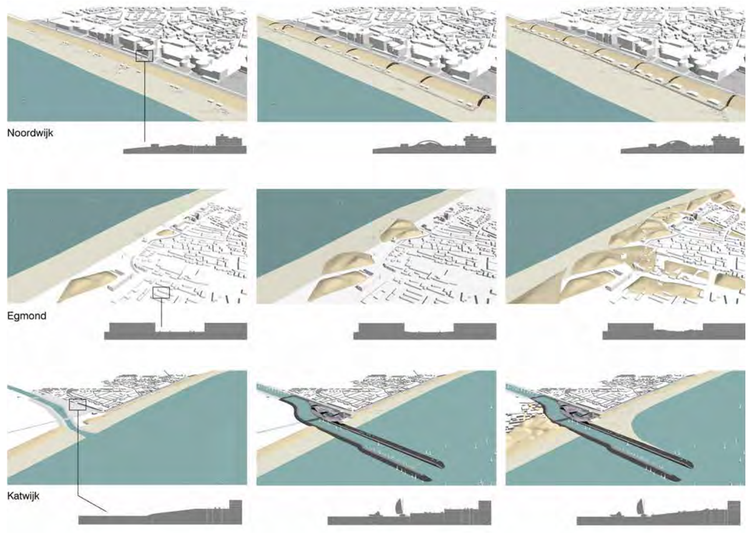
Impression boulevard Katwijk

Noordwijk

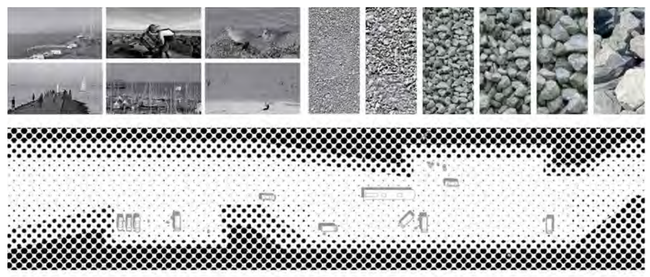
Egmond

Katwijk

Analysis coastal villages



Transformation strategy coastal villages

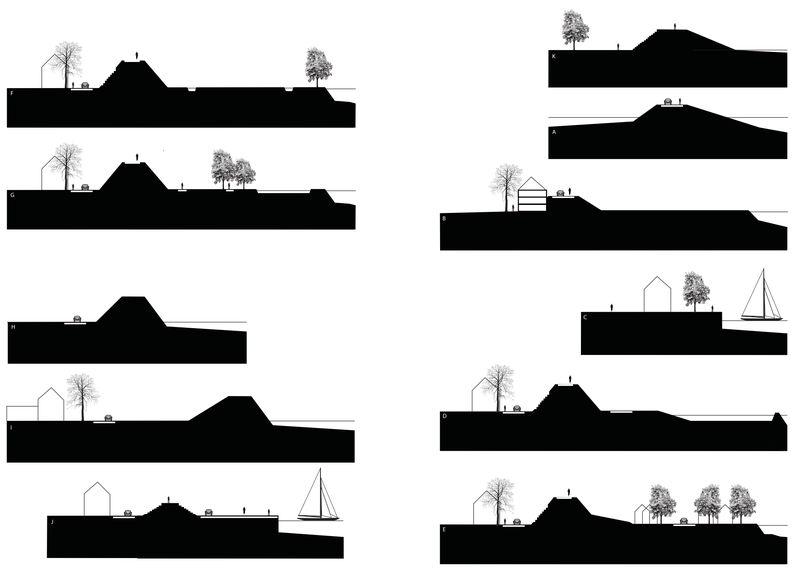


Materialization Katwijk

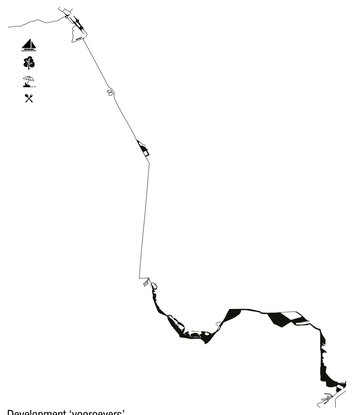
WIERINGERMEERDIJK

Wieringermeerpolder / design research / commissioned by Nieuw Landschap (Miranda Reitsma en Urban Synergy) / 2013

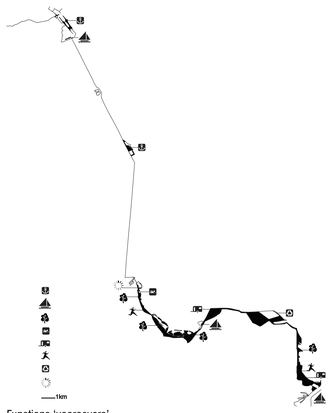
LINT was asked by Nieuw Landschap to conduct a cartographic inventory for the Wieringermeerpolder in relation to climate change, agricultural upscaling and recreational networks. The Atlas Wieringermeer shows the context, the history, the structure and the different layers of the polder landscape. It explains the characteristics of the landscape and the processes that shaped it. Special attention is paid to the relationship of the polder with the IJsselmeer. A comparison between the Wieringermeerdijk and the West Frisian Omringdijk shows that the accessibility of the Wieringermeerdijk is bad and that recreational use is low. The Atlas indicates the assignments for the Wieringermeerpolder to adapt towards future challenges.



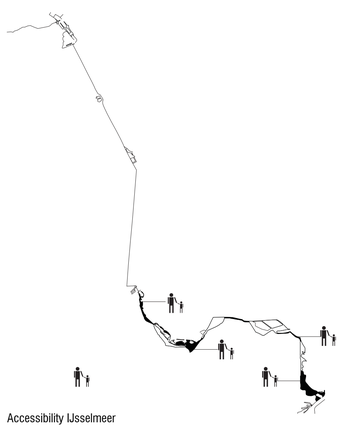
Sections along the IJsselmeer



Development 'vooroevers'

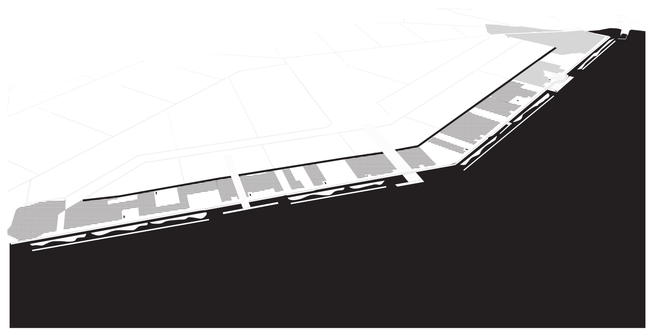


Functions 'vooroevers'



Accessibility IJsselmeer

Relationship inland and shore



Wieringermeerdijk with new 'achterhoeves'

LINT
landscape interventions