

REGULAR COUNCIL

TO: **Mayor & Council** DATE: **December 13, 2017**
 FROM: **General Manager, Engineering** FILE: **4816-706**
 XC: **5225-23**
 SUBJECT: **Development of a Surrey Coastal Flood Adaptation Strategy
 2017 Year End Update**

RECOMMENDATION

The Engineering Department recommends that Council receive this report as information.

INTENT

The purpose of this report is to update Council on the development of a Coastal Flood Adaptation Strategy (“CFAS”).

BACKGROUND

At its Regular meeting on December 19, 2016, Council received Corporate Report No. R263; 2016. The purpose of that report was to update Council on the progress made in developing the 5-phase CFAS to address current flood hazards and incorporate long-term flood protection needs resulting from forecast climate change.

The sequence of the 5 phases of the project is illustrated in Figure 1.



Figure 1. Phases of the CFAS

In parallel to Surrey’s CFAS process, development of a Lower Mainland Flood Management Strategy (“LMFMS”) for the Fraser River floodplain is underway, facilitated by the Fraser Basin Council. Phase 1 of the LMFMS took place between 2014 and 2016 and has concluded. The risks, vulnerabilities and consequences of a large flood event, including the effects of sea level rise, have been published to www.FloodStrategy.ca for the region. Phase 2 of the LMFMS is underway, with a view towards completion in 2019. The process and results of developing the Surrey CFAS will influence the LMFMS and be complementary. The goal for the LMFMS is to secure consensus among partners about regional priorities, cost-sharing and funding commitments for flood management.

DISCUSSION

CFAS Phase 1: What Matters Most and Who is Affected?

The Phase 1 events hosted since the 2016 update to support the project’s participatory, community-driven planning approach are listed below:

Event	Dates	Overall Participants
Three focus groups: <ul style="list-style-type: none"> • Agriculture & Farming • Community & Residential • Environment & Recreation 	February 3 to March 8, 2017	60+
Three technical workshops: <ul style="list-style-type: none"> • Green Shores™ Shoreline Design focus on Colebrook • PIEVC™ Infrastructure Vulnerability • Coastal Design Workshop with UBC SALA and experts from the Netherlands 	November 10 2016 to April 26, 2017	100+
Open House	April 26, 2017	30+
Presentations: <ul style="list-style-type: none"> • Regional Adaptive Collaborative Webinar • Horticulture Growers Short Course (Pacific Agriculture Show) • Association of Professional Engineers and Geoscientists Annual Conference • Two Crescent Beach Property Owners Association Quarterly Meetings • Climate Action Secretariat Office • Public Works Association BC • Council Committees (PAAC, ESAC, AFSAC, PRSTC, DAC, SHAC) • Surrey Lowland Annual Meeting • South Nicomekl Irrigation Meeting • Understanding Risk Vancouver 	September 2016 to March 2017	300+

The results of the three focus groups are attached as Appendix “I”. To better advance the results of the focus groups, 86 detailed surveys were undertaken to identify, validate and prioritize concerns. The top concerns identified were related to infrastructure, agriculture/food security and residential areas. While 42 thematic areas were identified from this in-person and online engagement, key areas of concern are listed below with a corresponding primary indicator:

- Residents: People permanently displaced
- Agriculture: Permanent loss of agricultural land
- Environment: Impacts to wetland habitats, freshwater fish habitats and riparian areas
- Infrastructure: Percent of service/transportation infrastructure made vulnerable
- Economy: Permanent loss of businesses
- Recreation: Diversity of recreational opportunities

Through direct consultation with the Semiahmoo First Nation (“SFN”), an additional value to address their concerns has been summarized as Culture, with a primary indicator:

- Culture: Land disturbance

The project team has also had a presence at various events through an exhibit that has been displayed at Ocean Park Library, Semiahmoo Library, Surrey Central Library, City Hall and the Surrey Simon Fraser University Atrium. The project team also had a presence at a number of events including Party for the Planet, Environmental Educators Provincial Specialist Association, Rising Tides and Skin Boats, Alex Fest, and World Ocean Day.

The project has been included in classes at the elementary and secondary levels at School District 36 as well as post-secondary classes from Simon Fraser University, University of British Columbia and University of the Fraser Valley.

Using the CitySpeaks platform, an initial online survey was conducted on coastal flooding in Surrey. 608 responses were received. 84% of participants are concerned about the impacts of coastal flooding. The majority of participants indicated sea level rise is of equal or greater importance by comparison to other issues Surrey is facing. Additional results and analysis of the CitySpeaks survey are available in Appendix “II”.

In addition to CitySpeaks, more detailed surveys both in hard copy and one available digitally were used in Phase 1, generating over 200 responses. Responses indicated that there is a high level of engagement on the issue and a strong desire to provide input to the City in developing the CFAS.

CFAS Phase 2 and 3: What Can We Do and What is Acceptable?

These phases of the project include option development and what is acceptable, and are over half way completed, expected to be fully completed by April 2018. While the overall study area represents 20% of Surrey’s land base, the area has been divided into three chapters for evaluation:

- Chapter One: Mud Bay including the Serpentine River and Nicomekl River lowlands
- Chapter Two: Crescent Beach
- Chapter Three: Semiahmoo Bay and the Little Campbell River

Different events that have been hosted to engage residents, stakeholders and partners are listed below:

Engagement Event	Dates	Overall Participants
GreenShores™ Workshop - Focus on Crescent Beach	July 11, 2017	24
Advisory Group – Focus Mud Bay	July 25, 2017	32
Study Tour – Focus Mud Bay	September 25 or September 26, 2017	48
Infrastructure Triple Bottom Line Assessment – Focus Mud Bay West of 152 Street	October 10, 2017	50+
Four rounds of meetings with SFN	April 4 to December 6, 2017	2-5
Regulators Workshop	October 17, 2017	~20
Story Map Presentations: <ul style="list-style-type: none"> From Farmland to Saltmarsh Agriculture Focus on Mud Bay Dynamic Beautiful Ever Changing Residential and Recreation Focus on Crescent Beach 	September 18 and September 26, 2017	20 in person and over 1,500 application views online
Presentations: <ul style="list-style-type: none"> Engineers and Geoscientists BC Liveable Cities Forum 	September 19, 2017 to October 20, 2017	50+
Semiahmoo Bay Options Workshop	November 2, 2017	17
Coastal Land Stewards Workshop	November 17, 2017	10+

Advisory Group

A Project Advisory Group has been established and includes representation from:

- Agricultural Land Commission
- A Rocha Canada
- Anderson Walk (BCS2382) Strata
- Bird Studies Canada
- City of Surrey
- Corporation of Delta
- Crescent Beach Property Owners Association
- Delta Farmers Institute
- Ducks Unlimited Canada
- Engineers and Geoscientists BC
- Fraser Valley Real Estate Board
- Friends of Semiahmoo Bay Society
- Hopkins Berry Farm
- Kooldale Farms Ltd.
- Lindrian Farms
- Little Campbell Watershed Society
- M&M Pacific Coast Farms
- Metro Vancouver
- Ministry of Agriculture
- Ministry of Transportation and Infrastructure
- Mud Bay Dyking District
- Nicomekl Enhancement Society
- Residents at large
- Surrey Board of Trade
- Surrey Environmental Partners
- Surrey Heritage Advisory Commission
- School District #36
- UBC School of Architecture and Landscape Architecture
- Westland Insurance Group
- White Rock
- Winners Holstein Ltd.

At the first Project Advisory Group meeting on July 25, 2017, adaptation options for Mud Bay were reviewed. The Project Advisory Group will meet two or three more times over the next six months to review and help evaluate coastal flood management options and to provide input into the final CFAS.

Infrastructure Triple Bottom Line Assessment

Building on the Infrastructure Vulnerability Assessment workshop on March 10, 2017, a triple bottom line assessment was performed on two illustrative adaptation options. This workshop elicited specific areas of concern to the infrastructure sector. Organizations participating in the workshop included:

- Agricultural Land Commission
- Associated Engineering
- BC Agriculture and Food Climate Action Initiative
- BC Hydro
- City of Surrey
- Corporation of Delta
- EcoPlan
- Emergency Management BC
- Engineers and Geoscientists BC
- Engineers Canada
- FortisBC
- Fraser Basin Council
- Metro Vancouver
- Ministry of Environment
- Ministry of Transportation and Infrastructure
- Northwest Hydraulic Consultants
- RCMP
- Representing Surrey Board of Trade
- SRY Rail Link
- Thrive Consulting
- University of British Columbia
- Vancouver Fraser Port Authority

An Assessment Team, comprised of twelve organizations, will review the findings of the workshop and a report will be issued outlining key infrastructure considerations to inform the broader CFAS.

International Support

Building off the Coastal Design Workshop of Phase 1, the team of consultants from the Netherlands, in partnership with UBC's School of Architecture and Landscape Architecture, continue to provide technical input to the project in Phase 2 and 3. This team has secured further funding from the Kingdom of the Netherlands and a delegation is planned to participate in the project in February 2018. The international perspective has been well received by stakeholders and has helped inform options developed for Mud Bay as well as the evaluation of options.

Shortlisting Process

Consultation with partners and stakeholders was initially based on a draft listing of 18 distinct options throughout Phase 2 of the CFAS. Based on the input received in the first round of consultation in Phase 2, stakeholders did not accept "No Adaptation" as an option for any of the three chapters. The "No Adaptation" option will be communicated for context only and as a reason for why action is required and will no longer be considered an option. Other options specific to a particular chapter were also found to not be acceptable as distinct approaches to long-term flood adaptation. The eight options removed after the first round of Phase 2 consultation of the CFAS development were:

- Mud Bay: No Adaptation
- Mud Bay: Coastal Realignment to 152 Street
- Mud Bay: River Realignment
- Crescent Beach: No Adaptation
- Crescent Beach: Current Conventions
- Crescent Beach: Expanded Edge Land Side
- Crescent Beach: Flood Tolerant Architecture
- Semiahmoo Bay: No Adaptation

The remaining options and their evaluation will be released and reviewed in the upcoming broader consultation process to identify preferred options that fall within the following budget ranges:

1. Under \$100 Million
2. Between \$100 Million and \$1 Billion
3. Over \$1 Billion

Given the significant investment required to adapt to sea level rise and become more resilient, staff are looking to receive input from decision makers at the Provincial and Federal government before preferred strategies are identified at the end of Phase 3 of the CFAS development. The preferred options within the three budget ranges will be presented at an Open House in Spring 2018.

Next Steps

At the completion of Phases 2 and 3 in developing the CFAS, Phase 4: *How Will We Do It?* will commence in Spring 2018. This phase of work is primarily technical and will engage with specific key stakeholders. Input from decision makers at the Provincial and Federal government will lay the foundation for future partnerships to later implement the CFAS.

Timeline

Originally, the CFAS was anticipated to align with the regional LMFMS development being facilitated by the Fraser Basin Council. However, as the timeline for the regional work has been extended, the Surrey CFAS is anticipated to be completed well before the LMFMS Phase 2 is completed.

The approximate timeline for key tasks remaining in the CFAS development are:

2018

- Refine draft mitigation strategies to increase resilience;
- Host additional workshops and open houses;
- Rank draft mitigation strategies to increase resilience;
- Link with the Crescent Beach Land Use Plan update;
- Revisit Flood Protection Elevation Requirements for Hazard Area Development Permits (Crescent Beach and South Westminster);
- Develop benefit/cost analysis for each draft preferred flood mitigation strategy to increase resilience;

- Complete detailed economic analysis of preferred mitigation strategies to increase resilience;
- Identify potential funding partners; and
- Present the preferred CFAS for Council's consideration.

Beyond 2018

- Link with regional flood strategy;
- Secure funding partners for the CFAS;
- Implement aspects of the CFAS and monitor; and
- Update the CFAS periodically as new climate change information becomes available.

SUSTAINABILITY CONSIDERATIONS

The process of developing the CFAS will strengthen community engagement and will set the direction for future actions that will support several themes in the Sustainability Charter. In particular, the CFAS relates to the Sustainability Charter themes of Infrastructure, Built Environment and Neighbourhoods, Ecosystems, and Public Safety. Specifically, the CFAS development supports the following Desired Outcomes and Strategic Directions:

- Energy and Climate DO6: The City anticipates changing weather patterns and sea level rise as a result of climate change, and implements appropriate infrastructure, land use planning and emergency response solutions that will be resilient over the long term;
- Neighbourhoods and Urban Design SD8: Strengthen and promote community engagement and programming in public spaces;
- Green Infrastructure DO12: Surrey protects ecosystem services and manages natural assets in order to create resiliency to adapt and thrive in a changing climate; and
- Emergency Preparedness and Prevention SD6: Promote development types and locations that will be minimally impacted by natural disasters.

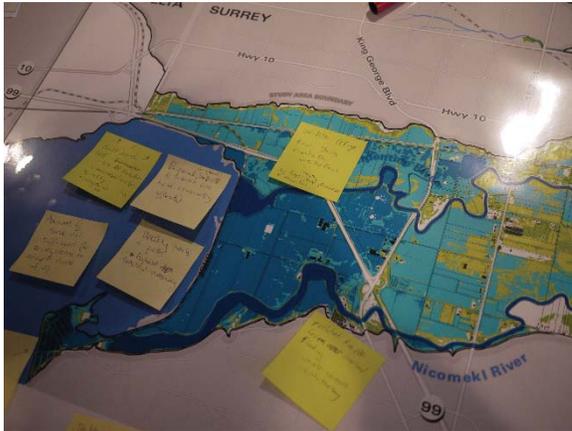
CONCLUSION

Based on the above discussion, it is recommended that Council receive this report as information and have staff report back to Council with a draft Coastal Flood Adaptation Strategy.

Fraser Smith, P.Eng., MBA
General Manager, Engineering

JA/MO/cc

Appendix "I" - Coastal Flood Adaptation Strategy Phase 1 Focus Group Engagement
Appendix "II" - Coastal Flood Adaptation Strategy Survey of CitySpeaks Members Survey Results



CFAS Phase 1 Focus Group Engagement

Agricultural Focus Group: February 3, 2017
Residential Focus Group: February 8, 2017
Environmental Focus Group: March 8, 2017

Summary Report

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PROJECT OVERVIEW

Surrey’s 35-kilometer coastline coast faces a big challenge because of sea level rise, which is projected to rise 50 centimeters (about 1.5 feet) over the next 50 years. Coastal areas, such as Surrey’s coastal floodplain, can expect more frequent and severe flooding from sea level rise and storm surges. Making up about 20% of Surrey’s entire land area, the coastal floodplain is a large low-lying area that stretches from Boundary Bay and Mud Bay along the Nicomekl and Serpentine Rivers toward Cloverdale and Newton. The area also includes the Campbell River/ Semiahmoo Bay area near White Rock and Semiahmoo First Nation. It is home to historic and important neighborhoods, farms and businesses, critical infrastructure and transportation corridors, and internationally recognized bird and wildlife habitat.

To prepare for these changes and build resiliency, the City of Surrey is developing a Coastal Flood Adaptation Strategy (CFAS) for Surrey’s coastal floodplain area. The CFAS project is broken into five general phases 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.

Map: Project Area



PHASE 1 FOCUS GROUPS

In keeping with Surrey's commitment to community engagement, the CFAS project takes a community driven, participatory planning approach, inviting stakeholders and residents of the study area to interactive workshops. The focus groups for Phase 1 strive to answer the question: "what matters most, and who is affected?"

Present at each workshop were the consultants and various representatives from the City of Surrey. At the beginning of each workshop, participants were each given a printed CFAS Primer Booklet to follow along with during the presentation, take notes and keep as a take-away. At each group table (typically 2-3 tables were occupied), an 11x17 map atlas was provided as well as large base maps with 2010 and 2100 flood maps printed on clear acetate. Markers, post it notes and stickers were provided for communication throughout the workshop. Other visualizations in the room included a 1:1 scale wall map that illustrates sea level rise and dykes heights, and a 3D printed model of the study area.

In Phase 1, The City of Surrey hosted interactive workshops for the following focus groups:

- February 3, 2017: Agriculture Focus Group
- February 8, 2017: Residential Focus Group
- March 8, 2017: Environmental Focus Group

Agenda

The agenda for the workshop was divided into four sections:

1. **Introductions and Overview:** The objective of the first section of the workshop was to introduce participants to the CFAS project, Surrey's coastal floodplain, and growing hazards due to climate change. This was accomplished through a 30-minute digital presentation while participants ate dinner or lunch. The presentation was followed up with a quiz on general knowledge of the Primer and Atlas, and an opportunity for Q&A.
2. **Issues and Concerns:** The objective of this section was to capture the issues and concerns of participants in response to the first section. This was accomplished through an activity/ breakout session in small groups followed by group discussion and voting. Each group had one facilitator and one note taker. Using the base maps and 2010 and 2100 flood overlays, group answers the following questions:
 - What concerns you most today? In 20-years? In 50-years? In 80-years?
 - What would you most want to avoid now and in the future?

As the information gathered in this section was the focus of the workshops, this activity took approximately 50 minutes.

3. **Options Identification:** The objective of this section was to identify options for adaptation that respond to earlier issues and concerns. This was accomplished through a presentation on adaptation options (protect, retreat and accommodate), an activity/ breakout session in small groups and group discussion and voting. Each group had one facilitator and one note taker. The

Environmental Focus Group included a presentation on Green Shores from DG Blair of the BC Stewardship Centre.

Using the base maps, groups answered the following questions:

- What adaptation actions could be pursued to address the identified concerns?
 - What adaptation actions could you do?
 - Who would need to be involved in other adaptation actions (e.g., Surrey, Province, Federal Government, organizations, etc.)
 - Which option would you pursue first? Why? In 20 years? in 50 years? In 80 years?
 - How well does the action respond to the top concerns identified by group?
4. Next Steps and Wrap Up: The last section of the workshop followed reported back some common themes of the workshop and informed the participants of ways to get involved in the project as well as next steps.

OVERARCHING THEMES

Based on a review of notes recorded during and after the workshops, comments received and feedback provided by event staff (consultant team staff, City of Surrey)

Agriculture Viability

- Loss of agricultural land
- Financial losses due to property and crop damage
- Investment loss (long term farming investments, generational practices)
- Soil salination damaging crops on short and long term basis
- Livestock disruption

Residential Impacts

- Impacts to Semiahmoo First Nations (archeological sites, spiritual and sacred sites, traditional medicine and foods)
- Home displacement (long term and short term)
- Damage to homes
- Property values
- Community and aesthetic impacts (views, heritage sites, character of area)

Environmental Impacts

- Coastal habitat loss (ex: salt marsh coastal squeeze)
- Freshwater habitat loss (ex: Serpentine Fen)
- Global and cascading impacts of habitat loss (ex: Pacific Flyway)
- Adverse effects on water quality from pollutant run off after flooding events

Infrastructure Impacts

- Damage and disruption to transportation routes (highways and rail)
- Disruption of regional road network

- Damage to critical utilities

Economic

- Business interruptions
- Loss in farm gate revenue
- Employment loss

Health and Well-Being

- Accessibility of evacuation routes during flood events
- Safe drinking water
- Public awareness and transparency of flood issues

Recreation

- Loss of trail network
- Loss of waterfront/ beach access

Flood Management

- Need to be adaptive and flexible
- Operations costs
- Capital costs

AGRICULTURAL FOCUS GROUP

Date: February 3, 2017

Time: 12:00 pm

Location: Cloverdale Recreation Centre

Participants: 29



Image: Agricultural Focus Group

Agriculture Priorities:

1. Farmland viability (23%)
2. Localized flooding (14%)
3. Existing infrastructure vulnerability (14%)
4. Economic loss (12%)
5. Irrigation + Salination (10%)
6. Groundwater emergence (9%)
7. Environmental impacts (8%)
8. Transportation (7%)
9. Food security (4%)

Summary

Not surprisingly, agriculture priorities were focused highly on farmland viability, with localized flooding and damage to infrastructure coming in second. Adaption options were often focused on addressing farmland viability and thus, raising dykes and offshore sea barriers were popular options. As most participants live in the study area, individuals were typically focused on specific issues relating to their property or farm.

RESIDENTIAL FOCUS GROUP

Date: February 8, 2017

Time: 6:00 pm

Location: South Surrey Recreation Centre

Participants: 16



Image: Residential Focus Group

Residential Priorities:

1. Agriculture impacts (i.e. viability, food security) (20%)
2. Infrastructure vulnerability (i.e. rail lines, evacuation routes, derailment/dangerous goods) (20%)
3. Home damage & loss of property value (i.e. loss of views) (19%)
4. Localized flooding (15%)
5. Environmental & habitat impacts (10%)
6. Erosion of shoreline (9%)
7. Impact to vulnerable communities (i.e. First Nations) (3%)
8. Health and wellbeing of citizens (2%)
9. Recreation, tourism impacts & beach access (2%)
10. Business interruptions (i.e. golf course) (0%)

Summary

This focus group had a variety of stakeholders such as business owners and residents in the study area and residents outside of the study area. Priorities were more evenly weighted although, perhaps surprisingly, agriculture and infrastructure tied for the top priority. Adaptation options combined a variety of soft (ex: barrier islands) and hard options (ex: larger dykes). Adaptation options considered the environmental impacts (such as habitat loss), residential impacts (such as loss of views) and agricultural viability.

ENVIRONMENTAL FOCUS GROUP

Date: March 8, 2017

Time: 6:00 pm

Location: South Surrey Recreation Centre

Participants: 18



Image: Environmental Focus Group

Environmental Priorities:

1. Infrastructure flooding (rail, roads, utilities, evacuation routes, emergency response) (24%)
2. Ecological and habitat impacts (species at risk, migration routes, wildlife refuges) (24%)
3. Agriculture impacts (i.e. viability, food security, loss of ALR) (16%)
4. Water quality impacts from flooding (garbage, pollution, groundwater) (13%)
5. Home damage & loss of property value (properties without homes) (9%)
6. Loss of spiritual & sacred sites, traditional foods, medicines, archeological sites (unregistered) (6%)
7. Economic impacts (biz, farms, restoration costs, tax payer burden) (5%)
8. International impact (salmon hatcheries) (2%)
9. Recreation & tourism (trails, marinas) (0%)

Summary

The environmental workshop had an additional presentation from DG Blaire of the BC Stewardships center on “Green Shores” strategies prior to the breakout session on adaptation options. This greatly impacting the discussion on adaptation options as options such as beach nourishment featured highly as an adaptation option. This focus group also explored retreat scenarios more than any other focus group and went into more detail on environmental issues and concerns.

APPENDIX A: DOCUMENTATION

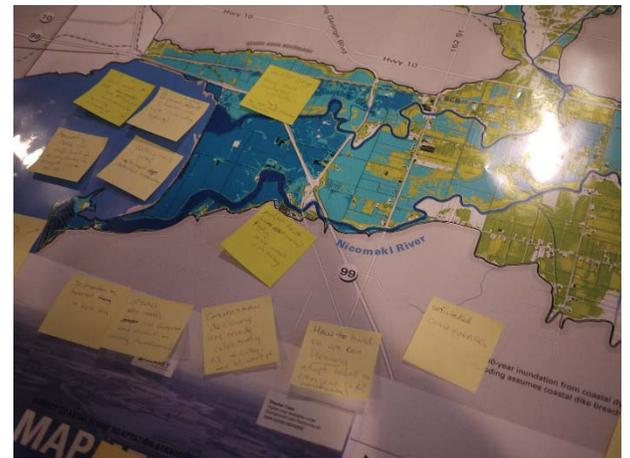
Agriculture Focus Group



Residential Focus Group



Environmental Focus Group



APPENDIX B: AGRICULTURAL FOCUS GROUP WORKSHOP NOTES

CFAS Agricultural Focus Group – February 3, 2017

Table A

Facilitators: Carla, Tommy

Issues and Concerns

1. Economic Loss
Displacement of families that have put in generations of time and money into running farm operations. Extensive money investments have been made into these farms over several generations and that would be lost (e.g., blueberry farmers)
2. Loss of Agricultural Land
Salination is a big concern and contributes to loss of agriculture land. Loss of local food production (e.g., homeowner in ALR with small farm operation)
3. Localized Flooding
Sea dams are closed longer creating a higher potential for flooding. Great deal of challenges with localized flooding. Issues with lack of irrigation and lack of water licenses. Farms can't grow without having access to water. Water is plentiful in non-growing seasons (e.g., blueberry farmers)
4. Dyke Height and Rip Rap Protection
We're building dykes for a 20-min event. If they are made higher they need to be constructed where they can handle the water pressure when these events happen. Concern that the dykes are not stable enough to handle the water events when they occur

Options Identification

1. Bay 'Wall'
Made to eventually accommodate a gate. Helps with water retention in the summer and limiting water coming in the winter. This is a long-term, big-picture solution. Better to spend the money here rather than piece-meal dyke upgrades.

Do this first because it takes care of SO many other issues and problems. And from an environmental perspective it is very beneficial for coastal ecosystems.

Even if this was decided as the 'ultimate' option to follow it will still be 15-20 years out once all studies and construction has been completed – in the meantime people still

need relief from high river levels and to get those levels down to reduce spot flooding. The sea dam pump stations therefore are an important addition for the short term.

2. Sea Island Combined with Retreat

3. Pump Station at Sea Dam

This is considered a partial retreat option but a short-term option as well (compared to the Bay Wall)

Comments

When do we 'do' this? At what point do we actually move ahead? When do people stop putting money into their properties because retreat is determined THE options and when does it get implements? How? Where do you start first?

Retreat doesn't feel like a viable option (this should be the last resort)

Table B

Facilitators: Matt Osler, Charlene Menezes

Issues and Concerns

1. Transportation Impacts

Road, rail, evacuation routes, preparedness. i.e., movement of people and goods [tied for third]

2. Farmland viability

Crop damage, salinization, land loss, feed supply impacts [highest concern]

3. Human health

Risk to life, water quality, septic impacts, pollution [second highest]

4. Infrastructure

Maintenance costs (to farm infrastructure), electricity, inter-jurisdictional issues/impacts (Delta, Langley) [tied for third]

5. Environmental health

To fens, saltwater

Options Identification

1. Retreat to 148th St

Add barrier (and move sea dams here), shown on map as blue N-S line

a. Use barrier to floodproof area east of 148th St

b. Control rare floods from roughly seaward of Hwy 99 to 148th St. See "Control" dashed line drawn on map, and "Control Flood Zone" behind it.

- c. Land seaward of Hwy 99 “Control” line is the zone of “Frequent Flooding”, as indicated on map
- d. Implementation timeline should be focused around accessible level of risk tolerance. Was proposed that existing Mud Bay area (west of KGB) might be expected to flood once every ten years with saline water, with area between Hwy 99 and 148 St once every 50 years and then the areas east of 148 Street would be expected to be floodproofed. When SLR is expected to threaten the land east of Hwy 99 more than 1/50 AEP then it should be raised
- e. Generally considered less desirable option, something of a backup if offshore barrier not feasible

What actions would be needed for this option?

- Start from “Control” line. Base location of this boundary on a particular statistical frequency for flooding.
- Wait as long as possible to build floodproof barrier at 148th, such as after big earthquake. Or build it to withstand earthquake proactively.
- Compensate landowners on seaward side, in Frequent Flooding Zone (and potentially in Control Flood zone). Step 1 would be to secure permissions for this land use. Or adapt to flooding on that land.
- These plans need to accompany regional plan to secure this land for agricultural use.

2. Offshore barrier at Mud Bay, (shown on map as curved red line)

- Alignment could either include coverage to Crescent Beach to protect it, or because of impacts to property values, just accommodate (raise buildings) there
- Questions asked about soil viability in Mud Bay to support barrier. M. Osler informed that study has been done, and it is technically feasible, but would require significant amount of fill to offset the anticipated settling, thereby adding to the costs or extensive foundation improvements
- Land behind it can be reclaimed for new farmland or aquaculture
- Opportunities on/within barrier itself:
 - recreation trail or road
 - power plant/station to harness wind or tidal power
 - accommodate fish passage
- Upon reflection of other groups, proposed the barrier to extend across Delta to tie-in to high ground
- Recognized need to study regional impacts of wall as would be a significant impact with possible unintended consequences

What actions would be needed for this option?

- Study surrounding area impacts (environmental, etc.)

- Potential funders could be rail, tourism industry (could potentially build floating hotel behind barrier). Could use P3 model for funding. Or BOT (build-operate-transfer) model, used in Hong Kong.
- Could build as breakwater first, and then make barrier water-tight in future when sea level rise has reached threshold
- Need to maintain land behind it for agriculture use

Table C

Facilitators: Samantha, Markus

Issues and Concerns

1. Personal Economic Loss
Loss / damage to infrastructure (equipment), buildings (farm investments) and revenue losses from poor crop yield / loss of farm gate revenue
2. Infrastructure Loss
Hwy 99, King George Blvd, railways
3. Agriculture Viability
Water ponding in fields, crop damage / loss, salinity impacts, inundation impacts, viability of farm operation, well water quality
4. Future Farm Generations
Raising children / training them to inherit lands and continue farming on the lands; could be lost if the land is affected by sea level rise / climate change
5. Loss of livelihood
Proud to be farming and providing food for the region
Loss of farm production
6. Fish and wildlife impacts
7. Food security
100-mile diet, farm to table proximity
8. Increased impermeable Surfaces
Loss of vegetated areas
Increased pavement and fill for non-farm uses
9. Funding Sources

Cost / benefit of long term options

Who pays for works? All taxpayers or just those in study area? Municipal vs Provincial vs Federal contributions

Options Identification

1. Raise river / ocean dyke network (short term)
2. Improve / replace sea dams in current locations (short term)
3. Increase pumping (short term).
4. Raise FCL requirements so future homes / barns / buildings built higher (but this doesn't address crop viability under rising waters) (short term).
5. Move sea dams to interface between Mud Bay and river mouths to protect lands west of Hwy 99 and incorporate pump stations into sea dams (medium term).
6. Offshore barrier / dyke (long term).
Allow industrial and/or residential uses in portions of reclaimed land area to offset costs to construct barrier / dyke
Allow remaining areas to naturalize as marshlands
7. Small scale interventions.
Pump more water off the lands
Reforestation of non-farmed areas to increase evapotranspiration

Table C

Facilitators: Jessica, Andrew

Issues and Concerns

1. Agriculture Viability
Retaining long-term land viability for agriculture
Preventing soil salination due to flooding and seepage
Sea water infiltrating under dykes
2. Transportation
Retain transportation networks
3. Water Quality
Irrigating fields and effects of well salination
4. Utilities
Need municipal water service
5. Flood Infrastructure
Rising rivers due to frequently closed sea dams
Increasing field flooding and overflowing ditches due to closed floodboxes

Larger and more extensive pump stations required

6. Recreation
Raising dykes on Crescent Beach to allow continued recreational use

Options Identification

1. Offshore Barrier
Construct dam/dyke across Mud Bay to retain agricultural land
Use for vehicle, train, pedestrian transportation
Earth or concrete construction
2. Upgrade Existing Dykes and Flood Infrastructure
Raise ocean dykes along existing shore, coupled with river dykes
Build new sea dams at coastal locations coupled with pump stations
Canal/lock system for boats
3. Retreat.
Use land until it is no longer viable
4. Offshore Barrier Islands
To dissipate wave energy. Coupled with a dyke across Mud Bay.
Recreational use and wildlife habitat
5. Alert System/ Public Awareness.
Floodplain-wide alert system for coastal dyke breach (joke: “When the Levee Breaks” by Led Zeppelin)

Table C

Facilitators: Jeannie, Allison

Issues and Concerns

1. Ground Water Flooding (not directly coastal flooding)
All participants living in area experience frequent nuisance flooding today from ground water.
Even if dykes are raised – ground water will continue to rise. High water table.
Concern about how ground water and river water will discharge in ocean (via gravity/ pumps/ floodboxes/ etc.)
Pump stations are currently failing – they will need to be more robust in the future
2. Agriculture Viability
Concern about increased flooding (beyond nuisance) and ground water becoming saline.
Some farmers near mud bay are unable to use ditch water b/c it is too saline.
Salt water moving upstream and effecting more agriculture
3. Loss of Land
Large dykes will take up more land and some participants also concerned about losing view/ connection to water

4. Water Quality
Concern about saline water entering well water.
Arsenic in well water
5. Adaptation Implementation
Short term vs. Long term solutions
How will short term of politics ensure long term solutions?

Options Identification

1. Offshore Barrier
Explore this option: would it be cheaper to build an offshore barrier than to maintain infrastructure (dykes etc) inland?
Where would it be? Needs to work with Delta if it will have any effect.
2. Upgrade Existing Dykes and Flood Infrastructure
When doing this, build in flexibility and begin to prepare for future expansion. Use materials that are long lasting.
Build Fish ladder when upgrading sea dams.
3. Raise Homes on Fill / Raise FCL
Thinks this should happen but expressed concern about how high homes will go and the imbalance of heights. One resident has a low home and neighbor just built new home that is raised. Resident feels this new home encroaches on his space (blocked views / undesirable views into other home).
4. Retreat to Highway 99
Would be okay with this option if there is compensation. Who would pay for this?
One participant feels that this would actually result in a loss of habitat (loss of wetlands).

APPENDIX C: RESIDENTIAL FOCUS GROUP WORKSHOP NOTES

CFAS Residential Focus Group – February 8, 2017

Table A

Facilitators: John, Connie

Issues and Concerns

1. Property Loss and Value
 - E.g., Riverside Community Centre – being built in a known floodplain. Why?
 - E.g., Golf Course - Nico Wynd – concerns over flooding, erosion and standing water
 - The course is a revenue source for the strata
 - Dunsmuir Community Gardens
2. Infrastructure
3. Agriculture (Food Security)
4. Environmental and biodiversity losses
5. Economic Impacts
 - Businesses – farms and Crescent Beach
6. Recreation and Tourism
7. Mental health and well being
8. Semiahmoo First Nations (concerns over water and coastal erosion)
9. Erosion and impacts on rail line (derailments)

Options Identification

1. Upgrade Existing Dykes
 - (low hanging fruit, a good place to start), building dykes
 - Using structural clay for the dyke material. (paid to take or buy for cheap)
2. River works
 - River widening, dredging, lagoons/spillways/cisterns-for water storage to during dry months
3. Salt marshes and wetlands
4. Offshore islands
5. Sea barrier (offshore)

Table B

Facilitators: Matt, Allison

Issues and Concerns

1. Agricultural Viability
Concern regarding long term disruption to blueberry farming
Concern for disruption to livestock, but recognize they are more mobile than berry farming
2. Property Damage
Water damage to homes
3. Neighborhood Character
Loss of views if dykes are raised
Concern over flood construction levels getting too high (resulting in very large houses)
4. Regional and Local Transportation Infrastructure
BNSF Rail submerged and disrupting regional transportation
Concern over damage to Highway 99
Emergency evacuation for Crescent Beach
Damage to sewer lines
5. Recreation
Beach Access. Loss of beach access if dyke is built out and extended onto shoreline
Beach material: a beach that is structurally sound may not be good for recreation (ex: rip rap vs. sand)
6. Shoreline Erosion
Loss of shoreline along Crescent beach due to storms and high tide.
7. Implementation and Funding of Solutions.
Who's Responsibility? Who will pay to maintain dyke at BNSF rail
Concern that rail has less stake in the region, yet manages a major line of defense

Options Identification

1. Offshore Breakwater/ Jetty
Collaborate with Delta
Hard structure (3km barrier)
2. Barrier Islands
To absorb storm impact (use material dredged from rivers)
3. Upgrade existing dykes to meet current standards
4. Short term Emergency Temporary Dykes
5. Move Sea Dams to Mouth of Rivers (if offshore barrier built)
6. Erosion Resistant Dykes
7. Multiple Dykes (Primary and Secondary in case one fails)
Small scale: Berms at Crescent Beach
Large scale: Secondary dyke at King George Hwy.
Integrate new highway infrastructure with flood defense
8. Dry Proofing and Raise Construction Levels

APPENDIX D: RESIDENTIAL FOCUS GROUP WORKSHOP NOTES

CFAS Environmental Focus Group March 8, 2017

Table A

Facilitators: John, Mike

Issues and Concerns

1. Infrastructure
Flooding of rail, highways, utilities (power, gas, sewer, water)
2. Agriculture impacts
Loss of ALR, food security
3. Semiahmoo cultural impacts
Archeological sites, including unregistered sites
Cultural, spiritual and sacred sites
Access to traditional foods and medicines
4. Environmental impacts
Biodiversity losses
Species at risk
Migration routes and corridors, especially flyways and migratory water birds
Critical raptor habitat
Fish species affected in tidal zones
Salmon hatchery impacts (3 hatcheries in study area)
Biodiversity Conservation Strategy should be amended to create new wildlife habitat areas to replace areas lost to flooding.
Impacts to spawning salmon @ sea dams
Erosion impact on shoreline and habitats
Intertidal impacts to wildlife
Loss of agricultural field habitat
5. Economic impacts
Businesses – farms and Crescent Beach
Property values
Soil salinization – also a concern for non-coastal species and plants
Restoration costs (from flooding)
Loss of jobs
Financial – loss of property
Tax burden and high cost of “doing something” – options are all \$\$\$
6. Shoreline erosion
short-term impact to be concerned about

7. Emergency access and management a key issue
 - Evacuation costs in flood event
 - Infrastructure recovery without access after a flood event is a concern
8. Recreation and Tourism
 - Loss of parkland for recreation
9. Wildlife and Flora Refuge
10. River Flooding further up river
11. Trade Offs
 - E.g., “I’m less inclined to provide for houses on floodplain built in the last 15-years versus protecting agricultural land and providing for wildlife”.

Options Identification

1. Offshore Barrier Islands
 - To dissipate wave energy
2. Increase dyke heights
 - Using green shore/soft shore techniques
3. Develop new dykes where none exist, but using greenshore/softshore techniques
4. Managed retreat
5. Accommodate – wet-proof
6. Spit Restoration
 - Spit on Campbell River @ river mouth – will help reduce erosion and better protect Semiahmoo
 - Ensure that petroglyphs are protected. Some petroglyphs in Semiahmoo Bay @ Semiahmoo First Nation aren’t “just rocks” and appear only once or twice during the lowest tides (Note: might need to check on how they can be preserved and still “appear” as sea level rises)
 - Coastal First Nations were and are, more resilient
7. Reduce upstream overland water flows into rivers
8. Seed existing shorelines with sturdier native plants
9. Accommodate during re-build
10. Explore greenshore options at Crescent Beach

Table B

Facilitators: Matt, Allison, Maggie

Issues and Concerns

1. Habitat Impacts
 - Fish and Wildlife habitat loss due to coastal squeeze and hydrological changes (loss of biofilm, salt marshes and eel grass)
 - Loss of the above habitats will have global and cascading impacts on migratory bird populations and other species
 - Serpentine Fen provides winter refuge from storms for waterfowl
 - Loss of refuge if the Fen is flooded or if salt water transitions the freshwater habitat
 - Habitat for shore spawning fish lost (forage fish)
 - Agriculture provides compatible crops for overwintering waterfowl.
 - The rate of sea level rise is faster than the rate at which some ecosystems can adapt
2. Loss and Damage of Property/ Homes
 - From flooding and/or footprint of larger dykes
 - Heritage Homes being damaged
3. Agriculture Viability and Food Security
 - Ongoing salt water intrusion as well as increased coastal flooding
 - Large areas of agriculture could be lost – what will this mean for food security?
4. Regional and Local Transportation Infrastructure
 - Regional connections disrupted
 - Emergency response: disruption of emergency routes could lengthen emergency response
5. Water Quality
 - Salt water contaminating well water
 - Runoff water from flooding could pick up road pollutants and other contaminants and have detrimental impacts of habitat
6. Recreation and Access to Open Spaces
 - Walking trails are highly valued from a parks perspective.
 - Access to open spaces
7. How Decisions Are Made Collectively as a City
8. Longer Durations of Flooding
9. Economic Impacts
 - Property Values
 - Impacts on Taxpayers
 - Economic impacts due to loss of farmland, etc.

Options Identification

1. Managed Retreat
 - Look at areas that experience higher flood areas and retreat from these areas.
 - Retreat to Highway 99 and reinforce with new highway.
 - Rolling easement with dyke breaches to create new marsh habitat.
 - Retreat the BNSF Rail

2. Hard structures combined with beach nourishment at Crescent Beach
3. Offshore Breakwater or barrier islands
4. Barrier islands that can also provide beach nourishment (similar to sand engine)
5. Dykes with wider crest that can be increased over time.
6. Dyke with low slope rip rap or green shored approach.
7. Marsh restoration
8. Accommodate: Recreation path on old rail line.
9. Marsh restoration can filter pollutants before entering bay.
10. Improve flood control for river flooding
11. Leave current dyke in place to break waves.



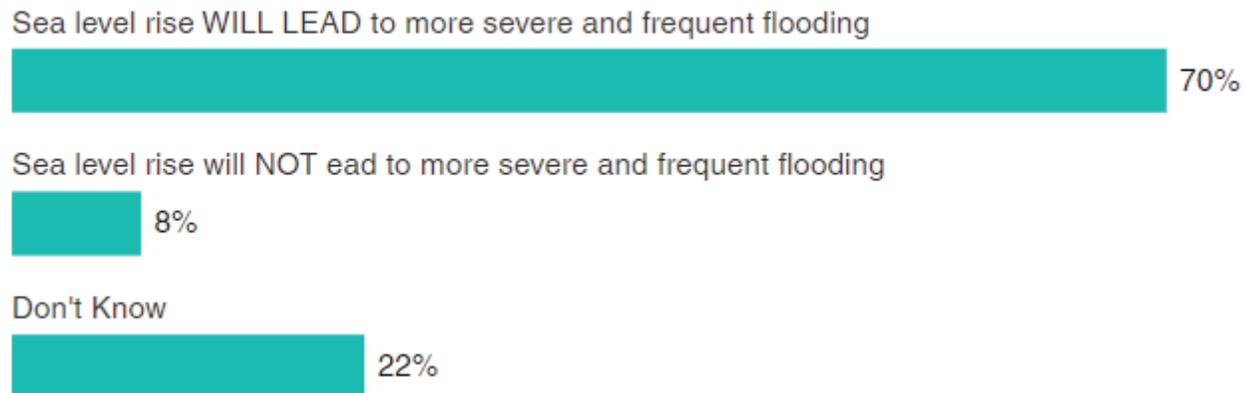
Coastal Flooding Adaptation Strategy - Survey of CitySpeaks Members

Survey Results
June 16, 2017

The results of this survey, conducted between May 31, 2017 and June 16, 2017, are not weighted to the City of Surrey's population. The results are based on 608 surveys completed by a fair representation of the City of Surrey population. Where notable differences exist between one gender, age or area category and another the survey results presented include further detailed breakdowns. Where no notable differences appear the breakdowns by gender, age or area have not been included.

In your opinion If nothing is done, sea level rise **WILL LEAD/WILL NOT LEAD** to more severe and frequent flooding in Surrey's coastal floodplain over the next 80 years?

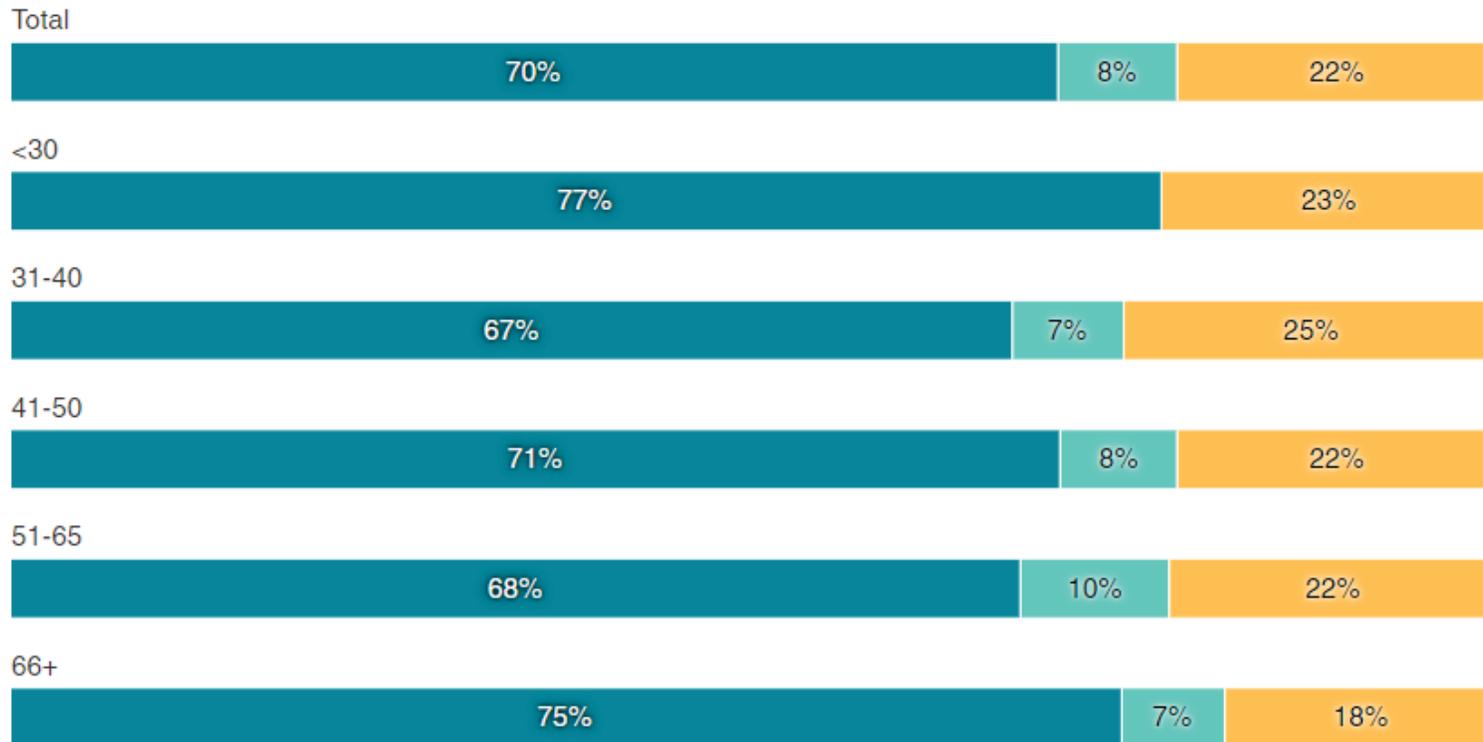
Total participants: 608



In your opinion If nothing is done, sea level rise WILL LEAD/WILL NOT LEAD to more severe and frequent flooding in Surrey's coastal floodplain over the next 80 years? [AGE]

Total participants: 608 • Subgroups: age_rollup_cos - <30 (22), 31-40 (95), 41-50 (102), 51-65 (230), 66+ (158)

- Sea level rise WILL LEAD to more severe and frequent flooding
- Sea level rise will NOT lead to more severe and frequent flooding
- Don't Know



In your opinion If nothing is done, sea level rise WILL LEAD/WILL NOT LEAD to more severe and frequent flooding in Surrey's coastal floodplain over the next 80 years? [GENDER]

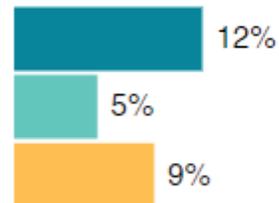
Total participants: 608 • Subgroups: gender_q5 - Male (260), Female (324), Prefer not to answer (23)

● Male ● Female ● Prefer not to answer

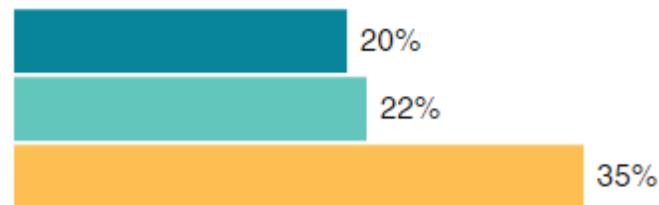
Sea level rise WILL LEAD to more severe and frequent flooding



Sea level rise will NOT lead to more severe and frequent flooding



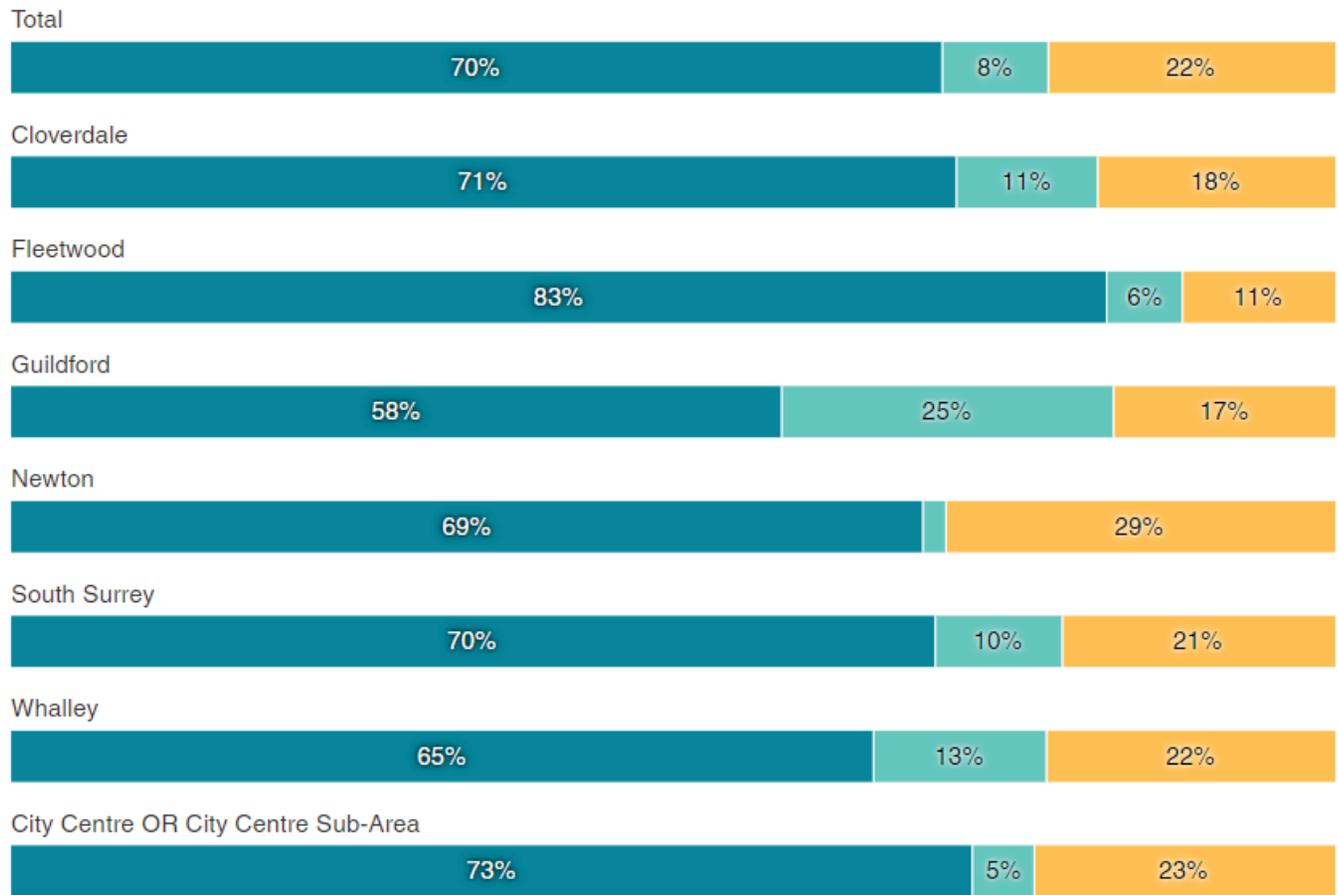
Don't Know



In your opinion If nothing is done, sea level rise WILL LEAD/WILL NOT LEAD to more severe and frequent flooding in Surrey's coastal floodplain over the next 80 years? [AREA]

Total participants: 608 • Subgroups: multiple_region_hhld - Cloverdale (56), Fleetwood (35), Guildford (24), Newton (58), South Surrey (73), Whalley (23), City Centre OR City Centre Sub-Area (22)

- Sea level rise WILL LEAD to more severe and frequent flooding
- Sea level rise will NOT lead to more severe and frequent flooding
- Don't Know



Do you live, farm, work and/or recreate in Surrey's coastal floodplain area?

Total participants: 608

I live in the study area



I farm in the study area

0%

I work in the study area



I recreate in the study area



None of the above

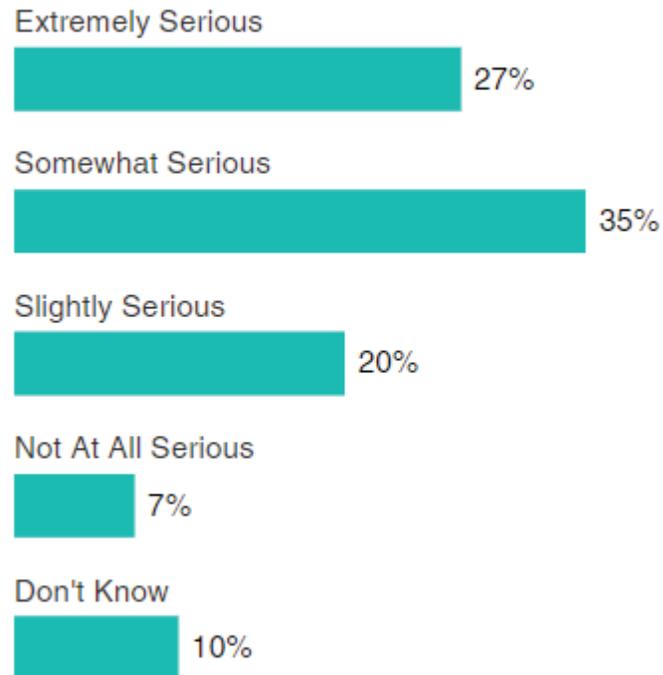


I don't know / not sure



How serious of a problem do you think sea level rise and coastal flooding will be for Surrey during the next 80 years?

Total participants: 608



How serious of a problem do you think sea level rise and coastal flooding will be for Surrey during the next 80 years? [AGE]

Total participants: 608 • Subgroups: age_rollup_cos - <30 (22), 31-40 (95), 41-50 (102), 51-65 (230), 66+ (158)

● Extremely Serious
 ● Somewhat Serious
 ● Slightly Serious
 ● Not At All Serious
 ● Don't Know

Total



<30



31-40



41-50



51-65



66+



How serious of a problem do you think sea level rise and coastal flooding will be for Surrey during the next 80 years? [GENDER]

Total participants: 608 • Subgroups: gender_q5 - Male (260), Female (324), Prefer not to answer (23)

● Extremely Serious
 ● Somewhat Serious
 ● Slightly Serious
 ● Not At All Serious
 ● Don't Know

Total



Male



Female



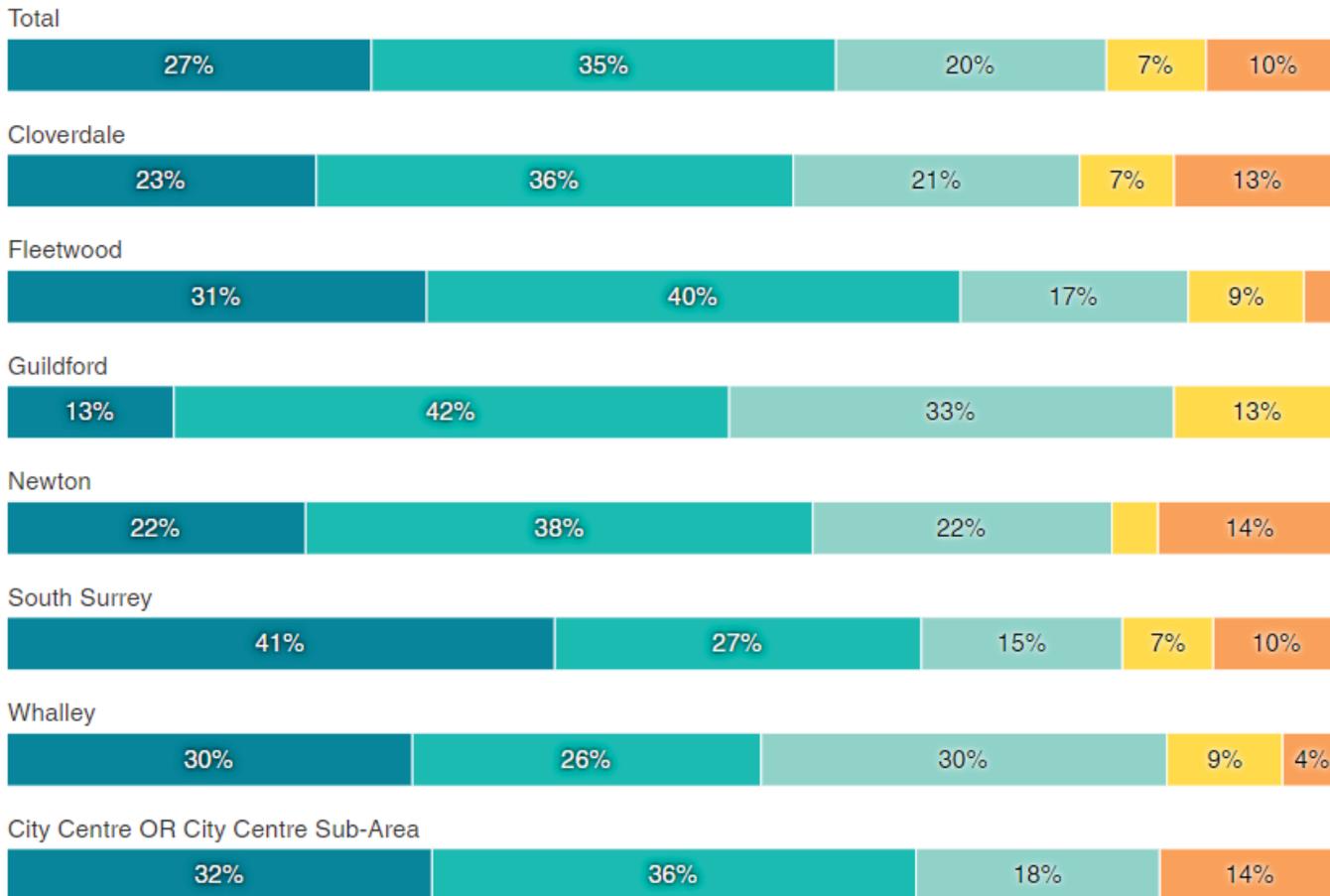
Prefer not to answer



How serious of a problem do you think sea level rise and coastal flooding will be for Surrey during the next 80 years? [AREA]

Total participants: 608 • Subgroups: multiple_region_hhld - Cloverdale (56), Fleetwood (35), Guildford (24), Newton (58), South Surrey (73), Whalley (23), City Centre OR City Centre Sub-Area (22)

● Extremely Serious ● Somewhat Serious ● Slightly Serious ● Not At All Serious ● Don't Know



How concerned are you about the impacts of coastal flooding?

Total participants: 608

Extremely Concerned



Somewhat Concerned



Slightly Concerned



Not Concerned



Don't Know



How concerned are you about the impacts of coastal flooding? [AGE]

Total participants: 608 • Subgroups: age_rollup_cos - <30 (22), 31-40 (95), 41-50 (102), 51-65 (230), 66+ (158)

- Extremely Concerned
- Somewhat Concerned
- Slightly Concerned
- Not Concerned
- Don't Know

Total



<30



31-40



41-50



51-65



66+



How concerned are you about the impacts of coastal flooding? [GENDER]

Total participants: 608 • Subgroups: gender_q5 - Male (260), Female (324), Prefer not to answer (23)

- Extremely Concerned
- Somewhat Concerned
- Slightly Concerned
- Not Concerned
- Don't Know

Total



Male



Female



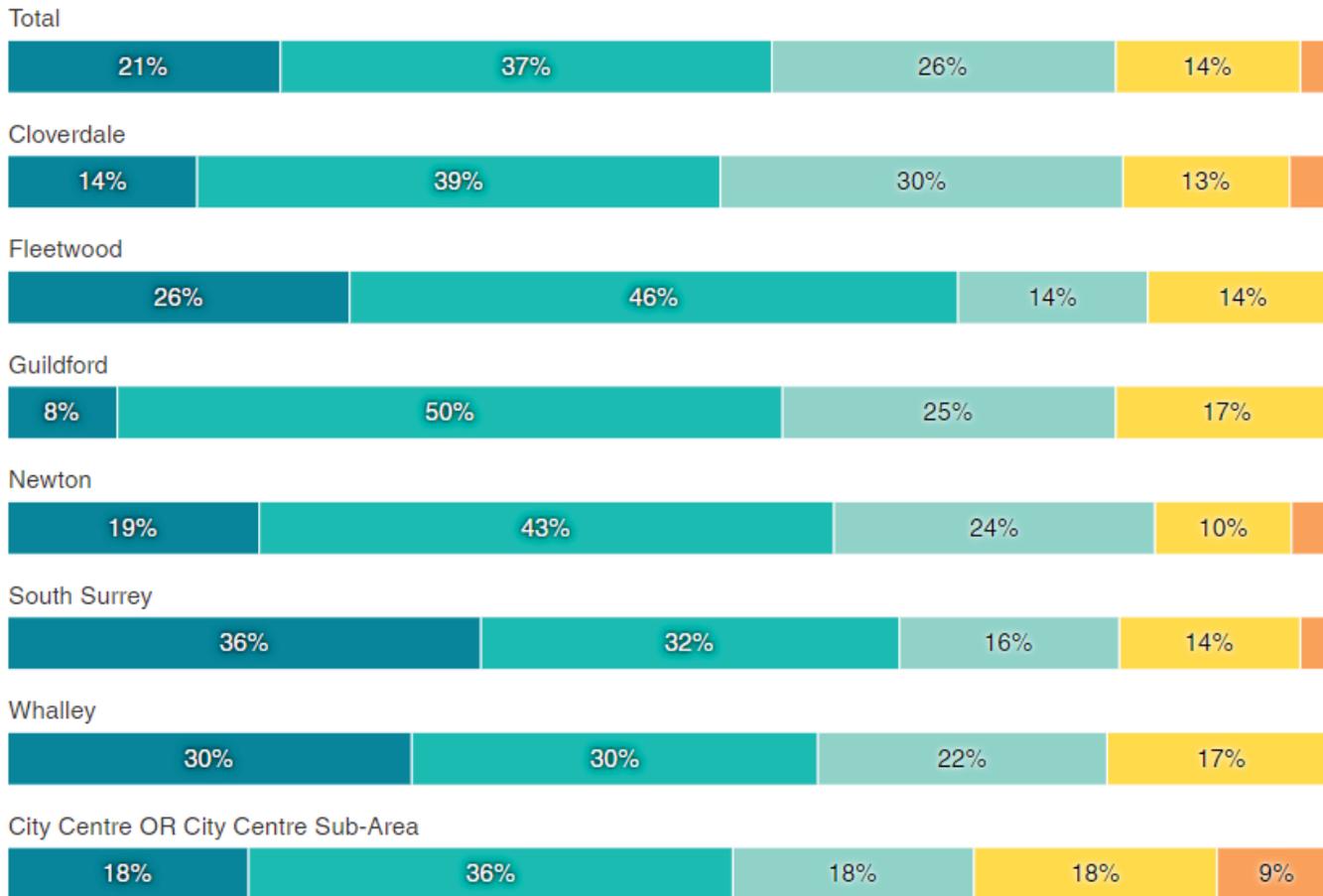
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How concerned are you about the impacts of coastal flooding? [AREA]

Total participants: 608 • Subgroups: multiple_region_hhld - Cloverdale (56), Fleetwood (35), Guildford (24), Newton (58), South Surrey (73), Whalley (23), City Centre OR City Centre Sub-Area (22)

- Extremely Concerned
- Somewhat Concerned
- Slightly Concerned
- Not Concerned
- Don't Know



By comparison to other issues Surrey is facing, how important is the issue of sea level rise and coastal flooding?

Total participants: 608

Much More Important



Somewhat More Important



Equally Important



Somewhat Less Important



Not At All Important



I don't know/not sure



By comparison to other issues Surrey is facing, how important is the issue of sea level rise and coastal flooding? [AGE]

Total participants: 608 • Subgroups: age_rollup_cos - <30 (22), 31-40 (95), 41-50 (102), 51-65 (230), 66+ (158)

- Much More Important
- Somewhat More Important
- Equally Important
- Somewhat Less Important
- Not At All Important
- I don't know/not sure

Total



<30



31-40



41-50



51-65



66+



By comparison to other issues Surrey is facing, how important is the issue of sea level rise and coastal flooding? [GENDER]

Total participants: 608 • Subgroups: gender_q5 - Male (260), Female (324), Prefer not to answer (23)

- Much More Important
- Somewhat More Important
- Equally Important
- Somewhat Less Important
- Not At All Important
- I don't know/not sure

Total



Male



Female



Prefer not to answer



By comparison to other issues Surrey is facing, how important is the issue of sea level rise and coastal flooding? [AREA]

Total participants: 608 • Subgroups: multiple_region_hhld - Cloverdale (56), Fleetwood (35), Guildford (24), Newton (58), South Surrey (73), Whalley (23), City Centre OR City Centre Sub-Area (22)

● Much More Important
 ● Somewhat More Important
 ● Equally Important
 ● Somewhat Less Important
● Not At All Important
 ● I don't know/not sure

Total



Cloverdale



Fleetwood



Guildford



Newton



South Surrey



Whalley



City Centre OR City Centre Sub-Area

