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CORPORATE REPORT

NO: **R167** COUNCIL DATE: **SEPTEMBER 29, 2014**

REGULAR COUNCIL

TO: **Mayor & Council** DATE: **September 24, 2014**

FROM: **Deputy City Engineer**
General Manager, Planning & Development FILE: **0410-20(MOE)**
5225-23

SUBJECT: **Proposed Amendments to the Provincial Flood Hazard Area Land Use Management – City of Surrey Comments**

RECOMMENDATION

The Engineering Department and Planning & Development Department recommends that Council:

1. Receive this report as information;

2. Authorize the City Clerk to forward a copy of this report and the related Council resolution to the Ministry of Environment as the City's input regarding the document titled "Flood Hazard Area Land Use Management Guidelines".

INTENT

The purpose of this report is to:

- Provide an overview of the Ministry of Forest, Lands and Natural Resource Operations (MFLNRO) "Flood Hazard Area Land Use Management Guidelines", a copy of which is attached to this report as Appendix I;
- Provide an overview of recent publications pertaining to Flood Hazard Management in British Columbia; and
- Identify from the perspective of the City of Surrey the key opportunities and concerns related to the Flood Hazard Area Land Use Management Guidelines for the purpose of providing input to the Province.

BACKGROUND

At its Regular meeting on March 10, 2008 Council considered Corporate Report R032; 2008, and adopted its recommendations which included the adoption of a new City Policy entitled *"Development within the Nicomekl and Serpentine River Floodplain Policy"*. This Policy restricts development within the Serpentine and Nicomekl floodplain areas, except where current zoning or approved Local Area/Neighborhood Concept Plan designations allow development or redevelopment to occur. The Policy also establishes criteria to evaluate development proposals in the floodplain for current and future climate change conditions, in order to ensure that these proposals properly address the many implications of such development.

At its Regular meeting on April 8, 2013, Council considered Corporate Report R054; 2013, and adopted its recommendations. The report documented that the City is not willing to assume responsibility for either of the Colebrook Dyking District and the Mud Bay Dyking District until such time as a long term and sustainable funding program has been established by the Province to address the costs of necessary upgrades to the dykes in these Districts related to sea level rise and other coastal hazard.

The report also documents at a high level the estimated costs to both dyke upgrades to achieve Provincial Seismic Design Criteria, and to address the impacts of sea level rise and other coastal hazards included in the Provincial report issued in 2012 entitled *"Cost of Adaptation – Sea Dikes and Alternative Strategies*". This report follows details and recommendations of another Provincial report issued in 2011 entitled "*Climate Change Adaption Guidelines for Sea Dikes and Coastal Flood Hazard Land Use - Draft Policy Discussion Paper"*. For the region, the Province has estimated the cost of works related to seismic upgrades, sea level rise and other coastal hazards to be $9.5 billion. For Surrey, these costs are estimated as follows:

Area	**Cost**
Fraser River	$986 million
Mud Bay and Colebrook	$464 million
Crescent Beach	$119 million
TOTAL	**$1.57 Billion**

Relevant Publications pertaining to Flood Hazard Management in BC

Further to Corporate Report R054; 2013, there have been eight reports recently published by five organizations that are relevant to flood hazard management, several of which, staff were consulted during their development. These reports are as follows:

- *Simulating the Effects of Sea Level Rise and Climate Change on Fraser River Flood Scenarios, Final Report [BC Ministry of Forests Lands and Natural Resource Operations, July, 2014]*
- *The Economic Importance of the Lower Fraser River[Various Lower Mainland Chambers of Commerce, July 2014]*
- *National Floodplain Mapping Assessment – Final Report [Public Safety Canada, June, 2014]*
- *Seismic Design Guidelines for Dikes, 2nd Edition [BC Ministry of Forests Lands and Natural Resource Operations, June, 2014]*
- *Floodplain Mapping Funding Guidebook for BC Local Governments [*British Columbia Real Estate Association, *May, 2014]*
- *Floodplain Mapping Backgrounder [*British Columbia Real Estate Association, *May, 2014]*
- *Sea Level Rise Adaptation Primer, A toolkit to build adaptive capacity on Canada's South Coasts [BC Ministry of Environment, October, 2013]*
- *Guidelines for Legislated Flood Assessments in a Changing Climate in British Columbia [Association of Professional Engineers and Geoscientists of BC, October, 2012]*

A summary of each publication is attached in Appendix II.

Following these publications, the Province is seeking to update the Flood Hazard Area Land Use Management Guidelines (the "Guidelines") to include design considerations for land use and development in areas that will be affected by sea level rise. The Guidelines are a means to protect people and their property in the event of a flood emergency by requiring local governments, land-use managers, and approving officers to develop and implement land-use management plans, and make subdivision approval decisions in areas subject to flood hazards.

The proposed changes to the Guidelines recently provided to the City seek to introduce:

- Requirements for buildings, subdivision and zoning to allow for expected sea level rise to the year 2100;
- Land use adaptation strategies to allow for expected sea level rise to the year 2200; and
- Lots created through subdivision to have viable building sites on natural ground that complies with sea levels expected in the year 2100.

Although being referred to as Guidelines, their content is linked to Provincial legislation as follows:

- The Local Government Act section 910(1) defines "Provincial Guidelines" as the policies, strategies, objectives, standards, guidelines and environmental management plans, in relation to flood control, flood hazard management and development of land that is subject to flooding, prepared and published by the minister under section 5 of the Environmental Management Act;
- The Local Government Act section 910(3)(a) states that a local government must "consider the Provincial guidelines" in making bylaws that designate land as a floodplain; and
- The Compensation and Disaster Financial Assistance Regulation section 15 states that structures built in an area designated as floodplain under Local Government Act section 910 must be "properly flood protected" to be eligible for assistance to repair damage resulting from a flood.

DISCUSSION

Significant flooding has occurred throughout Canada over the past several years. Notably, Calgary and Toronto suffered significant losses in 2013, while a large portion of Saskatchewan had significant flooding earlier this year. Flood Management provides an opportunity to ensure the economic prosperity of a region by minimizing disruption and financial losses from natural hazards.

In Canada, homes within floodplains are not able to obtain flood insurance. When there is a flood event in British Columbia, the Provincial government, through Emergency Management BC may offer some insurance to impacted parties. Often the Provincial Government receives disaster funding from the federal government in large scale disasters through an agreement with Public Safety Canada.

In British Columbia, the Compensation and Disaster Financial Assistance Regulation states that structures built in an area designated as floodplain under the Local Government Act must be "properly flood protected" to be eligible for assistance to repair damage resulting from a flood.

Historically, "properly flood protected" has meant that the habitable areas of all homes or buildings have a floor elevation constructed above the 200 year floodplain level regardless of whether there are any dykes protecting the floodplain area. The 200 year floodplain level used for these purposes did not include an allowance for sea level rise, subsidence and wave effects.

In areas such as South Westminster and most of the Serpentine & Nicomekl lowlands, habitable areas have been constructed on fill in an effort to ensure that the minimum floor elevation for the habitable areas is above the 200 year floodplain level. In the Crescent Beach area, the City has permitted variances to these elevations due to aesthetic concerns by residents in the area associated with raising the minimum floor elevation for the habitable area in this established area. A map outlining the existing 200 year floodplain areas in Surrey and the potential expansion of these areas for 2100 and 2200 sea level rise conditions is attached to this report as Appendix III.

Staff have reviewed the proposed Guidelines amendments and see the merits with the proposed changes, particularly regarding the need to plan and manage for sea level rise. The key items outlined in the Guidelines are:

- Flood control elevations for buildings, subdivision and zoning to allow for sea level rise to the year 2100 (the "2100 Flood Control Level (FCL)");
- Land use adaptation strategies to allow for sea level rise to the year 2200;
- Lots created through subdivision to have viable building sites on natural ground that complies with the year 2100 FCL;
- The development approving officer should require a restrictive covenant stipulating that any future reconstruction must meet the FCL and setback requirements in force at the time of redevelopment, and including a liability disclaimer if reconstruction does not take place at or before the planned lifespan of the building, and
- Residential, commercial and institutional development in areas within the 2100 floodplain that are protected by standard dikes are required to comply with full flood proofing requirements for their respective categories, with a possible exception for development within Sea Level Rise Planning Areas.

Concerns with Proposed Guidelines

Although staff see the merits with many of the proposed changes to facilitate reduced risk of flood losses, there are a number challenges to satisfy the proposed changes. These concerns are summarized below.

Flood control elevations for buildings, subdivision and zoning to allow for sea level rise to the year 2100 (the "2100 FCL")

The City's recently updated Official Community Plan (OCP) addresses development and hazard land conflicts through general policy which limits and restricts development in floodplains and through a proposed new Development Permit Area (DPA) specifically created to deal with development challenges in flood prone areas. The OCP has passed Third Reading and is anticipated to be adopted before year end. The Zoning By-law also has provisions for developments located in floodplain areas, stipulating that all homes within floodplains are required to have a minimum floor elevation for their habitable area at or above the established floodplain elevation, unless a variance has been granted. However, establishing new flood control elevations according to the Guidelines to allow for sea level rise to the year 2100 is challenging in several areas of the City.

For example, in parts of the Crescent Beach area some lots are at an elevation of 1.0m [3.3 ft] geodetic above current sea level. To meet the current Provincial Guidelines, habitable area construction must be at or above 3.3m [10.8 ft].The City has granted variances for developments in the Crescent Beach area due to challenges associated with raising the minimum floor elevation for the habitable area in this established area. With the proposed 2100 FCL changes to the Guidelines, the habitable area elevation is projected to be between 4.9m [16.1 ft] to 5.8m [19.0 ft] depending on lot location. This will result in the need to place a large amount of imported fill on a lot in order to construct the habitable areas of a new home above this elevation. Alternatively, the habitable areas of the home including its electrical and mechanical equipment must be located on the second floor of the home, with only non-habitable floor space such as a garage and storage rooms located on the ground floor.

As a result, some of the challenges associated with meeting the proposed changes to the Guidelines may include:

- Increase in construction costs;
- Difficulty in maintaining a consistent streetscape form and neighborhood character as new homes will be located well above existing, neighboring homes;
- Difficulty achieving the full density (floor area ratio) on a site due to maximum building height restrictions. Variance to height restrictions can be granted, but these variances may affect the consistency of streetscapes and the livability of neighboring homes;
- Accessibility and safety compromised by the need for more stairs;
- Increased potential for unauthorized conversion of non-habitable spaces below flood elevations into habitable space such as secondary suites following building inspection ; and
- Difficulty maintaining commercial uses at grade along sidewalks in neighborhood commercial areas.

Even with the proposed changes, Council is still able to approve variances to the Guidelines. However, there is concern that these variances could expose the City to financial risks under Emergency Management BC's Compensation and Disaster Financial Assistance Regulation which stipulates that structures in a floodplain are to be "properly flood protected". Specifically, the City may be responsible for the cost of any compensation provided under Provincial Regulation given that it was the City that provided the variance.

Land use adaptation strategies to allow for sea level rise to the year 2200

In addition to the actions discussed above, the City's recently updated OCP seeks to address long range sea level rise. As part of the OCP and Hazard Lands DPA the following policy has been included:

- D2.10 – Consider and prepare for the projected impacts of climate change on flood hazard areas due to sea level rise and flood risk. Take into account the effects of long-term climate changes such as increased flooding events, increased runoff due to development and a reduced percentage of overall mature tree cover.

The exact timeframe for considering and preparing for the projected impacts of climate change has not been specified in the Guidelines.

One challenge with the proposed change to the Guidelines is that the best science respecting sea level rise predictions for the year 2200 are speculative at this time. As a result, any attempt to establish the area of influence (existing areas not currently considered within the floodplain may be considered as now being within a floodplain) or extent of influence (increase in depth of flooding from the current or year 2100 levels to the year 2200 levels) for sea level rise to the year 2200 is unreliable.

2100 Residential, commercial and institutional development in areas protected by standard dikes are required to comply with full flood proofing requirements for their respective categories, with a possible exception for development within Sea Level Rise Planning Areas

The purpose of this change is to provide an opportunity for an exemption to some of the proposed changes to the Guidelines. The Province has yet to provide a definition for a "Sea Level Rise Planning Area," Although it is expected that it will be defined as an area that are serviced by dykes that are designed to protect up to the year 2100 and potentially the year 2200.

Based on this expectation, there are no floodplain areas within the City that meet this criteria, and the City has yet to establish if it will be able to meet this criteria given that the Province has roughly estimated that the cost to simply meet the year 2100 requirements for dykes along the Fraser River, Colebrook, Mud Bay and Crescent Beach is approximately $1.6 billion. This estimated cost does not include the cost to upgrade the dykes along both the Nicomekl River and Serpentine Rivers. Given these overwhelming costs, it is unlikely that any area in the City or even in the Lower Mainland will be considered as a Sea Level River Planning Area. This will result in homes and businesses being constructed to provincial FCL levels regardless of community flood protection.

Considerations for the Proposed Guidelines

Given the challenges discussed above it is recommended that the Province revise the Guidelines as follows:

- Provide a definition of Sea Level Rise Planning Areas
- Clearly outline under what conditions exceptions to flood proofing requirements within Sea Level Rise Planning Areas may be granted;
- Provide considerations for impacts to existing development and measures to address challenges associated with raising minimum floor elevations (eg. Staged approach to increasing flood protection requirements);
- Require land use adaptation strategies to allow for sea level rise to only the year 2100, until such time when the accuracy of sea level predictions to the year 2200 improves; and
- Provide regular reviews/updates to sea level rise predictions beyond 2015. Reviews should be every 10 years as science evolves.

Next Steps

Staff will continue to advance knowledge of the implications of sea level rise and climate change as it pertains to watercourses and floodplains within the region and the City, consistent with the City's Climate Adaptation Strategy through studies by the City and those completed by the Fraser Basin Council through their Joint Program Committee for Integrated Flood Hazard Management.

Technical work by staff is currently focused on understanding the potential implications of expected sea level rise and climate change to the coastal floodplains of Mud Bay, Crescent Beach, and the Nicomekl and Serpentine River systems. This includes a detailed assessment of both infrastructure vulnerabilities and flood levels for the year 2100, a cursory review of vulnerabilities and flood levels in the year 2200, and several detailed intermediate time horizons. The intent is to understand the potential impacts and develop strategies and staging plans to address potential vulnerabilities in a coordinated fashion.

Staff anticipate that in 2015, the anticipated vulnerabilities will be understood and that the development of a drainage and flood strategy can commence shortly thereafter. Following this work, revised floodplain maps for these floodplains, incorporating new areas vulnerable from Climate Change can then be developed.

Technical work by the Fraser Basin Council on the Fraser River floodplain is currently comprised of three projects. The goals of the three top priority projects currently underway are to:

- Achieve a better understanding of present and future floods of concern;
- Identify greatest vulnerabilities and the economic impacts of a major flood; and
- Assess current flood protection infrastructure, policies and plans.

Following completion of these studies, further work will continue in an effort to establish a regional drainage and flood strategy. Revised floodplain maps for the Fraser River floodplain, incorporating new areas vulnerable from Climate Change can then be developed. A timetable for completion of this work has yet to be established.

CONCLUSION

Based on the above discussion, it is recommended that Council:

1. Authorize the City Clerk to forward a copy of this report and the related Council resolution to the Ministry of Environment as the City input regarding the document titled "Flood Hazard Area Land Use Management Guidelines".

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Engineering

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Planning and Development

VL/JA/CAB/GF/MO/ras

Appendix I – Section 3.5 and 3.6 – Flood Hazard Area Land Use Management Guidelines (DRAFT – May 7, 2013)
Appendix II – Relevant Publications pertaining to Flood Hazard Management in British Columbia
Appendix III – 200 – Year Floodplain

BRITISH COLUMBIA

AMENDMENT
(DRAFT – MAY 7, 2013)

Section 3.5 and 3.6 – Flood Hazard Area Land Use Management Guidelines

3.5 The Sea

3.5.1 Background and Reference Documents

The content for this Amendment is drawn primarily from, " Climate Change Adaptation Guidelines for Sea Dikes and Coastal Flood Hazard Land Use – Guidelines for Management of Coastal Flood Hazard Land Use", Ausenco Sandwell, report to BC Ministry of Environment, January 27, 2011 and the companion reports, "Sea Dike Guidelines" and "Draft Policy Discussion Paper", also dated January 27, 2011.

These 2011 reports, including terminology, definitions and explanatory figures, supplement this Amendment to the "Flood Hazard Area Land Use Management Guidelines". Where there is any inconsistency between the Ausenco Sandwell (2011) reports and this Amendment document, the Amendment document shall govern. These reports are referenced in this Amendment as:

"Draft Policy Discussion Paper" - AS(2011a)
"Guidelines for Management of Coastal Flood Hazard Land Use" - AS (2011b)
"Sea Dike Guidelines" - AS (2011c)

These reports are available on the ministry web page:

http://www.env.gov.bc.ca/wsd/public_safety/flood/fhm-2012/draw_report.html

3.5.2 Design and Planning Time Frame

Requirements for buildings, subdivision, and zoning should allow for sea level rise (SLR) to the year 2100.

Land use adaptation strategies should allow for sea level rise to the year 2200.

3.5.3 Recommended Sea Level Rise Scenario for BC

Allow for 0.5 m by 2050, 1.0 m by 2100 and 2.0 m Global Sea Level Rise by 2200 relative to the year 2000 as per Figure 1.

Adjust for regional uplift and subsidence using the most recent and best information available. Where no information is available, assume neutral conditions (i.e. no uplift or subsidence).

The scenario in Figure 1 is intended to be reviewed in 2015, or sooner if there is significant new scientific information.

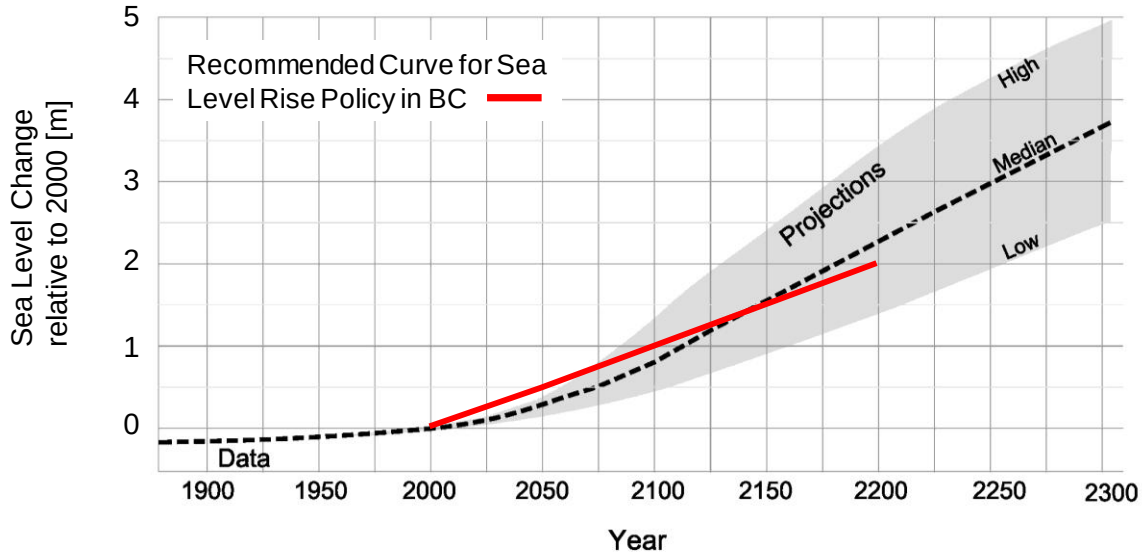


Figure 1. Recommended Global Sea Level Rise Curve for Planning and Design in BC

3.5.4 Sea Level Rise Planning Areas

Local Governments should consider defining SLR Planning Areas and developing land use planning strategies integrating both flood protection (sea dikes) and flood hazard management tools. These areas should include inland floodplains adjacent to tidally influenced rivers where potential flood levels will be increased by sea level rise.

3.5.5 Strait of Georgia

3.5.5.1 Standard FCLS and Setbacks

The Year 2100 FCL should be established for specific coastal areas during the SLR Planning Area process by a suitably qualified professional. The Year 2100 FCL should be the minimum elevation for the underside of a wooden floor system or top of concrete slab for habitable buildings, and should be determined as the sum of:

- The 1:200 Annual Exceedence Probability (AEP) water level as determined by joint probability analyses of high tides and storm surge;
- Allowance for future SLR to the year 2100;
- Allowance for regional uplift, or subsidence to the year 2100;
- Estimated wave effects associated with the Designated Storm; and
- Freeboard.

Note: Alternatively, the Year 2100 FCL can be determined by a simplified but more conservative method as described in the Ausenco Sandwell (2011) reports. Example calculations of FCLs for specific areas in coastal BC are provided in Table 3-2 AS(2011b) where the FCL is determined as the sum of:

- Allowance for future SLR to the year 2100;
- Allowance for regional uplift, or subsidence to the year 2100;
- Higher high water large tide (HHWLT);
- Estimated storm surge for the Designated Storm;
- Estimated wave effects associated with the Designated Storm; and
- Freeboard.

The building setback should be at least the greater of 15 m from the future estimated Natural Boundary of the sea at Year 2100, or landward of the location where the natural ground elevation contour is equivalent to the Year 2100 FCL (refer to Figure 2-2 in AS (2011b) for a definition sketch).

The setback may be increased on a site-specific basis such as for exposed erodible beaches and/or in areas of known erosion hazard.

3.5.5.2 Subdivision

All lots created through subdivision should have viable building sites on natural ground that comply with the Year 2100 FCL and setback guidelines noted above.

To regulate redevelopment at the end of the building lifespan, the development approving officer should require a restrictive covenant stipulating that any future reconstruction must meet the FCL and setbacks requirements in force at the time of redevelopment, and including a liability disclaimer if reconstruction does not take place at or before the planned lifespan of the building.

3.5.5.3 Development on Existing Lots

On existing lots, if meeting the setback guidelines noted above would sterilize the lot (i.e., not allow even one of the land uses or structures permitted under the current zoning), the development approving official may agree to modify setback requirements as recommended by a suitably qualified professional, provided that this is augmented through a restrictive covenant stipulating the hazard, building requirements, and liability disclaimer.

The Year 2100 FCL requirements would still apply to new habitable building construction.

3.5.5.4 Lots with Coastal Bluffs

For lots containing coastal bluffs that are steeper than 3(H):1(V) and susceptible to erosion from the sea, setbacks should be determined as follows:

1. If the future estimated Natural Boundary is located at least 15 m seaward of the toe of the bluff, then no action is required and the setback should conform with other guidelines that adequately address terrestrial cliff and slope stability hazards.
2. If the future estimated Natural Boundary is located 15m or less seaward of the toe of the bluff, then the setback from the future estimated Natural Boundary should be located at a horizontal distance of at least 3 times the height of the bluff, measured from 15 m landwards from the location of the future estimated Natural Boundary.

   In some conditions, setbacks may require site-specific interpretation and could result in the use of a minimum distance measured back from the crest of the bluff. The setback may be modified provided the modification is supported by a report, giving consideration

to the coastal erosion that may occur over the life of the project, prepared by a suitably qualified professional.

3.5.6 Outside the Strait of Georgia Area - Areas Subject to Significant Tsunami Hazard

For coastal lands subject to tsunami hazards, the tsunami setback and elevation as determined below will typically exceed the "standard" setbacks and elevations determined for the Year 2100 as described in 3.5.5.1. Where the tsunami hazard is low, the greater FCLs and setbacks shall apply.

A subdivision application in tsunami prone areas must include a report by a suitably qualified professional who must formulate safe building conditions for each proposed lot based on a review of recent Tsunami hazard literature plus the historical report, "Evaluation of Tsunami Levels Along the British Columbia Coast", by Seaconsult Marine Research Ltd., dated March 1988.

At a minimum, building conditions should protect improvements from damage from a tsunami of equal magnitude to the March 28,1964 tsunami that resulted from the Prince William Sound, Alaska earthquake.

Setback –
Setback requirements should be established on a site-specific basis and take into account tsunami hazards.

The setback must be sufficient to protect buildings and must be at least 30 metres from the Year 2100 estimated natural boundary.

FCL –
FCL requirements should be established on a site-specific basis and take into account tsunami hazards.

Reductions to these requirements should only be considered where the building can be built to the Tsunami FCL on bedrock.

3.6 Areas Protected by Standard Dikes

Residential, commercial and institutional developments in areas protected by standard dikes are required to comply with full flood proofing requirements for their respective categories, with a possible exception for development within Sea Level Rise Planning Areas as noted below.

Setback –

Buildings should be located a minimum of 7.5 metres away from any structure for flood protection or seepage control or any dike right-of-way used for protection works. In addition, fill for floodproofing should not be placed within 7.5 metres of the inboard toe of any structure for flood protection or seepage control or the inboard side of any dike right of-way used for protection works.

Additional dike right of way and building set back requirements should be defined for Sea Level Rise Planning Areas to accommodate upgrading of dikes for sea level rise

Any change to these conditions requires the approval of the Inspector of Dikes.

FCL –

Buildings and manufactured homes in areas protected by standard dikes should meet minimum FCLs prescribed for the primary stream, lake or sea adjacent to the dike and the FCL requirements for any internal drainage (minimum ponding elevations).

Relaxation of FCL requirements for new development in coastal areas protected by standard dikes may be appropriate for Sea Level Rise Planning Areas where the long term flood protection strategy and dike upgrading program has been approved by the Inspector of Dikes. This relaxation should be augmented through a restrictive covenant stipulating the hazard and protection strategy, building requirements, and liability disclaimer.

3.6.1 Secondary sources of flooding

Where there are secondary sources of flooding within diked areas, the appropriate requirements as set out in Clauses 3.1 through 3.5 should be applied. These should include consideration of minimum ponding elevations behind the dike to protect against internal drainage.

AMENDED: _____, 2013

APPENDIX II

Relevant Publications pertaining to Flood Hazard Management in British Columbia

Simulating the Effects of Sea Level Rise and Climate Change on Fraser River Flood Scenarios, Final Report (July, 2014)

This report was prepared by the Flood Safety Section of the Ministry of Forests, Lands and National Resource Operations, with extensive input from both Northwest Hydraulic Consultants and the Pacific Climate Impacts Consortium. Both the City of Surrey and the City of Vancouver's Joint Probability works were used by the report researchers for the assessment of sea level rise on the Fraser River delta. It was released in July, 2014 and identifies extensive further work be performed to reduce uncertainty. City staff through their working groups with the Fraser Basin Council were aware of this report and assisted in the development of how the information was to be communicated and used when released.

The report consists of a summary of a range of possible flood levels along the Lower Fraser River that could result from various climate change and sea level rise scenarios. The results have considerable uncertainty and are considered to be used as background material in further studies about to begin with the Joint partnership group of the Fraser Basin Council.

Past work by the Province has focused on the 200 year return event, while this report suggests that the dense population base of the Lower Fraser River warrants a higher standard and presents results for return events as large as 10,000 years similar to some European standards. Under both the moderate and intense climate change scenarios with the year 2100 sea level rise indicate significant implications for the Surrey Fraser River floodplain area. Currently the Fraser River Floodplain within Surrey is governed by the Fraser Freshet. With projected sea level rise, the winter storm surges from the ocean up the Fraser may pose a higher threat and require a higher level of protection than what currently exists.

The various scenarios modelled show that the current level of protection along the Surrey Fraser frontage may be reduced to a 50 year event from the current standards under possible sea level rise and climate change scenarios.

The results of this study are to be used as reference for the Joint partnership group of the Fraser Basin Council. Through the Fraser Basin Council, the steering committees are looking at 3 key studies which hope to establish an appropriate return period for the Lower Fraser Region, infrastructure needs and critical deficiencies in the flood protection systems

The Economic Importance of the Lower Fraser River (July, 2014)

Prepared by the Chamber of Commerce and released July, 2014. This document cites a $50 billion value of development within the floodplain. It suggests that the financial loss from a significant flood outweigh the costs of developing and implementing a comprehensive flood management program. It urges the various levels of governments and other stakeholders in the Lower Fraser to work towards a long-term plan to improve flood management.

National Floodplain Mapping Assessment – Final Report (June, 2014)

This report was commissioned for Public Safety Canada, prepared by MMM Group Ltd and issued in June, 2014. It highlights that the value of flood damages has exceeded $10 billion over the past decade. It recommends a process of how the Government of Canada can assist in updating the severely outdated and incomplete floodplain maps throughout Canada. The estimated cost is 365 million. Under the draft proposed technical standards, the City's existing flood maps would be significantly more detailed and there may be a change in return period design.to the 1-in-1,000 annual return period from the current 1 in 200 year event. Floodplain mapping would show a variety of return events from the 1:100 year event, to 1:1000 year event. The draft technical standards are proposing new development to be flood proofed to the 500 year event, with safe access up to the 350 year event. These standards have yet to be approved by the federal government nor vetted by the provincial government. They also do not have allowances for sea level rise but are general in nature to try to provide consistency across Canada.

Seismic Design Guidelines for Dikes, 2nd Edition (June, 2014)

This report was commissioned for the Ministry of Forests, Lands and National Resource Operations, Flood Safety Section, prepared by Golder Associates and issued June, 2014. These guidelines have had minor revisions to the 1st edition which was contemplated under the *Cost of Adaptation – Sea Dikes and Alternative Strategies.* Seismic events addressed in the Guidelines range from a 1:100 year to a 1:2475 year return event. The general approach is that dykes must remain intact; however, repairs will be required to reinstate the dyke crest elevation. None of the City's current dyke segments are expected to satisfy the guidelines except at the City's most recent drainage pump stations (Pattullo and Maple Pump Station). Staff provided comments to the Province upon review of the 1st Edition and provided venues for review and discussion of the technical merits and complications with the second edition as well.

Floodplain Mapping Funding Guidebook for BC Local Governments (May, 2014)

This report was commissioned for the British Columbia Real Estate Association, prepared by Sustainability Solutions Group and Ebbwater Consulting and issued May 2014. The report highlights that of OECD countries, it is rare to not have a national funding strategy in place to conduct Floodplain Mapping. It identifies that since the Provincial Floodplain Mapping programed ended in 1998, fewer than ten municipalities and regional districts have completed floodplain maps. While the City of Surrey is listed as one, the recent mapping has been prepared for preliminary review of potential changes from Sea Level Rise and should not be considered suitable for public circulation. Staff continue to investigate this matter and will advise Council when conclusive results are available. Surrey staff participated in the background surveys for this report discussing our flood strategies and concerns with mapping extensively with the report authors.

Floodplain Mapping Backgrounder (May, 2014)

This report was commissioned for the British Columbia Real Estate Association, prepared by Sustainability Solutions Group and Ebbwater Consulting and issued May 2014. The purpose of the document is to outline the benefits to communities of having up-to-date floodplain maps. This document introduces a variety of Floodplain Mapping methodologies, many of which have not been implemented locally before. These include: flood depth, flood velocity and propagation, flood event map, channel migration, hazard mapping, velocity mapping, flood evacuation, probabilistic flood hazard, flood consequence and flood risk maps. It also describes internet based flood information tools and summarizes the resources required to create floodplain maps.

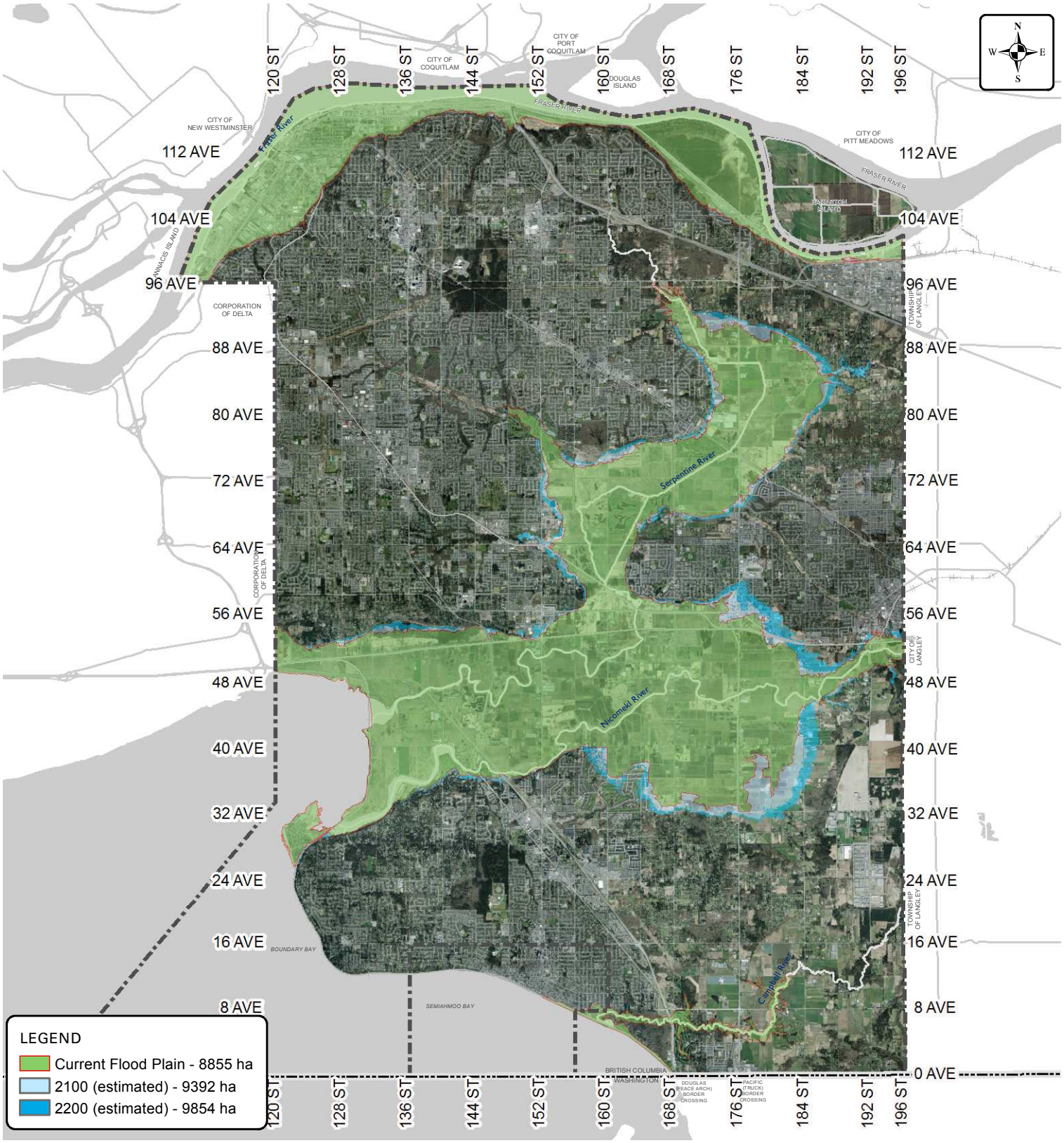
Sea Level Rise Adaptation Primer, A toolkit to build adaptive capacity on Canada's South Coasts (October, 2013)

Prepared by the Arlington Group for the British Columbia Ministry of Environment, with funding from Natural Resources Canada, was released October, 2013. This document canvasses the various tools available in Canada to plan for Sea Level Rise. An extensive consultation process with many BC communities was undertaken as part of the development of this document. Surrey hosted one of these sessions with staff from various departments attending and providing input. The document compares approaches for Planning, Regulatory, Land Use Change or Restriction, Structural and Non-Structural requirements. Many examples throughout Canada are provided to demonstrate pro and cons of various approaches taken by local government to address sea level rise. Surrey's draft OCP is proposing Hazard Lands Development Permit areas which include floodplain areas. This will help ensure properties in potentially vulnerable areas are designed appropriately.

Guidelines for Legislated Flood Assessments in a Changing Climate in British Columbia (October, 2012)

Prepared by the Association of Professional Engineers and Geoscientists of British Columbia, and released in October, 2012, the guidelines apply to any flood assessment requested by an Approving Officer. In the case of the City of Surrey, the Planning and Development Department have relied upon existing Floodplain Maps and have not placed this burden on development applicants to retain professionals to assess the flood hazard. This practice guideline introduces an explicit allowance for Climate Change increase in precipitation. It provides for a ten percent increase in precipitation if stream flow records do not indicate an increase in flow, and twenty percent increase if they do.

APPENDIX III



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200 – Year Floodplain

ENGINEERING DEPARTMENT

Source: G:\MAPPING\GIS\Maps\CorporateReps\Utility\EM-FloodPlain2-AP.mxd