City of Richmond

Report to Committee

To:	Public Works and Transportation Committee	**Date:**	June 23, 2014
From:	John Irving, P.Eng. MPA Director, Engineering	**File:**	10-6060-04-01/2014-Vol 01
Re:	**Flood Protection Update 2014**		

Staff Recommendation

That the staff report titled, "Flood Protection Update 2014," dated June 23, 2014, from the Director, Engineering, be received for information.

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Director, Engineering
(604-276-4140)

REPORT CONCURRENCE		
ROUTED TO:	**CONCURRENCE**	**CONCURRENCE OF GENERAL MANAGER**
Sewerage & Drainage	☑	
REVIEWED BY STAFF REPORT / AGENDA REVIEW SUBCOMMITTEE	**INITIALS:**	**APPROVED BY CAO**

Staff Report

Origin

The City of Richmond's topography is generally flat with a natural average elevation of 1m above mean sea level. Surrounded by the Fraser River and the Strait of Georgia, Richmond's flood protection system includes 49 km's of dikes, 622 km of drainage pipes, 178 km of ditches, and 41 drainage pumping stations. Many areas have been raised out of the flood plain through land development related land improvements.

Private and public land with improvements in Richmond are valued at approximately $63 billion. To protect this investment, the City is focused on implementing and improving policies, practices and infrastructure to maintain and improve flood protection service levels and mitigate the effects of climate change. The *2008 – 2031 Richmond Flood Protection Strategy* is the City's guiding framework for continuing upgrading and improvement of the City's flood protection system.

Accepted science indicates that climate change will increase winter precipitation, increase summer storm intensity and raise sea levels. The City can expect a 0.2 m rise in sea level over the next 50 years and a further 0.8 m over the subsequent 50 years totalling 1.0 m over the next 100 years.

The City's Flood Protection Program supports Council's Term Goals for Financial Management, Managing Growth and Development, Sustainability, Municipal Infrastructure Improvement and Waterfront Enhancement.

Flood protection is a regular point of discussion at the Public Works and Transportation Committee meetings. This report updates Council on flood protection system planning efforts and improvements.

Findings of Fact

Weather

Rainfall

Rainfall highlights for 2013 include the following:

- Approximately 960 mm of rain fell on the City in 2013, which is 23% less than the average annual rainfall of 1,239 mm.
- September was the wettest month in 2013 with 131 mm of recorded precipitation.
- The rainiest day in 2013 was November 2, with 45 mm of rainfall in a 24 hour period, which is well below the single day precipitation record for Richmond of 74 mm on December 16, 1979.
- The most significant storm of 2013 was on September 16, which recorded a rainfall intensity of 7.3 mm / hour over two hours and has a statistical return period of 10 years.

In general, 2013 was a below average rainfall year, but there were two 10 year return period storms. All events were within the design limits for Richmond's drainage system and identified flooding issues were local in nature and unrelated to drainage system capacity. Climate change experts are predicting that storms will become more intense in the future and the occurrence of two 10 year return period storms in 2013 supports this hypothesis. Staff will continue to monitor changes in rainfall patterns due to climate change and update drainage system plans as required.

Freshet

The 2014 Fraser River freshet reached 5 year return period flows briefly in early June and has been lower since then. Less than average snow pack and lower than average rainfall have resulted in a relatively low Fraser River freshet in 2014 and the river is not expected to experience high water levels again this year. The City's diking system performed well and there were no flooding concerns related to this year's freshet.

Flood Protection Policy and Planning

The *Provincial Flood Hazards Statues Amendments Act*, 2003, transferred responsibility for floodplain regulation from the Province to local municipalities. This has provided opportunities to strengthen Richmond's flood protection policies and create autonomous flood protection strategies. The *2008 – 2031 Richmond Flood Protection Strategy* is the overarching framework that guides Richmond in developing policy and strategy for overall improvement of the flood protection system. Highlights of the City's recent flood protection policy and planning achievements are provided in ***Table 1***.

Table 1 - Highlights of the City's recent flood protection policy and planning achievements

Year	Achievement
2002	A Drainage Utility established to provide a dedicated funding source for drainage improvements
2002	A multi year project begins to hydraulically model West Richmond's drainage system and prioritise system improvements
2002	A multi year project begins to create Richmond's first Flood Protection Management Strategy
2005	The Tsunami Hazard at the Fraser River Delta Study is completed. No tsunami was found to impact Richmond in the last 4000 years (since geological records began)
2006	The 2006 – 2031 Flood Protection Management Strategy is finalised
2006	A Dike Utility is implemented to provide a dedicated funding source for dike improvements
2006	The East Richmond Agricultural Water Supply Study is finalised to prioritise area wide drainage and irrigation system improvements
2008	The 2008 – 2031 Flood Protection Management Strategy replaces the 2006 strategy
2008	The Flood Plain Designation and Protection Bylaw No. 8204 is enacted
2009	The Mid Island Dike Study concludes that it is more cost effective to upgrade Lulu Island's perimeter dike than to build a mid island dike
2011	Drainage Modelling is updated to support Bylaw 9000, The 2041 Official Community Plan
2013	City Council adopt recommendations of the Dike Master Plan – Phase 1 Report that includes

	endorsement of Steveston Island as the preferred long term diking solution in Steveston
2013	Richmond's Ageing Infrastructure Planning Report to Council was updated to identify drainage funding requirements and infrastructure targets
2014	Richmond's Integrated Rainwater Resource Management Strategy is being finalised
2014	The East Richmond Agricultural Water Supply Study Update was completed

Drainage System Planning

The City's drainage system improvement plan includes a number of integrated facets that support and guide the City's five year capital plan. Hydraulic models are utilized to identify required capacity based improvements for existing and future conditions, condition assessment identifies elements that are deteriorating and require repair or replacement, ageing infrastructure assessments identify deteriorating infrastructure for replacement and long term financial requirements, and the Integrated Rainwater Resource Management Strategy will identify potential strategies for reducing the overall flows in the drainage system, while improving water quality.

Hydraulic Modeling

Drainage system capacity improvements are based on the results of computer based hydraulic modeling. Drainage system water level monitoring is utilized to calibrated and validate computer models to ensure they are an accurate representation of field conditions. The City is divided into two areas for modeling purposes based on basic land use, West Richmond and East Richmond.

West Richmond is primarily a highly developed urban environment. The West Richmond hydraulic model was updated based on the 2041 OCP and is utilized to identify and forecast drainage system elements that are or will be undersized as a result of ongoing development.

East Richmond is primarily agricultural and the drainage system is utilized for both drainage and irrigation purposes. The 2013 East Richmond Agricultural Water Supply Update study updated the East Richmond hydraulic model to include drainage systems improvements implemented since the original study in 2006. Hydraulic model results were combined with anecdotal information from the farm community to update planned drainage system improvements in East Richmond.

Both of the hydraulic models have considered the impacts of climate change on the drainage system and updates will be required as the science of climate change evolves.

Hydraulic modeling results from the 2041 OCP study and the 2013 East Richmond Agricultural Water Supply Update generated a catalogue of prioritized capacity based drainage system improvements that will be brought forward for Council's consideration as part of the City's five year Capital Program.

Condition Assessment

The City has approximately 56 km of box culverts that are critical to the drainage system. Some of these box culverts are deteriorating and causing sink holes adjacent to them. Staff has reviewed the issue and identified a plan for remediation. Box culvert lining projects will be brought forward for Council's consideration as part of the City's five year capital plan.

Ageing Infrastructure

The ageing infrastructure assessment predicts short, medium and long term requirements for infrastructure replacement due to deterioration. The ageing infrastructure assessment for drainage infrastructure considers age, material, criticality, soil condition, and condition assessment to determine the useful life of the City's pipes, box culverts and drainage pump stations. Short term requirements are brought forward for Council's consideration as part of the City's five year capital plan and longer term requirements are reported to Council for consideration as part of the City's longer term financial strategy.

Integrated Rainwater Resource Management Strategy

The Integrated Rainwater Resource Management Strategy (IRRMS) is undergoing final revisions and will be brought forward to Council for consideration in the fall. The City is required to complete the IRRMS in 2014 as a municipal commitment in Metro Vancouver's Integrated Liquid Waste and Resource Management Plan. The Strategy reviews a broad scope of rainwater issues, including rainwater re-use, detention, green roofs, storm water quality and strategies to reduce the impact of development on the drainage system. It also identifies monitoring and tracking initiatives that support Riparian Management Areas (RMA's), which supports the City's ecological network. After the IRRMS is implemented, staff will incorporate impacts of the IRRMS in the hydraulic models and update the catalogue of capacity based improvements and their timing.

Ecological Network

Richmond's Ecological Network (EN) is the inter-connected system of natural areas across Richmond, of which the City's drainage infrastructure forms an important component. As such, Richmond's Ecological Network Management Strategy is integrated with the other drainage planning tools listed above in the development of drainage maintenance and improvement plans.

Dike Planning

The City's dikes are critical infrastructure that protect the City from inundation from the Fraser River and the Straight of Georgia. Climate change is causing sea levels to rise that must be accommodated by the City's diking system. The City is developing a master plan to address this issue. The City continues to pursue dike improvements through development that meet the long term sea level rise requirements. Seismic design of the City's dikes is an emerging issue based on guidelines released by the Province in 2011.

Climate Change

Sea levels are predicted to rise approximately 1.2 m in Richmond over the next 100 years due to climate change. The best predictions indicate that the City can expect 0.3 m of sea level rise over the next 50 years with 0.9 m of sea level rise in the subsequent 50 years. Based on the current science, the City has significant time to plan and prepare for this eventuality.

To address sea level rise, the City is developing a Dike Master Plan. To date, Phase 1 of the plan associated with Steveston Harbour and the West Dike has been adopted by Council. Staff is currently requesting permission from the Province to perform a preliminary survey and geotechnical work on Shady Island in preparation for feasibility level work to utilize the island as the primary dike. Staff are also in discussions with Port Metro Vancouver (PMV) to mitigate the erosion of Sturgeon Bank and potentially build barrier islands to protect the West Dike from waves. Development of the Dike Master Plan – Phase 2 will begin later this year.

In 2011 the BC Ministry of Environment published the *Climate Change Adaptation Guidelines for Sea Dikes and Coastal Flood Hazard Land Use Sea Dike Guidelines*. These guidelines recommend criteria for calculating the recommended height for sea dikes for existing and future conditions. These guidelines appear to recommend dike heights that are much higher than those required by current provincial regulation. Staff continues to work with the Provincial Dike Inspector to interpret the guideline and develop appropriate future dike heights for the City.

Seismic Guidelines

In 2011, the BC Ministry of Forests, Lands and Natural Resource Operations published the *Seismic Design Guidelines for Dikes*. The guideline is based on performance criteria that limits displacement of dike during a seismic event. There are alternate methods of providing adequate seismic protection for the dikes that fall outside of the provincial guidelines that are considerably less expensive and deserve exploration. Staff continue to work with the Provincial Dike Inspector to rationalize the seismic requirements for the City's dikes and develop alternate strategies that provide an appropriate level of cost effective seismic protection.

Development

Developments adjacent to the City's dike want to take advantage of the waterfront as an amenity. To do so, it is often desirable to raise the dike and the adjacent development to long term elevations. Developments often fill the area between the dike and private property which has the effect of creating a much wider effective dike, which benefits the City and the development. Richmond has ongoing success with dike raising through development.

Infrastructure Improvement

Richmond's Drainage and diking infrastructure is continually improving. This is achieved through the City's 5 Year Capital Plan (funded by the Drainage and Diking Utilities) and private development. Accomplishment highlights include:

- The City implemented $45M of drainage and diking improvements since 2008, of which $9.6 million was contributed by senior government grant funding. A further $9.9M of drainage and diking improvements will be implemented in 2014.
- Ten drainage pump stations have been rebuilt to increase drainage system capacity, resiliency and meet long term drainage needs as well as locally improve dike elevation. Two additional stations have undergone significant mechanical refurbishment and 12 out of 31 major stations have backup generator power.
- 4.4 km of dike have been or are scheduled to be raised to a geodetic elevation of between 4.0 m and 4.7 m, which exceeds the Provincial requirement of 3.5 m to 3.9 m.
- Watercourse, drainage sewer and catch basin cleaning rates have been increased to a five year cycle.

The City's 2015 – 2019 Five Year Capital Plan is under development and will propose approximately $50 M of drainage and dike upgrades, examples of which will include:

- 5 drainage pump station rebuilds.
- 10 laneway drainage upgrades.
- $7 M of dike upgrades.

Staff continue to apply for senior government grants to fund these and other projects.

Financial Impact

None

Conclusion

Flood protection is the primary responsibility of the City of Richmond. The ongoing pressures of climate change, development and system aging require ongoing drainage and diking improvements to maintain the City's high flood protection standards. The City's drainage and diking utilities ensure there is dedicated funding available for improvements that are advanced through the City's capital planning process. Over $45M of drainage and diking works have been completed by the City since 2008, and a further $9.9M will be completed by the end of 2014.

Richmond's drainage infrastructure is well developed and complex. Computer based hydraulic models are used to identify existing capacity issues and forecast future capacity requirements. Capacity issues are merged with ageing infrastructure renewal needs in development of the City's Five Year Capital Plan. The Integrated Rainwater and Resource Management Strategy will be incorporated into this process, when it is finalized later this year.

Rising sea levels induced by climate change is a long term issue and staff are developing a long term master plan to that will address this issue. Phase 1 of the Dike Master Plan, which addresses Steveston and the West Dike, was completed and endorsed by Council in 2013. Staff is currently pursuing authorization from the province to access Shady Island to perform preliminary survey and geotechnical work required to develop Shady Island as a primary dike. Staff is also working

with PMV to stop the erosion of Sturgeon Bank and potentially build barrier islands identified in the Dike Master Plan – Phase 1.

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