City of Richmond

Agenda

Public Works and Transportation Committee
Electronic Meeting

Council Chambers, City Hall
6911 No. 3 Road

Wednesday, June 21, 2023
4:00 p.m.

Pg. # ITEM

MINUTES

PWT-5 ***Motion to adopt the minutes of the meeting of the Public Works and Transportation Committee held on May 17, 2023.***

NEXT COMMITTEE MEETING DATE

July 19, 2023, (tentative date) at 4:00 p.m. in the Council Chambers.

AGENDA ADDITIONS & DELETIONS

DELEGATIONS

PWT-10 1. (1) Nathan Davidowicz to provide additional information about the 480 bus and the bus service in Richmond

PWT-12 (2) James Yu to present on 480 bus route

PLANNING AND DEVELOPMENT DIVISION

2. **KITTIWAKE DRIVE - TRAFFIC CALMING PILOT PROJECT UPDATE**
(File Ref. No. 10-6450-09-01) (REDMS No. 7233657)

PWT-17 See Page **PWT-17** for full report

Designated Speaker: Sonali Hingorani

STAFF RECOMMENDATION

That Option 3 to implement a pilot project for the temporary installation of two asphalt speed cushions on Kittiwake Drive for a trial period of six months, as described in the staff report titled "Kittiwake Drive - Traffic Calming Pilot Project Update" dated May 19, 2023 from the Director, Transportation, be endorsed.

3. **2023 ROAD SAFETY INITIATIVES UPDATE AND VISION ZERO REVIEW**
(File Ref. No. 10-6450-09-01) (REDMS No. 7215288)

PWT-22 See Page **PWT-22** for full report

Designated Speaker: Sonali Hingorani

STAFF RECOMMENDATION

That the road safety initiatives, as outlined in the staff report titled "2023 Road Safety Initiatives Update and Vision Zero Review" dated June 5, 2023 from the Director, Transportation, be received for information.

ENGINEERING AND PUBLIC WORKS DIVISION

4. **2022 ANNUAL WATER QUALITY REPORT**
(File Ref. No. 10-6000-01) (REDMS No. 7233576)

PWT-34 See Page **PWT-34** for full report

Designated Speaker: Bryan Shepherd

STAFF RECOMMENDATION

(1) That the annual report titled "2022 Annual Water Quality Report" dated May 17, 2023, from the Director of Public Works Operations, be endorsed; and

(2) That the annual report titled "2022 Annual Water Quality Report" dated May 17, 2023, be made available to the community on the City's website and through various communication tools including social media channels and as part of community outreach initiatives.

5. **DRAINAGE CANAL BANK FAILURE REPAIRS-12506 VICKERS WAY**
(File Ref. No. 10-6340-20-P.2022CD00096Vol) (REDMS No. 7237488)

PWT-110 See Page **PWT-110** for full report

Designated Speaker: Kevin Roberts

STAFF RECOMMENDATION

That funding of $1,000,000 from the Drainage Improvement Reserve Fund for the drainage canal bank failure repairs at 12506 Vickers Way, be approved and that the Consolidated 5 Year Financial Plan (2023-2027) be amended accordingly, as detailed in the report titled "Drainage Canal Bank Failure Repairs - 12506 Vickers Way" dated May 23, 2023, from the Director, Engineering.

6. **CIRCULAR PROCUREMENT POLICY IMPLEMENTATION AND PROGRESS UPDATE**
(File Ref. No. 10-6125-07-04) (REDMS No. 7181733)

PWT-113 See Page **PWT-113** for full report

Designated Speaker: Peter Russell

STAFF RECOMMENDATION

That results of the implementation of circular economy criteria into projects and procurement activities, as noted in the staff report titled "Circular Procurement Policy Implementation and Progress Update," dated May 8, 2023, from the Director, Sustainability and District Energy, be posted online to inform the public.

7. **DIKE MASTER PLAN - PHASE 4 REPORT**
(File Ref. No. 10-6060-01) (REDMS No. 7182372)

PWT-139

See Page **PWT-139** for full report

Designated Speaker: Eric Sparolin

STAFF RECOMMENDATION

That the "Dike Master Plan – Phase 4 Final Report," as attached in the staff report titled "Dike Master Plan – Phase 4 Report," dated May 23, 2023, from the Director, Engineering, be endorsed for capital project and development planning purposes.

8. **MANAGER'S REPORT**

ADJOURNMENT

City of Richmond

Minutes

Public Works and Transportation Committee

Date:	Wednesday, May 17, 2023
Place:	Council Chambers Richmond City Hall
Present:	Councillor Carol Day, Chair Councillor Michael Wolfe Councillor Chak Au Councillor Kash Heed Councillor Alexa Loo (by teleconference)
Also Present:	Councillor Andy Hobbs Councillor Bill McNulty
Call to Order:	The Chair called the meeting to order at 4:00 p.m.

MINUTES

It was moved and seconded
That the minutes of the meeting of the Public Works and Transportation Committee held on April 19, 2023, be adopted as circulated.

CARRIED

AGENDA ADDITION

The Chair advised that Reduction of Speed in Hamilton Area will be considered as Item No. 3A.

PLANNING AND DEVELOPMENT DIVISION

1. **ICBC-CITY OF RICHMOND ROAD IMPROVEMENT PROGRAM AND INTERSECTION SAFETY CAMERA PROGRAM – 2023 UPDATE**
(File Ref. No. 10-6460-01) (REDMS No. 7159425)

In response to queries from Committee, staff noted that (i) a report regarding improvements to Hamilton area sidewalks and walkways is forthcoming, (ii) the installation of traffic video cameras at No. 5 Road and Cambie Road is a separate project from the intersection improvement project, and (iii) speed violations have significantly decreased since the implementation of the Province's Intersection Safety Camera Program in 2019.

It was moved and seconded

(1) That the proposed road safety improvement projects, as described in Attachment 2 of the staff report titled "ICBC-City of Richmond Road Improvement Program and Intersection Safety Camera Program – 2023 Update," dated April 18, 2023 from the Director, Transportation be endorsed for submission to the ICBC 2023 Road Improvement Program for consideration of cost-share funding; and

(2) That should the above applications be successful, the Chief Administrative Officer and General Manager, Planning and Development be authorized to execute the cost-share agreements on behalf of the City, and that the Consolidated 5 Year Financial Plan (2023-2027) be amended accordingly.

CARRIED

ENGINEERING AND PUBLIC WORKS DIVISION

2. SNOW REMOVAL FROM PRIORITY MULTI-USE PATHWAY CORRIDORS - SUMMARY OF PILOT INITIATIVES

(File Ref. No. 10-6360-13) (REDMS No. 7178265)

In response to queries from Committee, staff noted that (i) a single snow removal pass over multi-use pathways (MUPs) is not recommended as it could create a more hazardous condition for users, (ii) the City of Vancouver has six Holder municipal sidewalk tractors to maintain a steady pattern of treatment on MUPs, (iii) non-delineated bike lanes are cleared by the regular plow and brine treatment, (iv) the City did not receive any complaints from bike lane users during the 2022-2023 winter season, (v) the procurement process for a mini sweeper with attachments is underway and once acquired, will be licensed and able to go on roadways, and (vi) property owners are not required to clear MUPs under *Traffic Control and Regulation Bylaw No. 5870*, and a review of the Bylaw is underway.

Discussion then ensued with regard to the costs related to snow removal on MUPs and potential budget implications and staff were requested to provide additional information on the cost and timeline to implement the proposed initiatives.

It was moved and seconded

That the staff report titled "Snow Removal from Priority Multi-Use Pathway Corridors – Summary of Pilot Initiatives" dated April 17, 2023, from the Director, Public Works Operations be received for information.

CARRIED

3. **2023 SUBMISSION TO THE DISASTER MITIGATION AND ADAPTATION FUND – RICHMOND FLOOD PROTECTION PROGRAM**
(File Ref. No. 10-6060-04-01) (REDMS No. 7215498)

In response to a query from Committee, staff noted that the 4.6 kilometers of dike to be upgraded includes multiple sections and a map showing locations will be provided to Council.

It was moved and seconded

(1) That the submission to the Disaster Mitigation and Adaptation Fund– Richmond Flood Protection Program requesting funding for up to 40% of the project cost, for a total of $35,600,000 to upgrade approximately 4.6 kilometers of dike and the No. 6 Road North Drainage Pump Station be endorsed;

(2) That the Chief Administrative Officer and General Manager, Engineering and Public Works be authorized to enter into funding agreements with the Government of Canada for the above mentioned project should it be approved for funding by the Government of Canada; and

(3) That, should the above mentioned project be approved for funding by the Government of Canada, the Consolidated 5 Year Financial Plan (2023-2027) be amended accordingly.

CARRIED

3A **REDUCTION OF SPEED IN HAMILTON AREA**
(File Ref. No.)

Discussion ensued regarding potential traffic calming measures and the need for speed reduction in the Hamilton area. As a result of the discussion, the following **referral motion** was introduced:

It was moved and seconded
That staff investigate reducing the speed limit in the entire Hamilton area, and report back.

CARRIED
Opposed: Cllr. Heed

Discussion ensued regarding traffic calming measures and improvements in the Hamilton area. As a result of the discussion, staff were directed to provide a memorandum, cataloguing traffic calming measures in the Hamilton area.

Discussion then ensued with regard to road safety concerns near the Cranberry Children's Centre in Hamilton. As a result, the following **referral motion** was introduced:

It was moved and seconded
That staff study the speed limit in the area near Cranberry Children's Centre on Westminster Highway, and report back.

The question on the referral motion was not called as staff provided further advice, and as a result there was agreement from the mover, the seconder and all members present to withdraw the referral motion, and the referral motion was **WITHDRAWN**.

Further discussion took place on traffic calming along the area near Cranberry Children's Centre, and as a result, staff were directed to staff were directed to conduct a speed limit study in the area near Cranberry Children's Centre on Westminster Highway.

4. MANAGER'S REPORT

(i) Upcoming Cycling Events

Staff highlighted upcoming cycling events, including HUB Cycling's Go by Bike Week (May 29-June 4, 2023), a Celebration Station sponsored by the City of Richmond on June 2 at the Canada Line Bikeway at River Drive, Bike to School week (May 29 to June 2, 2023), and the 21st annual Island City Bike Tour on June 11, 2023.

(ii) Public Works Open House

Staff highlighted that in honour of National Public Works Week, the City held the Public Works Open House on May 13, 2023, in-person for the first time since 2019. The event was very successful with approximately 4000 attendees and over 350 volunteers.

In response to a query from Committee, staff noted that the virtual program will launch on Sunday, May 21 and will direct residents to the Capital Projects Highlights website and include information regarding various construction projects that are underway.

(iii) Roadworks Construction 11000 Block of Steveston Highway

Staff noted that the curb replacement work currently underway will be completed by the end of the week, and repaving is scheduled for the summer and will take place during evening to limit traffic disruption to the public.

ADJOURNMENT

It was moved and seconded
That the meeting adjourn (5:08 p.m.).

CARRIED

Certified a true and correct copy of the Minutes of the meeting of the Public Works and Transportation Committee of the Council of the City of Richmond held on Wednesday, May 17, 2023.

Councillor Carol Day
Chair

Shannon Unrau
Legislative Services Associate

From: Nathan Davidowicz
To: CityClerk
Subject: Re: PWT Committee
Date: June 6, 2023 12:39:48 PM

Thank you. Could you please distribute the following:

Here is the original announcement from Sept. 7, 1979 of the Richmond-UBC bus route.

https://www.translink.ca/-/media/translink/documents/rider-guide/buzzer-archives/1970s/1979/buzzer_1979_09_07.pdf#view=fitH

Additional information is available by looking up bus No. 480 on the 2019 bus summaries

https://public.tableau.com/app/profile/translink/viz/2019TSPR-BusSeaBusSummaries/TheWorkbook

In 2019 the 480 bus carried just over 1M riders (1011000)
Weekdays only from about 6 am to 9 pm (15 hrs per day compared to 20 hrs per day on other Richmond buses)
On an average day it had 4,060 riders or on average about 32 riders for each trip.
There were 66 trips to UBC and 62 trips from UBC
However during the peak UBC Winter session(Sept. to April) these yearly averages are higher.

Most bus trips were done by articulated 18 m (60 ft) buses.

In January 2020 the 480 bus was cutback to operate only during rush hours about 5 hrs per day.
providing 30 trips to UBC and 30 trips from UBC
In late March 2020 all the 480 bus trips were cancelled.

The 480 bus is a good example of the " Death Spiral of Transit "

What's a public transit death spiral? It's a vicious cycle of service cuts and fare hikes that push people away from public transit and into their cars, further decreasing public transit systems' revenue, which leads to further service cuts that impact Canadians' ability to get to work, school, groceries, social services, and other daily essentials.

If this is allowed to happen, it will make roads more congested, increase carbon emissions and air pollution, and have the greatest impact on society's most vulnerable - who have no other options.

(1) From Environmental Defence:(Nate Wallace)
https://www.theglobeandmail.com/opinion/article-service-cuts-to-public-transit-are-just-the-first-step-in-a-death/?
https://environmentaldefence.ca/wp-content/uploads/2023/02/Public-Transit-Funding-Media-Backgrounder-Final.pdf

https://environmentaldefence.ca/report/public-transit-path-to-net-zero/
https://environmentaldefence.ca/2023/03/21/atu-canada-and-environmental-defence-call-on-premiers-minister-freeland-to-save-public-transit-in-upcoming-budgets/
(2) From CBC Radio: https://www.cbc.ca/player/play/2162910787554
(3) From Vox: https://www.vox.com/future-perfect/23653855/covid-transit-fares-buses-subways-crisis

Thank you
Nathan Davidowicz

Dear TransLink customer relations team,

My name is James Yu, and I wrote to your team several weeks ago regarding the 480 service. I wish to thank you for your earlier correspondence regarding the discontinuation of the route. I appreciate the depth and extent of your analysis regarding the route and its alternatives, and understand that actions regarding restoration of service are significant investments.

Please find attached to this email a petition to reinstate the 480 service. This petition was signed digitally by over 655 individuals and counting, and 270 individuals have agreed to release their names in writing with the included text. We collectively continue to believe that your analysis of the current state of service does not match our experiences on the corridor, and that restoration of the 480 would be beneficial to all parties involved. I would appreciate if this petition and email could be forwarded to planning.

I appreciate and understand that current service provisions prevent easy allocation of service to the 480. However, like how the revised 44 was a result of innovative and unique problem-solving, I encourage TransLink to find innovative ways to provide faster, more efficient service on the 480 corridor, as engagement on the petition indicates that the service is in demand. If improving service quality for commuters contributed to the revised 44, it must contribute to restoration of the 480. For consideration by planning, I would like to know whether one or all of the following improvements would be feasible and allow the 480 to be restored efficiently with as minimal a cost as possible:

1. Reroute **northbound** (**not** southbound) service on the 480 via the Sea Island Connector WB and Arthur Laing Bridge instead of Bridgeport Road EB and Oak Street Bridge.

As you mentioned, bridge traffic is an issue for the 480. However, I do not believe that traffic is an issue in the southbound direction, seeing as the Granville Street bus lanes and the 71st Avenue bus priority signalized on-ramp allow the 480 to bypass the majority of existing traffic in the area. It is correct, however, that there is limited possibility for transit priority on the northbound Oak Bridge ramp. Google Maps data indicates that routing northbound service (only) via the Sea Island Connector and Arthur Laing instead may be faster during the morning peak hour, given that the route is physically shorter and that there are fewer traffic signals. Moreover, unlike the Oak Street Bridge, there is an HOV priority lane along the entire length of the Arthur Laing on-ramp, allowing the 480 to bypass merge-induced traffic on this bridge. This would make northbound service significantly faster, more sustainable long-term, and further put the speed of the 480 ahead of alternatives. I acknowledge that this would come at the cost of two local stops in the Marpole area; however, the savings to service hours are better than having no service at all, and the two stops are served by high frequency high capacity routes which easily and quickly connect to the 480 at 71st & Granville.

2. Reroute the 480 to use 49th, Marine, Dunbar and 41st instead of operating straight down 41st, in both directions.

This would reduce service duplication between the R4 and 480 and provide new express service to relieve capacity on the 49. This capacity is much-needed as the 49 often operates crush-loaded into 41st, Marine and Wesbrook Village, preventing passengers in the area from using the service. This would also allow the 480 to use the bus-only left turn onto 49th from Granville, which means service would not be stuck in traffic on the left turn to 41st from Granville. While there is some heavy traffic on Marine between 49th and Dunbar, this traffic is comparable to the existing traffic in Kerrisdale (where bus priority measures are also impossible due to parking demands), and so runtimes should be comparable. Express service has already operated on 49th and Marine during detours, so there is precedent for such a change.

3. Reroute the 480 at UBC to continue down Marine Drive to the bus loop instead of turning into 16th and Wesbrook Mall, in both directions.

Google Maps data indicates that this would be faster northbound due to the significant traffic pinch point on Wesbrook between 16th and Thunderbird. More importantly, however, express stopping procedures on SW/NW Marine Drive would provide two benefits to transit users. For commuter students, Marine Drive bus stops would allow students to disembark closer to their lecture halls, shortening the commute in both directions in comparison to all alternative services. For students who live on-campus, the additional capacity on 480 coaches at UBC as a result of early disembarking allows these students to use the 480 as a "residence connector" between residences along Marine and the bus loop, which would relieve capacity on the severely overcrowded 68 shuttle route. Buses deadheading to/from the garage can also operate in-service at these stops, providing bidirectional capacity relief for the 68. There is precedent for conventional service to operate here as this was the official 480 detour during the 2010 Olympics. This change would shorten commuter student commutes, provide relief for the 68, generate additional ridership, reduce service duplication further and shorten runtime in the northbound direction.

4. Reduce or discontinue the 9 extension between Alma and UBC, and reinvest service hours into the 480.

I understand that available service hours are limited. However, since 44 service is being expanded this Fall, there must be hours available for investment. Nonetheless, there are several options to reallocate existing service to the 480. 2022 Transit Service Performance Review data indicates that the 9, which operates at a high frequency between Alma and UBC during peak hours, is very low ridership. Peers I have spoken to corroborate this information. Given that the peak hour 9 extension to UBC is duplicated by the high frequency 4, 14 and 99 services, and that the TSPR indicates the 4 and 14 have available capacity as well, it would be a more efficient use of these service hours to reduce or entirely discontinue this extension in favour of reinvesting the hours into the much more in-demand 480. Instead of having buses operate empty into/out of UBC during peak hours, they would be much better used restoring pre-pandemic service on the Richmond-UBC corridor, as that is where service is demanded. This setup for the 9 is similar to how the local 41 does not continue to UBC because it too has duplicate local service (49) which continues to UBC.

5. Invest savings from 319 reductions induced by the R6 RapidBus into the 480.

As there will be reductions in 319 service once the R6 RapidBus opens next year, these newly open resources could be reinvested into the 480.

6. In tandem with a reduced or discontinued 9 extension, operate the 480 out of Vancouver Transit Centre instead of Richmond Transit Centre.

The current deadhead between RTC and UBC is very long, as is the deadhead between RTC and Bridgeport Station. If buses operated out of VTC instead, there would be a very significant saving of service hours during all peak hours in all directions. The following considerations indicate this:

- Morning deadhead from VTC to Bridgeport: this is reverse-peak travel and shorter, as opposed to RTC-Bridgeport which is much longer and in peak direction traffic.
- Morning deadhead from UBC to VTC: this is much shorter than UBC-RTC, since buses only need to run to Marpole instead of traveling all the way down Hwy 99.
- Afternoon deadhead from VTC to UBC: this is again, much shorter than RTC-UBC, since buses only need to run from Marpole.
- Afternoon deadhead from Bridgeport to VTC: this is, again, reverse-peak travel and shorter, as opposed to Bridgeport-RTC which is much longer and peak direction.
- Additional capacity at VTC to accommodate the 480 would arise from the proposed #9 extension reductions, as conventional buses from the 9 extension would shift 1-1 to the 480.

Collectively, these improvements would allow the 480 to run more efficiently, faster and serve more passengers while using fewer service hours and requiring less new hour investments.

The 480 is a key regional connection designed to compensate for the unique geometry of our region. Like the diagonal, direct connection the express 430 makes between Richmond and Metrotown in the east, the 480 creates a diagonal, direct connection between Richmond and UBC in the west, being both more convenient and faster than alternative service. Back in the 2000s when the 98 B-Line launched, capacity relief measures had to be added soon after in the form of the 488 and 492 express services which diverged from the 98 route. Similar to this, the 480 is needed now as a capacity relief measure which diverges from the R4 RapidBus.

While you mentioned in your analysis that the R4-Canada Line option takes 43-46 minutes whereas the 480 would take 47 minutes, this does not account for overcrowding on the R4 preventing Richmond and South Fraser passengers from taking full advantage of it. In the northbound direction, pass-ups at Cambie are severe enough that my peers and I have to take the 49 to avoid being 10+ minutes behind schedule. This route takes several minutes more than the R4, which means the 480 would be faster than our current commute even without any of my proposed improvements. In the southbound direction, lineups for the R4 at UBC can often be several hundred students long, which can mean 10+ minute delays even when service is on time. Again, the 480 would be faster, as passengers would not be funneled into one service.

The on-time performance of the R4 does not mean that students arrive on-time, as pass-ups force students onto delayed, later arrivals.

While overcrowding on the eastern portions of the R4 and 49 are an issue, this is an issue that dates to well before the pandemic. Overcrowding on the western areas, however, was accelerated by the discontinuation of the 480. We believe that pre-pandemic service standards at UBC should be restored prior to implementing new service improvements; it is unfair to the several thousand long-distance UBC commuters who face a continuously worsening commute for our corridor to be cannibalized while progress advances with us left behind. As you are adding service to the 44 and 250 corridors with West Vancouver-UBC direct service, despite the fact that the 44 and 250 rank well behind the R4 and 49 in terms of overcrowding in the 2022 Transit Service Performance Review, it would be severely inequitable not to restore pre-pandemic service levels on the wider-serving 480 as well. Overcrowding on the Canada Line between King Edward and Broadway is also an issue; however, if the 99 is as viable of an alternative as has been stated, then passengers from Richmond who currently use it to reach UBC would shift to the 480, adding capacity to the Canada Line in this area.

Moreover, overcrowding on this segment is not mutually exclusive with the overcrowding in our segment. As you mentioned, overcrowding between Richmond and 41st will be worsening with the Fall opening of Capstan Station, and a reinstated 480 funded by reallocations from the 9, when considering Richmond passengers who take the 99 to UBC would shift to the 480, would provide the additional capacity required to accommodate this. Furthermore, peers I have spoken to that currently drive on the Richmond-UBC corridor would have otherwise used the 480 had it existed. If the 480 were to be reinstated, this would reduce vehicle traffic levels on the Richmond-UBC corridor, improving speeds for all users in the area.

Thank you for your consideration of these potential changes, as well as the petition. I acknowledge that any service reallocation is a monumental task, but we collectively believe that service restoration will be well worth the effort. We look forward to hearing from you.

Sincerely,

James Yuming Yu, BSc

Ph.D. Student of Economics, UBC

Dear TransLink administrators,

We, the students and staff of UBC and supportive members of the public, call on TransLink to restore the suspended 480 bus service between Bridgeport Station and UBC to uphold the standards of equity and fairness for students in our region.

With the 480 suspended, students from Richmond and the communities of Ladner, Tsawwassen, North Delta, Surrey and White Rock are now required to transfer via the Canada Line and R4 RapidBus to reach campus. TransLink has stated that this alternative is 1-4 minutes faster than the 480 would be during peak hours when accounting for transfers; this does not however account for the severe delays and overcrowding on the R4 that has prevented Richmond and SoF students from using it in the first place. The closest alternative is the 49, which takes several minutes more than the R4 due to being a local service with no transit priority, putting it behind the 480 in terms of speed. Moreover, due to the added transfer and shoulder-to-shoulder overcrowding, students are unable to spend as much of the commute studying as otherwise. This has deducted several hours of study time per week and forced students to take time away from their friends and family, worsening their mental health.

Additionally, the current complexity of the commute between Richmond and UBC has drawn many students away from transit entirely. Students are drawn away from Richmond dining and rental options and face more expensive options closer to campus because the crowding and transfers are not worth the financial savings. Students have also resorted to driving between Richmond and UBC, which has worsened traffic in the area and is slowing buses down.

TransLink is restoring the previously suspended West Vancouver-UBC service for the upcoming Fall semester, under the justification that capacity is required on the UBC-Downtown and Marine Drive corridors. To restore this pre-pandemic service while also ignoring the overcrowding situation between UBC and Richmond caused by the lack of pre-pandemic service standards is severely inequitable, especially when considering that the Richmond-UBC corridor serves significantly more communities and that the 480 saw twenty times more ridership than the West Vancouver-UBC service. If improving service quality for commuters contributed to the restoration of West Vancouver-UBC service, it must play a factor in the restoration of the 480.

We the 655 signatories from [the petition] demand that the standards of equity and fairness be upheld for students in our region. We ask that the 480 be reinstated, at least for peak hours peak direction, between Bridgeport Station and UBC.

We appreciate your time in considering this matter.
Sincerely,
The undersigned on behalf of the 655 signatories.

City of Richmond

Report to Committee

To:	Public Works and Transportation Committee	**Date:**	May 19, 2023
From:	Lloyd Bie, P.Eng. Director, Transportation	**File:**	10-6450-09-01/2023-Vol 01
Re:	**Kittiwake Drive - Traffic Calming Pilot Project Update**		

Staff Recommendation

That Option 3 to implement a pilot project for the temporary installation of two asphalt speed cushions on Kittiwake Drive for a trial period of six months, as described in the staff report titled "Kittiwake Drive - Traffic Calming Pilot Project Update" dated May 19, 2023 from the Director, Transportation, be endorsed.

Lloyd Bie, P.Eng.
Director, Transportation
(604-276-4131)

REPORT CONCURRENCE		
ROUTED TO:	**CONCURRENCE**	**CONCURRENCE OF ACTING GENERAL MANAGER**
Engineering	☑	
Fire Rescue	☑	
RCMP	☑	
SENIOR STAFF REPORT REVIEW	**INITIALS:** CJ	**APPROVED BY CAO**

Staff Report

Origin

At its regular meeting of September 26, 2022, Council endorsed the following:

That Option 3 to implement a pilot project for the temporary installation of two speed cushions on Kittiwake Drive for a trial period of six months, as described in the staff report titled "Kittiwake Drive – Traffic Calming Update", dated September 26, 2022, from the Director, Transportation, be endorsed.

This report provides the results of the temporary traffic calming installation.

This report supports Council's Strategic Plan 2022-2026 Focus Area #3 A Safe and Prepared Community:

> *Community safety and preparedness through effective planning, strategic partnerships and proactive programs.*

This report supports Council's Strategic Plan 2022-2026 Focus Area #6 A Vibrant, Resilient and Active Community:

> *Vibrant, resilient and active communities supported by a wide variety of opportunities to get involved, build relationships and access resources.*

Analysis

Background of Traffic Calming Request

Kittiwake Drive is a local street within a neighbourhood subdivision located south of Steveston Highway that connects No. 2 Road to Kingfisher Drive. There is a 50 km/h speed limit and parking is permitted on both sides of the street. Westwind Elementary School is located west of Kittiwake Drive across Kingfisher Drive.

In June 2021, staff received a petition from residents of Kittiwake Drive requesting speed cushions to address concerns of speeding motorists. Further to the request, staff conducted a traffic study and consulted with residents to develop traffic calming options. As a result of this process, temporary speed cushions were recommended at two locations on Kittiwake Drive, one at Pintail Drive and the other at Pelican Court/Plover Drive (Figure 1).

Figure 1: Kittiwake Drive Temporary Speed Cushion Locations

Speed cushions include cut-outs for passage by emergency vehicles. The raised portion of the device reduces passenger car speeds while going over the hump, while the longitudinal gaps allow fire trucks to avoid the raised cushion.

As these speed cushions were the first to be introduced on a local roadway in Richmond, temporary pre-fabricated speed cushions were installed on a trial basis for six months as approved by Council. Installation occurred on October 27, 2022 (Figure 2) and the six month pilot project is now complete.

Figure 2: Kittiwake Drive Temporary Speed Cushion

Outcome of Traffic Calming Trial

During the trial period, staff conducted a speed study to assess the effectiveness of this measure and obtained comments from residents.

- ### Traffic Speed Study

  Before Speed Cushion Installation: A traffic speed survey was conducted prior to the installation of the speed cushions confirming a speeding issue on Kittiwake Drive. The 85th percentile speed for westbound motorists was 67 km/h while that of eastbound motorists was 55 km/h. The 85th percentile speed indicates the highest speed that 85 per cent of the vehicles are travelling at or below. This measurement is an industry standard for determining speed limits and assessing the level of action required to address speeding issues.

  After Speed Cushion Installation: Counts taken during the trial period indicate an 85th percentile speed for westbound motorists as 38 km/h and that of eastbound motorists of 37 km/h. The results of the traffic speed study confirm the speed cushions have been effective at slowing drivers down on Kittiwake Drive. Vehicle speeds have reduced by 29 km/h in the westbound direction and 18 km/h in the eastbound direction.

- ### Resident Feedback

  Within the six month trial, feedback was received from three out of the 21 residents on Kittiwake Drive. One correspondence was related to the location of the speed cushions and a preference for the eastern location to be installed closer to No. 2 Road. Two residents near Pintail Drive indicated they were not in support of the speed cushions due to perceived vibration and noise when traversed by larger vehicles.

Next Steps

The results of the traffic calming pilot project on Kittiwake Drive confirmed vehicles speed reduction through the implementation of temporary speed cushions. However, concerns have been expressed by adjacent residents regarding vibration and noise.

Based on these combined factors, staff have identified three possible traffic calming options for consideration.

Option 1: Status Quo (Not Recommended)

With the majority of the residents on Kittiwake Drive requesting traffic calming measures, as well as the results of the before and after vehicle speeds recorded on Kittiwake Drive, staff do not recommend a do nothing option.

Option 2: Traffic Circles (Not Recommended)

This option would install traffic circles on Kittiwake Drive, one at Pintail Drive and the other at Pelican Court/Plover Drive. While traffic circles are a proven device in reducing vehicle speeds, it was not supported by the majority of the residents along Kittiwake Drive during past consultation. Therefore, staff do not recommend this option at this time.

Option 3: Trial Installation of Speed Cushions (Recommended)

Staff recommend a trial installation of asphalt speed cushions that will be constructed with a lower profile than the temporary measures to address the noise and vibration concerns. The prefabricated temporary speed cushions have a height of 9 cm and the proposed profile for the asphalt speed cushions will be similar to the other asphalt speed cushions installed in the Hamilton area. The Hamilton speed cushions have been re-profiled with a reduced height of 7 cm and have been successful at addressing vibration and noise emission yet still help to discourage speeding.

Staff will monitor the vehicle speeds in response to the installation of the lower height asphalt speed cushions and will consult with residents through ongoing communication during the six month trial period. Staff will bring forward further recommendations regarding traffic calming measures on Kittiwake Drive for Council consideration after completion of the trial period.

Construction of the asphalt speed cushions are planned for summer 2023. Installation is anticipated to be substantially completed before the start of school in September.

To discourage speeding, the temporary devices will remain until construction of the asphalt version commences. Once replaced, the temporary speed cushions will be stored and staff will review opportunities to reuse this application elsewhere in the City.

Financial Impact

The cost to implement the permanent speed cushions is $25,000, which can be funded by the approved 2023 Traffic Calming Program.

Conclusion

A pilot project to install two speed cushions on Kittiwake Drive at Pintail Drive and Pelican Court/Plover Drive, for a period six months has completed. Staff assessed the effectiveness of the traffic calming device in reducing vehicle speeds.

The result of a post installation speed study indicates a decrease in operating speed as a result of the safety intervention of 18km/h eastbound and 29 km/h westbound. Staff recommend reduced height installing asphalt speed cushions on Kittiwake Drive on a trial basis to discourage speeding. Staff will monitor the improvements to traffic safety and receive feedback regarding neighbourhood impacts during the pilot.

Upon completion a six month trial, staff will report back to Council.

Sonali Hingorani

Sonali Hingorani, P. Eng.
Manager
Transportation Planning and New Mobility
(604-276-4049)

SH:ck

City of Richmond

Report to Committee

To:	Public Works and Transportation Committee	**Date:**	June 5, 2023
From:	Lloyd Bie, P.Eng. Director, Transportation	**File:**	10-6450-09-01/2023-Vol 01
Re:	**2023 Road Safety Initiatives Update and Vision Zero Review**		

Staff Recommendation

That the road safety initiatives, as outlined in the staff report titled "2023 Road Safety Initiatives Update and Vision Zero Review" dated June 5, 2023 from the Director, Transportation, be received for information.

Lloyd Bie, P.Eng.
Director, Transportation
(604-276-4131)

Att. 3

REPORT CONCURRENCE		
ROUTED TO:	**CONCURRENCE**	**CONCURRENCE OF ACTING GENERAL MANAGER**
Community Bylaws	☑	
Fire Rescue	☑	
RCMP	☑	
SENIOR STAFF REPORT REVIEW	**INITIALS:** CJ	**APPROVED BY CAO**

Staff Report

Origin

Road safety is a shared responsibility that involves collaboration and engagement with multi-disciplinary partners and all levels of government. The City implements and supports a number of proactive mitigation measures throughout the year to improve road safety outcomes, especially for vulnerable road users such as pedestrians and cyclists. As part of staff's road safety planning and intervention development, the City's Traffic Safety Advisory Committee creates a co-operative partnership between City staff, community groups and other agencies, to enhance traffic, pedestrian and cycling safety in Richmond. This report presents an overview of the on-going and planned road safety initiatives for 2023 and highlights the activities undertaken 2022.

At the Council meeting of March 27, 2023, staff received the following direction:

That the Vision Zero strategies be referred to staff for further analysis.

This report responds to the referral.

This report supports Council's Strategic Plan 2022-2026 Focus Area #2 Strategic and Sustainable Community Growth:

> *Strategic and sustainable growth that supports long-term community needs and a well-planned and prosperous city.*
>
> *2.4 Enhance Richmond's robust transportation network by balancing commercial, public, private and active transportation needs.*

This report supports Council's Strategic Plan 2022-2026 Focus Area #3 A Safe and Prepared Community:

> *Community safety and preparedness through effective planning, strategic partnerships and proactive programs.*
>
> *3.2 Leverage strategic partnerships and community-based approaches for comprehensive safety services.*

Analysis

Traffic Safety Advisory Committee

Council endorsed the establishment of the Traffic Safety Advisory Committee (TSAC) in 1997. As part of the planning and review of road safety projects, staff meet quarterly with the Committee to seek input on corrective measures. In collaboration with other agencies, road safety related education campaigns and events are undertaken throughout the year.

TSAC has representatives from the following groups to develop strategies to improve road safety from a multi-disciplinary perspective:

- Insurance Corporation of BC (ICBC)
- Richmond School District 38
- Richmond District Parents Association
- Vancouver Coastal Health
- Richmond RCMP and Richmond Fire-Rescue
- City Transportation and Community Bylaws

The Committee provides feedback on a wide range of traffic safety issues such as school zone and adjacent roadway concerns and neighbourhood traffic calming requests. TSAC will continue to provide input and participate in the on-going and planned road safety initiatives for 2023 as summarized below.

2023 Road Safety Initiatives

Staff and the Committee collaboratively undertake road safety initiatives that can be grouped into three categories (3E's); Engineering, Education and Enforcement to promote safer streets in Richmond with a focus on reducing vehicle speeds.

Engineering Initiatives - Road Design and Operational Enhancements

To design safer streets, high-risk places such as school zones and collision prone areas are assessed for engineering measures to enhance the operational and geometrical attributes of a street.

School Zone Pedestrian and Traffic Safety: Staff will develop physical interventions to address traffic safety-related issues within school zones and adjacent roadways. School zone safety initiatives also include revisions to vehicle parking and circulation layout at schools, supporting the enforcement of school zone traffic violations, and introducing new walkways and crosswalks as well as upgrading crosswalks to improve pedestrian safety. Staff have met with the principals of all 38 public elementary schools in Richmond to discuss their specific concerns. In 2023, staff will continue this process with the high schools. All road works around schools are approved by school administration prior to implementation.

Figure 1: Talmey School Walkway

Safety interventions completed/planned in 2023 include:

- Walkway improvements at Talmey Elementary School and Walter Lee School (Figure 1).
- Raised crosswalks to be implemented this summer at Walter Lee, Jessie Wowk and Tomsett Schools.
- A speed reader board will be installed this year at Tomsett Elementary School.
- Continue the in-street delineator sign placement on local streets fronting schools.

The in-street delineator signs have been successful at alerting drivers of the school zone and increasing safety in neighborhoods. The placement of these signs effectively narrows the travel lane which reduces vehicle speeds as drivers are required to slow down to negotiate the sign.

Twenty of the 38 elementary schools in Richmond now have this treatment. Consistent application of these signs creates a uniform school zone environment in the City, thereby modifying driver behaviour and encouraging drivers to slow down when entering school zone.

Traffic Calming: In response to resident requests or identified speeding issues, staff will perform an assessment, consult with the community, implement and monitor road safety and traffic calming measures where warranted in local neighbourhoods.

In response to resident concerns, to date in 2023, the following speed reduction interventions have been implemented or are currently being reviewed:

- In-street delineator signs have been installed at Dover Crescent at all crosswalk locations.
- A separate staff report titled *Kittiwake Drive - Traffic Calming Pilot Project Update*, recommending a trial of asphalt speed cushions on Kittiwake Drive to address speeding concerns raised by residents is being presented to the June 21, 2023 Public Works and Transportation Committee for consideration.
- Staff have also received a number of complaints regarding the marked crosswalk at No. 2 Road and Kittiwake Drive. While the crossing does not warrant a pedestrian signal based on traffic and pedestrian volumes, staff is reviewing the opportunity to install a raised cross walk at this location.

Road Network Safety Screening Study: In 2019, Council approved improvements to address the top 20 most collision-prone intersections in the City. A status of the Council approved 2023 capital projects include:

- *No. 4 Road and Westminster Highway Intersection Upgrade*: This intersection is ranked #7 of the City's Top 20 collision prone intersections. Upgrades include increasing left-turn capacity along with pedestrian and cycling facility upgrades. This project is currently at detail design phase with completion anticipated in Q3 2024.

- *No. 2 Road and Blundell Road Intersection Upgrade:* This intersection is ranked #10 of the City's Top 20 collision prone intersections. Upgrades include increasing pedestrian refuge areas and modifications to centre median on south approach to increase safety at access points. This project is currently at the design stage and is estimated to be completed in Q4 2025.

Removal of Channelized Right-Turn Islands to Improve Road Safety: In September 2022, Council approved the removal of channelized right-turn islands at several intersections within City jurisdiction. The upgrade to a standard intersection configuration with 90 degree right-turn geometry will slow vehicle speeds and improve safety between motorists and pedestrians/cyclists crossing the intersection.

Detailed design is underway for upgrades to the following intersections:

- Cooney Road/Westminster Highway
- Cooney Road/Granville Avenue
- No. 4 Road/Alderbridge Way
- No. 2 Road/Westminster Highway

Discouraging Vehicle Speeding: Pursue opportunities to curb vehicle speeding in the community. In January 2023, Council endorsed Traffic Bylaw No. 5870 amendments to remove all 60 km/h speed zones.

All roads within City jurisdiction now have a maximum posted speed limit of 50 km/h consistent with the default speed limit in the *BC Motor Vehicle Act*. Discussion at the Public Works and Transportation Committee of May 17, 2023, included review of potential posted speed limit reduction in the Hamilton area. Staff will undertake a traffic study, consult with residents and bring forward recommendations and any bylaw amendments for Council consideration in 2023.

Education Initiatives

Under this initiative, the City supports a variety of road safety campaigns and education to develop knowledge skills that enable pedestrians, cyclists and drivers to use the road safely.

Pedestrian and Traffic Safety Education and Campaigns: Staff will continue to support and participate in on-going multi-agency efforts to increase the level of pedestrian and traffic safety, such as the annual campaigns held by ICBC and Richmond RCMP in various locations. A list of the planned ICBC 2023 road safety campaigns is provided in Attachment 1.

Bicycle Education for Students: Jointly with HUB Cycling and the Richmond School District, the City will facilitate cycling education courses to all Grade 6 and 7 elementary school students over a two-year period (i.e., approximately 19 schools per year). Students will learn the rules and responsibilities of riding on City streets and bike paths and receive hands-on practice with fundamental cycling skills on school grounds and local neighbourhood streets.

E-Scooter and E-Bike Safety Campaign: Staff will continue social media posts to deploy safety and education regarding the use of e-bicycles and e-scooters, focused on raising awareness of the e-scooter pilot project, bylaws and the safe operation of e-scooters.

Enforcement Initiatives

Active enforcement helps to shape road user behaviour and encourages compliance with the traffic regulations. Studies suggest that increased observance of the road rules is achieved if people believe that not obeying them will result in outcomes such as tickets and fines.

Richmond RCMP continue to conduct speed enforcement on major roads as well as enhanced enforcement at specific locations when requested. From January 1 to May 9, 2023, Richmond RCMP enforcement activities included 567 tickets issued for speeding and 79 tickets issued for excessive speeding (at least 40 km/h over the posted speed limit).

Community Bylaws and Richmond RCMP regularly provide coordinated enforcement in school zones. Other typical on-going measures include the deployment of Speed Watch volunteers.

Intersection Safety Camera Program

The Province's Intersection Safety Camera Program includes nine red light cameras and one speed enforcement camera located in Richmond. The camera located at the intersection of Cambie Road includes automated speed enforcement capabilities. This camera registered 2048 speed violations in 2020, 527 speed violations in 2021 and 671 speed violations in 2022. Data on speed violations from 2023 will be collected to measure the effectiveness of automated enforcement cameras in reducing speed violations.

Staff will continue to work with ICBC and the Province to encourage the implementation of more Intersection Safety Cameras within Richmond.

Highlights of 2022 Road Safety Activities

In 2022, the City responded to traffic safety concerns at a number of schools and from local residents. Attachment 2 provides an overview of the implemented traffic calming measures to address speed-related concerns where warranted and supported. Highlights of other transportation system upgrades to enhance road safety and the 2022 education and enforcement efforts are also summarized.

Review of Vision Zero Strategies

At the Council meeting of March 27, 2023, representatives of the Richmond Poverty Reduction Coalition (RPRC) presented their report on Improving Pedestrian Safety in Richmond through Vision Zero Strategies. Recommendations from the RPRC's study included:

1. Assemble a working group to prepare a Vision Zero proposal with representatives from public health, City departments, law enforcement, and the Richmond School District 38.
2. Increase efforts to enforce the pedestrian's right of way.
3. Promote awareness campaigns that highlight pedestrian vulnerability and inspire ownership of pedestrian safety.
4. Examine opportunities to advocate with ICBC and TransLink for safer and more sustainable policies.

Following the Council meeting, representatives of the Richmond Poverty Reduction Coalition (RPRC) were invited to attend and share the findings of their pedestrian safety project at the March 30, 2023 TSAC meeting. As TSAC includes members from the City, local public health, enforcement and education sectors, this forum is appropriate for discussion of the areas of interest identified by this stakeholder. The programs and activities that the Committee undertakes throughout the year encompass the four recommendations of the RPRC study. RPRC will be invited to all future TSAC meetings to share their perspective on agenda items and to add agenda items for review and discussion.

The following section provides a background on the broader Vision Zero approach to road safety management and how the City's road safety initiatives align and advance Vision Zero strategies.

Overview of Vision Zero

The goal of Vision Zero is to eliminate all motor vehicle related fatalities and serious injuries within a very ambitious timeframe of five to 10 years. A Vision Zero commitment to eliminating traffic deaths means addressing all factors contributing to safe mobility, including the road users, vehicles, speeds, road design, and post-crash care. Vision Zero recognizes a multi-disciplinary approach is required for road safety and involves partnership between all levels of government and participation and input from several road safety stakeholders.

The formation of the City's Traffic Safety Advisory Committee that includes a diverse group of road safety agencies contributing to a safer transportation system in Richmond has been in place for 25 years; well ahead of the Vision Zero recommendation for a multi-disciplinary approach to road safety being adopted in North America in the mid 2010's.

Vision Zero Strategies

Although some of the Vision Zero strategies fall outside of the purview of local government, several of the City's programs and policies directed at increasing road safety align with Vision Zero. In addition to the City's road safety initiatives described in this report, a comprehensive list of the City's transportation-related actions that align and advance the Vision Zero goal are provided in Attachment 3. The key Vision Zero strategies are discussed below.

- Speed Management

  Vision Zero's focus is primarily on changing driver behaviour by reducing posted speed limits. Reductions in vehicle speeds can have a very significant influence on the severity of crashes and injuries, particularly those involving pedestrians. Research indicates that pedestrians suffer much more serious injuries when struck by high-speed vehicles than when struck by vehicles going 30 km/h or slower. This is consistent with the policy direction for the region as outlined in TransLink's new Transport 2050 plan which advocates for reduced default speed limits for local/urban streets of 30 km/h to 40 km/h. A lower posted speed limit on local residential streets will support making the streets more comfortable for pedestrians and cyclists.

  However, until a lower speed limit is formalized at a regional level, this is best implemented on a case by case basis when residents feel that a 50 km/h speed limit is too fast. The challenge with implementing reduced speed zones to date has been the lack of support from a majority of residents for such. Even in cases where a traffic study indicates vehicles operating at 30 km/h on average, resident survey to formalize the lower speed zone has yielded less than majority support for the addition of 30 km/h speed limit signs.

  A City-wide blanket lower speed limit for local streets could address this challenge, however, would require associated traffic calming measures, increased enforcement levels and could create confusion among drivers crossing municipal boundaries.

This approach could also be considered excessive, as a review of historic crash data shows that local residential streets represent five per cent of the vehicle collisions in the City. The current approach to targeting road safety interventions on local roads where safety concerns are identified is appropriate given the number of collisions on these types of roadways.

Staff have commenced review of lowering the speed limit in the Hamilton area neighbourhood. A staff report with recommendations and associated bylaw amendments is anticipated to be brought forward for Council consideration in Q4 2023.

- Safe Street Design
  In 2019, Council endorsed the report titled "Review of Collision Prone Intersections", which identified and recommended improvements to address the top 20 most collision-prone intersections in the City.

  This screening of the City's road network study that undertook an in-depth data-driven technical analysis to identify locations with the highest risk of collisions is also consistent with the strategies of Vision Zero. The City's study also goes above and beyond Vision Zero as the program includes mitigation measures along with a concrete action plan for new and dedicated City funding towards the implementation of the safety improvements identified in the study.

- Monitoring and Evaluation
  Staff monitor and evaluate the effectives of specific safety features implemented through before and after studies. On a system wide basis, historic ICBC crash data (available 2017 to 2021), the number of intersections per year experiencing 25 or greater collisions continues to decrease in the City (Figure 2).

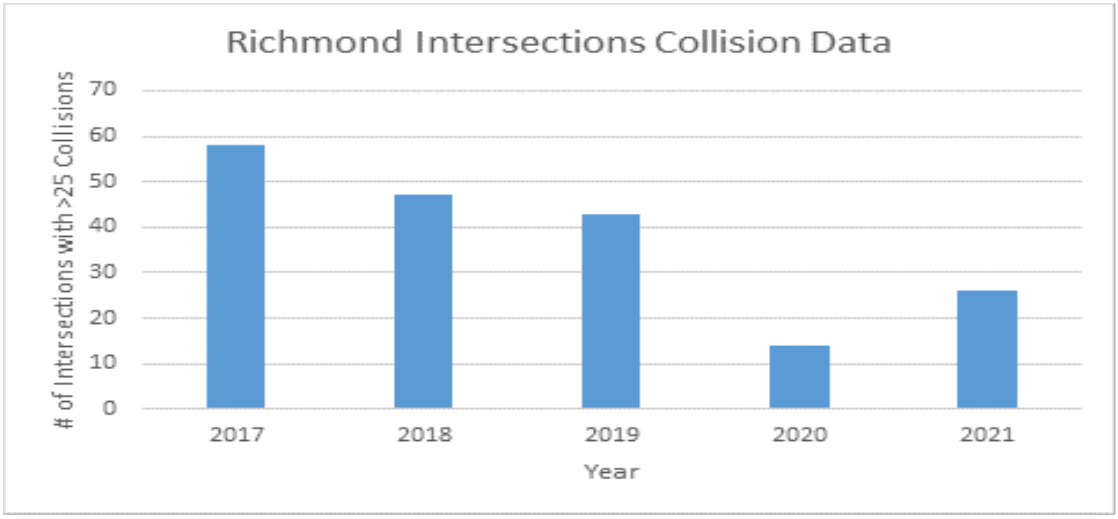

Figure 2: Number of Intersections with Greater than 25 Collisions

Setting a timeline to achieve zero traffic deaths and serious injuries is also a part of a Vision Zero commitment.

Review of cities that have adopted Vision Zero does not indicate that any have been able to eliminate all traffic related fatalities and injuries through adoption. The City's current road safety approach to develop a customizable set of solutions through data-gathering, local partnerships, community education, enforcement and re-engineering when necessary maximizes investment by implementing safety interventions where they are needed.

Staff will continue to explore opportunities to enhance and expand safety outcomes and discourage vehicle speeding which is consistent with the Vision Zero philosophy.

Financial Impact

None.

Conclusion

The ongoing and planned road safety initiatives for 2023 will continue efforts to further encourage safer use of the transportation network for vehicles, pedestrian and cyclists in Richmond. These will include implementing a range of proven safety mitigation measures encompassing engineering, education and enforcement activities.

The Traffic Safety Advisory Committee, a multi-agency forum, dedicated to enhancing pedestrian and traffic safety within Richmond will provide input on and support of various traffic safety improvements and programs.

The City's road safety projects, programs and policies are aligned with the recommended strategies of the Vision Zero safety movement. The City's annual road safety initiatives advance the Vision Zero goal by reducing the frequency of collisions through the implementation of a wide range of speeding countermeasures directed at making travelling around Richmond more safe and comfortable.

As the Richmond School District is an essential partner in the delivery of the school zone traffic safety program, staff will forward a copy of this staff report to the Richmond Council-School Board Liaison Committee for information.

Sonali Hingorani

Sonali Hingorani, P. Eng.
Manager,
Transportation Planning and New Mobility
(604-276-4049)

SH:ck

Att. 1: 2023 ICBC Road Safety Campaign Calendar
2: 2022 Overview of Road Safety Highlights
3: Examples of City's Transportation-related Actions that Align with Vision Zero

Attachment 1

2023 ICBC Road Safety Campaign Calendar

	MARCH		APRIL	MAY		JULY	SEPTEMBER			OCTOBER		DECEMBER
Enhanced Enforcement Period **BCACP**	Distracted Drivers Campaign	Occupant Restraint Campaign		High Risk Driving Campaign		Summer Impaired Driving Campaign (Alcohol/Drug)	Distracted Driving Campaign		Occupant Restraint Campaign	Drive Relative to Conditions Campaign (Speed/ Pedestrian)		Winter Impaired Driving Campaign (Alcohol/Drug)
Road Safety Issue **ICBC**	Distractions	Occupant Restraint	Auto Crime	High Risk Driving	Motorcycles	Summer Impaired (alcohol/drug)	Distractions	Back to School*		Drive Relative to Conditions (Speed/Peds)	Shift into Winter (Pedestrian Safety)	Winter Impaired (alcohol/drug)
Campaign Messages **PWT - 31**	Distracted driving now causes more fatal crashes in BC than impaired driving. Even short glances away from the road increases your risk of crashing. Leave your phone alone while driving.	Wearing your seatbelt is one of the best ways to protect yourself from being injured or even killed in a crash. It's also the law. A ticket will cost you $167 – so remember to buckle up.	Any unsecured vehicle is a target for auto crime, with older vehicles having the highest risk. Use an immobilizer or steering wheel lock, and make sure you lock your doors to reduce your risk	Speed is the number one contributing factor for car crash fatalities, ahead of distracted or impaired driving. When you slow down you see more of the road. Reducing your speed gives you more time to react. Bike to Work Week: Whether you're a driver or a cyclist, we all have a role to play in sharing the road safely.	As a driver, you can only see motorcycles when you really look for them. Especially at intersections, and when changing lanes, stay alert and yield right-of-way appropriately. Motorcycle riders and their passengers should wear "all the gear, all the time".	When you drink and drive, you not only risk your life but those of others on the road. If your summer activities involve alcohol, you need to plan ahead to get home safely. If you've been drinking, don't drive. Use a designated driver, call a taxi or rideshare, or take transit.	Distracted driving causes more fatal crashes in B.C. than impaired driving. Even short glances away from the road increases your risk of crashing. Leave your phone alone while driving.	We're encouraging parents to review the rules of the road with their children and go over their daily route to and from school. Drivers should be completely focused on the road and watching for children, especially in or around school zones.	Wearing your seatbelt is one of the best ways to protect yourself from being injured or even killed in a crash. It's also the law. A ticket will cost you $167 – so remember to buckle up.	More police will be enforcing safe driving for everyone, specifically targeting speeders. When you slow down you see more of the road. Reducing your speed gives you more time to react. You see pedestrians when you really look for them.	Adjust your driving for the road conditions you encounter. In bad weather, slow down, increase your following distance and allow extra travel time. Nearly half of all crashes with pedestrians happen between October and January, as visibility and weather conditions get worse.	When you drink and drive, you not only risk your life but those of others on the road. If your holiday festivities involve alcohol, plan ahead for a safe ride home: arrange a designated driver, call a taxi or rideshare, take transit, or use Operation Red Nose if services are available in your community.
Target Audience	**BC drivers**	**BC drivers**	**Auto Thieves**	**BC drivers. Motorcyclists, Pedestrians, cyclists**	**BC drivers**	**BC drivers 19-45 years of age**	**BC drivers**		**All car occupants**	**BC drivers**	**BC drivers**	**BC drivers 19-45 years of age**

2022 Overview of Road Safety Highlights

Safety Initiatives	Intervention	Location/Description
Engineering	In-Street Markers in School Zones	• Henry Anderson Elementary School • William Bridge Elementary School • Samuel Brighouse Elementary School • Thomas Kidd Elementary School • William Cook Elementary School • Spul'u'Kwuks Elementary School • Howard DeBeck Elementary School • John T. Errington Elementary School • École Élémentaire James Gilmore Elementary School
	Traffic Calming	• Temporary installation of speed cushions on Kittiwake Drive in October 2022. • New traffic circle was installed at Barnard Drive and Robson Court in spring 2022. • 4th Avenue / Manoah Steves Elementary School.
	Traffic and Signal Operations	• Installation of two new traffic signals: Shell Road/Williams Road and Cook Road/midblock between No. 3 Road and Buswell Street. • Traffic cameras added at six signalized intersections. • Installation of a new pedestrian signal at Westminster Highway and Westminster Highway North. • Four new pedestrian actuated special crosswalks. • 20 signalized intersections were improved to include overhead illuminated (LED) street name signs to enhance intersection visibility. • New Audible Pedestrian Signal (APS) intersections and/or push buttons installed at 33 intersections.
	Speed Reader Boards	• 22760 block of Westminster Highway. • Westminster Highway near the Hamilton Transit Centre.
Education Initiatives	Pedestrian Safety	• In November 2022 Richmond RCMP officers and community police volunteers conducted a total of four pedestrian safety education and enforcement campaigns that involved the distribution of reflectors and proactive engagement with pedestrians. Locations focused on Canada Line Stations (Richmond-Brighouse and Lansdowne) and the Minoru Centre for Active Living.
	Cycling Safety	• Bike to School Education for Students: a total of 1,627 students from 19 elementary schools received hands-on practice with fundamental cycling skills on school grounds and local neighbourhood streets.
	E-Bicycle and E-Scooter Safety	• An information handout to convey the rules and regulations of e-scooters in the city was developed by the Richmond Block Watch office. These were distributed on shared pathways, at road side and at community events in 2022.
Enforcement Initiatives	Distracted Driving	• Richmond RCMP officers and community police volunteers conducted “Cell Watch” deployment in March, September and October 2022. Approximately 2590 motorists were checked, 50 warning letters and 27 violation tickets were issued.
	Speed Management	• Richmond RCMP enforcement activities in 2022 included 1467 tickets issued for speeding and 130 tickets issued for excessive speeding.

Examples of City's Transportation-related Actions that Align with Vision Zero

- Annual Arterial Crosswalk Improvement Program to upgrade existing marked crosswalks on arterial roads to special crosswalks.
- Annual Accessible Pedestrian Signals (APS) Program to upgrade all City-owned special crosswalks, pedestrians signals and full traffic signals with APS features.
- Other annual capital programs to enhance road safety:
    - Neighbourhood Walkway Program: construction of new and/or enhancement of existing neighbourhood walkways/sidewalks.
    - Active Transportation Improvement Program: implementing cycling and rolling (e.g., wheelchairs and scooters) improvements.
    - Arterial Roadway Improvement Program: implementing pedestrian and traffic safety improvements along arterial roads and at arterial road intersections.
    - Traffic Calming Program: the implementation of traffic control measures to address concerns regarding through (short-cutting) traffic and excessive speed on the City's public roads.
- On-going partnership with ICBC:
    - Road Safety Improvement Program: cost-share funding.
    - Network Screening Study: identification of high crash locations and road safety countermeasures.
- On-going partnership with Richmond RCMP (Traffic Section): identification of roadways for increased enforcement.
- Cycling Education Courses: annual funding of courses for elementary school students and local residents.
- Follow the Province's Community Road Safety and Vision Zero Toolkit that provides road safety designs and strategies that local governments can implement to improve road safety.

City of Richmond

Report to Committee

To:	Public Works and Transportation Committee	**Date:**	May 17, 2023
From:	Suzanne Bycraft Director, Public Works Operations	**File:**	10-6000-01/2023-Vol 01
Re:	**2022 Annual Water Quality Report**		

Staff Recommendations

1. That the annual report titled "2022 Annual Water Quality Report" dated May 17, 2023, from the Director of Public Works Operations, be endorsed; and

2. That the annual report titled "2022 Annual Water Quality Report" dated May 17, 2023, be made available to the community on the City's website and through various communication tools including social media channels and as part of community outreach initiatives.

Suzanne Bycraft
Director, Public Works Operations
(604-233-3338)

Att. 2

REPORT CONCURRENCE	
CONCURRENCE OF GENERAL MANAGER	
SENIOR STAFF REPORT REVIEW	INITIALS: CJ
APPROVED BY CAO	

Staff Report

Origin

In 2001, the Province of British Columbia enacted the Drinking Water Protection Act, which gave authority to the Minister of Health to implement and enforce standards for water supply systems in British Columbia. In May 2003, regulations to be implemented under the Act were adopted by the legislature as the Drinking Water Protection Regulation. These Acts were updated on April 29, 2014, under Bill 18 – 2014: the Water Sustainability Act. These regulations are designed to ensure the safe supply of drinking water.

This report presents the City's "2022 Annual Water Quality Report" (the Report), which enables the City to meet its obligations for public reporting to comply with applicable requirements in accordance with these regulations. The City was able to ensure the safe and adequate supply of essential water services throughout 2022. A summary of the Report is presented as Attachment 1, with the full report included as Attachment 2.

This report supports Council's Strategic Plan 2022-2026 Focus Area #2 Strategic and Sustainable Community Growth:

> *2.3 Ensure that both built and natural infrastructure supports sustainable development throughout the city.*

This report supports Council's Strategic Plan 2022-2026 Focus Area #3 A Safe and Prepared Community:

> *3.3 Ensure the community is collectively prepared for emergencies and potential disasters.*
>
> *3.4 Ensure civic infrastructure, assets and resources are effectively maintained and continue to meet the needs of the community as it grows.*

This report supports Council's Strategic Plan 2022-2026 Focus Area #5 A Leader in Environmental Sustainability:

> *5.3 Encourage waste reduction and sustainable choices in the City and community.*

This report supports Council's Strategic Plan 2022-2026 Focus Area #6 A Vibrant, Resilient and Active Community:

> *6.1 Advance a variety of program, services, and community amenities to support diverse needs and interests and activate the community.*

Analysis

The Drinking Water Protection Regulation requires water purveyors in BC to possess an operating permit, which confirms the Drinking Water Officer for the area has approved the water supply. Vancouver Coastal Health is responsible for the placement and function of the Drinking

Water Officer, who has the authority to monitor water purveyors to ensure they are providing safe drinking water through compliance with the British Columbia Drinking Water Protection Regulation, and any other conditions of the operating permit.

Under the Regulation, the City of Richmond is required to:

- Develop and maintain a process to notify the Drinking Water Officer and the Medical Health Officer of situations or conditions that could render unsafe drinking water;
- Implement and maintain a plan for collecting, shipping and analyzing water samples that adequately represent all areas within the City, in compliance with the direction set by the Drinking Water Officer; and
- Implement and maintain a plan for reporting results to the Drinking Water Officer and to water users.

Richmond thrives on its ability to provide water to residents and businesses, and water for fire protection services. To ensure a consistent supply, the capital watermain replacement program is a proactive approach to avoiding breaks and has proven to be a reliable and valuable tool in water distribution management. In 2022, Public Works staff attended to 16 watermain breaks without compromising the integrity of the water distribution system. Repairs for a single watermain break can amount to $100,000, in addition to damage to private properties and service disruptions to businesses and residents. As such, a proactive replacement and maintenance program is essential to minimizing costs and ensuring minimal to no disruptions in water quality and supply.

Water conservation is an important aspect of Richmond's Water Services operations. Climate change, heat events and increasingly dry summers in recent years have emphasized a critical need for City-wide water conservation efforts. The City implements various programs to promote the conservation of water and to ensure that wastage of potable water is minimized. Richmond's various water conservation programs are outlined in the Report.

Highlights of the Report include:

- Richmond residents enjoyed high-quality, safe and reliable drinking water.
- 2,048 water samples were collected to ensure water quality and each passed with exceptional results.
- Test results confirm high-quality water and demonstrate continuous improvement.
- Richmond's total water usage decreased by 2.3% from 34.1M cubic metres in 2021, to 33.3M cubic metres in 2022, despite a population increase of 1.5% from 227,146 to 230,584 over the same year.
- Richmond's 37 water fountains found on dikes and in parks provided potable water to the public while promoting tap water consumption as an alternative to bottled water.

In addition to these highlights, safety measures and response procedures were continued in compliance with COVID-19 protocols that helped ensure staff were confident in their own safety and could perform their duties and responsibilities without compromise during the pandemic.

These and many other initiatives are detailed in the Report.

Proposed Communication

Subject to Council's approval, the Report will be posted on the City's website and made available through various communication tools including social media channels and as part of community outreach activities.

Financial Impact

None

Conclusion

The Report outlines the methods in which the City manages its water system to ensure compliance with applicable provincial requirements under the Drinking Water Protection Act. In 2022, the City's water quality met and exceeded the required standards to ensure residents enjoyed high quality, reliable and safe drinking water.

This report will be reviewed and endorsed by the Medical Health Officer of Vancouver Coastal Health Authority as part of the City's reporting obligations.

Bryan Shepherd
Manager, Water Services
(604-233-3334)

BS:

Att. 1: 2022 Annual Water Quality Report
2: 2022 Annual Water Quality Report Summary

Attachment 1

City of Richmond

2022 Annual Water Quality Report

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Richmond

Richmond is dedicated to promoting the value of municipal tap water, maximizing opportunities for use of tap water in municipal facilities and developing strategies for making tap water the "water of choice" in our community.

Executive Summary

The purpose of this report is to fulfill the requirements set out in the British Columbia Drinking Water Protection Act (BCDWPA) by giving an overview of the water distribution system, describing the maintenance conducted, detailing some of the unique features of the system and providing the results of Richmond's water quality testing program.

Test results confirm high-quality water and demonstrate continuous improvement. Richmond's water system is provided with the highest degree of care to ensure that it's an inhospitable environment for any harmful bacteria or toxins. Utility funding contributes to proactive watermain replacement and maintenance projects that will ensure the overall health of the system well into the future.

In 2022, the City of Richmond's Water Services staff undertook the following:

- Provided 33.3 million cubic of the highest quality drinking water to over 230,584 Richmond residents.
- Between 2020 and 2022, the per capita consumption decreased by 2.4%, resulting in the conservation of about 800,000 cubic metres of water in 2022.
- Conducted 2,048 microbiological tests from 40 test locations.
- Maintained 12 pressure reducing valve (PRV) stations.
- Repaired 16 watermain breaks without compromising the integrity of the water distribution system while maintaining positive pressure.
- Discovered and repaired 90 non-visible underground leaks through Richmond's leak detection program using noise loggers measuring sound frequencies in the targeted pipe allowing any leaks to be heard and recorded.
- Provided service to Richmond's 5,109 fire hydrants to ensure water is available during an emergency.
- Repaired 205 service connections.
- Installed 4,180 metres of new capital watermain.
- Installed 170 water services for new developments.

The City of Richmond's Water Services section takes its role as a water purveyor very seriously and is proud to be the guardian of such a precious resource.

Contents

1.0 Introduction

In 2002, the City of Richmond implemented a Drinking Water Quality Monitoring Program to comply with provincial and federal legislations: the British Columbia Drinking Water Protection Act (BCDWPA), the British Columbia Drinking Water Protection Regulations (BCDWPR), the Water Quality Monitoring and Reporting Plan for Metro Vancouver and the Guidelines for Canadian Drinking Water Quality (GCDWQ). Under these legislations, the City of Richmond is required to:

- Develop a process to notify the Vancouver Coastal Health (VCH) Drinking Water Officer and the VCH Medical Health Officer of any condition that could render unsafe drinking water.
- Implement a sampling program that adequately represents all areas within the City.
- Meet the requirements of the BCDWPA and ensure test results are immediately available to the VCH Medical Health Officer.
- Receive an annual construction permit for the construction, installation and extension of the water distribution system.
- Ensure that the City's water distribution system is classified under the criteria for the Environmental Operators Certification Program (EOCP) and that Water Services staff are certified to the same level as the distribution system.
- Produce an annual report detailing the results of the City's water quality monitoring program for review by VCH.

The conditions set out in the BCDWPA require all water systems in BC be classified as a Level I through IV facility. Richmond's system is classified as a Level III facility so all staff that work on the system are responsible for possessing a valid Level I to Level III EOCP certificate. To obtain and maintain a level of certification, staff must successfully complete the required training and hands-on experience. This ensures staff are able to respond appropriately and immediately to problems prior to them becoming a risk to health or property.

The following report outlines all the great work that Water Services staff perform to deliver safe and good-quality drinking water to the City's residents and the things they accomplish every day to operate and maintain a robust water infrastructure system.

Metro Vancouver Seymour Capilano Filtration Plant – Facing South

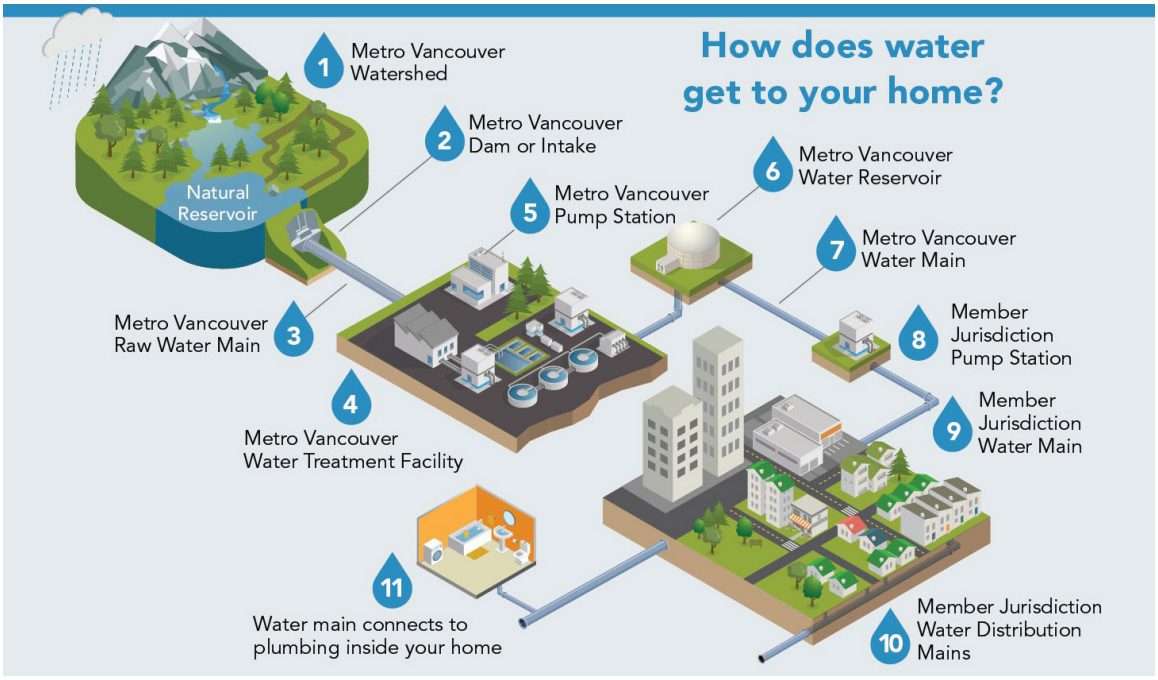
2.0 Water Treatment and Supply

The City of Richmond purchases its drinking water from Metro Vancouver Water District (Metro Vancouver), which supplies most of the region with water. Metro Vancouver supplies treated drinking water to Richmond via three large transmission mains. The water then enters the City's water distribution system through various connections throughout the City. The water is then delivered to residences and businesses through the City's distribution network and to service connections at each property. Water Services staff is in charge of taking care of the Water Distribution System to ensure that everyone in the City gets great quality water with minimal interruptions.

2.1 Where Richmond's Water Comes From

Metro Vancouver manages three local watersheds: Capilano, Seymour, and Coquitlam. The watersheds contain large collection lakes called reservoirs which collect and store rainfall and snowmelt from the mountains.

Water from the reservoirs is treated at two water treatment facilities: the Seymour Capilano Filtration Plant (SCFP), which treats water from the Seymour and Capilano reservoirs, and supplies two thirds of the region's drinking water; and the Coquitlam Water Treatment Plant (CWTP), which treats water from the Coquitlam reservoir and supplies the remaining third of the region's drinking water. The City of Richmond gets the majority of its water from the Seymour and Capilano reservoirs.



Metro Vancouver Watershed and Water Transmission Map

The SCFP is the largest filtration plant in Canada and has the capacity to filter and disinfect up to 1.8 billion litres of water per day. It is located in the Seymour watershed so water is transmitted from the Capilano reservoir to the SCFP and back by two underground watermains called "Twin Tunnels", which are over seven kilometres long and 3.8 metres in diameter. Water at this facility undergoes filtration and UV disinfection.

The CWTP is located north of the City of Coquitlam and treats 380 million litres of water per day. Water at this facility undergoes ozone and UV disinfection.

2.2 Richmond's Water System

The City of Richmond owns, operates, and maintains a water distribution system, which delivered 33.3 million cubic metres of water to the 230,584 residents and businesses in the City in 2022. Once Metro Vancouver treats the water, it is carried into Richmond via their large transmission mains; Angus Drive main, Lulu Island-Delta main and Tilbury main. Richmond then draws water through 12 connection points along Metro Vancouver's mains. Each connection has a pressure-reducing valve (PRV) station. The PRV stations are monitored from the Works Yard through a supervisory control and data acquisition (SCADA) system. Downstream of the PRV stations is the rest of the City's water distribution system consisting of distribution mains, hydrants, valves, service connections and more. An overview of Richmond's water system is shown on Figure 1.

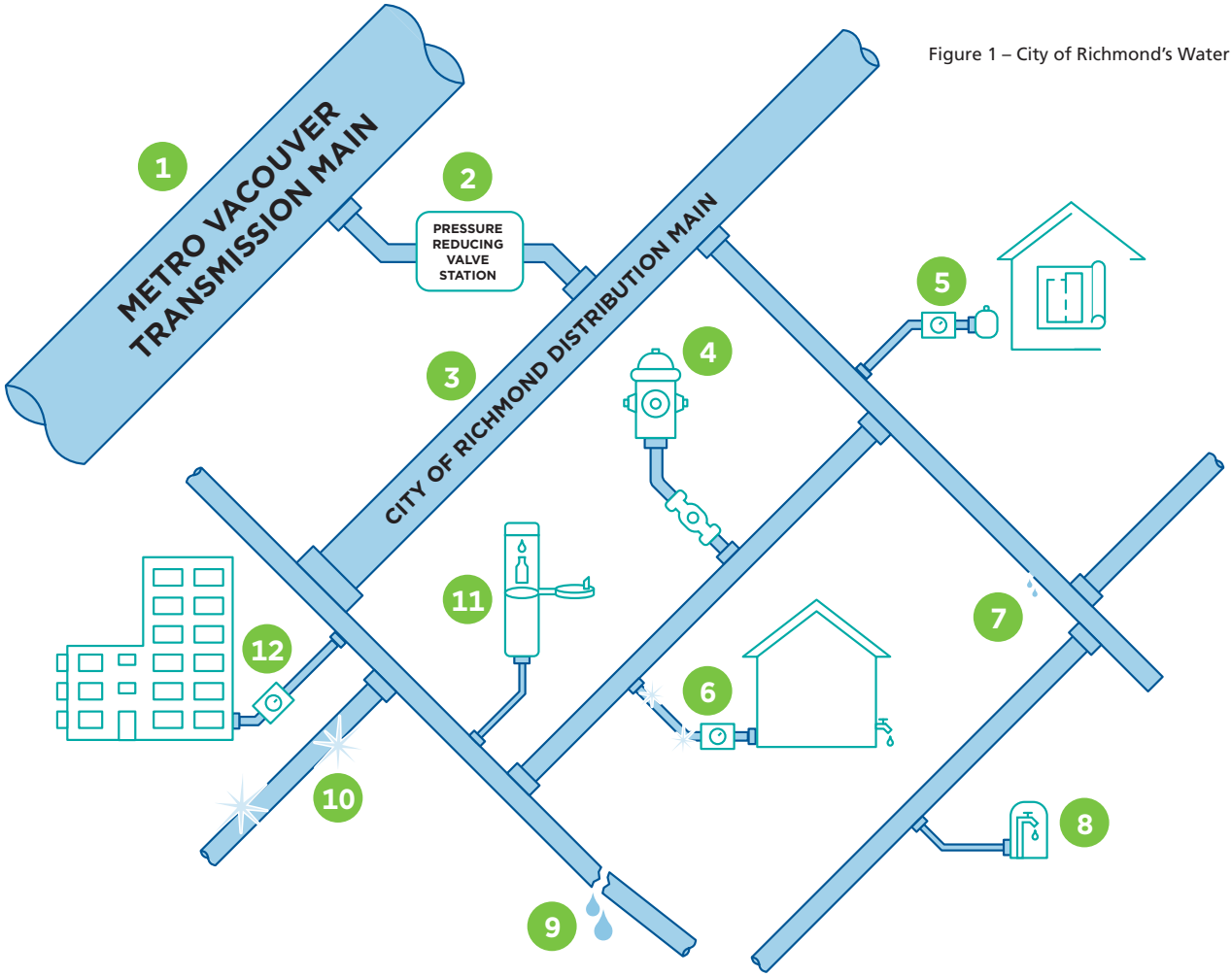
2.3 Mobile Emergency Response Unit

Water Services staff are trained to operate the mobile emergency water treatment trailer for use during a major emergency where the City's water is contaminated or unavailable. All components that come in contact with the treated water are compliant with the Guidelines for Canadian Drinking Water Quality (GCDWQ). Cartridges reduce turbidity, activated carbon improves taste and odour, and UV units disinfect the water. Additionally, sodium hypochlorite is added to provide a second source of disinfection and chlorine will provide residual disinfection in the water.

The treatment trailer is capable of filtering approximately 60 litres of water per minute and can draw water straight from the Fraser River. The trailer was designed with the consideration of factors such as extreme weather events, sudden loss of clean water from Metro Vancouver and seismic events. It is regularly maintained and tested by Water Services staff to ensure that the City has clean safe water for Richmond residents during an emergency.

Mobile Emergency Response Unit

Figure 1 – City of Richmond's Water System



1. Metro Vancouver supplies drinking water to the City of Richmond via three transmission mains.
2. Pressure-reducing valve (PRV) stations are the interface between Metro Vancouver's mains and the City of Richmond's water system. Water Services crews operate and maintain 12 PRV stations throughout the City.
3. The City of Richmond's water system is made up of 636km of watermains. The watermains are all interconnected in different ways to supply high-quality water to Richmond residents. In 2022, Water Services provided 33.3 million cubic metres of water to over 230,584 City of Richmond residents.
4. Fire hydrants play an important role in the City's water system. They deliver large quantities of water for fighting fires and help keep the City's drinking water safe by providing a way for water to be safely flushed out of the water system. In 2022, Water Services staff serviced and maintained 5,109 hydrants. For more information on our flushing programs, see Section 3.2.1 in this report.
5. Water service connections link City of Richmond's watermains to houses and businesses. Water Services crews installed 170 new service connections to properties throughout the City.
6. Sometimes service connections can get damaged or break due to different reasons. Water Services crews are always ready to repair water connections to prevent service disruptions to residents. In 2022, crews repaired 205 water service connections.
7. The City of Richmond's Leak Detection Program that uses specialized equipment to find underground leaks in the water system. In 2022, City staff discovered and repaired 90 leaks. For more information the City's Leak Detection Program, see Section 4.4 in this report.
8. Water Sampling Stations help Water Services staff monitor the quality of the City's drinking water. There are 40 stations located in strategic locations throughout the City. In 2022 Water Services staff took 2,048 water samples from the system. These samples were taken to a lab for analysis. The test results and discussion are contained in Section 3.2 in this report.
9. All pressurized systems can develop breaks due to the strain on the pipes. Water Services staff minimize breaks by replacing aging infrastructure and implementing a Pressure-Management Program (for more information, see Section 4.2 in this report). In 2022, City staff responded to and repaired 16 watermain breaks.
10. The City of Richmond has a watermain replacement and installation program to upgrade aging underground water infrastructure and improve the watermain network throughout the City. In 2022, Water Services crews installed 4,180 metres of watermains of various sizes.
11. Drinking water fountains help bring fresh drinking water to City of Richmond's residents and are a sustainable way of keeping hydrated while on-the-go. Water Services staff maintained and serviced 37 fountains along Richmond's dikes and in parks. For more information, see Section 5.1.2 of this report.
12. Water metering is important since it measures how much water each property has used. This makes sure that residents only pay for what they use and it also keeps residents informed of their water usage and promotes water conservation. In 2022, approximately 82% of the City's water usage was metered. For more information on the City's various Water Metering Programs, see Section 4.1 in this report.

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3.0 Ensuring the Quality of Richmond's Drinking Water

Many different aspects go into ensuring the quality of Richmond's drinking water. From conducting programs and preventative maintenance, to water monitoring and testing, including taking quick action in case a watermain break or water contamination does happen.

3.1 Promoting Water Quality

Water Services staff take great pride in providing high-quality water to residents in the City. Through various programs and preventative maintenance, staff ensure that the water is safe to drink and the risk to the water quality is minimized.

3.1.1 Flushing Program

Water Services conducts a unidirectional flushing program every year. Unidirectional flushing involves forcing water in a single direction through a specific route through the pipes by closing or opening valves in a strategic way. Forcing the water in a single direction increases the velocity of the water flow and ensures that the inside of the pipes are being scoured and cleaned while the water is flushed. The water is then drained through hydrants at the end of the flushing sequence to remove the debris from the system. Cleaning the inside of the pipes is important because it prevents bacterial growth and removes possible sediment from the system.

The City also conducts regular weekly, monthly and annual flushing at lower velocities to eliminate stagnant water in dead-ends and other low-demand areas.

3.1.2 Reduce Watermain Leaks and Breaks

The City has various programs that reduce leaks and breaks in the system, which help keep Richmond's drinking water safe and clean. Whenever there is a watermain break, the system can experience a loss of pressure, which can create negative pressure. When a watermain has cracks or gaps between joints, there is a possibility that ground water can be siphoned back into the system during times of negative pressure.

Two programs that promote water conservation also help keep the City's drinking water safe by preventing this ingress of ground water. The Leak Detection and Pressure Management programs reduce watermain breaks and minimize weak spots in the distribution system where ground water can get into the pipes. You can learn more about these programs in Section 5 of this report.

3.1.3 Quick Response to Watermain Leaks and Breaks

Not only is reducing watermain breaks in a system important, but responding quickly when leaks and breaks happen is just as crucial. Quick response by staff eliminates the chance or the amount of time that groundwater can enter the system, which in turn prevents contaminants from getting into the watermains. An example of quick thinking and coordination by Water Services staff during a watermain leak is detailed in the Community Connections article in Appendix B. Water Services staff are always on call and trained to respond to all levels of watermain breaks. See Appendix C to see staff response to breaks with suspected contamination.

3.1.4 Backflow Preventer Program

To protect the City's water system and ensure great water quality, Water Services staff install a backflow preventer at every hydrant that has an active hydrant-use permit. The backflow preventer acts as a one-way valve and helps keeps outside water from getting into the City's water system, which keeps possible contaminants out.

3.2 Monitoring Water Quality

The City of Richmond collects water samples on a weekly basis at 40 dedicated sampling sites. These sites are strategically located throughout the City to provide a suitable representation of the City's water quality across the whole network. In 2022, 2,048 water samples were collected by Water Services staff and sent for analysis at Metro Vancouver laboratories. These sample results were reviewed by Vancouver Coastal Health, the Health Authority in Richmond, to ensure the drinking water met the standards and parameters outlined in the British Columbia Drinking Water Protection Regulations (BCDWPR). Figure 2 – Water Sampling Stations Map shows a map of the sampling stations throughout the City and Appendix D contains a list of the sites, complete with their addresses.

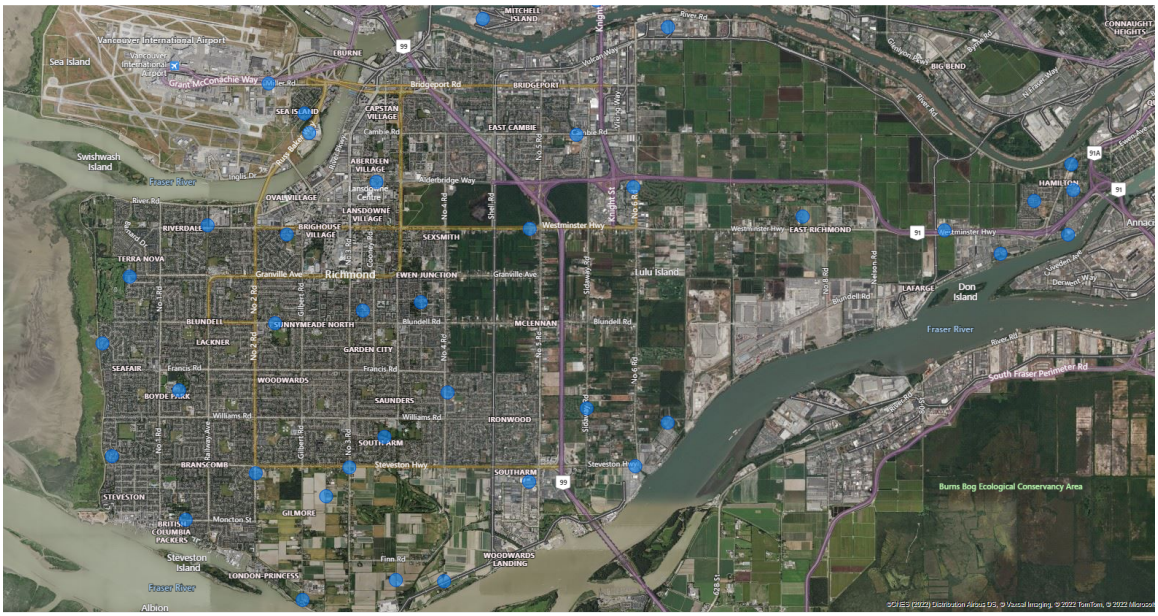

Figure 2 – Water Sampling Stations Map

3.2.1 Bacterial Parameters

The City of Richmond and Metro Vancouver conduct bacteriological tests for total coliform, fecal coliform and heterotrophic plate counts (HPC). The presence of these organisms in drinking water indicates that the water may be contaminated and may contain potentially harmful bacteria, viruses or parasites. Appendix E contains all of the City of Richmond's 2022 water test results.

Total Coliforms

Total coliform bacteria reproduce in water, soil or digestive systems of animals. The presence of total coliforms indicates water may have been contaminated or that the disinfection process is inadequate.

The number, frequency and location of samples for total coliform testing will vary depending on the type and size of the system and jurisdictional requirements. Provincial standards state that no sample contain more than 10 total coliforms per 100 ml, and that 90% of samples must have zero coliform bacteria in a sample over a 30-day period. In 2022, the City of Richmond's water met the drinking water requirement for total coliforms.

Fecal Coliforms

Fecal coliforms are present in large numbers in the feces and intestinal tracts of humans and other warm-blooded animals, and can enter bodies of water and water systems through contamination by human and animal waste. Due to the high risk of diseases and parasites, provincial standards state there can be no detectable fecal coliforms per 100 ml sample. In 2022, the City of Richmond's water met the drinking water requirement for fecal coliforms.

Heterotrophic Plate Count

Heterotrophic plate count (HPC) tests measure the level of the heterotrophic microorganism population in the City's drinking water. HPC tests indicate the presence of nutrients that could facilitate the growth of harmful bacteria, and can be a sign of changes in water quality if levels are elevated during treatment and distribution. Higher than normal HPC levels inform operators that there is an unusual increase of stagnant water or low chlorine residuals in the watermains. By reducing the HPC levels through the City's flushing programs, the possibility of bacteriological growth is decreased because the pipes become an inhospitable environment for bacteria to thrive. The small amount of free chlorine residual in the water also disinfects and eliminates harmful substances within the distribution system.

In 2022, three of the 2,048 water samples exceeded regulated levels for HPC's at 500 CFU/mls. Water Services staff flushed the corresponding section of the system until an acceptable result was obtained and verified through additional sampling procedures.

3.2.2 Chemical Parameters

Testing is done for chemicals in the water to ensure the proper amount of chlorine is in the system, to confirm that by-products from the disinfection process do not remain in the water and to ensure that naturally-occurring chemicals in the water are at acceptable levels.

Chlorine Residual

Chlorine residual is a measurement of the free chlorine remaining in the distribution system at the point of delivery to the customer. Chlorine is added to the City's drinking water by Metro Vancouver as part of the disinfection process to prevent bacterial growth during distribution. When the source lakes experience high turbidity (like during a storm), Metro Vancouver will increase the chlorine that's added to the water at their plants to ensure that the water quality is maintained despite the higher-than-desired turbidity. Typically, the slightly higher concentration of free chlorine in the system dissipates by the time it reaches the City's system. Sometimes the higher concentration remains in the system and can cause a chlorine taste and smell in the water. Despite the increased chlorine, the water is still safe to drink.

There also needs to be a minimum level of chlorine residual to protect Richmond's water supply from bacteriological contamination or growth. The minimum parameter for free chlorine residual in the water is 0.2 mg/L. In recent years, the City has made great progress in improving chlorine residuals by executing various flushing programs to clean and flush the watermains. In 2022, all of the water samples met the requirement of at least 0.2 mg/L. All of the 2022 chlorine residual results can be found in Appendix E.

Disinfection By-Products

Disinfection by-products are potentially harmful compounds produced by the reaction of a water disinfectant (such as chlorine or ozone) with naturally occurring organic matter in water. Two common chlorination by-products are Trihalomethanes (THMs) and Haloacetic Acids (HAAs).

THMs that are present in drinking water can enter the human body via multiple routes of exposure. These include ingestion by consuming water and inhalation and skin absorption from showering and bathing. Under the Guidelines for Canadian Drinking Water Quality (GCDWQ), the maximum acceptable concentration for THMs is 100 parts per billion (ppb). The maximum level for THMs is based on a running annual average of samples taken every three months. High levels on a particular day are not of concern unless they are consistently high over the latest four samples. Typically, THM levels will be highest in the summer and lowest in the winter months.

Under the GCDWD, the maximum acceptable concentration for HAAs is 80 parts per billion (ppb). Like THMs, HAAs are also monitored quarterly and are calculated on a running annual average of samples taken every three months.

The City utilizes the Metro Vancouver laboratory to perform quarterly tests for HAAs and THMs. These were carried out at representative sampling sites in accordance with a joint Metro Vancouver and City of Richmond monitoring plan. In 2022, all results were within acceptable levels as defined in the GCDWQ. See Appendix F for all test results and current running levels of THM and HAA in the system.

Testing a Water Sample

Acidity (pH Value)

The measurement of acidity is known as pH. A pH below 7.0 is considered acidic, above 7.0 is considered basic, with 7.0 being neutral. It is recognized that acidic water will accelerate the corrosion of metal pipes, often causing blue-green staining in household fixtures.

The acidity of the City's water is controlled by Metro Vancouver. The Seymour-Capilano filtration plant includes pH adjustment and corrosion control in its treatment processes. It is expected that the pH of drinking water will rise in the coming years as the filtration plant reaches its full capacity. Since natural acidity in water corrodes metal pipes over time, the pH increase will extend the lifespan of water plumbing systems and enhance water quality.

Metals

The City's water quality program also includes testing for metals that can be present in natural water sources like copper, iron, lead, and zinc. Appendices E and F contain a list of the metal limits stated by the GCDWQ and the results from the samples taken in 2022. All results were within or below the GCDWQ limits.

3.2.3 Physical Parameters

The water in Richmond's distribution system is tested for turbidity and temperature on a weekly basis. Information is also collected on the taste and odour of Richmond's water by actively tracking water quality complaints. The 2022 temperature and turbidity test results can be found in Appendix E.

Turbidity

Turbidity is a measure of water clarity and cloudiness in the water, and is caused by dissolved substances that are present in the water. Turbidity is measured in Nephelometric Turbidity Units (NTU). The guideline for turbidity should not exceed 5 NTUs in a distribution system providing that source water protection, monitoring, and water treatment requirements are met including increased levels of residual chlorine. Turbidity is a concern because increased turbidity compromises the drinking water disinfection process, and can allow microbes to grow or indicate that there is a presence of microbes in the system.

In general, sites with elevated turbidity are located in sections of the distribution network where there is low demand on the water system or where dead-end watermains exist. The increase may be attributed to sediment disturbance in the distribution system. In 2022, 12 samples out of 2,048 had turbidity levels that exceeded 1 NTU and of those, two exceeded 5 NTUs. If a sample indicates a turbidity level greater than 5 NTUs in the distribution system, affected watermains in the test area are flushed and re-tested until a satisfactory result is obtained.

Temperature

High temperatures in the distribution system can affect the amount of chlorine residual and can contribute to bacterial growth. Typically, the temperature of drinking water in the distribution system rises during summer months. Records indicate that one customer complaint was received regarding Richmond's water temperature in 2022. Water Services staff responded by flushing and testing the water at a nearby hydrant. In 2022, of the 2,048 samples taken, 278 exceeded the aesthetic guideline of 15°C. The highest temperature recorded was 19°C. The vast majority of these elevated temperatures were recorded during the summer months and "heat wave" events.

Testing Water Temperature

Taste and Odour

Taste and odour are monitored through customer complaints. If the water quality meets all the other parameters set out in this report, the taste and odour of the water should not change. Most of the time the different taste and odour will be the result of an increase in free chlorine, which is safe to drink. However, it's important for the City and Water Services staff to track and react to complaints because it could mean that contamination has occurred somewhere in the system.

Records indicate that 14 complaints were received regarding taste and four complaints were received regarding odour in 2022. These complaints generally relate to high levels of chlorine residual in that part of the system at that particular time. Residents who complained about taste or odour problems were advised to flush their internal system by running their taps. If the problem was not resolved, Water Services staff were dispatched to the location until a satisfactory result was obtained and verified through laboratory analysis.

3.2.4 Failed Samples

It is important for City staff to deal with failed sample results are dealt with right away. The City's standard response to a failed water sample is:

- Re-sample from the same station.
- Flush the watermain extensively.
- Re-sample again from the same station.
- Isolate the watermain to one feed until test results confirm compliance with the British Columbia Drinking Water Protection Regulations (BCDWPR).

3.2.5 Notifications

Under the Drinking Water Protection Act, the Metro Vancouver laboratory must immediately inform the City of Richmond, the Drinking Water Officer and the Medical Health Officer if a water supply system result fails to meet established guidelines. Immediate action and precautions are taken and notifications are given. If any threats are made to the water supply, the Drinking Water Officer must be notified immediately.

Water safety situations such as chemical or biological contamination, turbidity over 5 NTU, disinfection failure, loss of pressure due to high demand, or a watermain break where there is suspected contamination, would be considered an emergency and immediate action would be taken. The Drinking Water Officer and Medical Health Officer would be notified immediately. See Appendix C for more details about the actions taken by Water Services staff.

Water quality advisories are issued to the general public when necessary. Similarly, if there is construction or a service being done that will affect the quality of the drinking water, a notification will be issued to the affected residents.

4.0 Water Conservation

Water conservation efforts are important to ensure that the regional system can keep up with the growing population in the area, to safeguard the region's water supply and to help maintain the area's beautiful environment. Climate change and increasingly dry summers have expedited the need for city-wide water conservation efforts.

The City of Richmond continues to succeed in reducing annual water consumption despite a growing population by implementing corporate and community-wide initiatives. These include water metering, pressure management, leak reduction and detection programs, a toilet rebate program and a rain barrel sale program.

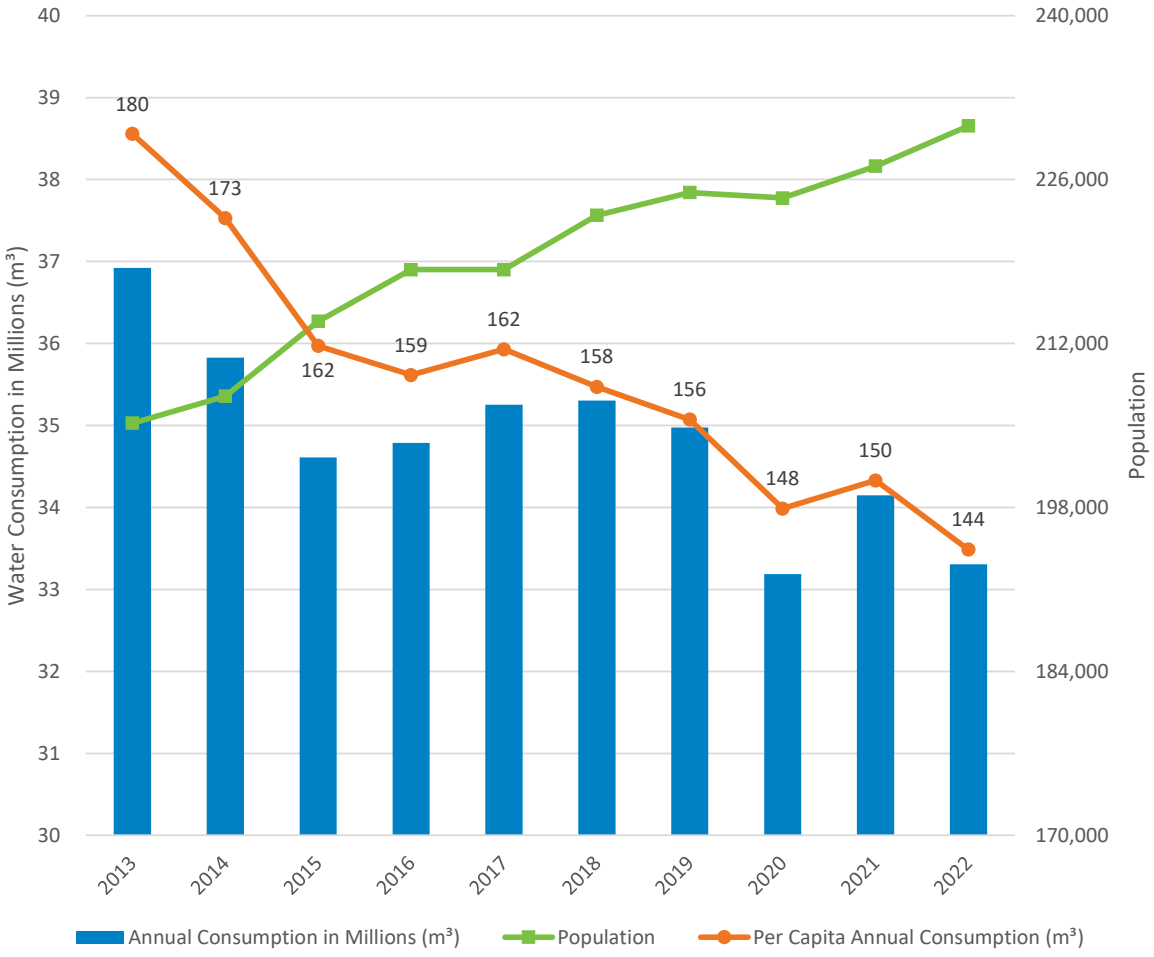

Figure 3 – Water Consumption vs Population (2013 to 2022)

The graph in Figure 3 shows how the City of Richmond has been conserving water despite an increase in population over the years. Other than in 2021, the City's water consumption per capita has been steadily decreasing since 2017; when the single-family water meter program was completed. Between 2020 and 2022, the per capita consumption decreased by 2.4%, resulting in the conservation of about 800,000 cubic metres of water in 2022. In 2021, the whole region saw a spike in water consumption due to the heat events that were experienced during the summer.

Water conservation has become more critical in recent years due to heat events, dry summers, and climate change. As more water conservation programs are developed, water consumption in the City will decrease further to support the region's push to conserve water.

4.1 Water Metering Programs

Water metering plays a significant role in the City's water management program as it promotes water conservation and charges residents for their water usage in a fair and equitable way. Water meters allow residents and businesses to pay for the actual amount of water they use, rather than being billed on the flat-rate system. Approximately 82% of the City's water usage was metered in 2022.

In Richmond, 100% of single-family residential homes are metered since the completion of the universal single-family water meter program in 2017. Additionally, 100% of industrial, commercial and institutional properties are metered.

Starting in 2022, in line with the City's dedication to water conservation efforts in the region, Water Services staff are gradually implementing mandatory metering for multi-family properties. Currently, 56% of multi-family complexes in Richmond, including all new developments, are metered. All remaining unmetered properties are scheduled to be metered over the next 15 years.

Multi-Family Water Meter Installation

4.2 Pressure Management Program

Using the Pressure Reducing Valve (PRV) stations, the City of Richmond reduces water pressure by 10 PSI from October to May, causing the system pressure to change from 90 PSI to 80 PSI. The purpose of this practice is to reduce the volume of leakage during a lower demand period and extend the life of the City's water infrastructure. During summer months, a timer-based system lowers the pressure from 90 PSI to 80 PSI from 1:00 to 5:00am. A decrease in nighttime flows, leakage, and watermain breaks have been observed since the inception of this program.

4.3 Leak Reduction Program

The City's Leak Reduction Program involves using the fixed-base metering system to detect single-family properties with continuous water consumption. City staff identify the properties and educate the homeowners about the continuous usage, which could indicate a leak in their private system. The program can significantly reduce overall private property leakage since leaks can be detected by the system earlier than when they become visible or obvious.

4.4 Leak Detection Program

The leak detection program discovers non-visible underground leaks within the City's distribution system using noise loggers measuring sound frequencies in the targeted pipe allowing any leaks to be heard and recorded.

4.5 Toilet Rebate Program

The City of Richmond's Toilet Rebate Program provides a utility account rebate of $100 to homeowners who install a low-flush toilet. Single and multi-family homeowners are eligible to apply for a lifetime maximum of two rebates per property. Industrial, commercial and other non-residential properties are not eligible at this time. This program encourages homeowners to replace older, high-volume toilets with low-flush toilets to conserve water and to reduce costs. In 2022, there were 627 rebates submitted and processed.

4.6 Rain Barrel Sale Program

Rain barrels are excellent outdoor water-saving devices that collect and store rainwater from rooftops for lawn and garden use. Rainwater is a great water source for lawns, plants and gardens. For metered households, using rainwater will reduce the amount of tap water used for your garden therefore decreasing the utility bill. In 2022, 206 rain barrels were sold to Richmond residents.

Rain barrels are available for purchase at the City's Recycling Depot by Richmond residents only. The barrels can hold up to 208 litres. Installation instructions are included.

Rain Barrel Connected to Roof Spout and Hose

4.7 Lawn Watering Regulations

To help manage the high demand for drinking water during the hot and dry summer months, Metro Vancouver imposed stage one lawn watering regulations from May 1 to October 31, 2022. The planned regulations were originally set to end on October 15, but due to the unusually dry September, the restrictions were extended to ensure the volume of water in the reservoirs was adequate to meet the region's demand.

The graph in Figure 4 shows the monthly consumption in the City compared with the average maximum temperature and the total monthly precipitation.

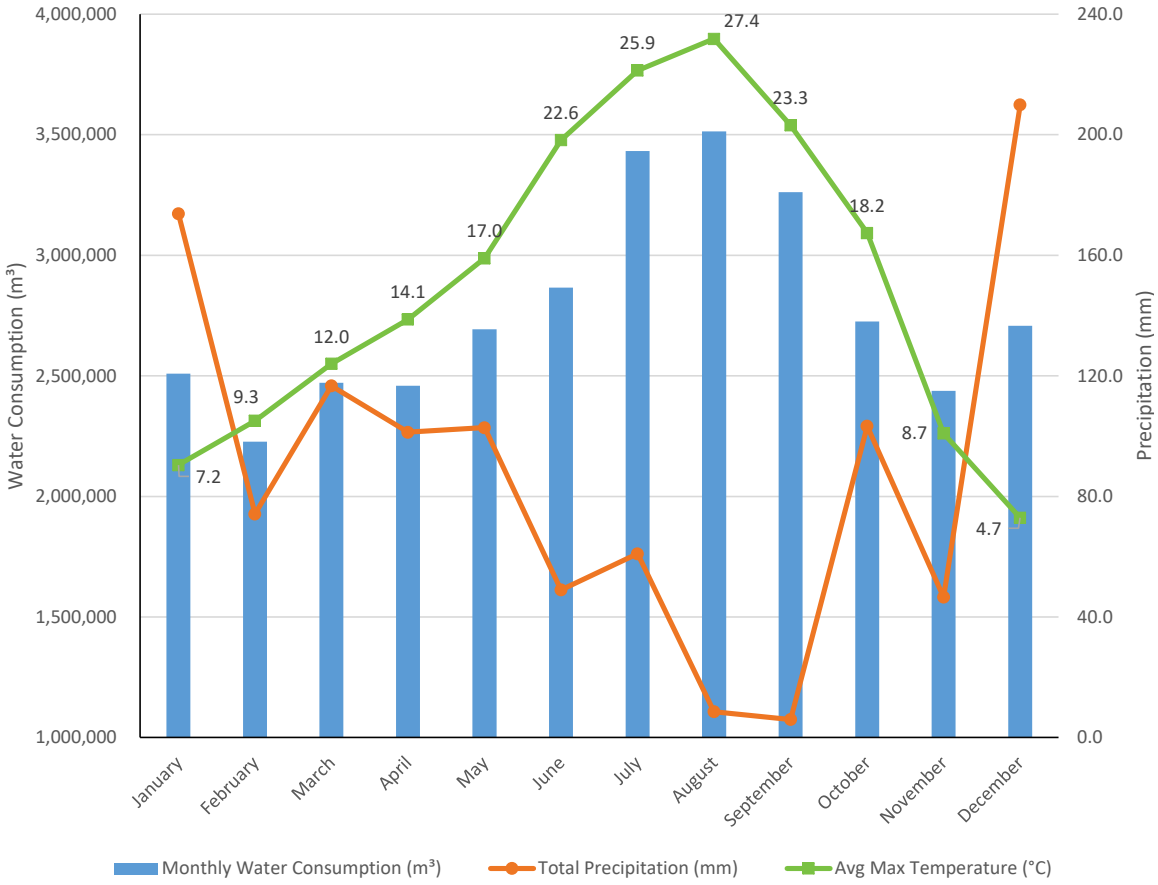

Figure 4 – 2022 Monthly Water Consumption and Climate Information

As the temperature increases, the City-wide consumption increases with it. The higher demand combined with the decrease in precipitation during summer months results in the Metro Vancouver reservoirs water levels decreasing at a greater pace during the summer months. Water conservation, especially in the summer, is vital in order to maintain a minimum amount of water in the reservoirs in case of emergency and to preserve the natural environment.

5.0 Community Outreach

Initiatives to promote City of Richmond's clean drinking water and encourage sustainability are also present throughout the City. As part of Water Services' community outreach, staff are prepared to deploy misting stations at strategic locations to assist the public in staying cool during extreme weather events.

5.1 Tap Water Initiative

Metro Vancouver's tap water campaign is an initiative to encourage tap water consumption by the public and highlight public drinking fountains so that people can refill water bottles or simply get a drink of high-quality water. The City of Richmond is dedicated to promoting the value of tap water, maximizing opportunities for use of tap water in facilities and developing strategies for making tap water the water of choice.

5.1.1 Portable Drinking Water Units

To support the Tap Water Initiative, Richmond's Water Services section is proud to maintain portable drinking units that are used at numerous community events. The units provide the public with potable tap water and to promote tap water usage as an alternative to bottled water consumption. Samples are tested upon installation to ensure good quality water for the public to enjoy. In 2022, Water Services staff maintained four portable drinking fountain units, installed units at 44 community events, which were used for 100 total days.

Portable Drinking Water Unit at Gateway Theatre

Permanent Drinking Fountain with Dog Bowl

5.1.2 Permanent Drinking Water Fountains

The 37 water fountains found on Richmond's dikes and in parks are maintained by Water Services. They are tested and inspected regularly to ensure accessible high-quality drinking water. The fountains are turned off in winter months to prevent freezing and costly damage and are turned back on in the spring for the public to enjoy. An auto-flushing unit was installed on one of the longer service pipes connected to a fountain to ensure water quality and maintain adequate chlorine residual. The fountains allow people out in the community to enjoy high-quality water. Some of the City's water fountains even have an additional bowl at ground level to make sure pets can also stay hydrated.

5.2 Misting Stations

In response to recurring extreme hot weather, Water Services staff designed and built misting stations that can be placed at a potable water source, like a hydrant, and provide a way for people to cool down. In coordination with Emergency Programs, misting stations were deployed in parks and popular outdoor locations during three heat events during the 2022 summer to provide heat relief. Misting stations were also deployed outside of heat events throughout the City.

Misting Station at Aberdeen Neighbourhood Park

6.0 In Conclusion

In 2022, Richmond residents enjoyed high-quality drinking water. From the protected watersheds to the local taps, both Metro Vancouver and the City of Richmond focus on providing safe high-quality drinking water.

Test results confirm our commitment to maintaining our water quality and system at an exceptional level and demonstrate our aim for continuous improvement. Richmond's water system is operated and maintained to the highest degree of care to ensure that it's free from any harmful bacteria or toxins. The City of Richmond's Water Services section takes its role as a water purveyor very seriously and is proud to be the guardian of such a precious resource.

Water Services staff continue to employ best management practices in the operation and maintenance of the water system. Staff are EOCP certified, meet all requirements of the British Columbia Drinking Water Protection Act and are well equipped to operate and maintain all aspects of the water system from the source to property lines.

The City values the strong working relationship with Vancouver Coastal Health and acknowledges them as important partners in maintaining high-quality drinking water throughout Richmond.

Sincerely,

Bryan Shepherd
Manager, Water Services
City of Richmond
604-233-3334
bshepherd@richmond.ca

APPENDIX A: REFERENCES

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    Document No. 2236678

APPENDIX B: COMMUNITY CONNECTIONS ARTICLE

CONNECTING COMMUNITY:

Pipe repair in the air

When an air valve broke on a pipe connecting the River Road area of Richmond to Mitchell Island, it triggered a repair process involving multiple organizations, innovative solutions and extensive safety measures.

Why? Because the watermain pipe runs under the Knight Street bridge, more than six storeys (or 26.5 metres) above the Fraser River.

When City of Richmond staff were made aware of a leak under the bridge, they went to the area immediately and found water pouring out into the river. Water is chlorinated to keep it safe for drinking, but it is not permitted in natural water sources like the river. To stop the chlorinated water from running into the river, a Water Services crew quickly throttled down the water pressure to minimize the flow of water going through the damaged pipe. The City continued to provide a reliable water supply to Mitchell Island using a secondary pipe, as the City has two pipes in place to ensure there is backup in place for a secure water supply.

"We acted quickly to mitigate the environmental concerns from the chlorinated water leaking into the river as an interim measure," says Bryan Shepherd, Manager, Water Services, Engineering & Public Works for the City of Richmond. "But we also knew that the complexity of the work under the bridge would take time to plan and complete due to a variety of challenges present. This also meant it would require a team effort."

Continued on next page

Right from the planning stages, the pipe repair in the air project exemplified the City's core values by focusing on the power of teams who share a common goal. Everyone involved demonstrated concern for each other while building on their individual and collective knowledge.

OBTAINING ACCESS AND SAFETY PLANNING

The first challenge was how to gain access to damaged pipe. TransLink owns the Knight Street Bridge, so the City required permission from TransLink to perform any repairs. In addition, the pipe needing repair was only accessible through a vertical ladder on one of the piers and a series of suspended catwalk systems under the bridge. These areas required up-to-date safety certifications.

Making repairs up in the air also required extensive safety measures. The City's Occupational Health and Safety (OHS) team members, Anastasia Riabkova and David Richards, coordinated with TransLink to confirm that the required annual inspections of the ladder and catwalk lifelines certifications were up to date. Next, they developed a plan for a safe working procedure. The inspections and safety plan were required prior to start of work to ensure the equipment would protect workers from a fatal fall and keep everyone safe on the job site.

The safe work procedure was also a key step for the City to obtain an Indemnity Inspection Agreement with TransLink, which allowed the City to access the horizontal and vertical lifelines and perform necessary maintenance and repair work.

The Indemnity Inspection Agreement also required the City to provide a High Angle Rescue Agreement. Kevin Gray, Deputy Fire Chief, Richmond Fire Rescue worked together with Riabkova and Richards to create the High Angle Rescue Agreement. The City's legal team then reviewed and finalized the Indemnity Inspection Agreement.

"Chief Gray and his team went above and beyond to support this repair project," says Shepherd. "They offered to provide the Public Works crew with a pre-entry inspection, on-site rescue support, and a means to transport materials from the ground to the catwalk using ropes. Richmond Fire Rescue crews also leveraged this repair project to practice their high angle training."

APPLYING INNOVATION AND TRAINING

While City staff worked together to complete the agreement with TransLink and establish safety measures, the Water Services crew wanted a better look at the damage to assess what caused the leak and what would be needed for repairs. Fortunately, the City has staff who are trained to fly drones so they could apply innovative technology to make their task easier. After getting approval from the Vancouver Port Authority, a pilot flew a drone to assess the damaged area and confirmed that a broken air valve was the source of the leak.

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With the source of the leak confirmed, the Water Services crew could start planning the repair. Not surprisingly, the first big challenge that needed to be addressed was the height and ensuring the safety of the crew who would be under the bridge.

The Occupational Health and Safety team, Richmond Water Services and Richmond Fire Rescue worked together to ensure that workers performing this task had all the necessary fall protection training, fall protection equipment and a fall plan.

Murray Barstow, Water Services Supervisor for the City, organized a team that was trained in fall protection, ticketed with utility repair and comfortable with working 26.5 metres up in the air. As well, certified firefighters would work with the repair crew, both up on the bridge and on the ground.

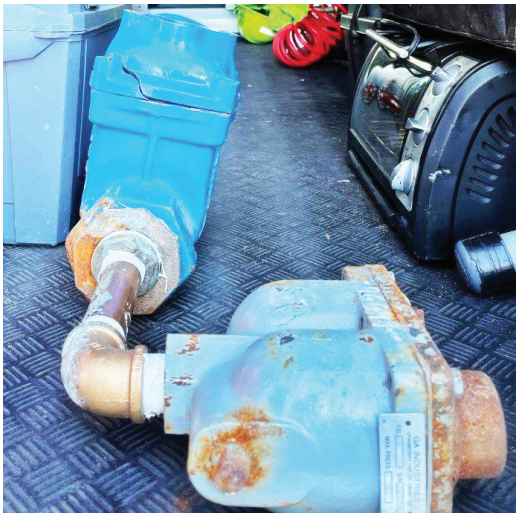
"We needed to use Water Services staff as they are trained and ticketed for our utility, but we also asked for volunteers. They would be working close to 100 feet in the air, so you can't just assign a task like this," says Shepherd. "The two people who volunteered were already trained and certified in fall arrest, they already had harnesses that were fit to them, and they were not afraid of heights."

SHARING THE SPACE WITH THE LOCAL WILDLIFE

Another challenge that the City encountered was the presence of peregrine falcons in the area.

"When we were assessing the damage, a falcon was dive-bombing the drone so we knew the birds were in the area, and it was close to nesting season when we would be doing the work," says Shepherd. "There were also concerns that the falcons may attack our crews, so we needed to bring on someone with expertise in this area."

An environmental consultant was brought onto the project to ensure the safety of both the birds and the workers.



REPAIRS IN THE AIR

After two months of planning, getting required approvals, ensuring all safety measures were in place and taking steps to protect the falcons, the repairs could finally proceed safely and in compliance with all provincial and federal regulations.

Water Services staff, Colin Hutchinson and Ken Laboucane, performed the repair work on the bridge while two Fire Rescue staff stayed on the catwalk on standby in case rescue was needed. They replaced the air valve, which is about the size of a basketball, installed a shut-off valve and replaced about four feet of pipe where the air valve was located. This took about four hours to complete.

Eight Fire Rescue staff remained on the ground to assist further in the event of an emergency and helped raise and lower equipment using a rope pulley system.

The environmental consultant used binoculars to observe the behaviour of the birds. During the repair work, the falcons began to fly around and make noise to indicate they were concerned and unhappy with the presence of workers.

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Work was halted for 30 minutes to allow for the falcons to calm down and prevent provoking an attack on the workers. The environmental consultant assessed whether the falcons were being adversely impacted and if the job site needed to be shut down. Fortunately, after the 30 minutes had passed, the falcons were calm and perched on a nearby tree.

"It's exciting work. It's challenging. It's scary. And after completion it's rewarding," says Shepherd, who, having done work under the bridge in the past, would know. "I think there's a lot of adrenaline. When everyone gets back down safely, it's a huge sense of accomplishment."

While the aerial adventure portion of the work was completed, additional work was still needed before the water could be turned back on. The Water Services crew injected about 40 litres of high concentration chlorine into the water running through the 450 mm pipe and let it sit for 24 hours to disinfect the pipe before water could be turned back on.

"We take continuous measurements until its dark purple on the litmus paper to show a high concentration of the chlorine, and then we let it sit so it can eat up any bacteria, dirt or other contaminants that may have entered the pipe," says Shepherd.

When the chlorine was released from the pipe, the crew ran it through vitamin C pucks, which dissipates the chlorine so it could safely be released into a gravel lot. Next, they did water quality testing. After about three days, the results were in, and the water quality test came back clear, so they turned the water back on.

The City takes over 2,000 samples each year to test the water to ensure the water quality is good.

"Our job is to supply water to Richmond residents, regardless of the height or how hard the work is," notes Shepherd. "Our crews enjoy their work, and are thrilled to provide the Richmond community with clean water."

Thanks to collaboration, training, and innovation, the repairs to the watermain were completed safely and the pipe connecting two communities in Richmond is again secure and fully operational.

"I'm proud of the crew's accomplishment and the collaboration of the different parties involved," adds Shepherd. "It seemed like they had fun. I went to school with Darren Rowley, a Company Officer and Lieutenant with Fire Rescue, and I know he was very proud of his team too. Overall, it was a really good repair, and this is one we'll talk about for years."

APPENDIX C: SPECIFIC EMERGENCY RESPONSE PLANS

Positive Response for E. Coli or Fecal Coliform

In the event of possible E. Coli or fecal coliform contamination, all steps to ensure public health and safety will be taken, including banning water usage if necessary. If a water sample tests positive for fecal coliform, the following response plan will occur:

- The City of Richmond's water quality staff, the Drinking Water Officer and the Medical Health Officer will be notified by the Metro Vancouver laboratory
- Interim samples from the site will be examined. Interim samples are samples in the period between when the fecal positive sample was taken and when it was determined to be fecal positive
- Arrangements will be made for the immediate collection of a repeat sample including, where possible, samples from upstream and downstream of the fecal positive sample
- Chlorine residual for the sample noted on the sampler's data sheet will be reviewed to determine if a localized loss of disinfectant occurred
- Water Services staff will be contacted to determine if there was any loss of pressure or other unusual events that may have led to contaminants entering the system
- The need for a boil-water advisory will be evaluated by the City, the Drinking Water Officer and the Medical Health Officer. If a boil water advisory is deemed necessary, the municipality will carry out various means to inform the public. Metro Vancouver will be informed of this public advisory
- The City, in consultation with the Medical Health Officer, will determine the need and extent for a boil water advisory
- The Metro Vancouver laboratory will initiate procedures to identify species of the fecal positive organism with standard biochemical tests
- The Medical Health Officer will be contacted with the repeat sample results and the results of the species identification on the fecal positive sample when these tests are complete

Chemical or Biological Contamination Response

In the event of chemical or biological contamination, in source waters or the City's distribution system, the following actions will be taken by the City of Richmond and Metro Vancouver:

- Immediately notify Vancouver Coastal Health
- Identify the chemical and any public health risk factors associated with its presence in potable water
- Isolate the contaminated zone area and determine the level of contamination
- Issue a public advisory in consultation with the Drinking Water Officer and Medical Health Officer

In the event of possible biological or chemical contamination, all steps to safety will be taken to ensure public health, including banning water usage if necessary.

Turbidity Response

Turbidity (cloudy water) occurs during periods of heavy rain at and surrounding Metro Vancouver water sources. The City of Richmond, in collaboration with Vancouver Coastal Health, developed a turbidity response plan, which considers the City's responsibility for due diligence without unreasonably constraining the water utility's ability to operate the system.

Should there be a turbidity event, the results will be assessed and staff will:

- Begin a rigorous sampling program for microbiological activity and residual chlorine
- Monitor the City's supervisory control and data acquisition (SCADA) system with updates sent to Vancouver Coastal Health on a predetermined schedule
- Flush areas and re-test

- If necessary (in consultation with Vancouver Coastal Health), issue a public communication and issue a boil-water advisory to residents receiving turbid water

Response to Interruption of Primary and/or Secondary Disinfection

Upon notification by Metro Vancouver Operations that an interruption in disinfection has occurred:

- Staff will monitor residual levels of chlorine at strategic locations in the Metro Vancouver supply area
- The City's SCADA system will be monitored with updates sent to Vancouver Coastal Health on a predetermined schedule, as set by the health authority
- In cases where chlorine residual is less than 0.2 ppm, City crews will flush the affected area until an acceptable level is achieved

These actions will continue until disinfection is resumed and adequate levels of residual chlorine have been reached in the distribution system

Response to Loss of Pressure Due to High Demand

In the event of a pressure loss due to high demand:

- City staff will attempt to rectify the problem as soon as possible using various demand management techniques and by supplementing supply to problem areas
- Metro Vancouver, the Drinking Water Officer and the Medical Health Officer will be notified of any water quality issues
- City staff will perform chlorine residual tests at various locations to determine if adequate disinfectant is present in the distribution
- All water quality complaints from the public will be thoroughly investigated due to the potential for water contamination during low water pressure

Response to Watermain Breaks with Suspected Contamination

All watermain breaks where chemical or microbiological contamination of the system is suspected will be immediately reported to the Drinking Water Officer and the Medical Health Officer. The municipality will isolate the contaminated section from the rest of the distribution system. Once the watermain has been repaired, chlorine residual testing will be conducted at various locations affected by the main break. If low chlorine residuals are found, necessary actions to increase the levels of free chlorine will be carried out. If bacterial contamination is suspected, water samples will be analyzed and appropriate action taken.

APPENDIX D: WATER SAMPLING SITES

	Sampling Station Number	Water Sampling Sites
Monday	RMD-250	6071 Azure Road
	RMD-251	5951 McCallan Road
	RMD-252	9751 Pendleton Road
	RMD-253	11051 No. 3 Road
	RMD-254	5300 No. 3 Road
	RMD-255	6000 Blk. Miller Road
	RMD-256	1000 Blk. McDonald Road
	RMD-269	14951 Triangle Road
	RMD-270	8200 Jones Road
	RMD-271	3800 Cessna Drive
	RMD-272	751 Catalina Crescent
	RMD-273	Opp. 8331 Fairfax Place
	RMD-274	10920 Springwood Court
Wednesday	RMD-257	6640 Blundell Road
	RMD-258	7000 Blk. Dyke Road
	RMD-259	10020 Amethyst Avenue
	RMD-260	11111 Horseshoe Way
	RMD-261	9911 Sidaway Road
	RMD-262	13799 Commerce Parkway
	RMD-263	12560 Cambie Road
	RMD-264	13100 Mitchell Road
	RMD-266	9380 General Currie Road
	RMD-268	13800 No. 3 Road
	RMD-277	Opp. 11280 Twigg Place
	RMD-278	6651 Fraserwood Place
	RMD-279	Opp. 20371 Westminster Highway
Friday	RMD-202	1500 Valmont Way
	RMD-203	23260 Westminster Highway
	RMD-204	3180 Granville Avenue
	RMD-205	13851 Steveston Highway
	RMD-206	4251 Moncton Street
	RMD-208	13200 No. 4 Road
	RMD-212	Opp. 8600 Ryan Road
	RMD-214	11720 Westminster Highway
	RMD-216	11080 No. 2 Road
	RMD-267	17240 Fedoruk Road
	RMD-249	23000 Block Dyke Road
	RMD-275	5180 Smith Crescent
	RMD-276	22271 Cochrane Drive
	RMD-280	11500 McKenzie Road

APPENDIX E: 2022 WATER QUALITY RESULTS

Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-202	1500 Valemont Way	2022-01-07 09:35	7	0.16	0.84	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-01-13 09:20	6	0.18	1.04	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-01-21 09:25	6	0.2	0.85	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-01-27 09:20	6	0.16	0.94	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-02-04 09:20	6	0.23	0.95	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-02-10 09:25	5	0.17	0.97	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-02-18 09:25	5	0.12	1.08	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-02-24 09:25	7	0.15	0.86	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-03-04 09:20	6	0.25	0.82	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-03-10 09:25	6	0.18	0.81	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-03-18 09:20	7	0.2	0.76	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-03-24 09:20	7	0.2	0.88	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-04-01 09:20	7	0.14	0.93	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-04-07 09:30	8	0.18	0.68	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-04-14 09:20	8	0.14	0.85	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-04-21 09:20	8	0.11	0.68	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-04-29 09:25	8	0.15	0.74	2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-05-05 09:30	8	0.14	1.19	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-05-13 09:25	9	0.1	0.71	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-05-19 09:25	9	0.13	0.69	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-05-27 09:30	9	0.15	0.63	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-06-02 09:25	10	0.15	0.67	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-06-10 09:30	10	0.13	0.6	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-06-16 09:20	11	0.12	0.62	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-06-24 09:20	10	0.13	0.61	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-06-29 09:30	11	0.12	0.69	2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-07-08 09:30	13	0.14	0.69	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-07-14 09:30	13	0.11	0.65	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-07-22 09:25	13	0.14	0.69	2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-07-28 09:40	13	0.52	0.77	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-08-05 09:20	15	0.15	0.55	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-08-11 09:30	15	0.14	0.58	10	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-08-19 11:00	15	0.13	0.73	4	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-08-25 09:20	15	0.16	0.7	6	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-09-02 09:40	16	0.1	0.65	4	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-09-08 09:40	16	0.09	0.67	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-09-16 09:14	16	0.12	0.58	6	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-09-22 09:30	16	0.12	0.54	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-09-29 09:25	15	0.13	0.55	4	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-10-06 09:20	16	0.16	0.53	4	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-10-14 09:20	16	0.12	0.5	2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-10-20 09:30	15	0.15	0.59	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-10-28 09:20	14	0.13	0.64	4	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-11-02 09:24	10	0.15	0.59	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-11-10 09:30	10	0.14	0.62	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-11-17 09:25	9	0.11	0.8	2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-11-25 09:20	9	0.16	0.68	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-12-01 09:30	8	0.2	0.73	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-12-09 09:25	7	0.19	0.64	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-12-15 09:25	7	0.14	0.93	<2	<1	<1	-	-
GRAB	RMD-202	1500 Valemont Way	2022-12-22 13:30	5	0.15	0.83	NA	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-01-07 11:15	7	0.16	0.66	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-01-13 11:00	6	0.16	0.93	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-01-21 11:00	5	0.21	0.96	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-01-27 11:00	6	0.17	0.66	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-02-04 11:00	6	0.13	0.71	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-02-10 11:00	6	0.16	0.69	2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-02-18 11:00	6	0.2	0.74	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-02-24 11:00	6	0.14	0.74	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-03-04 11:20	6	0.13	0.88	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-03-10 11:00	6	0.23	0.82	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-03-18 11:20	7	0.12	0.85	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-03-24 11:15	7	0.11	0.83	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-04-01 11:20	7	0.12	0.86	<2	<1	<1	-	-

PWT - 71

Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-203	23260 Westminster Highway	2022-04-07 11:10	8	0.15	0.75	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-04-14 11:20	8	0.11	0.78	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-04-21 11:00	9	0.1	0.73	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-04-29 10:45	8	0.1	0.78	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-05-05 11:00	8	0.08	0.84	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-05-13 11:00	9	0.09	0.7	2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-05-19 11:00	9	0.13	0.69	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-05-27 11:10	9	0.13	0.65	2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-06-02 11:00	10	0.12	0.75	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-06-10 11:10	9	0.16	0.65	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-06-16 11:00	9	0.34	0.82	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-06-24 11:00	12	0.13	0.78	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-06-29 11:10	10	0.12	0.78	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-07-08 11:10	11	0.16	0.76	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-07-22 11:00	12	0.17	0.72	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-07-28 11:30	13	0.53	0.87	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-08-05 11:20	15	0.2	0.6	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-08-11 11:10	14	0.19	0.77	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-08-19 11:30	16	0.17	0.69	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-08-25 11:15	15	0.14	0.7	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-09-02 11:30	16	0.22	0.79	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-09-08 11:30	16	0.12	0.77	48	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-09-16 11:30	16	0.12	0.68	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-09-22 11:10	15	0.31	0.65	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-09-29 11:00	15	0.22	0.7	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-10-06 11:00	16	0.19	0.65	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-10-14 11:00	16	0.12	0.67	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-10-20 11:10	14	0.16	0.72	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-10-28 11:15	14	0.22	0.67	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-11-02 11:00	11	0.15	0.75	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-11-10 11:10	9	0.12	0.69	2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-11-17 11:00	8	0.13	0.71	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-11-25 11:10	9	0.12	0.71	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-12-01 11:10	7	0.18	0.73	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-12-09 11:00	8	0.17	0.67	<2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-12-15 11:00	6	0.12	0.81	2	<1	<1	-	-
GRAB	RMD-203	23260 Westminster Highway	2022-12-22 15:00	6	0.32	0.58	NA	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-01-07 07:30	7	0.13	0.74	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-01-13 07:30	6	0.14	0.98	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-01-21 07:30	6	0.13	0.85	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-01-27 07:30	6	0.12	0.74	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-02-04 07:30	6	0.37	0.74	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-02-10 07:30	6	0.15	0.83	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-02-18 07:30	6	0.11	0.86	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-02-24 07:30	6	0.11	0.79	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-03-04 07:30	6	0.12	0.73	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-03-10 07:30	7	0.25	0.75	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-03-18 07:30	7	0.17	0.85	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-03-24 07:30	7	0.16	0.76	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-04-01 07:30	7	0.13	0.86	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-04-07 07:30	8	0.14	0.7	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-04-14 07:30	8	0.1	0.73	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-04-21 07:30	8	0.13	0.69	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-04-29 07:30	9	0.11	1	6	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-05-05 07:30	8	0.12	0.83	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-05-13 07:30	10	0.33	1.18	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-05-19 07:30	9	0.14	0.68	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-05-27 07:30	9	0.12	0.64	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-06-02 07:30	9	0.12	0.72	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-06-10 07:30	10	0.12	0.65	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-06-16 07:30	10	0.11	0.68	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-06-24 07:30	13	0.23	0.71	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-06-29 07:30	11	0.08	0.68	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-07-08 07:30	13	0.13	0.61	<2	<1	<1	-	-

Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-204	3180 Granville Avenue	2022-07-14 07:30	14	0.11	0.68	4	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-07-22 07:30	12	0.15	0.7	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-07-28 07:30	13	0.13	0.74	2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-08-05 07:30	15	0.1	0.55	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-08-11 07:30	15	0.12	0.63	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-08-19 07:30	16	0.12	0.7	2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-08-25 07:30	16	0.11	0.66	4	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-09-02 07:45	17	0.12	0.69	2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-09-08 07:45	18	0.1	0.64	24	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-09-16 07:45	16	0.18	0.63	2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-09-22 07:30	17	0.11	0.7	30	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-09-29 07:30	16	0.1	0.85	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-10-06 07:30	17	0.12	0.66	6	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-10-14 07:30	16	0.12	0.54	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-10-20 07:30	15	0.14	0.66	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-10-28 07:30	15	0.12	0.65	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-11-03 07:30	12	0.15	0.52	2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-11-10 07:30	10	0.18	0.62	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-11-17 07:30	9	0.11	0.52	2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-11-25 07:30	9	0.12	0.73	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-12-01 07:30	8	0.17	0.57	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-12-09 07:30	8	0.19	0.47	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-12-15 07:30	7	0.13	0.91	<2	<1	<1	-	-
GRAB	RMD-204	3180 Granville Avenue	2022-12-22 12:30	6	0.13	0.81	NA	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-01-07 09:15	7	0.16	0.83	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-01-13 09:00	6	0.25	0.99	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-01-21 09:00	5	0.19	0.91	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-01-27 09:00	5	0.18	0.82	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-02-04 09:00	6	0.16	0.66	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-02-10 09:00	6	0.17	0.72	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-02-18 09:00	5	0.12	0.75	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-02-24 09:00	6	0.12	0.83	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-03-04 09:00	6	0.12	0.75	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-03-10 09:00	6	0.16	0.77	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-03-18 09:00	6	0.11	0.72	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-03-24 09:00	7	0.14	0.83	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-04-01 09:00	7	0.1	0.97	2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-04-07 09:15	8	0.13	0.69	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-04-14 09:00	8	0.09	0.74	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-04-21 09:00	8	0.1	0.67	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-04-29 09:00	8	0.15	0.74	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-05-05 09:10	8	0.08	1.21	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-05-13 09:00	9	0.09	0.68	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-05-19 09:00	9	0.11	0.62	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-05-27 09:15	9	0.15	0.71	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-06-02 09:00	10	0.15	0.68	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-06-10 09:15	9	0.19	0.66	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-06-16 09:00	10	0.16	0.7	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-06-24 09:00	10	0.13	0.7	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-06-29 09:15	11	0.14	0.8	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-07-08 09:15	11	0.19	0.69	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-07-14 09:15	11	0.11	0.67	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-07-22 09:00	12	0.31	0.71	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-07-28 09:20	12	0.2	0.66	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-08-05 09:00	14	0.16	0.56	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-08-11 09:15	15	0.18	0.62	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-08-19 09:00	14	0.18	0.72	2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-08-25 09:00	15	0.13	0.65	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-09-02 09:20	16	0.2	0.77	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-09-08 09:20	16	0.24	0.69	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-09-16 09:20	15	0.14	0.64	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-09-22 09:15	15	0.23	0.58	2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-09-29 09:00	15	0.28	0.54	2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-10-06 09:00	16	0.11	0.81	<2	<1	<1	-	-

PWT - 73

Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-205	13851 Steveston Highway	2022-10-14 09:00	16	0.13	0.68	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-10-20 09:15	14	0.14	0.71	4	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-10-28 09:00	14	0.23	0.68	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-11-03 09:00	11	0.16	0.66	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-11-10 09:15	9	0.15	0.69	2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-11-17 09:00	8	0.14	0.74	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-11-25 09:00	9	0.11	0.67	2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-12-01 09:15	8	0.15	0.71	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-12-09 09:00	7	0.12	0.62	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-12-15 09:00	6	0.13	0.78	<2	<1	<1	-	-
GRAB	RMD-205	13851 Steveston Highway	2022-12-22 13:30	5	0.15	0.8	NA	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-01-07 07:45	6	0.14	0.87	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-01-13 07:45	6	0.12	1.08	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-01-21 07:45	6	0.13	0.79	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-01-27 07:45	6	0.13	0.76	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-02-04 07:45	6	0.13	0.69	2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-02-10 07:45	6	0.15	0.84	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-02-18 07:45	6	0.16	0.81	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-02-24 07:45	6	0.11	0.77	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-03-04 07:45	6	0.11	0.74	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-03-10 07:45	6	0.27	0.85	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-03-18 07:45	6	0.2	0.67	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-03-24 07:45	7	0.16	0.82	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-04-01 07:45	7	0.24	1.04	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-04-07 07:45	8	0.15	0.73	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-04-14 07:45	8	0.14	0.73	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-04-21 07:45	8	0.14	0.67	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-04-29 07:45	8	0.13	0.64	4	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-05-05 07:45	8	0.14	0.73	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-05-13 07:45	9	0.1	0.67	2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-05-19 07:45	9	0.13	0.69	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-05-27 07:50	10	0.29	0.75	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-06-02 07:45	10	0.32	0.74	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-06-10 07:50	9	0.18	0.68	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-06-16 07:45	9	0.12	0.72	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-06-24 07:45	10	0.27	0.72	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-06-29 07:50	10	0.14	0.78	6	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-07-08 07:50	11	0.31	0.71	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-07-14 07:50	11	0.31	0.66	4	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-07-22 07:45	12	0.27	0.68	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-07-28 07:45	12	0.4	0.74	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-08-05 07:45	14	0.12	0.56	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-08-11 07:50	14	0.12	0.64	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-08-19 07:45	14	0.11	0.72	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-08-25 07:45	15	0.15	0.7	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-09-02 08:00	15	0.21	0.7	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-09-08 08:00	16	0.26	0.68	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-09-16 08:00	16	0.37	0.65	4	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-09-22 07:50	16	0.14	0.87	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-09-29 07:45	15	0.37	0.68	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-10-06 07:45	16	0.18	0.63	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-10-14 07:45	16	0.69	0.73	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-10-20 07:50	15	0.17	0.57	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-10-28 07:45	14	4.5	0.8	2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-11-03 07:45	11	1.8	0.71	4	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-11-10 07:50	9	0.17	0.57	2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-11-17 07:45	8	0.11	0.66	2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-11-25 07:45	9	0.21	0.76	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-12-01 07:50	8	0.14	0.56	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-12-09 07:45	7	0.12	0.89	2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-12-15 07:45	7	0.13	0.92	<2	<1	<1	-	-
GRAB	RMD-206	4251 Moncton Street	2022-12-22 12:30	5	0.17	0.75	NA	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-01-07 08:55	7	0.15	0.75	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-01-13 08:45	5	0.21	1.06	<2	<1	<1	-	-

Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-208	13200 No. 4 Road	2022-01-21 08:45	5	0.16	1.01	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-01-27 08:45	6	0.12	0.88	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-02-04 08:45	6	0.14	0.84	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-02-10 08:45	7	0.19	0.91	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-02-18 08:45	6	0.17	0.91	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-02-24 08:45	6	0.12	0.89	2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-03-04 08:45	6	0.17	0.9	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-03-10 08:45	6	0.25	0.81	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-03-18 08:45	7	0.13	0.79	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-03-24 08:45	7	0.16	0.92	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-04-01 08:45	7	0.13	0.89	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-04-07 08:50	8	0.14	0.72	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-04-14 08:45	8	0.11	0.86	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-04-21 08:45	8	0.1	0.7	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-04-29 08:45	9	0.13	0.7	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-05-05 08:50	8	0.62	1.23	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-05-13 08:45	9	0.09	0.79	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-05-19 08:45	9	0.11	0.71	4	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-05-27 08:55	9	0.14	0.57	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-06-02 08:45	10	0.14	0.58	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-06-10 08:55	11	0.17	0.71	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-06-16 08:45	12	0.1	0.58	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-06-24 08:45	10	0.6	0.69	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-06-29 08:55	12	0.1	0.74	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-07-08 08:55	13	0.09	0.74	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-07-14 08:55	12	0.11	0.58	2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-07-22 08:45	12	0.16	0.63	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-07-28 09:00	14	0.13	0.74	2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-08-05 08:45	17	0.13	0.59	10	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-08-11 08:55	15	0.13	0.52	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-08-19 08:45	16	0.14	0.8	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-08-25 08:45	15	0.12	0.6	2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-09-02 09:00	16	0.09	0.68	2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-09-08 09:00	16	0.11	0.51	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-09-16 09:00	16	0.12	0.64	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-09-22 08:55	17	0.15	0.34	2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-09-29 08:45	16	1	0.34	44	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-10-06 08:45	16	0.12	0.61	2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-10-14 08:45	16	0.11	0.5	8	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-10-20 08:55	16	0.14	0.56	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-10-28 08:45	14	0.13	0.4	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-11-03 08:45	11	0.11	0.58	2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-11-10 08:55	10	0.12	0.57	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-11-17 08:45	8	0.09	0.68	2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-11-25 08:45	9	0.1	0.59	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-12-01 08:55	8	0.18	0.57	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-12-09 08:45	7	0.1	0.55	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-12-15 08:45	7	0.1	0.86	<2	<1	<1	-	-
GRAB	RMD-208	13200 No. 4 Road	2022-12-22 13:10	6	0.18	0.81	NA	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-01-07 08:40	7	0.13	0.77	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-01-13 08:30	6	0.18	1.17	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-01-21 08:30	5	0.13	0.91	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-01-27 08:30	7	0.11	0.77	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-02-04 08:30	6	0.14	0.9	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-02-10 08:30	6	0.14	0.95	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-02-18 08:30	6	0.13	1.02	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-02-24 08:30	5	0.12	0.92	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-03-04 08:30	6	0.1	0.87	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-03-10 08:30	6	0.23	0.85	2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-03-18 08:30	6	0.18	0.71	2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-03-24 08:30	7	0.12	0.86	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-04-01 08:30	7	0.12	0.9	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-04-07 08:35	8	0.16	0.71	2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-04-14 08:30	8	0.11	0.89	2	<1	<1	-	-

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Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-04-21 08:30	8	0.16	0.68	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-04-29 08:30	8	0.12	0.73	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-05-05 08:35	8	0.11	1.22	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-05-13 08:30	9	0.1	0.77	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-05-19 08:30	9	0.11	0.71	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-05-27 08:40	9	0.14	0.7	2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-06-02 08:30	10	0.12	0.83	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-06-10 08:40	9	0.17	0.78	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-06-16 08:30	10	0.11	0.87	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-06-24 08:30	10	0.13	0.71	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-06-29 08:40	10	0.12	0.69	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-07-08 08:40	12	0.11	0.74	2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-07-14 08:40	12	0.1	0.79	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-07-22 08:30	13	0.17	0.83	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-07-28 08:40	12	0.13	0.7	2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-08-05 08:30	15	0.13	0.7	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-08-11 08:40	14	0.12	0.76	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-08-19 08:30	15	0.11	0.68	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-08-25 08:30	15	0.12	0.83	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-09-02 08:45	16	0.1	0.77	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-09-08 08:45	16	0.09	0.81	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-09-16 08:45	16	0.12	0.81	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-09-22 08:40	16	0.12	0.75	8	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-09-29 08:30	15	0.2	0.6	6	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-10-06 08:30	16	0.14	0.72	10	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-10-14 08:30	16	0.2	0.66	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-10-20 08:40	15	0.15	0.68	2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-10-28 08:30	14	0.13	0.77	2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-11-03 08:30	11	0.17	0.76	6	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-11-10 08:40	9	0.11	0.76	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-11-17 08:30	8	0.22	0.64	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-11-25 08:30	9	0.34	0.79	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-12-01 08:40	8	0.15	0.71	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-12-09 08:30	8	0.16	0.72	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-12-15 08:30	7	0.13	0.93	<2	<1	<1	-	-
GRAB	RMD-212	Opp. 8600 Ryan Road	2022-12-22 13:10	5	0.14	0.92	NA	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-01-07 09:55	7	0.18	1.18	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-01-13 09:40	5	0.13	1.09	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-01-21 09:45	5	0.15	0.83	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-01-27 09:40	6	0.2	1	2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-02-04 09:40	6	0.19	0.96	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-02-10 09:40	5	0.17	0.95	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-02-18 09:45	5	0.15	0.93	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-02-24 09:45	6	0.12	0.87	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-03-04 09:40	6	0.17	0.9	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-03-10 09:45	6	0.15	0.79	2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-03-18 09:40	6	0.14	0.85	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-03-24 09:40	7	0.2	0.84	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-04-01 09:40	7	0.16	0.92	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-04-07 09:50	8	0.17	0.71	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-04-14 09:40	7	0.14	0.89	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-04-21 09:40	8	0.2	0.71	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-04-29 09:45	8	0.17	0.76	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-05-05 09:45	8	0.15	1	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-05-13 09:45	8	0.12	0.76	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-05-19 09:45	9	0.18	0.74	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-05-27 09:50	9	0.18	0.68	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-06-02 09:45	10	0.16	0.76	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-06-10 09:50	9	0.22	0.64	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-06-16 09:40	10	0.12	0.81	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-06-24 09:40	10	0.24	0.73	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-06-29 09:50	10	0.12	0.7	2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-07-08 09:50	11	0.15	0.86	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-07-14 09:50	11	0.11	0.8	<2	<1	<1	-	-

Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-214	11720 Westminster Highway	2022-07-22 09:45	12	0.19	0.78	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-07-28 10:00	11	0.18	0.77	2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-08-05 09:40	15	0.1	0.58	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-08-11 09:50	15	0.17	0.83	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-08-19 09:20	14	0.12	0.77	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-08-25 09:40	15	0.15	0.79	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-09-02 10:00	15	0.12	0.83	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-09-08 10:00	16	0.13	0.84	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-09-16 10:00	16	0.16	0.78	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-09-22 09:50	15	0.2	0.84	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-09-29 09:45	15	0.2	0.72	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-10-06 09:40	16	0.18	0.77	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-10-14 09:40	16	0.22	0.63	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-10-20 09:50	15	0.18	0.81	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-10-28 09:40	13	0.17	0.87	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-11-03 09:45	11	0.15	0.7	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-11-10 09:50	8	0.2	0.73	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-11-17 09:45	8	0.1	0.67	6	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-11-25 09:40	8	0.16	0.85	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-12-01 09:50	7	0.14	0.73	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-12-09 09:40	7	0.14	0.87	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-12-15 09:45	6	0.18	0.77	<2	<1	<1	-	-
GRAB	RMD-214	11720 Westminster Highway	2022-12-22 14:00	5	0.28	0.87	NA	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-01-07 08:00	6	0.14	1.13	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-01-13 08:00	6	0.12	1.22	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-01-21 08:00	6	0.13	0.89	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-01-27 08:00	6	0.12	0.85	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-02-04 08:00	6	0.16	0.92	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-02-10 08:00	6	0.15	0.92	2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-02-18 08:00	5	0.17	1.05	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-02-24 08:00	6	0.1	0.84	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-03-04 08:00	6	0.17	0.8	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-03-10 08:00	6	0.24	0.94	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-03-18 08:00	7	0.15	0.71	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-03-24 08:00	7	0.14	0.8	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-04-01 08:00	7	0.15	0.75	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-04-07 08:00	7	0.16	0.72	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-04-14 08:00	8	0.12	0.69	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-04-21 08:00	8	0.11	0.74	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-04-29 08:00	9	0.13	0.72	LA	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-05-05 08:00	8	0.14	0.83	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-05-13 08:00	9	0.1	0.69	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-05-19 08:00	10	0.33	0.94	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-05-27 08:05	9	0.19	0.64	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-06-02 08:00	10	0.13	0.75	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-06-10 08:05	9	0.13	0.77	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-06-16 08:00	9	0.1	0.73	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-06-24 08:00	10	0.19	0.75	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-06-29 08:05	10	1.4	0.71	2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-07-08 08:05	11	0.1	0.68	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-07-14 08:05	12	0.12	0.7	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-07-22 08:00	12	0.14	0.72	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-07-28 08:00	12	0.12	0.99	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-08-05 08:00	15	0.15	0.55	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-08-11 08:05	14	0.16	0.83	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-08-19 08:00	15	0.11	0.79	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-08-25 08:00	15	0.11	0.76	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-09-02 08:15	15	0.1	0.75	2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-09-08 08:15	16	0.1	0.77	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-09-16 08:15	16	0.16	0.53	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-09-22 08:05	16	0.14	0.64	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-09-29 08:00	15	0.13	0.58	8	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-10-06 08:00	16	0.14	0.7	2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-10-14 08:00	15	0.16	0.84	<2	<1	<1	-	-

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Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-216	11080 No. 2 Road	2022-10-20 08:05	15	0.14	0.64	4	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-10-28 08:00	14	0.17	0.7	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-11-03 08:00	11	0.15	0.63	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-11-10 08:05	9	0.14	0.64	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-11-17 08:00	8	0.16	0.89	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-11-25 08:00	9	0.15	0.72	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-12-01 08:05	7	0.14	0.72	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-12-09 08:00	7	0.14	0.82	2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-12-15 08:00	7	0.15	0.64	<2	<1	<1	-	-
GRAB	RMD-216	11080 No. 2 Road	2022-12-22 12:50	5	0.24	0.79	NA	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-01-07 10:30	8	0.2	0.62	2	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-01-13 10:15	6	0.17	0.78	<2	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-01-21 10:15	7	0.16	0.67	4	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-01-27 10:15	6	0.13	0.88	<2	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-02-04 10:15	6	0.17	0.72	<2	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-02-10 10:15	6	0.17	0.72	<2	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-02-18 10:15	7	0.14	0.68	<2	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-02-24 10:15	6	0.19	0.73	<2	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-03-04 10:20	6	0.13	0.73	<2	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-03-10 10:15	7	0.14	0.74	4	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-03-18 10:20	8	0.1	0.72	<2	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-03-24 10:20	7	0.15	0.71	<2	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-04-01 10:20	7	0.12	0.74	<2	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-04-07 10:25	9	0.12	0.6	<2	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-04-14 10:20	8	0.1	0.61	<2	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-04-21 10:15	9	0.19	0.63	<2	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-04-29 10:15	9	0.1	0.59	<2	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-05-05 10:15	9	0.11	0.88	4	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-05-13 10:15	10	0.1	0.61	42	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-05-19 10:15	10	0.21	0.58	4	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-05-27 10:25	9	0.14	0.56	<2	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-06-02 10:15	12	0.16	0.6	20	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-06-10 10:25	13	0.16	0.5	12	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-06-16 10:20	14	0.1	0.66	8	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-06-24 10:15	14	0.13	0.57	8	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-06-29 10:25	12	0.09	0.61	8	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-07-08 10:25	15	0.11	0.64	10	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-07-14 10:25	15	0.13	0.61	18	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-07-22 10:15	16	0.28	0.66	14	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-07-28 10:40	17	0.13	0.71	4	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-08-05 10:20	16	0.17	0.57	4	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-08-11 10:25	15	0.15	0.56	98	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-08-19 10:00	16	0.11	0.57	6	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-08-25 10:20	16	0.11	0.6	4	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-09-02 10:40	17	0.13	0.64	<2	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-09-08 10:40	17	0.14	0.57	6	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-09-16 10:40	19	0.12	0.55	2	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-09-22 10:25	16	0.43	0.64	<2	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-09-29 10:15	18	0.13	0.56	10	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-10-06 10:15	17	0.11	0.64	8	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-10-14 10:15	17	0.26	0.51	68	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-10-20 10:25	15	0.14	0.61	4	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-10-28 10:20	14	0.13	0.54	4	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-11-03 10:15	13	0.18	0.59	<2	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-11-10 10:25	9	0.14	0.58	<2	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-11-17 10:15	8	0.18	0.67	12	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-11-25 10:20	9	0.21	0.57	<2	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-12-01 10:25	8	0.16	0.65	6	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-12-09 10:15	7	0.19	0.65	<2	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-12-15 10:15	6	0.13	0.68	<2	<1	<1	-	-
GRAB	RMD-249	23000 Blk. Dyke Road	2022-12-22 14:30	5	0.24	0.61	NA	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-01-04 15:45	5	0.13	0.92	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-01-10 15:45	5	0.11	0.9	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-01-17 15:45	7	0.11	0.72	<2	<1	<1	-	-

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Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-250	6071 Azure Road	2022-01-24 15:45	6	0.12	1.19	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-02-01 15:45	6	0.13	0.84	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-02-07 15:45	6	0.13	0.75	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-02-14 15:45	6	0.19	0.72	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-02-22 15:45	6	0.11	0.9	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-02-28 15:45	6	0.12	0.87	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-03-07 15:45	6	0.1	0.79	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-03-14 15:45	6	0.13	0.77	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-03-21 15:50	7	0.13	1	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-03-28 15:45	7	0.14	0.96	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-04-04 15:45	7	0.08	0.81	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-04-11 15:45	8	0.09	0.72	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-04-19 15:45	8	0.1	0.71	4	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-04-25 15:45	8	0.1	0.76	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-05-02 15:45	9	0.12	0.68	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-05-09 15:45	10	0.13	0.74	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-05-16 15:45	9	0.11	0.61	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-05-24 15:45	9	0.36	0.77	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-05-30 15:45	9	0.13	0.55	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-06-06 14:15	11	0.1	0.76	2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-06-13 15:45	12	0.14	0.69	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-06-20 15:45	11	0.09	1.12	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-06-27 15:45	12	0.17	0.77	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-07-04 15:45	12	0.11	0.66	4	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-07-11 15:45	13	0.12	0.71	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-07-18 15:45	14	0.19	0.69	2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-07-25 15:45	13	0.11	0.83	4	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-08-02 15:45	16	0.2	0.74	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-08-08 15:45	16	0.1	0.69	6	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-08-15 15:45	16	0.1	0.64	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-08-22 15:45	14	0.11	0.79	8	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-08-29 15:45	17	0.1	0.66	8	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-09-06 15:45	16	0.09	0.67	10	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-09-12 15:45	17	0.13	0.74	8	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-09-20 15:45	17	0.1	0.62	10	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-09-26 15:45	16	0.09	0.72	14	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-10-03 15:45	16	0.08	0.76	20	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-10-11 15:45	16	0.11	0.63	18	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-10-17 15:45	15	0.12	0.65	8	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-10-24 15:45	15	0.17	0.72	10	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-10-31 15:45	13	0.12	0.69	2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-11-07 15:45	12	0.1	0.72	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-11-14 15:45	11	0.1	0.67	22	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-11-21 15:45	9	0.12	0.6	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-11-28 15:45	9	0.1	0.73	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-12-05 15:45	7	0.14	0.81	<2	<1	<1	-	-
GRAB	RMD-250	6071 Azure Road	2022-12-12 15:45	7	0.15	0.8	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-01-04 12:30	5	0.17	0.86	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-01-10 12:30	4	0.12	0.82	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-01-17 12:30	7	0.12	0.84	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-01-24 12:30	5	0.14	1.12	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-02-01 12:30	5	0.1	0.69	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-02-07 12:30	6	0.14	0.79	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-02-14 12:30	6	0.13	0.81	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-02-22 12:30	6	0.12	0.92	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-02-28 12:30	6	0.13	0.86	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-03-07 12:30	6	0.12	0.78	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-03-14 12:30	6	0.33	0.72	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-03-21 12:30	7	0.14	1.03	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-03-28 12:30	7	0.13	0.87	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-04-04 12:30	7	0.15	0.82	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-04-11 12:30	7	0.09	0.71	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-04-19 12:30	8	0.1	0.67	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-04-25 12:30	8	0.11	0.8	<2	<1	<1	-	-

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Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-251	5951McCallan Road	2022-05-02 12:30	9	0.11	0.72	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-05-09 12:30	8	0.14	0.73	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-05-16 12:30	8	0.1	0.7	8	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-05-24 12:30	9	0.26	0.68	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-05-30 12:30	9	0.16	0.85	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-06-06 14:30	10	0.13	0.78	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-06-13 12:30	9	0.13	0.57	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-06-20 12:30	11	0.09	0.7	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-06-27 12:30	9	0.18	0.84	4	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-07-04 12:30	12	0.09	0.8	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-07-11 12:30	10	0.12	0.79	16	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-07-18 12:30	12	0.11	0.7	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-07-25 12:30	12	0.11	0.67	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-08-02 12:30	14	0.15	0.76	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-08-08 12:30	13	0.14	0.71	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-08-15 12:30	14	0.11	0.74	2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-08-22 12:30	13	0.11	0.84	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-08-29 12:30	15	0.12	0.68	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-09-06 12:30	15	0.17	0.71	2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-09-12 12:30	15	0.12	0.7	LA	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-09-20 12:30	16	0.13	0.68	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-09-26 12:30	15	0.1	0.75	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-10-03 12:30	16	0.08	0.75	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-10-11 12:30	16	0.11	0.69	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-10-17 12:30	15	0.17	0.68	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-10-24 12:30	14	0.13	0.85	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-10-31 12:30	11	0.12	0.64	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-11-07 12:30	12	0.2	0.68	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-11-14 12:30	10	0.1	0.71	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-11-21 12:30	8	0.1	0.73	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-11-28 12:30	8	0.1	0.85	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-12-05 12:30	7	0.15	0.65	<2	<1	<1	-	-
GRAB	RMD-251	5951McCallan Road	2022-12-12 12:30	7	0.13	0.75	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-01-04 13:00	6	0.16	0.66	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-01-10 13:00	5	0.19	0.68	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-01-17 13:00	6	0.12	0.83	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-01-24 13:00	6	0.12	0.81	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-02-01 13:00	6	0.12	0.79	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-02-07 13:00	6	0.13	0.69	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-02-14 13:00	6	0.11	0.89	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-02-22 13:00	6	0.11	0.89	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-02-28 13:00	6	0.11	0.85	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-03-07 13:00	6	0.11	0.9	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-03-14 13:00	6	0.13	0.85	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-03-21 13:00	7	0.13	0.91	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-03-28 13:00	7	0.12	0.93	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-04-04 13:00	7	0.12	0.77	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-04-11 13:00	8	0.09	0.71	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-04-19 13:00	8	0.1	0.67	2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-04-25 13:00	7	0.12	0.73	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-05-02 13:00	9	0.09	0.64	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-05-09 13:00	9	0.12	0.69	2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-05-16 13:00	9	0.11	0.68	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-05-24 13:00	9	0.51	0.63	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-05-30 13:00	9	0.1	0.59	LA	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-06-06 14:45	11	0.11	0.64	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-06-13 13:00	11	0.15	0.56	2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-06-20 13:00	11	0.1	0.74	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-06-27 13:00	11	0.37	0.73	2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-07-04 13:00	13	0.29	0.67	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-07-11 13:00	13	0.12	0.66	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-07-18 13:00	14	0.12	0.66	2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-07-25 13:00	13	0.18	0.71	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-08-02 13:00	15	0.18	0.87	<2	<1	<1	-	-

Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-252	9751 Pendleton Road	2022-08-08 13:00	15	0.12	0.64	2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-08-15 13:00	15	0.09	0.56	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-08-22 13:00	15	0.44	0.73	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-08-29 13:00	16	0.12	0.57	22	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-09-06 13:00	17	0.1	0.64	12	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-09-12 13:00	17	0.09	0.6	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-09-20 13:00	16	0.23	0.58	2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-09-26 13:00	16	0.09	0.65	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-10-03 13:00	16	0.11	0.61	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-10-11 13:00	16	0.32	0.69	2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-10-17 13:00	15	0.18	0.54	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-10-24 13:00	15	0.13	0.68	8	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-10-31 13:00	12	0.11	0.53	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-11-07 13:00	12	0.2	0.61	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-11-14 13:00	11	0.1	0.67	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-11-21 13:00	8	0.16	0.61	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-11-28 13:00	10	0.12	0.68	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-12-05 13:00	7	0.13	0.69	<2	<1	<1	-	-
GRAB	RMD-252	9751 Pendleton Road	2022-12-12 13:00	7	0.18	0.69	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-01-04 13:40	5	0.18	0.96	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-01-10 13:30	5	0.13	1.25	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-01-17 13:35	6	0.12	0.96	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-01-24 13:30	6	0.13	1.08	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-02-01 13:35	6	0.12	0.9	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-02-07 13:30	6	0.17	0.83	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-02-14 13:30	6	0.13	0.95	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-02-22 13:30	6	0.17	1.01	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-02-28 13:30	6	0.15	0.84	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-03-07 13:30	6	0.12	0.94	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-03-14 13:30	6	0.17	0.8	6	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-03-21 13:30	7	0.15	1.01	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-03-28 13:30	7	0.14	0.91	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-04-04 13:30	7	0.17	0.77	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-04-11 13:30	7	0.12	0.76	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-04-19 13:30	8	0.12	0.67	2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-04-25 13:30	8	0.11	0.74	22	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-05-02 13:30	9	0.16	0.73	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-05-09 13:30	8	0.13	0.77	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-05-16 13:30	9	0.13	0.7	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-05-24 13:30	9	0.18	0.69	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-05-30 13:30	9	0.14	0.6	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-06-06 15:30	10	0.1	0.79	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-06-13 13:30	9	0.14	0.59	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-06-20 13:30	10	0.13	0.73	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-06-27 13:30	10	0.21	0.67	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-07-04 13:30	12	0.12	0.8	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-07-11 13:30	11	0.16	0.75	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-07-18 13:30	13	0.12	0.76	2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-07-25 13:30	12	0.14	0.93	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-08-02 13:30	14	0.11	0.74	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-08-08 13:30	14	0.14	0.73	40	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-08-15 13:30	14	0.11	0.75	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-08-22 13:30	13	0.09	0.68	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-08-29 13:30	15	0.1	0.74	4	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-09-06 13:30	16	0.11	0.78	2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-09-12 13:30	16	0.12	0.74	8	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-09-20 13:30	16	0.13	0.74	12	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-09-26 13:30	15	0.12	0.74	2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-10-03 13:30	16	0.11	0.69	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-10-11 13:30	16	0.12	0.66	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-10-17 13:30	15	0.18	0.75	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-10-24 13:30	14	0.19	0.83	2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-10-31 13:30	12	0.15	0.77	2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-11-07 13:30	11	0.21	0.77	<2	<1	<1	-	-

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Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-253	11051 No. 3 Road	2022-11-14 13:30	11	0.11	0.78	2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-11-21 13:30	8	0.1	0.84	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-11-28 13:30	8	0.12	0.86	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-12-05 13:30	7	0.67	0.88	<2	<1	<1	-	-
GRAB	RMD-253	11051 No. 3 Road	2022-12-12 13:30	6	0.14	0.78	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-01-04 14:30	6	0.14	0.93	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-01-10 14:25	5	0.11	0.86	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-01-17 14:25	7	0.11	0.74	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-01-24 14:25	6	0.12	0.83	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-02-01 14:30	6	0.11	0.83	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-02-07 14:30	6	0.11	0.74	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-02-14 14:30	6	0.12	0.85	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-02-22 14:30	6	0.12	1.04	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-02-28 14:30	6	0.11	0.83	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-03-07 14:30	6	0.13	0.87	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-03-14 14:30	6	0.13	0.73	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-03-21 14:30	7	0.12	0.88	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-03-28 14:30	7	0.12	0.92	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-04-04 14:30	7	0.13	0.74	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-04-11 14:30	7	0.09	0.73	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-04-19 14:30	8	0.1	0.73	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-04-25 14:30	9	0.11	0.88	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-05-02 14:30	9	0.12	0.63	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-05-09 14:30	10	0.12	0.67	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-05-16 14:30	10	0.11	0.7	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-05-24 14:30	9	0.21	0.57	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-05-30 14:30	8	0.13	0.6	2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-06-06 13:00	10	0.1	0.76	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-06-13 14:30	12	0.15	0.5	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-06-20 14:30	11	0.09	0.87	4	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-06-27 14:30	11	0.16	0.77	2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-07-04 14:30	12	0.12	0.69	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-07-11 14:30	13	0.14	0.69	2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-07-18 14:25	13	0.14	0.79	6	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-07-25 14:30	14	0.14	0.67	2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-08-02 14:30	15	0.15	0.73	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-08-08 14:30	15	0.13	0.66	8	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-08-15 14:30	16	0.27	0.66	80	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-08-22 14:30	15	0.1	0.84	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-08-29 14:30	16	0.11	0.63	4	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-09-06 14:25	16	0.1	0.69	64	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-09-12 14:25	17	0.61	0.66	230	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-09-20 14:30	15	0.12	0.58	78	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-09-26 14:30	16	0.11	0.6	120	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-10-03 14:25	16	0.1	0.68	90	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-10-11 14:25	16	0.11	0.61	44	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-10-17 14:25	15	0.2	0.68	34	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-10-24 14:30	15	0.16	0.66	72	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-10-31 14:30	12	0.11	0.64	4	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-11-07 14:25	11	0.23	0.74	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-11-14 14:25	10	0.15	0.75	4	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-11-21 14:30	13	0.12	0.7	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-11-28 14:30	9	0.13	0.81	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-12-05 14:30	7	0.11	0.66	<2	<1	<1	-	-
GRAB	RMD-254	5300 No. 3 Road	2022-12-12 14:30	7	0.12	0.81	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-01-04 15:00	5	0.23	0.87	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-01-10 14:55	4	0.15	1.11	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-01-17 14:55	6	0.12	0.74	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-01-24 14:55	5	0.16	0.94	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-02-01 15:00	5	0.14	0.91	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-02-07 15:00	5	0.17	0.84	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-02-14 15:00	5	0.15	0.9	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-02-22 15:00	5	0.14	1.09	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-02-28 15:00	5	0.18	0.77	<2	<1	<1	-	-

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Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-255	6000 Blk. Miller Road	2022-03-07 15:00	5	0.19	1.01	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-03-14 15:00	5	0.33	0.89	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-03-21 15:00	6	0.17	0.91	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-03-28 15:00	6	0.17	0.95	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-04-04 15:00	6	0.16	0.73	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-04-11 15:00	7	0.13	0.78	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-04-19 15:00	7	0.15	0.71	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-04-25 15:00	8	0.13	0.77	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-05-02 15:00	8	0.19	0.72	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-05-09 15:00	8	0.27	0.73	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-05-16 15:00	8	0.17	0.74	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-05-24 15:00	9	0.2	0.58	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-05-30 15:00	9	0.33	0.77	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-06-06 13:35	9	0.16	0.92	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-06-13 15:00	10	0.24	0.64	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-06-20 15:00	10	0.15	0.89	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-06-27 15:00	9	0.27	0.74	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-07-04 15:00	11	0.21	0.87	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-07-11 15:00	10	0.2	0.84	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-07-18 14:55	13	0.17	0.84	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-07-25 15:00	12	0.25	0.89	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-08-02 15:00	13	0.21	0.77	2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-08-08 15:00	13	0.22	0.6	4	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-08-15 15:00	14	0.27	0.7	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-08-22 15:00	13	0.14	0.79	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-08-29 15:00	15	0.16	0.86	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-09-06 14:55	15	0.14	0.8	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-09-12 15:00	15	0.18	0.75	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-09-20 15:00	15	0.17	0.72	6	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-09-26 15:00	15	0.18	0.88	6	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-10-03 15:00	15	0.15	0.71	4	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-10-11 14:55	15	0.12	0.79	2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-10-17 15:00	15	0.19	0.82	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-10-24 15:00	14	0.26	0.83	2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-10-31 15:00	11	0.24	0.78	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-11-07 15:00	10	0.22	0.79	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-11-14 15:00	9	0.14	0.78	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-11-21 15:00	8	0.2	0.65	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-11-28 15:00	8	0.13	0.81	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-12-05 15:00	6	0.24	0.53	<2	<1	<1	-	-
GRAB	RMD-255	6000 Blk. Miller Road	2022-12-12 15:00	6	0.16	0.91	<2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-01-04 14:45	5	0.2	0.78	<2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-01-10 14:40	5	0.12	0.68	<2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-01-17 14:40	7	0.11	0.7	<2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-01-24 14:40	7	0.13	0.8	<2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-02-01 14:45	6	0.11	0.72	<2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-02-07 14:25	6	0.16	0.73	<2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-02-14 14:45	6	0.11	0.84	<2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-02-22 14:45	5	0.12	1.2	<2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-02-28 14:45	6	0.13	0.88	2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-03-07 14:45	6	0.12	0.75	<2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-03-14 14:45	6	0.16	0.75	<2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-03-21 14:45	7	0.13	0.74	<2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-03-28 14:45	7	0.12	1.01	<2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-04-04 14:45	7	0.17	0.87	<2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-04-11 14:45	8	0.14	0.77	<2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-04-19 14:45	8	0.16	0.7	<2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-04-25 14:45	8	0.15	0.8	<2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-05-02 14:45	9	0.12	0.69	<2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-05-09 14:45	9	0.17	0.57	2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-05-16 14:45	9	0.11	0.67	4	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-05-24 14:45	10	0.12	0.99	<2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-05-30 14:45	10	0.14	0.73	<2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-06-06 13:20	12	0.12	0.63	<2	<1	<1	-	-

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Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-256	1000 Blk. McDonald Road	2022-06-13 14:45	13	0.14	0.46	<2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-06-20 14:45	12	0.11	0.58	<2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-06-27 14:45	13	0.21	0.76	2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-07-04 14:45	13	0.13	0.67	2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-07-11 14:45	13	0.12	0.8	4	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-07-18 14:40	14	0.1	0.68	2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-07-25 14:45	14	0.13	0.68	4	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-08-02 14:45	16	0.14	0.66	4	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-08-08 14:45	15	0.16	0.64	26	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-08-15 14:45	15	0.12	0.62	10	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-08-22 14:45	16	0.13	0.83	18	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-08-29 14:45	16	0.1	0.69	22	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-09-06 14:40	18	0.1	0.65	32	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-09-12 14:45	17	0.15	0.63	26	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-09-20 14:45	17	0.09	0.6	12	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-09-26 14:45	16	0.1	0.72	12	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-10-03 14:45	17	0.1	0.63	30	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-10-11 14:40	16	0.11	0.58	130	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-10-17 14:45	15	0.12	0.69	8	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-10-24 14:45	15	0.1	0.73	6	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-10-31 14:45	13	0.13	0.58	28	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-11-07 14:45	11	0.18	0.69	<2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-11-14 14:45	10	0.13	0.76	<2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-11-21 14:45	9	0.1	0.67	<2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-11-28 14:45	9	0.11	0.61	<2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-12-05 14:45	7	0.12	0.79	<2	<1	<1	-	-
GRAB	RMD-256	1000 Blk. McDonald Road	2022-12-12 14:45	7	0.15	0.67	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-01-05 15:45	5	0.12	0.88	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-01-12 15:45	6	0.18	1.08	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-01-18 15:45	6	0.17	1.39	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-01-26 15:45	5	0.12	0.83	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-02-02 15:45	6	1.1	0.74	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-02-09 15:45	6	0.17	0.75	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-02-16 15:45	6	0.11	0.76	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-02-23 15:45	6	0.1	0.82	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-03-02 15:45	6	0.13	0.74	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-03-09 15:45	6	0.37	0.9	<2	<1	1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-03-16 16:00	6	0.12	0.78	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-03-23 15:45	6	0.17	0.89	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-03-30 15:45	7	0.14	1.19	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-04-06 15:50	7	0.2	1.08	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-04-13 15:45	8	0.11	0.71	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-04-20 15:45	8	0.71	0.79	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-04-27 15:45	8	0.12	0.77	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-05-04 15:45	9	0.21	0.77	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-05-11 15:45	9	0.14	0.64	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-05-18 15:45	9	0.09	0.68	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-05-25 15:50	10	0.12	0.55	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-06-01 15:45	9	0.15	1.22	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-06-08 15:40	9	0.14	0.81	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-06-15 15:45	9	0.13	0.59	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-06-22 15:45	9	0.11	0.77	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-06-28 15:45	9	0.14	0.77	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-07-06 13:05	10	0.13	0.75	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-07-13 15:45	10	0.17	0.73	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-07-20 15:45	13	0.12	0.81	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-07-27 15:45	13	0.14	0.67	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-08-03 15:45	13	0.12	0.78	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-08-10 15:45	14	0.12	0.58	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-08-17 15:45	13	0.12	0.66	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-08-25 15:45	14	0.13	0.76	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-08-31 15:45	15	0.11	0.82	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-09-07 15:45	15	0.12	0.72	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-09-14 15:45	15	0.08	0.71	<2	<1	<1	-	-

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Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-257	6640 Blundell Road	2022-09-21 15:45	15	0.09	0.65	2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-09-28 15:45	15	0.09	0.71	2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-10-05 15:45	15	0.12	0.74	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-10-12 15:45	15	0.11	0.67	2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-10-19 15:45	15	0.2	0.75	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-10-27 15:45	13	0.09	0.69	2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-11-02 15:45	10	0.13	0.7	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-11-09 15:45	9	0.13	0.74	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-11-16 15:45	9	0.1	0.72	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-11-23 15:45	8	0.11	0.65	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-11-30 15:45	8	0.11	0.78	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-12-07 15:45	7	0.13	0.75	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-12-14 15:45	6	0.11	0.75	<2	<1	<1	-	-
GRAB	RMD-257	6640 Blundell Road	2022-12-21 15:45	5	0.19	0.78	NA	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-01-05 15:30	6	0.15	0.71	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-01-12 15:25	6	0.11	0.84	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-01-18 15:30	6	0.18	1.3	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-01-26 15:30	6	0.11	0.97	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-02-02 15:30	6	0.1	0.76	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-02-09 15:30	6	0.15	0.69	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-02-16 15:30	6	0.1	0.66	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-02-23 15:30	6	0.1	0.78	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-03-02 15:30	6	0.14	0.88	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-03-09 15:30	5	0.28	0.88	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-03-16 15:40	6	0.11	0.78	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-03-23 15:30	7	0.13	0.67	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-03-30 15:30	7	0.13	0.85	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-04-06 15:35	7	0.15	0.77	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-04-13 15:30	8	0.09	0.68	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-04-20 15:30	8	0.1	0.81	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-04-27 15:30	9	0.09	0.71	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-05-04 15:30	10	0.16	0.68	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-05-11 15:30	9	0.16	0.73	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-05-18 15:30	10	0.17	0.7	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-05-25 15:35	10	0.26	0.67	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-06-01 15:25	9	0.21	0.95	2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-06-08 15:25	11	0.16	0.72	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-06-15 15:25	10	0.1	0.78	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-06-22 15:25	10	0.14	0.96	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-06-28 15:30	11	0.12	0.74	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-07-06 12:50	11	0.23	0.74	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-07-13 15:30	12	0.15	0.74	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-07-20 15:25	14	1.5	0.78	26	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-07-27 15:25	14	0.08	0.71	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-08-03 15:30	16	0.13	0.7	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-08-10 15:25	15	0.09	0.53	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-08-17 15:30	15	0.09	0.77	4	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-08-24 15:30	16	0.13	0.66	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-08-31 15:30	16	0.08	0.74	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-09-07 15:30	16	0.08	0.67	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-09-14 15:30	16	0.07	0.62	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-09-21 15:25	16	0.12	0.53	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-09-28 15:30	16	0.12	0.6	6	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-10-05 15:30	16	0.09	0.59	4	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-10-12 15:30	16	0.1	0.52	2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-10-19 15:30	15	0.21	0.53	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-10-27 15:30	14	0.1	0.5	42	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-11-02 15:30	10	0.24	0.66	6	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-11-09 15:30	10	0.14	0.7	4	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-11-16 15:30	10	0.1	0.68	2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-11-23 15:25	8	0.13	0.6	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-11-30 15:30	9	0.1	0.78	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-12-07 15:30	7	0.23	0.65	<2	<1	<1	-	-
GRAB	RMD-258	7000 Blk. Dyke Road	2022-12-14 15:23	7	0.1	0.8	<2	<1	<1	-	-

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Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-258	7000 Blk. Dyke Road	2022-12-21 15:25	5	0.11	0.65	NA	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-01-05 14:40	5	0.17	0.87	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-01-12 14:40	7	0.12	1.16	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-01-18 14:40	6	0.15	1.38	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-01-26 14:45	7	0.19	0.9	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-02-02 14:45	6	0.13	0.69	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-02-09 14:45	6	0.14	0.6	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-02-16 14:40	7	0.11	0.79	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-02-23 14:40	7	0.1	0.93	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-03-02 14:40	6	0.11	0.72	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-03-09 14:40	6	0.31	0.96	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-03-16 14:50	6	0.14	0.72	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-03-23 14:45	7	0.14	0.75	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-03-30 14:45	7	0.17	0.84	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-04-06 14:50	9	0.14	0.78	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-04-13 14:45	8	0.15	0.66	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-04-20 14:45	8	0.21	0.76	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-04-27 14:40	9	0.09	0.66	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-05-04 14:40	9	0.14	0.67	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-05-11 14:40	9	0.12	0.74	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-05-18 14:40	9	0.13	0.64	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-05-25 14:50	10	0.15	0.68	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-06-01 14:40	10	0.15	0.65	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-06-08 14:40	11	0.14	0.8	2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-06-15 14:40	11	0.09	0.65	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-06-22 14:40	10	0.13	0.66	4	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-06-28 14:40	12	0.12	0.76	2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-07-06 12:20	13	0.17	0.74	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-07-13 14:40	13	0.16	0.71	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-07-20 14:40	14	0.1	0.78	4	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-07-27 14:40	13	0.09	0.66	6	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-08-03 14:45	15	0.13	0.75	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-08-10 14:40	15	0.15	0.55	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-08-17 14:45	15	0.11	0.79	8	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-08-24 14:45	17	0.13	0.81	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-08-31 14:45	16	0.1	0.8	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-09-07 14:45	16	0.08	0.62	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-09-14 14:40	17	0.09	0.63	4	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-09-21 14:40	17	0.12	0.63	2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-09-28 14:45	16	0.11	0.64	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-10-05 14:40	16	0.1	0.62	8	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-10-12 14:45	16	0.1	0.61	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-10-19 14:45	15	0.25	0.68	2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-10-27 14:40	14	0.11	0.62	4	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-11-02 14:40	11	0.17	0.73	6	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-11-09 14:45	10	0.12	0.79	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-11-16 14:25	10	0.11	0.66	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-11-23 14:40	9	0.12	0.66	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-11-30 14:45	9	0.11	0.84	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-12-07 14:40	8	0.17	0.78	<2	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-12-14 14:40	7	0.11	0.76	4	<1	<1	-	-
GRAB	RMD-259	10020 Amethyst Avenue	2022-12-21 14:40	6	0.1	0.78	NA	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-01-05 14:25	5	0.16	0.73	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-01-12 14:25	6	0.15	1.12	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-01-18 14:25	6	0.16	1.22	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-01-26 14:30	5	0.12	1.02	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-02-02 14:30	5	0.24	0.81	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-02-09 14:30	6	0.2	0.85	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-02-16 14:25	5	0.12	0.91	2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-02-23 14:25	6	0.13	0.92	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-03-02 14:25	6	0.14	0.78	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-03-09 14:25	6	0.51	0.91	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-03-16 14:35	6	0.2	0.74	2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-03-23 14:30	7	0.16	1.01	<2	<1	<1	-	-

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Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-260	11111 Horseshoe Way	2022-03-30 14:30	7	0.16	1.06	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-04-06 14:35	7	0.16	0.85	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-04-13 14:25	7	0.13	0.74	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-04-20 14:30	8	0.12	0.79	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-04-27 14:25	8	0.14	0.71	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-05-04 14:25	9	0.14	0.75	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-05-11 15:25	9	0.22	0.99	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-05-18 14:25	9	0.09	0.66	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-05-25 14:35	10	0.17	0.69	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-06-01 14:25	9	0.13	0.65	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-06-08 14:25	11	0.11	0.69	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-06-15 14:25	10	0.12	0.72	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-06-22 14:25	10	0.13	0.91	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-06-28 14:25	10	0.16	0.77	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-07-06 12:10	10	0.13	0.7	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-07-13 14:25	12	0.14	0.78	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-07-20 14:25	14	0.11	0.71	2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-07-27 14:25	13	0.12	0.62	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-08-03 14:30	15	0.16	0.66	2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-08-10 14:25	15	0.11	0.53	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-08-17 14:30	15	0.1	0.6	2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-08-24 14:30	16	0.14	0.78	2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-08-31 14:30	16	0.13	0.67	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-09-07 14:30	16	0.11	0.65	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-09-14 14:25	15	0.1	0.64	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-09-21 14:25	16	0.43	0.6	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-09-28 14:30	16	0.14	0.61	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-10-05 14:25	16	0.09	0.65	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-10-12 14:30	16	0.12	0.57	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-10-19 14:30	15	0.15	0.59	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-10-27 14:25	13	0.22	0.68	4	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-11-02 14:25	11	0.17	0.63	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-11-09 14:30	10	0.13	0.71	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-11-16 14:30	9	0.1	0.66	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-11-23 14:25	8	0.19	0.67	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-11-30 14:30	8	0.12	0.7	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-12-07 14:25	7	0.13	0.63	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-12-14 14:25	7	0.12	0.86	<2	<1	<1	-	-
GRAB	RMD-260	11111 Horseshoe Way	2022-12-21 14:25	6	0.19	0.64	NA	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-01-05 14:10	6	0.26	0.92	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-01-12 14:10	6	0.22	0.93	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-01-18 14:10	6	0.14	0.97	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-01-26 14:15	7	0.14	0.61	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-02-02 14:15	6	0.11	0.77	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-02-09 14:15	6	0.14	0.62	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-02-16 14:10	6	0.12	0.55	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-02-23 14:10	6	0.09	1.02	8	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-03-02 14:10	6	0.13	0.58	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-03-09 14:10	6	0.25	0.7	2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-03-16 14:20	6	0.1	0.7	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-03-23 14:15	7	0.11	0.7	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-03-30 14:15	7	0.15	0.87	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-04-06 14:20	9	0.11	0.56	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-04-13 14:10	8	0.08	0.61	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-04-20 14:15	8	0.08	0.62	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-04-27 14:10	8	0.07	0.97	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-05-04 14:10	9	0.08	0.63	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-05-11 14:10	10	0.11	0.63	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-05-18 14:10	10	0.2	0.66	60	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-05-25 14:20	10	0.11	0.64	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-06-01 14:10	9	0.1	0.72	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-06-08 14:10	11	0.16	0.59	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-06-15 14:10	10	0.1	0.73	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-06-22 14:10	10	0.1	0.78	<2	<1	<1	-	-

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Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-261	9911 Sidaway Road	2022-06-28 14:10	10	0.09	0.72	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-07-06 12:00	11	0.12	0.69	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-07-13 14:10	13	0.16	0.58	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-07-20 14:10	13	0.12	0.69	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-07-27 14:10	13	0.12	0.58	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-08-03 14:10	15	0.1	0.74	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-08-10 14:10	14	0.14	0.58	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-08-17 14:15	15	0.09	0.72	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-08-24 14:15	16	0.1	0.67	4	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-08-31 14:15	16	0.08	0.75	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-09-07 14:15	16	0.09	0.67	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-09-14 14:10	16	0.09	0.71	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-09-21 14:10	16	0.13	0.58	2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-09-28 14:15	16	0.2	0.54	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-10-05 14:10	15	0.12	0.71	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-10-12 14:15	16	0.09	0.53	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-10-19 14:15	15	0.16	0.63	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-10-27 14:10	14	0.12	0.56	2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-11-02 14:10	10	0.12	0.58	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-11-09 14:15	10	0.15	0.74	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-11-16 14:15	10	0.1	0.7	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-11-23 14:10	8	0.14	0.73	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-11-30 14:15	8	0.12	0.73	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-12-07 14:10	7	0.15	0.64	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-12-14 14:10	7	0.11	0.63	<2	<1	<1	-	-
GRAB	RMD-261	9911 Sidaway Road	2022-12-21 14:10	5	0.2	0.61	NA	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-01-05 13:15	6	0.17	0.68	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-01-12 13:20	6	0.18	0.91	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-01-18 13:20	6	0.14	1.02	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-01-26 13:30	6	0.16	0.93	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-02-02 13:25	6	0.16	0.69	2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-02-09 13:30	6	0.19	0.6	2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-02-16 13:15	6	0.11	0.64	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-02-23 13:15	6	0.29	0.84	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-03-02 13:15	6	0.2	0.69	2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-03-09 13:15	6	0.34	0.7	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-03-16 13:30	6	0.16	0.63	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-03-23 13:25	7	0.12	0.85	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-03-30 13:30	7	0.13	0.81	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-04-06 13:20	7	0.22	0.75	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-04-13 13:20	8	0.33	0.65	2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-04-20 13:20	8	0.3	0.71	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-04-27 13:15	8	0.09	0.86	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-05-04 13:15	8	0.09	0.74	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-05-11 13:15	9	0.1	0.67	2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-05-18 13:15	9	0.1	0.72	2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-05-25 13:20	11	0.12	0.62	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-06-01 13:20	8	0.12	0.57	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-06-08 13:15	10	0.16	0.65	6	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-06-15 13:20	9	0.13	0.84	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-06-22 13:20	10	0.15	0.79	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-06-28 13:15	10	0.11	0.81	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-07-06 11:20	11	0.12	0.82	2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-07-13 13:15	12	0.13	0.65	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-07-20 13:20	13	0.13	0.74	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-07-27 13:20	12	0.16	0.6	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-08-03 13:15	14	0.18	0.67	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-08-10 13:20	14	0.17	0.61	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-08-17 13:30	15	0.11	0.66	2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-08-24 13:20	15	0.16	0.72	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-08-31 13:20	16	0.1	0.7	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-09-07 13:25	16	0.18	0.65	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-09-14 13:15	16	0.11	0.67	6	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-09-21 13:20	16	0.2	0.55	2	<1	<1	-	-

Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-262	13799 Commerce Parkway	2022-09-28 13:20	16	0.13	0.62	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-10-05 13:15	15	0.13	0.73	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-10-12 13:20	15	0.12	0.64	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-10-19 13:20	15	0.67	0.71	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-10-27 13:15	13	0.21	0.75	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-11-02 13:15	10	0.14	0.72	4	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-11-09 13:20	10	0.14	0.72	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-11-16 13:20	10	0.12	0.7	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-11-23 13:20	8	0.21	0.67	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-11-30 13:20	8	0.13	0.7	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-12-07 13:15	7	0.14	0.65	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-12-14 13:20	6	0.11	0.92	<2	<1	<1	-	-
GRAB	RMD-262	13799 Commerce Parkway	2022-12-21 13:20	6	0.25	0.79	NA	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-01-05 12:30	5	0.22	0.77	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-01-12 12:30	6	0.17	1.17	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-01-18 12:30	6	0.15	1.21	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-01-26 12:30	6	0.34	1.03	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-02-02 12:30	6	0.17	0.79	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-02-09 12:30	6	0.18	0.74	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-02-16 12:30	6	0.11	0.75	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-02-23 12:30	6	0.12	0.82	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-03-02 12:30	6	0.1	0.72	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-03-09 12:30	6	0.4	0.96	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-03-16 12:30	6	0.18	0.69	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-03-23 12:30	7	0.15	1	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-03-30 12:30	7	0.13	0.89	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-04-06 12:30	7	0.15	0.9	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-04-13 12:30	8	0.1	0.74	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-04-20 12:30	8	0.15	0.81	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-04-27 12:30	8	0.1	0.86	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-05-04 12:30	9	0.16	0.69	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-05-11 12:30	9	0.14	0.84	2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-05-18 12:30	9	0.23	0.76	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-05-25 12:30	10	0.12	0.61	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-06-01 12:30	9	0.14	0.63	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-06-08 12:30	10	0.12	0.76	2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-06-15 12:30	9	0.11	0.77	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-06-22 12:30	10	0.13	1.14	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-06-28 12:30	10	0.13	0.75	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-07-06 10:45	11	0.38	0.54	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-07-13 12:30	11	0.17	0.63	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-07-20 12:30	13	0.13	0.69	2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-07-27 12:30	12	0.2	0.66	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-08-03 12:30	14	0.13	0.69	4	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-08-10 12:30	14	0.12	0.58	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-08-17 12:30	15	0.11	0.75	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-08-24 12:30	15	0.14	0.9	2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-08-31 12:30	16	0.1	0.78	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-09-07 12:30	16	0.09	0.67	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-09-14 12:30	16	0.08	0.69	4	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-09-21 12:30	16	0.14	0.63	2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-09-28 12:30	16	0.12	0.75	2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-10-05 12:30	15	0.12	0.77	38	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-10-12 12:30	16	0.17	0.66	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-10-19 12:30	15	0.23	0.71	16	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-10-27 12:30	13	0.16	0.94	2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-11-02 12:30	10	0.13	0.64	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-11-09 12:30	10	0.16	0.76	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-11-16 12:30	9	0.18	0.74	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-11-23 12:30	8	0.22	0.66	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-11-30 12:30	8	0.14	0.78	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-12-07 12:30	7	0.16	0.82	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-12-14 12:30	7	0.11	0.85	<2	<1	<1	-	-
GRAB	RMD-263	12560 Cambie Road	2022-12-21 12:30	6	0.13	0.82	NA	<1	<1	-	-

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Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-264	13100 Mitchell Road	2022-01-05 12:45	5	0.2	0.8	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-01-12 12:45	6	0.14	1.15	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-01-18 13:00	6	0.26	1.22	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-01-26 13:10	6	0.14	0.97	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-02-02 13:05	6	0.18	0.77	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-02-09 13:10	6	0.16	0.74	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-02-16 13:00	6	0.11	0.71	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-02-23 12:45	7	0.17	1.15	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-03-02 12:45	6	0.12	0.72	4	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-03-09 12:45	6	0.32	0.95	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-03-16 13:10	6	0.42	0.72	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-03-23 13:05	7	0.15	0.76	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-03-30 13:10	7	0.14	0.93	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-04-06 13:05	7	0.23	0.73	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-04-13 13:00	8	0.11	0.72	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-04-20 13:05	8	0.13	0.62	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-04-27 12:45	9	0.12	0.68	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-05-04 12:45	9	0.19	0.64	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-05-11 12:45	9	1	0.89	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-05-18 12:45	9	0.1	0.74	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-05-25 13:00	10	0.11	0.61	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-06-01 13:00	11	0.11	0.79	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-06-08 13:00	13	0.16	0.49	2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-06-15 13:00	13	0.15	0.57	4	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-06-22 13:00	10	0.11	0.71	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-06-28 12:45	11	0.12	0.82	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-07-06 11:05	14	0.12	0.68	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-07-13 12:45	13	0.18	0.79	8	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-07-20 13:00	13	0.29	0.67	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-07-27 13:00	12	0.18	0.66	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-08-03 13:00	14	0.16	0.73	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-08-10 13:00	15	0.15	0.64	8	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-08-17 13:10	15	0.1	0.76	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-08-24 13:05	16	0.21	0.76	8	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-08-31 13:00	16	0.12	0.77	8	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-09-07 13:05	16	0.09	0.67	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-09-14 12:45	16	0.09	0.66	34	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-09-21 13:00	16	0.12	0.64	2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-09-28 13:05	16	0.15	0.79	6	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-10-05 12:45	15	0.22	0.87	4	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-10-12 13:05	16	0.13	0.72	2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-10-19 13:05	15	0.18	0.68	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-10-27 12:45	13	0.12	0.61	2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-11-02 12:45	10	0.15	0.68	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-11-09 13:05	10	0.15	0.86	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-11-16 13:05	10	0.11	0.71	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-11-23 13:00	8	0.15	0.75	280	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-11-30 13:05	8	0.13	0.77	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-12-07 12:45	7	0.12	0.8	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-12-14 13:00	7	0.26	0.91	<2	<1	<1	-	-
GRAB	RMD-264	13100 Mitchell Road	2022-12-21 13:00	5	0.14	0.69	NA	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-01-05 14:55	5	0.15	1.21	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-01-12 14:55	5	0.15	1.05	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-01-18 15:00	7	0.12	1.39	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-01-26 15:00	5	0.15	1.04	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-02-02 15:00	6	0.16	0.78	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-02-09 15:00	6	0.16	0.73	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-02-16 14:55	6	0.11	0.88	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-02-23 14:55	6	0.14	0.98	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-03-02 14:55	6	0.11	0.7	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-03-09 14:55	6	0.43	1.01	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-03-16 15:05	6	0.18	0.8	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-03-23 15:00	7	0.19	1.1	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-03-30 15:00	7	0.16	0.94	<2	<1	<1	-	-

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Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-266	9380 General Currie Road	2022-04-06 15:05	8	0.19	0.88	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-04-13 15:00	8	0.12	0.75	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-04-20 15:00	8	0.27	0.8	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-04-27 14:55	8	0.12	0.75	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-05-04 14:55	9	0.2	0.74	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-05-11 14:55	9	0.15	0.86	2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-05-18 14:55	9	0.11	0.77	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-05-25 15:05	10	0.17	0.67	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-06-01 14:55	9	0.13	0.93	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-06-08 14:55	10	0.12	0.63	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-06-15 14:55	9	0.12	0.9	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-06-22 14:55	10	0.13	0.87	2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-06-28 14:55	10	0.15	0.88	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-07-06 12:30	11	0.23	0.87	4	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-07-13 14:55	13	0.18	0.72	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-07-20 14:55	13	0.11	0.73	2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-07-27 14:55	13	0.1	0.7	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-08-03 15:00	14	0.13	0.78	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-08-10 14:55	14	0.13	0.64	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-08-17 15:00	15	0.11	0.74	4	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-08-24 15:00	15	0.12	0.78	2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-08-31 15:00	16	0.11	0.85	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-09-07 15:00	16	0.1	0.7	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-09-14 14:55	16	0.1	0.73	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-09-21 14:55	16	0.12	0.67	4	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-09-28 15:00	16	0.12	0.79	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-10-05 14:55	15	0.09	0.77	6	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-10-12 15:00	16	0.12	0.68	2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-10-19 15:00	15	0.24	0.71	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-10-27 14:55	13	0.11	0.77	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-11-02 14:55	10	0.15	0.76	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-11-09 15:00	10	0.11	0.81	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-11-16 15:00	9	0.1	0.84	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-11-23 14:55	9	0.1	0.8	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-11-30 15:00	8	0.23	0.79	2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-12-07 14:55	8	0.14	0.79	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-12-14 14:55	6	0.13	0.87	<2	<1	<1	-	-
GRAB	RMD-266	9380 General Currie Road	2022-12-21 14:55	6	0.23	0.87	NA	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-01-07 10:10	7	0.18	0.8	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-01-13 10:00	6	0.16	1.12	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-01-21 10:00	6	0.12	0.73	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-01-27 10:00	6	0.21	0.82	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-02-04 10:00	7	0.16	0.73	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-02-10 10:00	7	0.17	0.82	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-02-18 10:00	7	0.16	0.7	2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-02-24 10:00	7	0.11	0.77	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-03-04 10:00	6	0.11	0.88	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-03-10 10:00	7	0.14	0.86	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-03-18 10:00	7	0.09	0.8	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-03-24 10:00	7	0.09	0.75	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-04-01 10:00	7	0.1	0.95	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-04-07 10:10	8	0.18	0.57	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-04-14 10:00	8	0.08	0.69	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-04-21 10:00	9	0.09	0.7	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-04-29 10:00	9	0.11	0.78	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-05-05 10:00	9	0.09	1.06	2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-05-13 10:00	10	0.1	0.7	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-05-19 10:00	10	0.1	0.69	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-05-27 10:10	10	0.23	0.66	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-06-02 10:00	10	0.14	0.68	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-06-10 10:10	11	0.14	0.61	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-06-16 10:00	11	0.13	0.76	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-06-24 10:00	12	0.1	0.66	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-06-29 10:10	12	0.12	0.71	<2	<1	<1	-	-

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Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-267	17240 Fedoruk	2022-07-08 10:10	14	0.12	0.69	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-07-14 10:10	14	0.09	0.74	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-07-22 10:00	14	0.21	0.7	2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-07-28 10:20	14	0.15	0.66	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-08-05 10:00	16	0.13	0.6	2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-08-11 10:10	16	0.13	0.64	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-08-19 09:40	16	0.16	0.67	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-08-25 10:00	16	0.11	0.67	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-09-02 10:20	17	0.15	0.75	72	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-09-08 10:20	17	0.12	0.67	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-09-16 10:20	17	0.11	0.72	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-09-22 10:10	16	0.14	0.58	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-09-29 10:00	15	0.26	0.67	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-10-06 10:00	16	11	1.1	2	-	-	<1	<1
GRAB	RMD-267	17240 Fedoruk	2022-10-14 10:00	17	0.16	0.62	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-10-20 10:10	15	0.14	0.69	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-10-28 10:00	15	0.18	0.71	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-11-03 10:00	12	0.11	0.68	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-11-10 10:10	10	0.12	0.68	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-11-17 10:00	9	0.15	0.72	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-11-25 10:00	9	0.12	0.7	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-12-01 10:10	7	0.14	0.64	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-12-09 10:00	8	0.18	0.6	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-12-15 10:00	6	0.11	0.74	<2	<1	<1	-	-
GRAB	RMD-267	17240 Fedoruk	2022-12-22 14:00	6	0.22	0.68	NA	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-01-05 15:15	5	0.16	0.86	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-01-12 15:10	6	0.11	0.97	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-01-18 15:15	6	0.14	1.24	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-01-26 15:15	6	0.12	0.97	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-02-02 15:15	6	0.19	0.73	2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-02-09 15:15	6	0.15	0.73	2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-02-16 15:15	6	0.11	0.87	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-02-23 15:15	7	0.1	0.8	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-03-02 15:15	6	0.17	0.85	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-03-09 15:15	6	0.29	0.95	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-03-16 15:20	6	0.13	0.84	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-03-23 15:15	7	0.15	0.83	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-03-30 15:15	7	0.17	1.06	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-04-06 15:20	7	0.13	0.73	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-04-13 15:15	8	0.1	0.66	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-04-20 15:15	8	0.1	0.77	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-04-27 15:15	9	0.1	0.67	4	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-05-04 15:15	9	0.15	0.66	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-05-11 15:15	9	0.12	0.87	2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-05-18 15:15	10	0.12	0.69	10	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-05-25 15:20	10	0.16	0.75	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-06-01 15:10	9	0.2	0.95	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-06-08 15:10	11	0.1	1.25	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-06-15 15:10	10	0.12	0.74	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-06-22 15:10	10	0.13	0.69	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-06-28 15:15	10	0.15	0.87	10	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-07-06 12:40	11	1.7	0.77	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-07-13 15:15	12	0.16	0.7	2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-07-20 15:10	13	10	1.27	<2	-	-	<1	<1
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-07-27 15:10	13	0.1	0.71	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-08-03 15:15	15	0.13	0.66	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-08-10 15:10	15	0.19	0.56	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-08-17 15:15	15	0.12	0.78	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-08-24 15:15	15	0.1	0.64	4	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-08-31 15:15	16	0.11	0.72	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-09-07 15:15	16	0.1	0.69	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-09-14 15:15	16	0.08	0.62	8	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-09-21 15:10	16	2.3	0.57	10	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-09-28 15:15	16	0.12	0.61	<2	<1	<1	-	-

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Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-10-05 15:15	16	0.1	0.61	4	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-10-12 15:15	16	0.11	0.55	8	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-10-19 15:15	15	0.18	0.52	2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-10-27 15:15	14	0.31	0.58	6	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-11-02 15:15	10	0.16	0.58	6	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-11-09 15:15	10	0.11	0.68	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-11-16 15:15	10	0.1	0.68	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-11-23 15:10	9	0.1	0.69	<2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-11-30 15:15	9	0.13	0.75	2	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-12-07 15:15	8	0.14	0.54	4	<1	<1	-	-
GRAB	RMD-268	13800 No. 3 Road (off Garden City)	2022-12-14 15:10	7	0.1	0.79	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-01-04 14:00	5	0.22	0.76	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-01-10 13:50	5	0.16	0.98	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-01-17 13:55	6	0.15	1.01	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-01-24 13:50	6	0.17	0.8	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-02-01 13:55	6	0.12	0.7	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-02-07 13:50	5	0.12	0.74	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-02-14 13:50	6	0.12	0.69	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-02-22 13:50	6	0.13	0.75	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-02-28 13:50	6	0.14	0.8	2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-03-07 13:50	6	0.1	0.78	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-03-14 13:50	6	0.15	0.8	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-03-21 13:50	6	0.1	0.77	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-03-28 13:50	7	0.13	0.91	2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-04-04 13:50	7	0.17	0.64	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-04-11 13:50	7	0.1	0.68	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-04-19 13:50	8	0.14	0.74	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-04-25 13:50	8	0.08	0.89	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-05-02 13:50	9	0.08	0.72	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-05-09 13:50	8	0.11	0.75	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-05-16 13:50	9	0.11	0.69	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-05-24 13:55	9	0.31	0.7	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-05-30 13:50	9	0.12	0.71	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-06-06 12:30	9	0.11	0.75	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-06-13 13:50	10	0.2	0.58	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-06-20 13:50	10	0.1	0.92	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-06-27 13:50	12	0.14	0.72	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-07-04 13:50	12	0.11	0.72	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-07-11 13:50	10	0.16	0.79	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-07-18 13:50	14	0.12	0.71	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-07-25 13:50	12	0.18	0.74	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-08-02 13:50	13	0.16	0.76	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-08-08 13:50	15	0.21	0.68	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-08-15 13:50	13	0.16	0.7	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-08-22 13:50	14	0.11	0.87	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-08-29 13:50	15	0.11	0.63	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-09-06 13:50	15	0.16	0.71	2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-09-12 13:50	16	0.17	0.7	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-09-20 13:50	17	0.13	0.61	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-09-26 13:50	16	0.13	0.66	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-10-03 13:50	16	0.11	0.73	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-10-11 13:50	16	0.14	0.61	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-10-17 13:50	15	0.17	0.7	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-10-24 13:50	14	0.13	0.78	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-10-31 13:50	12	0.14	0.71	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-11-07 13:50	12	0.25	0.68	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-11-14 13:50	10	0.16	0.77	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-11-21 13:50	8	0.16	0.77	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-11-28 13:50	8	0.09	0.74	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-12-05 13:50	7	0.16	0.72	<2	<1	<1	-	-
GRAB	RMD-269	14951 Triangle Road	2022-12-12 13:50	7	0.19	0.69	<2	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-01-04 14:15	6	0.16	0.95	<2	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-01-10 14:10	5	0.13	0.96	2	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-01-17 14:10	7	0.11	0.79	<2	<1	<1	-	-

Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-270	8200 Jones Road	2022-01-24 14:10	6	0.12	1.06	<2	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-02-01 14:15	6	0.1	0.86	<2	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-02-07 14:10	6	0.12	0.73	<2	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-02-14 14:10	6	0.12	0.85	<2	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-02-22 14:15	7	0.1	0.96	<2	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-02-28 14:15	6	0.12	0.81	<2	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-03-07 14:10	6	0.14	0.92	<2	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-03-14 14:10	6	0.12	0.7	<2	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-03-21 14:10	7	0.12	0.81	2	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-03-28 14:10	7	0.14	0.83	<2	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-04-04 14:10	7	0.13	0.78	<2	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-04-11 14:10	8	0.1	0.72	<2	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-04-19 14:10	8	0.11	0.71	<2	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-04-25 14:14	9	0.12	0.71	14	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-05-02 14:15	8	0.11	0.65	<2	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-05-09 14:15	10	0.13	0.7	2	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-05-16 14:15	9	0.1	0.65	14	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-05-24 14:15	9	0.37	0.64	6	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-05-30 14:15	9	0.15	0.62	16	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-06-06 12:45	11	0.13	0.85	<2	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-06-13 14:15	12	0.14	0.54	6	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-06-20 14:15	12	0.1	0.66	<2	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-06-27 14:15	11	0.14	0.63	8	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-07-04 14:10	12	0.11	0.77	4	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-07-11 14:15	10	0.11	0.73	2	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-07-18 14:10	15	0.12	0.58	22	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-07-25 14:10	15	0.11	0.76	4	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-08-02 14:10	17	0.16	0.86	18	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-08-08 14:15	16	0.16	0.67	52	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-08-15 14:10	15	0.11	0.7	40	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-08-22 14:15	14	0.1	0.67	140	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-08-29 14:15	16	0.14	0.65	18	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-09-06 14:10	17	0.08	0.65	280	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-09-12 14:10	17	0.3	0.67	140	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-09-20 14:15	16	0.11	0.6	190	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-09-26 14:15	16	0.09	0.64	390	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-10-03 14:10	16	0.11	0.63	96	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-10-13 09:40	16	0.13	0.55	100	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-10-17 14:10	15	0.17	0.63	260	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-10-24 14:15	15	0.26	0.7	180	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-10-31 14:15	12	0.19	0.63	350	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-11-07 14:10	11	0.21	0.71	<2	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-11-14 14:10	11	0.11	0.74	<2	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-11-21 14:15	9	0.09	0.78	<2	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-11-28 14:15	9	0.1	0.75	4	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-12-05 14:14	7	0.31	0.78	12	<1	<1	-	-
GRAB	RMD-270	8200 Jones Road	2022-12-12 14:15	7	0.1	0.71	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-01-04 15:15	6	0.16	1	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-01-10 15:10	5	0.12	1.01	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-01-17 15:10	6	0.11	0.97	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-01-24 15:10	6	0.13	0.97	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-02-01 15:15	6	0.12	0.97	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-02-07 15:15	6	0.11	0.76	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-02-14 15:15	6	0.13	0.88	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-02-22 15:15	6	0.11	0.99	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-02-28 15:15	6	0.19	0.74	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-03-07 15:15	6	0.11	1.04	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-03-14 15:15	6	0.18	0.73	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-03-21 15:15	7	0.13	1.04	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-03-28 15:15	7	0.13	0.96	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-04-04 15:15	7	0.14	0.85	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-04-11 15:15	8	0.23	0.75	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-04-19 15:15	8	0.11	0.69	2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-04-25 15:15	8	0.1	0.69	<2	<1	<1	-	-

Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-271	3800 Cessna Drive	2022-05-02 15:15	9	0.1	0.68	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-05-09 15:15	9	0.12	0.68	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-05-16 15:15	9	0.11	0.71	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-05-24 15:15	9	0.12	0.76	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-05-30 15:15	9	0.12	0.69	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-06-06 13:50	10	0.11	0.73	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-06-13 15:15	11	0.16	0.6	2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-06-20 15:15	11	0.09	0.91	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-06-27 15:15	11	0.16	0.73	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-07-04 15:15	12	0.12	0.66	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-07-11 15:15	10	0.14	0.79	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-07-18 15:15	14	0.13	0.83	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-07-25 15:15	15	0.14	0.69	14	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-08-02 15:15	16	0.21	0.79	22	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-08-08 15:15	14	0.14	0.65	22	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-08-15 15:15	14	0.5	0.84	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-08-22 15:15	15	0.11	0.76	32	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-08-29 15:15	16	0.13	0.68	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-09-06 15:15	16	0.08	0.65	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-09-12 15:15	17	0.12	0.6	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-09-20 15:15	16	0.12	0.65	8	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-09-26 15:15	15	0.13	0.71	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-10-03 15:15	16	0.14	0.73	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-10-11 15:10	16	0.11	0.65	2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-10-17 15:15	15	0.19	0.65	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-10-24 15:15	15	0.12	0.81	12	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-10-31 15:15	13	0.1	0.64	34	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-11-07 15:15	11	0.21	0.62	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-11-14 15:15	9	0.14	0.74	4	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-11-21 15:15	9	0.17	0.78	2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-11-28 15:15	9	0.12	0.7	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-12-05 15:15	7	0.14	0.7	<2	<1	<1	-	-
GRAB	RMD-271	3800 Cessna Drive	2022-12-12 15:15	7	0.12	0.83	<2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-01-04 15:30	5	0.21	1	<2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-01-10 15:25	5	0.14	0.96	2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-01-17 15:25	6	0.15	0.87	<2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-01-24 15:25	6	0.43	1.16	<2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-02-01 15:30	6	0.13	1.06	<2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-02-07 15:30	6	0.15	0.91	<2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-02-14 15:30	6	0.13	0.99	<2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-02-22 15:30	6	0.14	0.91	<2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-02-28 15:30	6	0.19	0.78	<2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-03-07 15:30	6	0.16	1.04	<2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-03-14 15:30	6	0.23	0.81	<2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-03-21 15:30	7	0.15	1.09	2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-03-28 15:30	7	0.52	1.02	<2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-04-04 15:30	7	0.18	0.69	<2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-04-11 15:30	8	0.12	0.78	<2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-04-19 15:30	8	0.11	0.72	2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-04-25 15:30	8	0.11	0.73	<2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-05-02 15:30	9	0.21	0.67	<2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-05-09 15:30	9	0.13	0.62	<2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-05-16 15:30	8	0.14	0.74	<2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-05-24 15:30	9	0.12	0.71	<2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-05-30 15:30	9	0.11	0.89	<2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-06-06 14:00	10	0.14	0.83	6	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-06-13 15:30	9	0.16	0.66	6	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-06-20 15:30	10	0.14	0.79	<2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-06-27 15:30	10	0.18	1.18	<2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-07-04 15:30	12	0.11	0.86	14	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-07-11 15:30	11	0.15	0.76	22	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-07-18 15:30	14	0.11	0.88	36	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-07-25 15:30	13	0.16	0.8	58	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-08-02 15:30	14	0.13	0.84	12	<1	<1	-	-

Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-272	751 Catalina Crescent	2022-08-08 15:30	15	0.15	0.76	34	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-08-15 15:30	15	0.67	0.72	66	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-08-22 15:30	14	0.11	0.88	110	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-08-29 15:30	16	0.14	0.71	130	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-09-06 15:30	16	0.17	0.8	130	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-09-12 15:30	17	0.19	0.66	<2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-09-20 15:30	16	0.18	0.77	16	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-09-26 15:30	16	0.19	0.87	750	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-10-03 15:30	16	0.91	0.9	100	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-10-13 10:10	15	0.33	0.82	44	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-10-17 15:30	15	1.4	0.76	<2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-10-24 15:30	14	0.21	0.88	8	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-10-31 15:30	11	0.13	0.76	14	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-11-07 15:30	11	0.2	0.82	6	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-11-14 15:30	9	0.18	0.78	8	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-11-21 15:30	8	0.14	0.87	2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-11-28 15:30	8	0.11	0.86	4	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-12-05 15:30	7	0.16	0.79	<2	<1	<1	-	-
GRAB	RMD-272	751 Catalina Crescent	2022-12-12 15:30	6	0.42	1	6	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-01-04 12:45	6	0.15	0.72	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-01-10 12:45	6	0.12	0.66	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-01-17 12:45	7	0.12	0.75	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-01-24 12:45	7	0.13	0.81	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-02-01 12:45	7	0.12	0.74	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-02-07 12:45	7	0.1	0.72	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-02-14 12:45	7	0.11	0.77	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-02-22 12:45	8	0.12	0.79	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-02-28 12:45	7	0.12	0.72	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-03-07 12:45	7	0.12	0.73	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-03-14 12:45	7	0.18	0.71	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-03-21 12:45	7	0.12	0.8	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-03-28 12:45	7	0.14	0.85	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-04-04 12:45	10	0.12	0.67	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-04-11 12:45	10	0.11	0.69	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-04-19 12:45	10	0.1	0.62	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-04-25 12:45	10	0.25	0.68	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-05-02 12:45	10	0.09	0.6	2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-05-09 12:45	11	0.14	0.68	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-05-16 12:45	11	0.11	0.63	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-05-24 12:45	12	0.44	0.6	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-05-30 12:45	13	0.11	0.6	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-06-06 15:15	14	0.12	0.66	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-06-13 12:45	14	0.15	0.52	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-06-20 12:45	15	0.09	0.58	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-06-27 12:45	15	0.2	0.68	4	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-07-04 12:45	17	0.13	0.6	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-07-11 12:45	16	0.12	0.65	2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-07-18 12:45	17	0.12	0.62	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-07-25 12:45	17	0.11	0.67	2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-08-02 12:45	19	0.2	0.67	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-08-08 12:45	19	0.18	0.59	6	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-08-15 12:45	19	0.11	0.62	4	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-08-22 12:45	18	0.11	0.73	6	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-08-29 12:45	19	0.13	0.61	6	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-09-06 12:45	19	0.09	0.68	4	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-09-12 12:45	19	0.12	0.58	2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-09-20 12:45	19	0.14	0.57	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-09-26 12:45	18	0.1	0.58	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-10-03 12:45	18	0.1	0.62	6	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-10-11 12:45	17	0.23	0.56	8	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-10-17 12:45	17	0.12	0.57	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-10-24 12:45	16	0.11	0.64	8	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-10-31 12:45	14	0.1	0.47	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-11-07 12:45	12	0.17	0.61	<2	<1	<1	-	-

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Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-11-14 12:45	11	0.15	0.61	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-11-21 12:45	8	0.1	0.49	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-11-28 12:45	10	0.1	0.68	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-12-05 12:45	8	0.15	0.7	<2	<1	<1	-	-
GRAB	RMD-273	Opp. 8331 Fairfax Place	2022-12-12 12:45	8	0.14	0.67	<2	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-01-04 13:20	6	0.16	0.9	<2	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-01-10 13:15	5	0.13	1.01	<2	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-01-17 13:15	6	0.12	0.99	<2	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-01-24 13:15	6	0.13	0.87	<2	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-02-01 13:15	6	0.15	0.8	<2	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-02-07 13:15	6	0.12	0.94	<2	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-02-14 13:15	6	0.18	0.9	<2	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-02-22 13:15	8	0.13	0.81	<2	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-02-28 13:15	7	0.14	0.85	<2	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-03-07 13:15	6	0.17	0.93	<2	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-03-14 13:15	6	0.18	0.73	4	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-03-21 13:15	7	0.12	0.81	<2	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-03-28 13:15	7	0.14	0.9	<2	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-04-04 13:15	7	0.14	0.68	<2	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-04-11 13:15	8	0.1	0.77	<2	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-04-19 13:15	8	0.1	0.78	<2	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-04-25 13:15	9	0.11	0.8	<2	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-05-02 13:15	11	0.1	0.65	<2	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-05-09 13:15	11	0.13	0.7	4	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-05-16 13:15	10	0.16	0.72	<2	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-05-24 13:15	13	0.11	0.64	<2	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-05-30 13:15	12	0.13	0.63	2	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-06-06 15:00	14	0.14	0.67	8	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-06-13 13:15	15	0.16	0.56	6	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-06-20 13:15	12	0.09	0.85	42	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-06-27 13:15	15	0.16	0.69	140	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-07-04 13:15	15	1.2	0.72	600	<1	5	-	-
GRAB	RMD-274	10920 Springwood Court	2022-07-11 13:15	16	0.11	0.74	20	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-07-18 13:15	18	0.13	0.63	1800	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-07-25 13:15	16	0.25	0.76	96	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-08-02 13:15	17	0.38	0.73	190	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-08-08 13:15	18	0.17	0.6	20	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-08-15 13:15	18	0.16	0.63	38	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-08-22 13:15	18	0.09	0.67	24	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-08-29 13:15	19	0.1	0.62	12	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-09-06 13:15	17	0.1	0.63	20	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-09-12 13:15	18	0.15	0.55	140	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-09-20 13:15	17	1	0.62	360	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-09-26 13:15	18	0.11	0.65	<2	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-10-03 13:15	17	0.11	0.65	54	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-10-11 13:15	16	2.4	0.68	60	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-10-17 13:15	16	0.16	0.55	74	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-10-24 13:15	16	0.55	0.64	98	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-10-31 13:15	13	0.21	0.55	32	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-11-07 13:15	12	0.16	0.65	<2	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-11-14 13:15	11	0.13	0.66	10	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-11-21 13:15	8	0.1	0.68	2	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-11-28 13:15	10	0.1	0.74	2	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-12-05 13:15	8	0.12	0.83	<2	<1	<1	-	-
GRAB	RMD-274	10920 Springwood Court	2022-12-12 13:15	7	0.1	0.76	<2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-01-07 11:00	7	0.13	0.66	<2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-01-13 10:45	6	0.19	0.92	<2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-01-21 10:45	6	0.21	0.79	2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-01-27 10:45	6	0.15	0.77	<2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-02-04 10:45	6	0.14	0.61	<2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-02-10 10:45	6	0.19	0.67	<2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-02-18 10:45	6	0.14	0.71	<2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-02-24 10:45	7	0.12	0.71	2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-03-04 11:00	6	0.17	0.82	<2	<1	<1	-	-

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Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-275	5180 Smith Crescent	2022-03-10 10:45	6	0.29	0.74	<2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-03-18 11:00	7	0.16	0.79	<2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-03-24 11:00	7	0.11	0.88	<2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-04-01 11:00	7	0.11	0.98	<2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-04-07 10:55	8	0.12	0.72	<2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-04-14 11:00	8	0.11	0.73	4	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-04-21 10:45	9	0.21	0.68	<2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-04-29 10:30	9	0.11	0.74	<2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-05-05 10:45	8	0.08	1.09	<2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-05-13 10:45	10	0.09	0.72	<2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-05-19 10:45	9	0.11	0.71	<2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-05-27 10:55	9	0.17	0.6	<2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-06-02 10:45	10	0.12	0.7	4	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-06-10 10:55	11	0.18	0.58	<2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-06-16 10:40	10	0.18	0.82	<2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-06-24 10:45	12	0.1	0.68	<2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-06-29 10:55	12	0.11	0.7	2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-07-08 10:55	13	0.16	0.65	6	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-07-22 10:45	14	0.27	0.65	<2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-07-28 11:10	13	0.14	0.56	6	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-08-05 11:00	15	0.6	0.6	32	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-08-11 10:55	15	0.12	0.64	14	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-08-19 10:40	16	0.22	0.64	8	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-08-25 11:00	15	0.14	0.6	2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-09-02 11:15	16	0.31	0.68	6	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-09-08 11:15	16	0.41	0.71	10	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-09-16 11:15	16	0.12	0.62	8	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-09-22 10:55	17	0.31	0.58	18	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-09-29 10:45	16	0.26	0.53	10	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-10-06 10:45	16	0.13	0.62	28	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-10-14 10:45	16	0.13	0.61	2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-10-20 10:55	15	0.57	0.68	2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-10-28 11:00	14	0.24	0.68	<2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-11-03 10:45	11	0.37	0.64	4	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-11-10 10:55	9	0.18	0.65	<2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-11-17 10:45	9	0.14	0.67	<2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-11-25 10:55	9	0.22	0.68	<2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-12-01 10:55	8	0.15	0.7	<2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-12-09 10:45	8	0.16	0.59	<2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-12-15 10:45	7	0.13	0.69	2	<1	<1	-	-
GRAB	RMD-275	5180 Smith Crescent	2022-12-22 15:00	6	0.32	0.54	NA	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-01-07 10:45	8	0.11	0.79	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-01-13 10:30	6	0.17	1.19	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-01-21 10:30	6	0.18	0.88	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-01-27 10:30	6	0.13	0.84	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-02-04 10:30	6	0.21	0.69	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-02-10 10:30	6	0.16	0.73	2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-02-18 10:30	6	0.13	0.72	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-02-24 10:30	6	0.17	0.81	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-03-04 10:40	6	0.14	0.8	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-03-10 10:30	6	0.22	0.83	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-03-18 10:40	7	0.1	0.78	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-03-24 10:40	7	0.1	0.67	2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-04-01 10:40	7	0.1	0.96	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-04-07 10:40	8	0.12	0.71	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-04-14 10:40	8	0.08	0.72	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-04-21 10:30	9	0.09	0.73	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-04-29 10:15	8	0.12	0.76	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-05-05 10:30	8	0.08	1.26	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-05-13 10:30	9	0.09	0.7	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-05-19 10:30	9	0.11	0.66	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-05-27 10:40	9	0.13	0.71	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-06-02 10:30	10	0.11	0.59	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-06-10 10:40	10	0.15	0.66	<2	<1	<1	-	-

Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-276	22271 Cochrane Drive	2022-06-16 10:20	9	0.23	0.79	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-06-24 10:30	12	0.1	0.58	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-06-29 10:40	11	0.13	0.65	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-07-08 10:40	13	0.11	0.71	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-07-14 10:40	14	0.12	0.61	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-07-22 10:30	15	0.2	0.61	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-07-28 10:55	13	0.25	0.76	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-08-05 10:40	15	0.1	0.52	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-08-11 10:40	15	0.18	0.7	2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-08-19 10:20	15	0.15	0.63	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-08-25 10:40	15	0.14	0.69	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-09-02 11:00	16	0.13	0.73	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-09-08 11:00	16	0.15	0.63	4	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-09-16 11:00	16	0.12	0.66	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-09-22 10:40	16	0.23	0.55	2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-09-29 10:30	15	0.13	0.59	6	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-10-06 10:30	16	0.12	0.64	2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-10-14 10:30	16	0.14	0.66	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-10-20 10:40	16	0.16	0.68	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-10-28 10:40	14	0.24	0.66	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-11-03 10:30	12	0.16	0.75	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-11-10 10:40	9	0.16	0.63	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-11-17 10:30	9	0.15	0.71	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-11-25 10:40	9	0.11	0.67	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-12-01 10:40	8	0.76	0.65	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-12-09 10:30	8	0.16	0.63	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-12-15 10:30	7	0.18	0.68	<2	<1	<1	-	-
GRAB	RMD-276	22271 Cochrane Drive	2022-12-22 14:30	6	0.24	0.63	NA	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-01-05 13:00	6	0.18	0.95	<2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-01-12 13:00	6	0.56	1.16	<2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-01-18 12:45	6	0.14	1.12	<2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-01-26 12:50	6	0.15	0.99	<2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-02-02 12:50	6	0.13	0.76	<2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-02-09 12:50	6	0.18	0.87	<2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-02-16 12:45	6	0.14	0.85	2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-02-23 13:00	6	0.11	0.8	<2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-03-02 13:00	6	0.11	0.68	<2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-03-09 13:00	6	0.36	0.89	<2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-03-16 12:50	6	0.41	0.68	<2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-03-23 12:50	7	0.2	1.06	<2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-03-30 12:50	7	0.32	1.01	<2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-04-06 12:50	7	0.18	0.8	<2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-04-13 12:45	8	0.2	0.73	<2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-04-20 12:50	8	0.1	0.7	<2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-04-27 13:00	9	0.12	0.72	<2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-05-04 13:00	9	0.16	0.62	<2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-05-11 13:00	9	0.13	0.89	2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-05-18 13:00	9	0.17	0.76	<2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-05-25 12:45	11	0.09	0.64	2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-06-01 12:45	11	0.11	0.66	<2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-06-08 12:45	11	0.13	0.72	4	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-06-15 12:45	12	0.1	0.74	2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-06-22 12:45	12	0.12	0.61	<2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-06-28 13:00	12	0.13	0.52	6	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-07-06 10:55	13	0.13	0.73	12	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-07-13 13:00	15	0.09	0.71	6	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-07-20 12:45	13	0.24	0.77	8	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-07-27 12:45	13	0.2	0.73	2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-08-03 12:45	17	0.15	0.77	2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-08-10 12:45	17	0.16	0.69	10	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-08-17 12:50	15	0.14	0.73	<2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-08-24 12:50	15	0.15	0.79	10	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-08-31 12:45	16	0.12	0.78	<2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-09-07 12:50	16	0.09	0.78	24	<1	<1	-	-

Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-09-14 13:00	17	0.1	0.76	16	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-09-21 12:45	17	0.14	0.69	32	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-09-28 12:50	16	0.19	0.8	14	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-10-05 13:00	15	0.27	0.76	10	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-10-12 12:50	16	0.13	0.68	26	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-10-19 12:50	15	0.16	0.76	20	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-10-27 13:00	14	0.12	0.73	2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-11-02 13:00	11	0.13	0.75	4	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-11-09 12:50	10	0.14	0.84	<2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-11-16 12:50	10	0.12	0.71	<2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-11-23 12:45	8	0.13	0.73	<2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-11-30 12:50	9	0.14	0.72	<2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-12-07 13:00	7	0.12	0.77	2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-12-14 12:45	7	0.13	0.87	<2	<1	<1	-	-
GRAB	RMD-277	Opp. 11280 Twigg Place	2022-12-21 12:45	6	0.14	0.71	NA	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-01-05 13:35	6	0.19	0.69	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-01-12 13:35	6	0.15	0.87	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-01-18 13:40	6	0.13	0.92	2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-01-26 13:45	6	0.21	0.74	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-02-02 13:45	6	0.11	0.7	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-02-09 13:45	6	0.25	0.7	2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-02-16 13:35	7	0.13	0.69	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-02-23 13:35	6	0.09	0.78	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-03-02 13:35	6	0.12	0.74	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-03-09 13:35	7	0.25	0.71	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-03-16 13:50	6	0.14	0.72	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-03-23 13:45	7	0.14	0.82	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-03-30 13:45	7	0.14	0.72	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-04-06 13:40	7	0.12	0.64	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-04-13 13:40	8	0.13	0.75	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-04-20 13:40	8	0.13	0.72	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-04-27 13:35	9	0.09	0.67	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-05-04 13:35	10	0.1	0.76	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-05-11 13:35	10	0.13	0.73	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-05-18 13:35	10	0.27	0.73	12	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-05-25 13:40	10	0.12	0.63	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-06-01 13:35	9	0.13	0.68	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-06-08 13:30	10	0.19	0.7	2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-06-15 13:35	9	0.13	0.76	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-06-22 13:35	10	0.15	0.71	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-06-28 13:35	11	0.1	0.68	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-07-06 11:35	14	0.19	0.66	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-07-13 13:35	11	0.2	0.71	4	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-07-20 13:35	13	0.28	1.11	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-07-27 13:35	12	0.18	0.69	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-08-03 13:35	14	0.27	0.69	4	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-08-10 13:35	15	0.23	0.65	2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-08-17 13:45	15	0.11	0.66	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-08-24 13:40	17	0.11	0.64	8	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-08-31 13:40	17	0.1	0.65	10	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-09-07 13:45	16	0.25	0.66	12	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-09-14 13:35	17	0.11	0.66	42	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-09-21 13:35	16	0.35	0.64	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-09-28 13:40	17	0.15	0.59	2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-10-05 13:35	16	0.1	0.66	8	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-10-12 13:40	16	0.12	0.62	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-10-19 12:40	15	0.21	0.7	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-10-27 13:35	13	0.19	0.68	12	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-11-02 13:35	10	0.38	0.64	4	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-11-09 13:40	10	0.13	0.72	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-11-16 13:40	10	0.14	0.82	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-11-23 13:35	8	0.24	0.6	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-11-30 13:40	9	0.15	0.66	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-12-07 13:30	7	0.14	0.71	6	<1	<1	-	-

Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-278	6651 Fraserwood Place	2022-12-14 13:35	7	0.13	0.77	<2	<1	<1	-	-
GRAB	RMD-278	6651 Fraserwood Place	2022-12-21 13:35	6	0.12	0.46	NA	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-01-05 13:50	4	0.1	0.85	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-01-12 13:50	6	0.29	0.76	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-01-18 13:55	6	0.13	1.27	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-01-26 14:00	5	0.16	0.74	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-02-02 14:00	5	0.14	0.75	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-02-09 14:00	5	0.15	0.72	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-02-16 13:50	6	0.16	0.74	4	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-02-23 13:50	5	0.12	0.76	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-03-02 13:50	5	0.21	0.75	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-03-09 13:50	5	0.24	0.73	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-03-16 14:05	6	0.15	0.76	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-03-23 14:00	6	0.15	0.87	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-03-30 14:00	6	0.15	0.93	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-04-06 14:00	7	0.14	0.77	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-04-13 13:55	8	0.07	0.67	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-04-20 14:00	7	0.08	0.72	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-04-27 13:50	8	0.1	0.69	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-05-04 13:50	9	0.11	0.8	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-05-11 13:50	8	0.09	0.72	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-05-18 13:50	9	0.23	0.74	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-05-25 14:00	10	0.09	0.52	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-06-01 13:50	9	0.12	0.75	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-06-08 13:50	9	0.21	1.21	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-06-15 13:50	9	0.13	0.76	2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-06-22 13:50	9	0.11	0.77	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-06-28 13:50	10	0.11	0.65	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-07-06 11:45	10	0.14	0.8	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-07-13 13:50	10	0.18	0.74	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-07-20 13:50	12	0.11	0.92	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-07-27 13:50	11	0.23	0.8	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-08-03 13:50	13	0.15	0.74	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-08-10 13:50	14	0.11	0.54	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-08-17 14:00	14	0.11	0.73	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-08-24 13:55	15	0.13	0.73	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-08-31 14:00	16	0.11	0.79	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-09-07 14:00	15	0.64	0.73	6	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-09-14 13:50	15	0.11	0.68	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-09-21 13:50	15	0.21	0.65	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-09-28 13:55	15	0.3	0.7	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-10-05 13:50	15	0.1	0.71	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-10-12 13:55	15	0.14	0.67	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-10-19 13:55	15	0.18	0.78	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-10-27 13:50	13	0.2	0.84	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-11-02 13:50	11	0.23	0.74	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-11-09 13:55	9	0.13	0.93	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-11-16 13:55	9	0.12	0.6	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-11-23 13:50	8	0.19	0.74	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-11-30 13:15	7	0.13	0.66	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-12-07 13:45	7	0.13	0.77	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-12-14 13:50	6	0.14	0.85	<2	<1	<1	-	-
GRAB	RMD-279	Opp. 20371 Westminster Highway	2022-12-21 13:50	5	0.25	0.71	NA	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-01-07 08:20	7	0.18	1.12	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-01-13 08:15	6	0.18	0.97	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-01-21 08:15	6	0.13	0.84	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-01-27 08:15	6	0.24	0.82	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-02-04 08:15	6	0.16	0.91	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-02-10 08:15	7	0.13	0.97	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-02-18 08:15	6	0.13	1.04	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-02-24 08:15	7	0.28	1.06	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-03-04 08:15	7	0.14	0.79	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-03-10 08:15	7	0.26	0.8	2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-03-18 08:15	7	0.15	0.75	<2	<1	<1	-	-

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Sample Type	Water Sampling Station Number	Water Sampling Station Address	Sampled Date	Temperature (°C)	Turbidity (NTU)	Chlorine Free (mg/L)	HPC (CFU/mL)	Ecoli (CFU/100mLs)	Total Coliform (CFU/100mLs)	Ecoli (MPN/100mLs)	Total Coliform (MPN/100mLs)
GRAB	RMD-280	11500 McKenzie Road	2022-03-24 08:15	7	0.12	0.9	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-04-01 08:15	7	0.13	1	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-04-07 08:20	8	0.14	0.73	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-04-14 08:15	9	0.12	0.91	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-04-21 08:15	8	0.12	0.69	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-04-29 08:15	10	0.13	0.68	2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-05-05 08:20	9	0.16	1.08	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-05-13 08:15	9	0.11	0.63	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-05-19 08:15	10	0.13	0.74	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-05-27 08:20	9	0.12	0.67	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-06-02 08:15	10	0.11	0.66	2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-06-10 08:20	11	0.18	0.7	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-06-16 08:15	10	0.12	0.71	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-06-24 08:15	10	0.13	0.74	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-06-29 08:20	12	0.12	0.8	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-07-08 08:20	12	0.11	0.7	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-07-14 08:20	13	0.1	0.68	18	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-07-22 08:15	14	0.14	0.78	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-07-28 08:20	13	0.13	0.83	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-08-05 08:15	15	0.16	0.59	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-08-11 08:20	15	0.16	0.72	2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-08-19 08:15	15	0.11	0.8	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-08-25 08:15	15	0.11	0.78	4	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-09-02 08:30	16	0.11	0.69	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-09-08 08:30	16	0.13	0.71	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-09-16 08:30	16	0.11	0.7	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-09-22 08:20	16	0.12	0.67	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-09-29 08:15	16	0.17	0.81	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-10-06 08:15	16	0.18	0.65	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-10-14 08:15	16	0.16	0.62	2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-10-20 08:20	15	0.19	0.57	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-10-28 08:15	14	0.11	0.79	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-11-03 08:15	12	0.11	0.66	4	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-11-10 08:20	10	0.16	0.35	8	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-11-17 08:15	9	0.11	0.57	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-11-25 08:15	9	0.15	0.72	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-12-01 08:20	8	0.18	0.79	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-12-09 08:15	8	0.17	0.67	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-12-15 08:15	7	0.15	0.85	<2	<1	<1	-	-
GRAB	RMD-280	11500 McKenzie Road	2022-12-22 12:50	6	0.48	0.66	NA	<1	<1	-	-

APPENDIX F: 2022 THM AND HAA TEST RESULTS

Water Sampling Station Number	Date Sampled	THM (ppb)						HAA (ppb)						
		Bromodichloromethane	Bromoform	Chlorodibromomethane	Chloroform	Total Trihalomethanes	Total THM Quarterly Average (Guideline Limit 100 ppb)	Dibromoacetic Acid	Dichloroacetic Acid	Monobromoacetic Acid	Monochloroacetic Acid	Trichloroacetic Acid	Total Haloacetic Acid	Total HAA Quarterly Average (Guideline Limit 80 ppb)
RMD-250	24-Feb-21	<1	<1	<1	23	25	25	<0.5	7	<1	<2	7	16	20
RMD-250	2-Jun-21	<1	<1	<1	20	22	25	<0.5	9	<1	<2	7	18	20
RMD-250	25-Aug-21	1	<1	<1	25	28	25	<0.5	11	<1	<2	8	19	20
RMD-250	25-Nov-21	<1	<1	<1	30	32	27	<0.5	10	<1	<2	9	19	18
RMD-250	16-Feb-22	<1	<1	<1	20	21	26	<0.5	9.7	<0.5	0.6	8	18	18
RMD-250	11-May-22	<1	<1	<1	25	27	27	<0.5	11	<0.5	1.1	7	18	19
RMD-250	17-Aug-22	<1	<1	<1	21	21	25	<0.5	7.8	<0.5	<5.0	5	14	17
RMD-250	17-Nov-22	2	<1	<1	28	30	25	<0.5	7.3	<0.5	0.8	6	14	16
RMD-251	24-Feb-21	<1	<1	<1	25	27	26	<0.5	7	<1	<2	7	17	17
RMD-251	2-Jun-21	<1	<1	<1	19	21	25	<0.5	10	<1	<2	8	20	19
RMD-251	25-Aug-21	1	<1	<1	26	29	26	<0.5	12	<1	<2	7	19	20
RMD-251	25-Nov-21	<1	<1	<1	28	29	27	<0.5	11	<1	<2	10	21	19
RMD-251	16-Feb-22	<1	<1	<1	11	12	23	<0.5	9.5	<0.5	0.7	7	17	19
RMD-251	11-May-22	<1	<1	<1	23	24	24	<0.5	10	<0.5	0.6	6	17	19
RMD-251	17-Aug-22	<1	<1	<1	21	21	22	<0.5	8.2	<0.5	<5.0	5	14	17
RMD-251	17-Nov-22	2	<1	<1	27	29	22	<0.5	6.9	<0.5	<0.5	5	12	15
RMD-258	24-Feb-21	<1	<1	<1	25	26	29	<0.5	8	<1	<2	8	18	21
RMD-258	2-Jun-21	<1	<1	<1	23	25	28	<0.5	11	<1	<2	9	22	22
RMD-258	25-Aug-21	1	<1	<1	32	34	28	<0.5	13	<1	<2	9	22	22
RMD-258	25-Nov-21	<1	<1	<1	31	32	29	<0.5	11	<1	<2	11	22	21
RMD-258	16-Feb-22	<1	<1	<1	23	24	29	<0.5	11	<0.5	0.6	8	20	21
RMD-258	11-May-22	<1	<1	<1	27	29	30	<0.5	12	<0.5	1	8	21	21
RMD-258	17-Aug-22	<1	<1	<1	27	27	28	<0.5	9.9	<0.5	0.7	8	18	20
RMD-258	17-Nov-22	2	<1	<1	28	30	28	<0.5	6.9	<0.5	0.6	6	14	18
RMD-259	24-Feb-21	<1	<1	<1	24	26	27	<0.5	6	<1	<2	4	11	17
RMD-259	2-Jun-21	<1	<1	<1	21	23	26	<0.5	9	<1	<2	8	18	17
RMD-259	25-Aug-21	1	<1	<1	31	33	27	<0.5	13	<1	<2	10	23	19
RMD-259	25-Nov-21	<1	<1	<1	32	32	29	<0.5	11	<1	<2	10	21	18
RMD-259	16-Feb-22	<1	<1	<1	21	22	28	<0.5	10	<0.5	0.5	7.7	18	20
RMD-259	11-May-22	<1	<1	<1	27	28	29	<0.5	11	<0.5	0.6	8	20	21
RMD-259	17-Aug-22	<1	<1	<1	30	30	28	<0.5	11	<0.5	0.8	9.6	21	20
RMD-259	17-Nov-22	2	<1	<1	32	34	29	<0.5	6.7	<0.5	0.6	5.7	13	18

PWT - 103

APPENDIX G: 2022 METAL LEVELS

Parameter	Canadian Guideline Limit	Reason Guideline Established
Aluminium Total (µg/L)	2,900	Health
Antimony Total (µg/L)	6	Health
Arsenic Total (µg/L)	10 (ALARA)	Health
Barium Total (µg/L)	2,000	Health
Boron Total (µg/L)	5,000	Health
Cadmium Total (µg/L)	7	Health
Calcium Total (µg/L)	none	
Chromium Total (µg/L)	50	Health
Cobalt Total (µg/L)	none	
Copper Total (µg/L)	2,000	Health
Iron Total (µg/L)	≤ 300	Aesthetic
Lead Total (µg/L)	5 (ALARA)	Health
Magnesium Total (µg/L)	none	
Manganese Total (µg/L)	120	Health
Mercury Total (µg/L)	1.0	Health
Molybdenum Total (µg/L)	none	
Nickel Total (µg/L)	none	
Potassium Total (µg/L)	none	
Selenium Total (µg/L)	50	Health
Silver Total (µg/L)	none	
Sodium Total (µg/L)	≤ 200,000	Aesthetic
Zinc Total (µg/L)	≤ 5,000	Aesthetic

ALARA = As Low As Reasonably Achievable

None = no established maximum acceptable concentration (MAC)

Guidelines updated: Nov 15, 2022

APPENDIX H: 2022 METAL TESTING RESULTS

Water Sampling Station Number	RMD-250	RMD-257	RMD-263	RMD-250	RMD-257	RMD-263
Water Sampling Station Address	6071 Azure Rd.	6640 Blundell Rd.	12560 Cambie Rd.	6071 Azure Rd.	6640 Blundell Rd.	12560 Cambie Rd.
Date Sample Taken	2-May-22	2-May-22	2-May-22	9-Nov-22	2-May-22	2-May-22
Metals						
Aluminum Total (µg/L)	26	26	28	32	30	33
Antimony Total (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Arsenic Total (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Barium Total (µg/L)	2.5	2.6	2.5	3.2	3.2	3.2
Boron Total (µg/L)	<10	<10	<10	<10	<10	<10
Cadmium Total (µg/L)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Calcium Total (µg/L)	8,810	8,850	8,950	8,190	8,370	8,270
Chromium Total (µg/L)	<0.05	<0.05	<0.05	0.07	0.07	0.06
Cobalt Total (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Copper Total (µg/L)	<0.5	1	0.9	0.8	0.8	0.9
Iron Total (µg/L)	7	9	7	<5	<5	7
Lead Total (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Magnesium Total (µg/L)	188	193	190	204	208	205
Manganese Total (µg/L)	8.1	12	7.6	7.8	8.1	8.9
Mercury Total (µg/L)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Molybdenum Total (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nickel Total (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Potassium Total (µg/L)	157	157	157	225	227	227
Selenium Total (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

PWT - 105

Water Sampling Station Number	RMD-250	RMD-257	RMD-263	RMD-250	RMD-257	RMD-263
Water Sampling Station Address	6071 Azure Rd.	6640 Blundell Rd.	12560 Cambie Rd.	6071 Azure Rd.	6640 Blundell Rd.	12560 Cambie Rd.
Date Sample Taken	2-May-22	2-May-22	2-May-22	9-Nov-22	2-May-22	2-May-22
Metals						
Silver Total (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Sodium Total (µg/L)	1,610	1,600	1,610	1,950	1,880	1,980
Zinc Total (µg/L)	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0

APPENDIX I: 2022 VINYL CHLORIDE RESULTS

Water Sampling Station Number	Water Sampling Station Address	Date Sampled	Vinyl Chloride µg/L
RMD-205	13851 Steveston Highway	18-May-22	<1
RMD-205	13851 Steveston Highway	1-Dec-22	<1
RMD-206	4251 Moncton Street	18-May-22	<1
RMD-206	4252 Moncton Street	1-Dec-22	<2
RMD-253	11051 No. 3 Road	18-May-22	<1
RMD-253	11051 No. 3 Road	1-Dec-22	<1
RMD-256	1000 Blk. McDonald Road	20-May-22	<1
RMD-256	1000 Blk. McDonald Road	1-Dec-22	<1
RMD-263	12560 Cambie Road	20-May-22	<1
RMD-263	12560 Cambie Road	1-Dec-22	<1

City of Richmond
6911 No. 3 Road, Richmond, BC V6Y 2C1
Telephone: 604-276-4000
www.richmond.ca

2022 Annual Water Quality Report Summary

In 2022, Richmond residents enjoyed high-quality, safe and reliable drinking water. The Annual Water Quality Report identifies rigorous measures taken to protect the City's water supply and demonstrates testing results from water sampling with full transparency in accordance with regulatory requirements.

Richmond is dedicated to promoting the value of municipal tap water, maximizing opportunities for use of tap water in municipal facilities and developing strategies for making tap water the "water of choice" in our community.

How does Richmond provide high-quality tap water?

- By testing all 40 water quality sites on a regular basis.
- By continuous preventative maintenance and monitoring.
- By providing the water system with the highest degree of care to ensure high-quality drinking water is free from any harmful bacteria or toxins.
- By proactive watermain replacement and maintenance projects.

2022 Results

- Provided 33.3 million cubic metres of the highest quality drinking water to over 230,584 Richmond residents.
- Between 2020 and 2022, the per capita consumption decreased by 2.4%, resulting in the conservation of about 800,000 cubic metres of water in 2022.
- Conducted 2,048 microbiological tests from 40 test locations.
- Maintained 12 pressure reducing valve (PRV) stations.
- Repaired 16 watermain breaks without compromising the integrity of the water distribution system while maintaining positive pressure.
- Discovered and repaired 90 non-visible underground leaks through Richmond's leak detection program using noise loggers measuring sound frequencies in the targeted pipe allowing any leaks to be heard and recorded.
- Provided service to Richmond's 5,109 fire hydrants to ensure water is available during an emergency.
- Repaired 205 service connections.
- Installed 4,180 metres of new capital watermain.
- Installed 170 water services for new developments.

Multi-Barrier Approach

Richmond recognizes that in order to provide the highest quality water, several methods must be used to ensure its superiority—hence the "Multi-Barrier Approach".

The "Multi-Barrier Approach" includes:

- Disinfection of the water at the source.
- Water quality monitoring capabilities at eight pressure reducing valve (PRV) stations.
- Weekly microbiological testing at 40 test locations.
- Maintenance practices that are of the highest standard.
- System operators that are certified by BC's Environmental Operators Certification Program (EOCP).

Heterotrophic Plate Count (HPC)

- The HPC count indicates the presence of nutrients that could facilitate the growth of harmful bacteria such as E.coli.
- By reducing the HPC levels, the possibility of bacteriological re-growth is essentially reduced.
- The minimal positive chlorine residual in our water also disinfects and eliminates harmful substances within our distribution system.

Summary

Richmond residents will continue to enjoy fresh, high-quality drinking water. It is without a doubt that the City of Richmond consistently excels at providing tap water of excellent quality and reliability.

Richmond

City of Richmond

Report to Committee

To:	Public Works and Transportation Committee	**Date:**	May 23, 2023
From:	Milton Chan, P.Eng Director, Engineering	**File:**	10-6340-20-P.2022CD00096/Vol 01
Re:	**Drainage Canal Bank Failure Repairs – 12506 Vickers Way**		

Staff Recommendation

That funding of $1,000,000 from the Drainage Improvement Reserve Fund for the drainage canal bank failure repairs at 12506 Vickers Way, be approved and that the Consolidated 5 Year Financial Plan (2023-2027) be amended accordingly, as detailed in the report titled "Drainage Canal Bank Failure Repairs – 12506 Vickers Way" dated May 23, 2023, from the Director, Engineering.

Milton Chan, P.Eng
Director, Engineering
(604-276-4377)

REPORT CONCURRENCE		
ROUTED TO:	**CONCURRENCE**	**CONCURRENCE OF GENERAL MANAGER**
Finance Department	☑	
Sewer & Drainage	☑	
Law	☑	
SENIOR STAFF REPORT REVIEW	**INITIALS:**	**APPROVED BY CAO**

Staff Report

Origin

In January 2021, settlement and surface cracks were observed by City maintenance staff along the drainage canal bank and pedestrian path located on City owned land at 12506 Vickers Way, in the Bath Slough drainage catchment.

The failing section of canal bank and pedestrian path was temporarily repaired by City forces. The cause of the failure was identified as the placement of heavy stacks of tiles on City property by a business operating on the adjacent private property. The condition of the canal bank has been continuously monitored while the damage was assessed and appropriate permanent repairs were determined. In recent months, this section of canal bank has deteriorated and immediate repairs are required.

Staff recommend that funding for permanent repairs be provided from the Drainage Improvement Reserve Fund.

This report supports Council's Strategic Plan 2022-2026 Focus Area #3: A Safe and Prepared Community:

- *Ensure civic infrastructure, assets and resources are effectively maintained to continue to meet the needs of the community as it grows.*

Analysis

The drainage canal bank and pedestrian path located on the City owned land at 12506 Vickers Way is failing. The bank failure at this location presents the potential for danger to public safety, damage to public infrastructure and private property, adverse effects to the environment as well as potential impacts to the City drainage network's functionality.

The failing section of canal bank and pedestrian path was temporarily repaired by City forces and its condition has been monitored while further investigation and design of a permanent repair was undertaken. Based on the initial field observations and the completion of a geotechnical report completed by a third party professional, the slope failure was caused by heavy stacks of tiles placed near to the slough bank, on City property, by users of the adjacent private property at 12500 Vickers Way. As a result, in January of 2023 the City filed a Notice of Civil Claim against the property owner and tenant of 12500 Vickers Way in the BC Supreme Court, seeking an order that the City be compensated for all damages to the City property, as well as all repair costs.

In recent months, the condition of the canal bank has deteriorated and is now in urgent need of repair. The area is now closed to the public to ensure safety. The proposed repair work will include the installation of sheet piles to stabilize the bank, reconstruction of the bank and restoration of the pedestrian path and hand railing to allow safe pedestrian passage along this stretch of Bath Slough canal.

The costs for the repair works are estimated at $1,000,000, including engineering consultant design and construction works.

Financial Impact

The total estimated capital cost for the repair of the failed section of canal bank and adjacent pedestrian path is $1,000,000.

A temporary funding source will be utilized to fund the repair until the Consolidated 5 Year Financial Plan (2023-2027) can be amended with this additional $1,000,000 to be funded by the Drainage Improvement Reserve Fund. In January of 2023 the City filed a Notice of Civil Claim against the property owner and tenant of 12500 Vickers Way in the BC Supreme Court, seeking an order that the City be compensated for all damages to the City property, as well as all repair costs. Any compensation received through the ongoing litigation process and any unused funds will be returned to the funding source.

Conclusion

The canal bank along 12506 Vickers Way is at risk of failure and in need of immediate repair. Staff will be using a temporary funding source to fund the repair. Staff recommend that funding for the repair work be provided from the Drainage Improvement Reserve Fund.

Kevin Roberts, P.Eng
Acting Manager
Engineering Design and Construction
(604-204-8512)

Elena Paller, P.Eng.
Project Manager,
Engineering Design and Construction
(604-276-4023)

City of Richmond

Report to Committee

To:	Public Works & Transportation Committee	**Date:**	May 8, 2023
From:	Peter Russell Director, Sustainability and District Energy	**File:**	10-6125-07-04/2023-Vol 0
Re:	**Circular Procurement Policy Implementation and Progress Update**		

Staff Recommendation

That results of the implementation of circular economy criteria into projects and procurement activities, as noted in the staff report titled "Circular Procurement Policy Implementation and Progress Update," dated May 8, 2023, from the Director, Sustainability and District Energy, be posted online to inform the public.

Peter Russell
Director, Sustainability and District Energy
(604-276-4130)

Att. 5

ROUTED TO:	CONCURRENCE	CONCURRENCE OF GENERAL MANAGER
Finance Department	☒	
Arts, Culture & Heritage	☒	
Library	☒	
Parks Services	☒	
Recreation & Sport Services	☒	
Engineering	☒	
Facility Services & Project Development	☒	
Public Works Division	☒	
Fire Rescue	☒	
Transportation	☒	
SENIOR STAFF REPORT REVIEW	**INITIALS:**	**APPROVED BY CAO**

Staff Report

Origin

This report responds to a referral from the February 22, 2021 Council meeting, which requested:

> *"(2) That Procurement Policy #3104 be reviewed in 18 months, and staff report back.."*

This report supports Council's Strategic Plan 2022-2026 Focus Area #1 Proactive in Stakeholder and Civic Engagement:

> *1.2 Advocate for the needs of Richmond in collaboration with partners and stakeholders.*

This report supports Council's Strategic Plan 2022-2026 Focus Area #2 Strategic and Sustainable Community Growth:

> *2.3 Ensure that both built and natural infrastructure supports sustainable development throughout the city.*
>
> *2.5 Work collaboratively and proactively to attract and retain businesses to support a diversified economic base.*

This report supports Council's Strategic Plan 2022-2026 Focus Area #3 A Safe and Prepared Community:

> *3.2 Leverage strategic partnerships and community-based approaches for comprehensive safety services.*

This report supports Council's Strategic Plan 2022-2026 Focus Area #5 A Leader in Environmental Sustainability:

> *5.1 Continue to demonstrate leadership in proactive climate action and environmental sustainability.*
>
> *5.3 Encourage waste reduction and sustainable choices in the City and community.*

This report supports the Richmond Circular City Strategy (RCCS), which Council approved on April 24, 2023. In line with the circular principles incorporated into Procurement Policy #3104, the RCCS is an innovative plan to steer Richmond toward a sustainable, equitable, and low-carbon economy, aiming for 100% circularity by 2050.

Analysis

In February 2021, Council endorsed an updated version of the City's Procurement Policy #3104, to include circular economy principles. The initiative differentiated the City as a leader in the public sector, by adapting procurement activities to support the organization and the community in moving towards a circular economy. The City's vision for the circular economy aims to maximize the value of resources by design, through responsible consumption, minimizing waste and reimagining how resources flow in a sustainable, equitable, low-carbon economy.

The City's work is guided by the following principles:

- **Design clean:** design our waste and pollution by prioritizing regenerative resources;
- **Keep using:** keep products and materials in an operational use;
- **Regenerate:** regenerate natural systems and mitigate climate change;
- **Collaborate to co-create:** collaborate to co-create innovation and joint value; and,
- **Maximize value:** maximize economic value for money.

Figure 1: City of Richmond circular economy principles framework

Staff capacity building approach

Since the inception of the City's circular principles, staff have engaged multiple vendors, stakeholders and internal staff to assess the City's current and future capacity to support the transition from a linear to a circular economy. The transition is supported through the setting of short and medium-term milestones that will ultimately lead the City to realize its long-term objective of achieving 100% circularity.

Within the past 24 months, the City has reflected circular economy requirements within the scope of work and/or has evaluated submissions against specific criteria relating to the circular economy in over 100 competitive processes. Staff are currently monitoring and evaluating the outcomes of the following:

- Information Technology (IT): 7 procurement activities
- Professional Services: 18 procurement activities
- Civil Construction and Infrastructure: 23 procurement activities
- Facilities, Maintenance and Operations (FMO): 17 procurement activities
- Fleet: 25 procurement activities

In the initial phase, staff recognized there was a lack of knowledge within the organization on what the circular economy represented or how it could be reflected in the City's day-to-day activities and initiatives. The level of market readiness across the City's supply base was also unknown. Given these factors, staff began integrating qualitative circular criteria into procurement processes in an effort to learn from suppliers, assess supply chain readiness within different supply markets and identify more opportunities to create new circular possibilities through procurement activities. Staff also reviewed circular procurement approaches used by other public and private sector organizations to identify best practices and further refine the City's approach. Responses from bidders were reviewed and shared with City departments to learn what information can be requested and how best to assess and score those responses. Appropriate criteria and guidelines for circular procurement methodologies were developed and more information was made publically available to assist vendors understanding of the City's vision for a circular economy.

The implementation approach encompassed the following (see Attachment 1 for more information):

- **Training, capacity-building, and stakeholder engagement:** Since the inclusion of circular economy goals within the City's Procurement Policy in February 2021, the City has organized numerous training and capacity-building events, including over 40 engagement meetings and 20 informal training sessions. Two internal workshops were held to explore further opportunities and challenges to advancing circular procurement. An intranet page was developed and updated with case studies and metrics to further illustrate circular principles in action.
- **Peer-to-peer and stakeholders collaboration:** City staff identified progressive practices from other leading cities, forging collaborations and participating in numerous circular pilot projects. The City has engaged with sustainability and procurement teams from other local governments and participated in procurement focus groups. In total, 52 peer-to-peer activities were undertaken. Some pilot projects include the Reclaimed Asphalt Pavement initiatives, Total Cost of Ownership in IT, and the Hydrogen Fuels pilot project.
- **Market consultation and supplier's engagement:** Market research was undertaken to identify the relative maturity of supply markets and appropriate specifications to use when procuring innovative circular products and services. The knowledge gained has enabled staff to consider different approaches on how best to implement circular principles in projects (See Attachment 2 – Case 14, 15, 16 and 17 as examples). Consulting with industry representatives in the pre-competitive procurement phase of projects is recognized as a key success factor when developing product and service specifications. Successful market consultation has enabled staff to set more realistic goals, evaluate tangible circular proposals, encourage collaboration with City departments and generate support for future circular initiatives.
- **Questionnaires:** Supported by Sustainability, the Purchasing department piloted the use of supplier questionnaires within some Request for Proposal (RFP) bid documents. The questionnaires were able to solicit qualitative information from bidders relating to products, services and the use of packaging materials. Through the questionnaires, more information on product life-cycles, repair and reuse possibilities, remanufacturing and recycling was able to be obtained, as well as information on the availability of extended warranties and service plans that offer opportunities to maximize the life of assets.
- **Evaluation of Proposals:** Proposals from bidders are routinely assessed according to their ability to meet the City's operational and project requirements. However where practical, supplier proposals are now also assessed against their alignment with the City's circular economy criteria. Information received from bidders relating to the use of environmentally-friendly materials, resource efficiency and circular business practices is now also collected and assessed. Evaluation processes are designed to ensure proposals are assessed on both their economic value and their alignment to circular goals and objectives. Depending on the product or service being procured, staff assign evaluation weightings between 5-10% for circular economy considerations.
- **Preliminary technical specifications:** Staff have developed preliminary requirements for various goods and services procured by the City that reflect specifications relating to life-

cycle costs, repair, reuse, remanufacturing, recycling and the availability of extended warranties.

Results and Learnings in the Last 24 Months

The City's efforts implementing circular economy principles in procurement and project activities have been encouraging to date (see more details in Attachment 3):

- **Enhanced circular economy knowledge and capabilities:** Vendors and stakeholders have an increased, but still limited understanding of the circular economy. Technical capabilities vary among suppliers, with some already offering circular solutions, as described in Case 4 - Circular Procurement Strategies for Enclosed Tractors and Flail Mowers and Case 11 - High RAP Pilot Program in City Roadworks (Attachment 2). Other suppliers may require additional support to implement and meet circular requirements. Suppliers have shown a commitments to learning and implementing circular approaches in support of City efforts, as shown in market consultation and Case 1 - Embracing Circularity in Infrastructure: The South Dike Upgrade Project (Attachment 2). Council-supported internal training programs, support, and capacity building have expedited the City's progress in implementing circular approaches in project and procurement activities (see Attachment 6 - Engagement Activity Responses by Staff).
- **Strengthened collaborative processes and stakeholder engagement:** Successful leadership initiatives, as demonstrated in projects like Case 14 - Circularity Integrated into Major Projects and Case 16 - Leading the Way: Project Development Engages with Suppliers and Stakeholders to Foster Circular Innovation (Attachment 2), show that early stakeholder engagement and collaborative activities are essential to identifying common opportunities and creating synergies. As members of the Circular Cities and Regions Initiative and Circular Innovation Council, peer-to-peer and stakeholder collaboration is essential for creating consistency and achieving results. Participation in focus groups, such as Reclaimed Asphalt Pavement, Total Cost of Ownership in IT, EcoHack-a-City, and dialogue around the hydrogen fuels pilot project, provide a platform for building collaboration among City departments and stakeholders. As the result of this participation, staff have developed tools such as a Total Cost of Ownership toolkit.
- **Positive outcomes and cost efficiency in circular procurement:** If carefully planned, implementing circular principles in procurement activities will not necessarily negatively impact costs, as demonstrated in the Reclaimed Asphalt Pavement Pilot Project. Staff observed that by taking a circular economy approach, cost savings can be realized. An example is described in Case 12 - Circular Approach for Synthetic Sports Surfacing Replacement in Hugh Boyd Park. Reusing crumb rubber at Hugh Boyd sports field provided cost savings of $330,000 compared to new infill and kept 800,000 pounds (363,000 kg) of rubber away from landfills (Attachment 2). Other procurement projects have also identified cost saving opportunities, such as Case 17: Furniture Circular Management. However, additional research and analysis needs to be conducted to assess and analyze potential savings over time (see Attachment 4). Ultimately, the City's Procurement Policy reflects a best value approach that also includes both financial and non-financial considerations.
- **Adapting to its Supply Base:** The inclusion of circular questionnaires in procurement activities has been relatively well-received by suppliers who have responded to bid opportunities advertised by the City. The implementation of circular economy criteria in bid

documents have highlighted a supplier's ability to provide circular opportunities, as demonstrated in Case 7: Circular Economy Principles in E-Scooter Share Procurement. More technological advancements and product/service developments are expected in the coming years when the possibilities for circular solutions are shared and highlighted.

The City's work was validated when the City was awarded the Organizational Environmental Programs Award by the Environmental Manager's Association (EMA) of BC in November 2022 for the implementation of a procurement policy that integrates circular economy criteria into corporate procurement activities. The award recognized the City's leadership in promoting environmental sustainability and corporate accountability.

Staff will continue to incorporate circular principles into selected procurements, ensuring alignment with the City's goals and strategies. Based on key results and learnings identified above, staff will undertake the activities described in the Attachment 4 – Next Steps to further implement circular economy principles through procurement activities.

Next Steps

Staff will continue to incorporate circular principles into selected procurements where feasible, ensuring alignment with the City's goals and strategies. Based on key results and learnings identified above, staff will undertake with current resources the following activities to further implementation of the circular economy principles and criteria integrated into the procurement policy (see more details in Attachment 4):

- **Establishing Metrics and Indicators for Circular Procurement Progress:** Implement key metrics to track circular economy principles in procurement, enhancing transparency and prioritizing long-term adherence to circular practices through progress monitoring and reporting.
- **Pilot Project Implementation:** Staff aim to explore more pilot projects with stakeholders and peers, as they are crucial for capacity building and evaluating progress towards a circular economy, while also enhancing the organization's image and regional reputation for sustainability and innovation.
- **Conducting Material Flow Analysis Study and Life-Cycle Analysis:** Following the October 2022 Council endorsement, a Material Flow Analysis study is in progress to assess Richmond's current circularity level and establish a baseline for circular economy progress, with additional Life-Cycle Analysis studies as needed for complex product opportunities.
- **Fostering Training and Capacity Building Initiatives:** Staff will engage in capacity-building and training alongside leading organizations, while collaborating with suppliers and stakeholders to identify circular procurement opportunities, deliver circular products and services, and refine regulatory references.
- **Advocating for Standardized Circular Metrics at the Regional Level:** Recognizing the need for standardized metrics and accessible measurement tools, advocate for the adoption of regional standardized metrics to ensure adherence to circular economy principles.
- **Engaging with Peer and Industry Working Groups:** Participate in working groups to engage with circular economy stakeholders, identify opportunities, synergies, and

metrics, and foster collaboration that advances circular principles in procurement activities.

Sharing the success stories to lead the pathway toward the circular economy

A recommendation is included to post results on the City's website and social media platforms as described in the report, including those that may arise in the future. Showcasing tangible examples of circular strategies in action strengthens the credibility of the City's circular efforts and inspires stakeholders, vendors, and other municipalities to replicate these practices.

Financial Impact

None.

Conclusion

The City of Richmond has made significant strides to incorporate circular economy principles in its procurement activities. However, staff recognize that this is only the beginning of its journey toward achieving 100% circularity by 2050. Numerous vendors and stakeholders have pledged their commitment to promote sustainability and a circular economy. To expedite progress, staff will continue to collaborate with suppliers to maintain dialogue and share experiences, tools and practices that facilitate the adoption of circular outcomes. Fostering ongoing collaboration will enable the expansion of circular principles to a broader range of projects and activities. A key benefit for the City has been the collaborations with peers, other levels of government and different stakeholders to enhance circular procurement practices further and inspire widespread market adoption. With Council endorsement, results will be posted on the City's website and social media, demonstrating the City's commitment to a circular economy. The EMA Award, given to the City for integrating circular economy principles into procurement, highlights the City's leadership in environmental sustainability.

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Att. 1: Implementation Activities
2: Circular Procurement Success Stories
3: Key learnings and results from implementing circular principles in corporate procurement and project activities
4: Next Steps
5: Analysis of the last 24 months' request for proposals by sector

Implementation Activities

Integration of circular principles into procurement activities has leveraged City's leadership in a way that is consistent with several existing City strategic sustainability goals including zero-waste, zero-emissions, ecosystem resilience and business mobilization. The engagement approach and earlier market engagement undertaken by staff supported the following benefits:

- Obtaining information on circular business models, an understanding how specific markets are structured and how they operate;
- Learning from suppliers to understand planned circular innovations;
- Increasing trust and credibility with suppliers;
- Creating market conditions to design circular products and services;
- Helping buyers identify opportunities for circularity and innovation;
- Clarifying needs and circular principles application in an appropriate to the context of the request to market players;
- Extending the life of products the City already owns;
- Encouraging the growth of circular supply chains by procuring more circular products, materials and services; and,
- Promoting new business opportunities based on resource-efficient models solutions (e.g. innovative rental systems, systems for sharing products and equipment or systems in which consumers buy the service provided by a product, rather than the product itself).

The implementation approach encompassed the following:

- **Training, capacity-building, and stakeholder engagement:** Since the adoption of the revised Procurement Policy in February 2021, the City has played a lead role in organizing multiple training programs and capacity-building engagements attended by both internal and external stakeholders. In November 2021, staff invited stakeholders to a workshop to identify opportunities and challenges for implementing a circular economy. These capacity-building and stakeholder engagements have enabled staff to obtain feedback from representatives from multiple industry sectors that in turn is helping to inform the City's ongoing circular procurement work. Staff carried out:
    - more than 40 engagement meetings with different internal and external stakeholders representing different industries to identify opportunities and readiness;
    - more than 20 informal training sessions with vendors, stakeholders and suppliers;
    - two internal staff workshops on circular procurement opportunities;
    - the development and update of an Intranet page with case studies to illustrate applications of circular principles in projects.

- **Peer-to-peer and stakeholders collaboration:** Staff have been able to capture promising practices and insights from other cities and jurisdictions. Staff have consistently demonstrated the City's leadership and commitment to circular procurement by bringing together peers and stakeholders, as well as forging vital strategic collaborations within a pre-competitive environment to co-create and identify opportunities for embracing circularity in local and regional markets. As part of peer-to-peer and stakeholder collaboration, the following activities have been undertaken:

-
    - Meetings with sustainability and procurement teams from other local governments, such as Mississauga, Edmonton, Vancouver, North Vancouver, Banff, Guelph, and the District of Peel.
    - Participation in procurement focus groups as part of the Circular Cities and Regions Initiative.
    - Regular involvement with the Circular Innovation Council and its partners.
    - Circular pilot projects: City staff organize and participate in circular pilot projects to assess the impact of circular innovation and create regional references to advance the circular economy. Pilot projects and study cases include:
        - Reclaimed Asphalt Pavement, in collaboration with National Zero Waste Council and Lafarge Canada
        - Total Cost of Ownership in IT organized by Green Economic Canada
        - Hydrogen fuels pilot project and research interviewing 24 industry stakeholders and non-profit organizations
        - Propane project as an alternative fuel, in collaboration with Sierra
        - e-Scooter pilot project to increase low-carbon option in Richmond mobility
        - EcoHack-a-City - Towards a Zero Waste Industrial Sector, co-hosts: District and City of North Vancouver
        - LEED certifications and the circular economy principles
        - CSA Group's Roadmap to Circularity with focus on low-carbon cement
    - Participation in 52 diverse peer-to-peer activities has facilitated the identification of shared opportunities, challenges, and synergies in pursuing the circular economy, fostering a culture of leading by example and embracing experiential learning.

- **Market consultation and supplier's engagement:** Market consultation was key to validate preliminary specifications and requirements for procuring innovative circular products and services. It was vital to consider current supplier business models and product specifications when conducting circular procurement. There was a correlation between the levels of technical specifications and market maturity, with more mature markets offering open specifications and less mature markets requiring guidance on potential solutions and market consultation providing valuable insights into circular opportunities.

- **Questionnaires in the request for proposal:** Request for Proposals (RFPs) incorporated qualitative questionnaires for various products, services, and packaging. Criteria included purchasing items that were durable, repairable, reusable, made with recycled or renewable content, containing less hazardous chemicals, maximizing resource efficiency, and featuring a collection and return system. Packaging specifications were requested to be made from reusable or recyclable materials and free from hazardous chemicals. Materials used in the manufacturing process were to be ideally locally sourced, seasonally, and regeneratively. The questionnaires also encouraged the elimination of problematic or unnecessary packaging through redesign and innovation, replacing single-use packaging with reusable formats or alternative delivery models, and utilizing packaging or plastics that were 100% recyclable with recycled content or sourced from

- renewable feedstock. A relative weighting of between 5% and 10% was typically given to circular performance in evaluating bid submissions. Consideration is routinely given to how well the proposals adhere to circular requirements and principles, including the use of environmentally-friendly materials, promote and resource efficiency, and adopting circular business practices. This evaluation process ensures bid submissions are assessed not only on their economic value but also on their ability to achieve circular goals and objectives.

- **Preliminary technical specifications:** In the initial phase, staff developed preliminary specifications for procurement projects and incorporated qualitative requirements for products or services being acquired. Utilizing more qualitative specifications were able to open up new opportunities for innovative, circular solutions without prescribing specific solutions. These solutions were better suited to meet departments' needs in terms of quality, quantity, and reliability. The use of functional specifications is dependent on a supply market's relative maturity regarding circularity and the complexity of the product or service group. To further encourage circular solutions, procurement activities incorporated the following requirements:
    - Conducting a life-cycle analysis to assess products and service costs throughout the entire lifespan, from production to end-of-life.
    - Promoting repair, reuse, remanufacturing, repurposing, and recycling so that products can be repaired to maximize their length of useful life, reused or shared to maximize product utility, and disassembled and recycled to maintain maximum value of resources for products at the end of their useful life.
    - Requiring an extensive warranty to reduce the need for more resources, inputs, and less frequent replacement.
    - Focusing on service instead of products.
    - Focusing on market dialogue.

Circular Procurement Success Stories

Case 1: Embracing Circularity in Infrastructure: The South Dike Upgrade Project
The South Dike Upgrade project improved the dike structure from No.3 Road to 400m west of No.4 Road. The primary objective was to engage a contractor for structural upgrades, while adhering with all regulatory agency requirements. Key tasks included clearing and grubbing, excavation, placement of dike fill and rip rap armouring, topsoil management and landscaping. Circular economy considerations were incorporated into the procurement process to promote responsible consumption, minimize waste, and create a sustainable, low-carbon economy.

Circular criteria involved a focus on reusing excavated materials, recycling raw materials and low-carbon transportation. Criteria was selected in consultation with the project team and based on the nature of the project. The expected impacts included a greater emphasis on keeping materials onsite and reusing them. The circular criteria contributed 5% to the overall evaluation of proposals. The criteria was assessed was based on the City of Richmond's vision for a circular economy and the assessment process involved analyzing proposals for the proportion of reused products, reused soil, recycled raw materials and low-carbon transportation.

Key learnings from the project include the importance of clear communication and understanding of circular economy principles during the design process. A wrap-up meeting with the contractor and engineer also provided valuable insights for improving the efficiency and effectiveness of future projects in achieving circular economy goals.

Case 2: Integrating Circular Procurement Practices in Municipal Fleet Operations
The Department of Fleet Operations implemented circular procurement practices in the acquisition of two 3/4 ton crew cab pickup trucks for the Parks and Environmental Program Departments. The project aimed to align with the city's Green Fleet Action Plan, which has a target of reducing greenhouse gas emissions by 20% by 2020, using 2011 as the baseline year.

The circular criteria used in the procurement process were based on fuel economy, vehicle emission reductions, long-term parts availability, ergonomics, and safety features. Consultations were held with internal user groups, mechanics, and external vendors to identify circular economy principles that aligned with the project's objectives.

The evaluation process included a mandatory questionnaire covering circular economy principles and practices, emphasizing product quality and safety, recycling and waste reduction, environmental and sustainability performance, product reuse, repair, and remake strategies, and the use of raw materials in the equipment.

Two proposals were received, with one being accepted as it met all requirements and demonstrated adherence to circular economy principles. The winning bid acknowledged the company's adoption of circular economy practices and aligned with the city's efforts to minimize

its environmental footprint and social impact. The evaluation process also considered fuel economy and emission reduction possibilities, which factored into the final decision.

Challenges included the scarcity of supply of units and the lack of understanding of circular economy principles among vendors. To overcome this, staff researched parent companies like Ford and Chevrolet, educated local distributors or dealerships on circular economy principles, and encouraged them to identify specific initiatives for future evaluations.

Case 3: Driving Circular Procurement: Fleet Transformation with Hybrid and Electric Vehicles

Staff implemented circular procurement practices in the acquisition of plug-in hybrid and fully electric passenger sedans and hatchback vehicles. The project aimed to align with the city's Green Fleet Action Plan, which has a target of reducing greenhouse gas emissions by 20% by 2020, using 2011 as the baseline year.

Circular economy criteria used in the procurement process were based on fuel economy, government environmental vehicle emission reductions, long-term parts availability, ergonomics for all body types, and safety features. Consultations were held with internal user groups, mechanics, and external vendors to identify circular economy principles that aligned with the project's objectives.

The evaluation process prioritized PHEV and BEV vehicles that met the circular criteria, such as LED lighting, safety features, and adherence to the BC Environmental Vehicles Emissions reduction requirements. The Fleet department has a robust fuel monitoring system, which allows them to measure the fuel economy, idling, and kilometers traveled by all vehicles. They have observed an approximate fuel and emission saving of over 47% by incorporating these vehicles.

Four proposals were received, with two being accepted. Circular criteria was aligned with the Green Fleet Action Plan, and some circular economy principles were included as mandatory features. The RFQ was completed before the implementation of a specific Circular Economy Questionnaire in the RFQ process.

Challenges included the scarcity of supply of units and the lack of understanding of circular economy principles among vendors. In order to address this challenge, the staff conducted research on parent companies like Ford and Chevrolet, provided education on circular economy principles to local distributors or dealerships, and motivated them to identify particular initiatives for future assessments. The increased cost due to mandatory requirements was factored into the budget, and reduced operating costs on the acquired units improved the Total Cost of Ownership.

Case 4: Circular Procurement Strategies for Enclosed Tractors and Flail Mowers

Fleet Operations implemented circular procurement practices in the acquisition of two enclosed tractors complete with 26-foot reach flail mowers. The project aimed to align with the city's Green Fleet Action Plan, which has a target of reducing greenhouse gas emissions by 20% by 2020, using 2011 as the baseline year.

Circular criteria used in the procurement process were based on fuel economy, government environmental vehicle emission reductions, long-term parts availability, ergonomics, and safety features. Consultations were held with internal user groups, mechanics, and external vendors to

identify circular economy principles that aligned with the project's objectives. Compliance with new bylaws regarding Emission Regulations was also researched.

A Circular Economy Questionnaire was included in the RFQ, covering topics such as parts availability, recycled or sustainably sourced materials, recycling of old equipment, and product reuse repair and remake strategies. The Fleet department has a robust fuel monitoring system, which allows them to measure the fuel economy, idling, and hours used by all vehicles. The units will also be equipped with LED lighting.

Two proposals were received, with one being accepted. The winning bid acknowledged the adoption of circular economy principles and practices, and the evaluation took into account fuel economy and emission reduction possibilities. The vendor met all requirements and was awarded the contract. Their ECO-Blue engine is optimized for fuel efficiency and reduced CO2 and NOX emissions.

Challenges included the scarcity of supply of units and limited vendor responses. The selected vendor, New Holland, provided several examples and links to videos showcasing their commitment to circular economy principles. The project demonstrated the successful implementation of circular procurement practices in acquiring vehicles that met operational needs while significantly reducing emissions and contributing to a more sustainable future.

Case 5: Circular Practices in Fuel System Replacement at City Works Yard
Fleet Operations undertook a circular procurement project for the replacement of underground electrical conduit, fuel pumps, installation of rain covers, and related works at the City Works Yard. The project was initiated after the failure of outdated pumps during the November 2021 atmospheric river event.

Western Oil Services, a City Contractor for over 20 years, was chosen as the sole authorized contractor for the Coencorp Fuelling System in British Columbia. The company has demonstrated a strong commitment to environmental concerns and has provided solutions to prevent any events that could impact the environment. The vendor is also required to adhere to stringent oil and gas regulations for installations and maintenance.

As a single-source procurement, there was no point distribution system applied to the contract. However, the City recognized the vendor's background and experience in environmental concerns. The new Veeder Root installed will monitor fuel levels and advise if there are any leaks in the fuel tanks, helping to mitigate any potential environmental impacts.

Challenges, opportunities, and learnings from this project included the importance of educating vendors about presenting their circular economy strategies and sharing this information with the City, potentially through an online platform or training sessions. While this specific procurement did not involve circular criteria evaluation, the project highlighted the importance of working with environmentally responsible vendors and incorporating circular principles in future procurement projects.

Case 6: Dump Body Unit Acquisition and Outfitting
Fleet Operations undertook a circular procurement project for the supply and delivery of one dump body unit and outfitting on a City provided single axle cab and chassis unit. This project

aligned with the City's Green Fleet Action Plan, which aims to reduce greenhouse gas emissions by 20% by 2020 and update the policy to incorporate 2030 targets and new strategies.

Circular criteria for this project was selected based on fuel economy, government environmental vehicle emission reductions, long-term parts availability, ergonomics, and safety features. Internally, consultation with end-user groups, mechanics, and policies like the Green Fleet policy took place. Externally, the City worked with Peterbilt and potential vendors to ensure all requirements were met. The expected impact of including these circular economy principles was the acquisition of vehicles that met operational needs while significantly reducing emissions.

Criteria was evaluated through a mandatory questionnaire included in the RFQ. The winning bid was awarded to the lowest bidder that met specifications, and the vendor's responses to the questionnaire confirmed their commitment to circular economy principles. The main cab and chassis were from Peterbilt, which has clearly defined circular economy and environmental justice programs.

Challenges faced during the project included the scarcity of supply of units and the limited understanding of circular economy principles among vendors. Staff had to research parent companies to find information on circular economy initiatives and then educate local distributors or dealerships on how to respond. City workshops could help vendors identify current initiatives and areas for improvement in their circular economy strategies.

Case 7: Circular Economy Principles in E-Scooter Share Procurement
Transportation aimed to procure a qualified contractor to develop, operate, maintain, and manage a publicly accessible electric kick scooter ("e-scooter") share system for the City's pilot program. The goal is to provide an alternative mode of transportation for residents, reducing automobile use, promoting active transportation and transit use, enhancing connectivity, and allowing multi-modal access to employment, recreation centers, and services.

Circular criteria used in the evaluation process included the nature and variety of circular economy and sustainability opportunities available to the City, the proponent's life cycle program, waste collection and reduction strategies, and energy management and conservation. These criteria were weighted at 5% of the evaluation process.

Six proposals were received, and Lime's proposal included strong emphasis on circular economy principles. Lime outlined that their e-scooters have a lifespan of at least five years, with every component being replaceable. At the end of their lifespan, Lime achieves nearly 100% landfill diversion with its end-of-life partners, recycling more than 96% of the materials.

Lime also utilizes a fleet management system to optimize field tasks, reduce vehicle kilometers traveled, and charges the e-scooters with 100% renewable energy. Lime employs e-vans and e-cargo bikes for collecting, rebalancing, and redeploying e-scooters in dense city areas.

The inclusion of circular criteria demonstrates the City's commitment to sustainability and circular economy principles in its e-scooter share pilot program. The selection of Lime as the contractor for the project ensures that the program will be managed with a strong focus on circular economy principles, such as the extended lifespan and high recycling rate of e-scooters, contributing to the City's overall sustainability goals.

Case 8: Circular Procurement of Vending Machines for Public Recreation Facilities
Recreation and Sport Services aimed to procure an experienced and qualified Vending Machine Contractor to provide commission-based vending services for food and beverages at twelve public recreation facilities. The primary objective was to have an automated and self-sufficient vending machine operation providing nutritional snacks and beverages, including all necessary equipment, supplies, and personnel.

Circular criteria was included in the evaluation process, with a focus on environmental impact reduction, energy management, waste reduction, and other circular opportunities. The circular criteria was weighted at 5% in the RFP. The evaluation committee considered corporate sustainability practices, including energy efficiency, vehicle fuel efficiency, greenhouse gas reductions, recycling and waste reductions, corporate social responsibility initiatives, and circular economy initiatives.

Five competitive bids were received. The inclusion of circular criteria helped one proposal, Compass Group Canada, gain a competitive edge. Compass Group Canada achieved higher scores in corporate sustainability and circular economy practices, displaying efforts to reduce emissions from operations and having a strong corporate profile. The company pledged to reduce CO2e emissions by 43% by 2025, uses Energy Star machines and LED lighting, plans to phase out bottled water within five years, recycles 100% of cardboard, and employs smart service data technology for increased fuel efficiency.

Challenges identified include the need for a clearer understanding of circular criteria and a process to evaluate and monitor the contractor's efforts in meeting these criteria. By addressing these challenges, the City of Richmond can further promote circular economy practices in its procurement processes and ensure that contractors follow through on their commitments.

Case 9: Circular Criteria in Procurement for Self-Checkout Kiosks at Richmond Public Library
The Richmond Public Library underwent a procurement project for the supply, installation, and support of 10 RFID self-checkout kiosks and associated software for the library's four branches. The procurement objectives aimed to find a competitive supplier capable of fulfilling the project's scope of work.

Circular criteria was included in the procurement process, focusing on the Circular Economy Assessment, which considered recycling programs, reuse and recycling of hardware and hardware components, waste reduction strategies, and energy efficiencies and management. The evaluation process consisted of two phases, with the circular criteria accounting for 5% of the score in Phase 1.

Four proposals were received from Envisionware, Mk, Convergent, and Bibliotheca. The circular criteria did not impact the process or the number of proposals submitted. The proponents responded to the circular criteria without issues, with most offering removal and recycling services for decommissioned hardware and associated parts at a cost.

Circular criteria was assessed by the review panel independently, with scores and comments reviewed by the Buyer. However, circular economy appeared to be an afterthought for most proponents, with responses seeming "stretched" to favor a positive outcome. As the self-

checkout kiosks were new equipment installed last year, the library will follow up on the supplier's commitment to recycling or reuse.

Case 10: High RAP Pilot Program in City Roads
Engineering and stakeholders initiated a high reclaimed asphalt pavement (RAP) pilot program to increase the use of recycled asphalt in municipal roads. The objectives included incorporating high RAP requirements in the annual paving program and seeking qualified contractors capable of delivering high RAP products.

The procurement strategy involved including questions and documents in the RFP to facilitate evaluation based on the ability to successfully deliver high RAP paving services. Award criteria considered the proponent's approach to circular economy considerations with a 5% weighting.

The City has paved a section of a 4-lane arterial road (No 5. Road, between Grandville Road and Blundell Avenue) with high RAP, and has several future locations planned for further application of this technology. This was the first project in Canada to use 40% RAP and has placed the City in a leadership role by engaging the local industry, reducing natural resource and fossil fuel use, and minimizing waste. The accreditation system ensures that the City obtains products that meet its specifications, and quality control is a crucial aspect of meeting these specifications. Based on the results of this pilot project, there is also the potential for cost savings through using high reclaimed asphalt.

Case 11: Circular Approach for Synthetic Sports Surfacing Replacement in Hugh Boyd Park
Parks Planning, Design & Construction initiated a project for Hugh Boyd Park Synthetic Sports Surfacing Replacement, which aimed to replace, recycle, and re-use the existing infilled sports surfacing system. The procurement strategy sought qualified proponents/contractors with the necessary experience, skills, and equipment to remove, clean, and re-install crumb rubber infill.

The contract required the removal and recycling of the existing synthetic turf surface and the installation of new synthetic turf playing field surfacing that meets the most current FIFA Quality Pro synthetic turf product standards. Award criteria focused on sustainability initiatives, energy management, waste reduction, emission reduction, recycling efforts, and preference for recycling and utilizing removed turf surface materials. Additionally, the proponents were required to provide ongoing maintenance and repairs within 48 hours notice, and a warranty of a minimum of 8 years for both labor and materials.

By reusing the existing crumb rubber infill, the life cycle of rubber was extended, preventing it from ending up in landfills and polluting the environment. Reusing crumb rubber at Hugh Boyd sports field provided cost savings of $330,000 compared to new infill and kept 800,000 pounds (363,000 kg) of rubber away from landfills.

Lessons learned include the viability of recycling and reusing crumb rubber infill for cost savings and sustainability. However, public perception regarding recycled tire crumb rubber can be controversial. Despite local, provincial, and national health authorities suggesting that recycled crumb rubber is safe for use in artificial turf sports fields, some organizations have concerns about the health and safety related to recycled tire rubber. This may impact future decision-making for its continued use in sports fields.

Case 12: Meetings with Architects and Construction Managers Sparks Circular Ideas for Collaboration

Prior to incorporating circular economy principles into the City's procurement process, meetings were held with 17 proponents, including architects and construction managers. The City's Manager of Capital Buildings Project Development and the Manager of Purchasing led the meeting and posed a question to the proponents:

"The City has declared its support for a circular economy and is looking to collaborate with innovative contractors/architects to achieve those goals. What ideas does your firm have and how should the City change its specifications to reflect a practical and value-added transition to a circular economy?"

The proponents were given time for internal discussions before providing their feedback and answers. This approach allowed the City staff to gauge the level of awareness, understanding, and market readiness for circular economy principles among the proponents.

Out of the shortlisted Architects and Construction Managers, 9 out of 10 Architects and 5 out of 7 Construction Managers provided responses to the question. The various responses showcased the proponents' ideas and suggestions for collaborating with the City to promote a circular economy, such as adopting sustainable materials, designing for disassembly, and prioritizing waste reduction.

One architectural firm, in particular, demonstrated a strong commitment to the circular economy by introducing their Senior Sustainability Consultant. This consultant shared valuable resources, such as research, tools, and insights on design for disassembly. As a result of this presentation, the architectural firm was connected with the staff to explore further collaboration and integration of circular economy principles into the City's projects.

Case 13: Circularity Integrated into Major Projects

The Capital Buildings Project Development has integrated circular economy principles into its Request for Proposals (RFP) for major projects. Vendors were asked to review the City's policy on circular and provide relevant examples of previous projects based on their understanding of the concept.

For the Steveston Community Centre and Library Replacement project, the RFP required vendors to provide relevant project references that achieved a LEED Gold Certification or a higher performing sustainability standard, such as Passive House or Net Zero Carbon. The scope of work for the project required the successful candidate to:

1. Design to achieve LEED Gold certification;
2. Design to meet the City of Richmond's Circular Economy Principles and Criteria; and
3. Design to meet City Building Facilities Design Guidelines and Technical Specifications.

These requirements have elements of circular principles embedded in them, emphasizing the City's commitment to sustainable practices. The successful candidate proposed Integrated Design Process (IDP) meetings as part of their proposal to review and progressively refine Circular Economy goals and targets. They also included a consultant in their project team to design the

building envelope for deconstruction, which extends the lifecycle of the materials used in the project.

As a result of this approach:

1. The City adopted its circular principles and criteria, finding relevant pre-existing requirements that can help create a set of metrics to measure circularity in future projects.
2. Vendors are given the opportunity to learn more about sustainable practices and incorporate them into their proposals, thus promoting a more sustainable and circular economy in the industry.

By incorporating circular principles into the RFPs and project requirements, the City is not only demonstrating its commitment to sustainability but also encouraging vendors to embrace these principles, leading to more environmentally responsible and resource-efficient projects.

Case 14: Circular Principles in Fire Rescue Department's Procurement Activities
The Fire Rescue department's procurement activities prioritize circular economy principles to enhance sustainability and cost-effectiveness. In this case, the City requested a single source supplier to meet their specific requirements. The rationale behind this decision was based on compatibility with existing city equipment, custom-built information systems, and inventory systems, as well as the absence of reasonable alternatives.

The supplier's approach to circular economy is evident in their commitment to reducing waste, reusing materials, and recycling components. Their products are of superior quality, with added value safety and performance features, ensuring a longer life cycle, reduced replacement costs, and lower ownership costs. This directly contributes to the reduction of waste in the city's procurement activities.

Fire hoses supplied by the chosen vendor can be repurposed for various municipal activities after their retirement from the fire service, further supporting the re-use principle. Additionally, aluminum couplings can be removed and recycled when the fire hose is no longer usable.

In their manufacturing facilities, the supplier practices responsible recycling procedures. They reuse water in test tanks, return empty polyester yarn cones for refilling, and use recyclable cardboard for shipping materials. Waste generated during production, such as aluminum and brass chips, is collected and recycled. Furthermore, the supplier has implemented energy-efficient lighting and reuses or recycles pallets received for shipping.

This case study demonstrates how circular procurement principles have been successfully incorporated into the Fire Rescue department's activities, promoting sustainability, cost savings, and responsible use of resources.

Case 15: Leading the Way: Project Development Engages with Suppliers and Stakeholders to Foster Circular Innovation
Project Development demonstrated leadership by proactively engaging with prequalified architects and construction management firms to explore opportunities for implementing a circular procurement approach in harmony with existing sustainability practices. By initiating

this engagement activity, the City communicated its intention to support circular economy initiatives and sought collaboration with innovative professionals to achieve these objectives.

A survey was distributed, asking participants to share their ideas on how the City could adapt its specifications to facilitate a practical and value-added transition to a circular economy. Various responses were received, including suggestions related to LEED, Passive House, and carbon reduction. Respondents emphasized the need for clear definitions and guidelines, such as methods of analysis, reuse examples, and data on material usage.

Quality control checks and cost analyses were recommended to ensure the achievement of circular economy goals. Some respondents noted that LEED was becoming less popular due to its high costs and restrictive nature. They suggested adopting best practices from LEED and other guidelines to develop a more practical approach.

The capability of consultants in the region to support circular economy initiatives was acknowledged, but respondents also identified a gap between political directives and project implementation. They recommended incorporating circular economy considerations at the beginning of the project stage or in the project definition study. This would enable the identification of opportunities and their inclusion in the request for proposals (RFP).

Budget constraints were highlighted as a challenge for incorporating circular economy principles in competitive bidding scenarios. Respondents suggested defining circular economy requirements in the owner's statement of requirements (OSR) and leaving the determination of options to consultants. Conducting a feasibility study in the pre-design stage and adjusting the project budget accordingly could help balance financial value and sustainability goals.

Project Development showcased its leadership by actively involving suppliers and stakeholders in the exploration of circular procurement opportunities. This collaborative approach, coupled with the valuable suggestions provided, can significantly contribute to the City's progress towards achieving its circular economy goals while maintaining a strong focus on sustainability.

Case 16: Furniture Circular Management: Implementing Circular Business Models for Sustainable and Cost-Effective Operations

Project Development demonstrated leadership by proactively implementing circular business models to improve city operations performance and reduce costs. One of the areas where this approach was applied is in the procurement and management of furniture.

Emphasizing the circular economy, the Project Development team utilized existing furniture products in the City's inventory for most reconfigurations. While new materials were occasionally required due to project specifications or insufficient stock, the team also refurbished furniture items, such as chairs, filing cabinets, and panels.

The approach to integrating furniture into the circular economy involved several key steps:

- Inventory management: maintaining an updated list of stock.
- Preventative maintenance: extending product lifetime through proper care.
- Corrective maintenance: repairing products as needed.
- Reuse: redistributing and cleaning products for future use.

- Repurposing: modifying products for new functionalities.
- Refurbishing: remanufacturing products to optimize their lifetime, such as reupholstering, repainting, or cleaning.
- Recycling: recovering the value of components and materials for use in new products.

The refurbished items proved to be significantly more cost-effective and required less lead time. For example, the average cost of a new upholstered chair was $602.20 with a 3-4 week lead time, while a refurbished chair cost $230.00 with only a 1-week lead time.

By embracing circular business models, Project Development has exemplified leadership in improving City operations performance and reducing costs. This approach, coupled with the efficient use of resources, supports the City's progress towards achieving its circular economy goals.

Case 17: King George Park Synthetic Turf Replacement
The project at King George Park involved the removal, disposal, and recycling of materials from the existing infilled synthetic turf system, as well as the supply and installation of a new thermoplastic elastomer (TPE) infilled synthetic turf and underlayment shock-pad system. Constructed in 2008, the artificial turf field at King George Park has exceeded its expected lifespan and now requires replacement to maintain minimum safety levels for operation.

In line with the City's circular economy vision, AstroTurf West outlined several initiatives for the King George Park project. The company uses a fuel-efficient fleet from 2018 and employs new equipment and technologies to clean and reuse existing turf infill. Furthermore, AstroTurf West will recycle the existing artificial turf locally by partnering with Fernwood Recycling Ltd., a company in Victoria, BC. The plastic-based turf fibers will be repurposed into composite fence posts for agricultural and landscaping applications. This circular approach demonstrates a commitment to sustainable procurement and resource efficiency in the development and maintenance of the City's parks.

Key learnings and results from implementing circular principles in corporate procurement and project activities

The City's efforts to implement circular economy principles in procurement and project activities have led to encouraging results to date and learnings, which can be summarized as follows:

- **Vendors and stakeholders have an emerging and limited understanding of circular economy:** Many vendors and stakeholders have a limited understanding of the opportunities presented by circular business models, often equating circularity solely with recycling. To address this issue, City staff have been proactive in providing information to City suppliers when requested.
- **Early market consultation is critical to achieve success implementing circular principles and criteria:** Engagement and market consultation with suppliers has helped them to better understand how to meet the City's expectations and goals. Dialogue with stakeholders helped identify quick wins and build momentum for implementing circular approaches.
- **If carefully planned, cost impacts can be mitigated:** The inclusion of circular economy criteria did not always translate to higher prices for products and services. In many cases, suppliers already had existing infrastructure making is relatively easy for suppliers to propose circular products and services
- **The inclusion of circular economy criteria has promoted circular solutions and products:** Through the City's procurement processes, it has become apparent that some suppliers are currently capable of providing circular opportunities that meet the City’s requirements during the design stage. Furthermore, the implementation of circular approaches has been applied at the system level, supplier level, or product level, depending on the market's maturity in embracing circularity. This has led to the identification of new and innovative solutions to procurement to advance circular principles in the City's operations.
- **Successful implementation of circular questionnaires in procurement activities:** The inclusion of circular questionnaires has been refined over time. Feedback and responses from suppliers has been helpful to adopt a more systematic approach to promoting circular principles. The questionnaires included inquiries about circular performance, sourcing of products and materials, and corporate circularity, as well as qualitative data to be considered when procuring goods and services with circular business models when possible.
- **The circular economy approach has identified some potential cost savings:** The City has identified potential cost savings through the implementation of circular principles, particularly in reducing waste and maximizing the use of resources. While further data collection is necessary to establish an objective baseline for quantifying these savings, early indications suggest that circular approaches have the potential to reduce total costs. By embracing circularity, the City can reduce the environmental impact of its operations while also promoting economic efficiency and innovation.
- **Suppliers demonstrated commitment to learning and implementing circular approaches in support of City efforts:** Suppliers have showed interest adopting circular approaches when providing products and services to the City. Response rates to

- advertised City procurements are unchanged. Moreover, some suppliers are proactively engaging City staff to share innovative opportunities for implementing circular principles, and showcasing their results.
- **Internal training, support, and capacity building proved crucial in identifying opportunities and implementing circular approaches in project and procurement activities:** As a result of the actions implemented, City staff developed a guide to support staff in integrating circular criteria into procurement activities. Workshops and meetings have identified champions and early adopters. These efforts have proven to be effective to encourage more staff to consider more sustainable and circular possibilities, fostering a culture of collaboration and continuous improvement.
- **Early stakeholder engagement and collaborative activities proved crucial in identifying opportunities and creating synergies:** Early engagement with stakeholders and vendors has encouraged more participation from suppliers to help advance City goals e.g. through issuing requests for information, conducting Life Cycle Assessments (LCAs) and business cases, and other research to determine the feasibility of promising circular initiatives.
- **Peer-to-peer and stakeholder collaboration as a critical action to create consistency and drive positive results in implementing circular criteria into projects and procurement:** This approach has significantly aided staff to learn and apply promising practices used other cities and jurisdictions. Staff have consistently showcased the City's leadership and commitment to circular procurement by bringing together peers and stakeholders, as well as building essential relationships to embrace circularity at a local and regional level.
- **Technical capability varies among suppliers, with some already offering circular solutions, while others need more support:** The number of suppliers providing circular solutions varies depending on the sector. The City's market for circular economy solutions is still in its early stages, and as such, suppliers may have a limited understanding of circular possibilities. However, markets are evolving and innovating, with new suppliers entering existing suppliers and adapting to the shift towards circularity. Staff recognize the value in identifying potential suppliers who have necessary expertise and experience in circular solutions and notifying them of potential bid opportunities and the demand for circular solutions.
- **Demand for products offering circular solutions** Contract requirements should be future-proofed to take advantage of these advancements and ensure that circular solutions remain relevant over time. It is important to identify suppliers who are innovative and forward-thinking in their approach to circularity, as well as those who have experience in developing and implementing circular solutions. Circular requirements may bring together suppliers from different subsectors in a new way, which can facilitate innovative circular solutions. Staff plan to set up regular meetings, training and support, and creating opportunities for joint problem-solving.

Next Steps

Staff will continue to incorporate circular principles into selected procurements where feasible, ensuring alignment with the City's goals and strategies. Based on key results and learnings identified above, staff will undertake with current resources the following activities to further implementation of the circular economy principles and criteria integrated into the procurement policy:

- **Establishing Metrics and Indicators for Circular Procurement Progress:** Develop and implement key metrics and indicators to measure and track the advancement of circular economy principles in procurement activities. These indicators will ensure circularity remains central to the procurement process, identify areas for improvement, and prioritize long-term adherence to circular practices. Moreover, monitoring and reporting progress will enhance transparency and traceability.
- **Sector-Specific Pilot Project Implementation:** Staff plan to investigate opportunities for additional pilot projects in collaboration with stakeholders and peers. Increased market engagement and collaborative pilot projects are essential for building capacity and assessing progress towards a circular economy. Successful examples will demonstrate the economic benefits and positive impact on the organization's image and regional standing as sustainable, responsible, and innovative.
- **Conducting Material Flow Analysis Study and Life-Cycle Analysis:** In accordance with the October 2022 Council endorsement, work is underway to develop a baseline analysis of Richmond's current circularity level through a Material Flow Analysis study. This study will establish a baseline for measuring progress towards a circular economy. Due to the complexity of circular opportunities among various products, complementary Life-Cycle Analysis studies may also be required.
- **Fostering Training and Capacity Building Initiatives:** Staff will continue to participate in internal and external training and capacity-building opportunities in collaboration with peers and leading organizations. Attendance at working group meetings and provision of informed input will facilitate the identification of circular procurement opportunities. Capacity building efforts must also extend to suppliers and stakeholders to enable the delivery of more circular products and services, as well as the refinement of regulatory references.
- **Advocating for Standardized Circular Metrics at the Regional Level:** Recognizing the need for standardized metrics and accessible measurement tools, advocate for the adoption of regional standardized metrics to ensure adherence to circular economy principles.
- **Engaging with Peer and Industry Working Groups:** Actively participate in peer and industry working groups to connect with a diverse range of circular economy stakeholders, identify common opportunities, synergies, metrics, case studies, pilot projects, and outcome-based indicators. This engagement will foster collaboration and promote the advancement of circular economy principles within procurement activities.

Analysis of the last 24 months' request for proposals by sector where circular criteria was implemented.

Information Technology (IT)

- Data Storage Solution and Services
- Provision of Telecommunications Services
- Network Hardware
- Video Detection System Hardware, Software and Services
- Supply and Delivery of Computer Equipment and Related Services
- RFID Self-Checkout Hardware, Software and Services
- Load Balancer Hardware including Support and Maintenance Services

Professional Services

- Prequalification for Architectural Consulting Services
- Transportation Improvement Programs 2020
- Consulting Services for Materials Flow Analysis
- Provision of Consulting Services for a Land Subsidence Study
- Services of a Mechanical Consultant for City of Richmond Facility Projects
- Prequalification for Pre-Construction and Construction Management Services for City of Richmond Building and Facility Projects
- Architectural Services for the Steveston Community Centre and Branch Library
- Consulting Services for Lansdowne Major Park Master Plan
- Steveston Community Park Playground and Outdoor Washroom Consulting Services
- Terra Nova Rural Park Historical Assets Program Plan
- Consulting Services for Green Fleet Action Plan 2030
- Consulting Services for West Cambie Neighborhood Park
- Provision of Engineering Consulting Services for Emergency Water Supply Plan Update
- Steveston Highway and No.3 Road & Steveston Highway and Gilbert Road Drainage Pump Station Upgrades
- Hydrogeological and Biophysical Assessment for Richmond Nature Park
- Provision of Consulting Services for a Land Subsidence Study
- Capstan Station Integration - development of conceptual designs
- Pre-Construction Services for the Steveston Community Centre and Branch Library

Civil Construction and Infrastructure

- Provision of Dewatering Services
- Design of Westminster & Cambie Rd Intersection Improvements
- Construction Services for No. 9 Road South Dike Upgrades
- 2021 Asphaltic Concrete Paving
- Supply and Installation of Conduits & Water Service Pipes Using Trenchless Technology and Other Related Civil Works
- Construction Services for River Road Sidewalk between No. 6 Rd and Burdette Street
- Conceptual Design of Gilbert Road Drainage Pump Station
- South Arm Community Park Playground Design-Build Services

- Talmey Neighbourhood School Park and Garnet Tot Lot Playground Design-Build Services
- Odlin Park Playground Design-Build Services
- Garden City Lands Screening Contractor
- McKim Way District Energy Distribution Piping Rehabilitation
- Steveston Community Park Playground and Outdoor Washroom Consulting Services
- Construction Services for Steveston Highway and No.3 Road & Steveston Highway and Gilbert Road Drainage Pump Station Upgrades
- Provision of Public E-Scooter Share Pilot Project
- Supply and Installation of LED Street Name Signs
- Odlin Park Playground Design-Build Services
- Talmey Neighbourhood School Park and Garnet Tot Lot Playground Design-Build Services
- Hydrogeological and Biophysical Assessment for Richmond Nature Park

Facilities, Maintenance and Operations (FMO)

- Rental of Coveralls and Related Services
- On Call Collection of Hazardous Materials
- Garden City Lands Screening Contractor
- McKim Way Distribution Piping Rehabilitation
- Car Seat Recycling Services
- MacDonald Beach Vegetation Planting Services
- Vending Machine Services for Public Recreational Facilities
- On-Call HVAC Service Provider
- Mattress and Upholstered Furniture Recycling Services
- Furniture Solutions and Management Services
- Supply and Delivery of (1) One 6500KG GVW Cutaway Van with Dual Rear Wheels
- Roll-Off and In-Ground Container Collection and Recycling/Disposal Services
- Garbage and Cardboard Containers and Collection Services at City Facilities
- Baseline Evaluation Test
- Tent and Event Supplies Rentals for Various City Events - BL

Fleet

- Supply and Delivery of Hybrid Minivans
- Supply & Delivery of One (1) Street Flusher Body on a City Provided Cab and Chassis
- Supply and Delivery of Two (2) 3/4 Ton Crew Cab Pick up Trucks
- Supply and Delivery of One (1) Conventional Zero Clearance Track Type Excavator
- Supply and Delivery of (1) One 6500KG GVW Cutaway Van with Dual Rear Wheels
- Supply and Delivery of One (1) Sewer Vacuum Combo Unit on a City Provided Cab and Chassis
- Supply and Delivery of One (1) Conventional Zero Clearance Track Type Excavator
- Supply and Delivery of Two (2) Dump Bodies and Outfitting on City Provided Tandem Cab and Chassis
- Supply and Delivery of Two (2) Conventional Zero Clearance/Zero Tail Swing Track Excavators

- Supply and Delivery of Two (2) Enclosed Tractors complete with 26 foot Reach Flail Mower
- GPS/AVL Pilot Project
- Supply and Delivery of Plug-In Hybrid and Fully Electric Passenger Sedans and Hatchback Vehicles
- Supply and Delivery of multiple plug-in hybrid and/or fully electric crossover vehicles
- Supply and Delivery of One (1) Forestry Aerial Lift Chipper Body with Boom and Smart PTO System on a City Provided Cab and Chassis
- Supply and Delivery of one (1) Mini Sweeper
- Supply and Delivery of one (1) 15,000 lb Fully Enclosed Exterior Fork Lift
- Supply & Delivery of Two (2) Two Ton Crew Cab Dump Trucks
- Supply & Delivery of One (1) Skid Steer Loader with Rubber Tracks
- Supply and Delivery of one (1) Dump Body Unit and Outfitting on a City Provided Single Axle Cab and Chassis
- 2023 Short Term Rental Vehicles
- Supply and Delivery of Fully Electric High Roof Van
- Supply and Delivery of Two (2) Two Ton Crew Cab Dump Trucks
- Supply & Delivery of One (1) Skid Steer Loader with Rubber Tracks
- Supply and Delivery of one (1) Dump Body Unit and Outfitting on a City Provided Single Axle Cab and Chassis
- Supply and Delivery of Six (6) Hybrid and/or Fully Electric Crew Cab Pickup Trucks
- Supply and Delivery of Multiple Four (4) Cylinder Hybrid Minivans
- Supply and Delivery of One (1) Fully Electric Bus
- Supply & Delivery of one (1) enclosed tractor complete with 16’ (foot) flail mower

City of Richmond

Report to Committee

To:	Public Works and Transportation Committee	**Date:**	May 23, 2023
From:	Milton Chan, P.Eng Director, Engineering	**File:**	10-6060-01/2023-Vol 01
Re:	**Dike Master Plan - Phase 4 Report**		

Staff Recommendation

That the "Dike Master Plan – Phase 4 Final Report," as attached in the staff report titled "Dike Master Plan – Phase 4 Report," dated May 23, 2023, from the Director, Engineering, be endorsed for capital project and development planning purposes.

Milton Chan, P.Eng
Director, Engineering
(604-276-4377)

Att. 2

REPORT CONCURRENCE		
ROUTED TO:	**CONCURRENCE**	**CONCURRENCE OF GENERAL MANAGER**
Real Estate Services	☑	
Parks Services	☑	
Public Works	☑	
Sustainability & District Energy	☑	
Development Applications	☑	
Policy Planning	☑	
Transportation	☑	
Intergovernmental Relations	☑	
SENIOR STAFF REPORT REVIEW	**INITIALS:**	**APPROVED BY CAO**

Staff Report

Origin

As detailed in the Council-endorsed Flood Protection Management Strategy, flood protection is integral to protecting the health, safety, and economic viability of the City of Richmond. A key action identified in the City's Flood Protection Management Strategy involves continuing to upgrade the City's perimeter dike in anticipation of climate change-induced sea level rise. The accelerated flood protection program supports completing all upgrades in a 50-year timeline. The City's Dike Master Plans address this need by recommending dike upgrade options for each dike section throughout the City.

Council has endorsed the following phases of Dike Master Plans to date:

- Dike Master Plan Phase 1 – Steveston and the West dike south of Williams Road, endorsed by Council on April 22, 2013;
- Dike Master Plan Phase 2 – West dike between Williams Road and Terra Nova Rural Park and north dike between Terra Nova Rural Park and No. 6 Road, endorsed by Council on April 23, 2018;
- Dike Master Plan Phase 3 – South dike between No. 2 Road and Boundary Road, endorsed by Council on March 25, 2019; and
- Dike Master Plan Phase 5 – Sea Island dike from the Sea Island Connector Bridge to the south end of 3800 Cessna Drive, Mitchell Island and Richmond Island, endorsed by Council on March 25, 2019.

The Dike Master Plan Phase 4 Draft Report was presented at the regular Council meeting on June 28, 2021, where Council resolved the following:

> *"That, as outlined in the staff report titled "Dike Master Plan Phase 4 – Public and Stakeholder Engagement", dated May 20, 2021, from the Director, Engineering, the public and stakeholder engagement program be endorsed."*

Staff have now completed public and key stakeholder consultation for Dike Master Plan Phase 4; the results of that consultation are the focus of this report. Dike Master Plan Phase 4 is the last phase of the plan, and upon its endorsement, the City's Dike Master Plan will be complete.

This report supports Council's Strategic Plan 2022-2026 Focus Area #1 Proactive in Stakeholder and Civic Engagement:

> *Proactive stakeholder and civic engagement to foster understanding and involvement and advance Richmond's interests.*
>
> *1.2 Advocate for the needs of Richmond in collaboration with partners and stakeholders.*
>
> *1.3 Increase the reach of communication and engagement efforts to connect with Richmond's diverse community.*

This report supports Council's Strategic Plan 2022-2026 Focus Area #2 Strategic and Sustainable Community Growth:

> *Strategic and sustainable growth that supports long-term community needs and a well-planned and prosperous city.*
>
> *2.1 Ensure that Richmond's targeted OCP update shapes the direction and character of the city.*

Analysis

The City of Richmond is situated in a flood plain and is approximately 1 metre above sea level, making flood protection critical to safeguarding the community. The City is protected from coastal flooding by 49 kilometres of perimeter dike. Current climate change science estimates that the sea level will rise approximately 1 metre by the year 2100, and 0.2 metres of land subsidence is forecasted over the same period.

The Flood Protection Management Strategy identifies strengthening and raising the City's dike to 4.7 metres geodetic as a priority response to sea level rise and increased variability in freshet flows due to climate change. All new dikes are designed to accommodate a further height increase to 5.5 metres to address sea level rise beyond 2100.

As outlined in the staff report titled "Accelerated Flood Protection Program Update," dated March 4, 2022, from the Director, Engineering, a target annual revenue level of $30 million by 2031 was endorsed for the Flood Protection Utility to support a 50 year implementation period, improving the City's diking infrastructure well in advance of the currently anticipated climate change impacts. Dike improvements are ongoing through the Council-approved Capital and development projects. Cost estimates for the remaining dike upgrades continue to be refined, and any changes to the required long-term funding will be brought forward for Council consideration in future Ageing Utility Infrastructure and Utility Budget reports.

The Dike Master Plans are intended to be a comprehensive guide to:

- Upgrading the City of Richmond's perimeter dike;
- Protecting Richmond from both storm surges and Fraser River freshet events;
- Adapting to sea level rise and land subsidence;
- Being seismically resilient;
- Integrating the Ecological Network Management Strategy vision and goals;
- Following the five strategic directions of the City's Waterfront Strategy (Working Together, Amenities and Legacy, Thriving Eco-Systems and Community, Economic Vitality, Responding to Climate Change and Natural Hazards); and
- Prioritizing dike improvement phasing to use resources efficiently.

All phases of the Dike Master Plan are shown in Figure 1. Council has endorsed Dike Master Plan Phases 1, 2, 3, and 5. Public and stakeholder consultation for Dike Master Plan Phase 4 is complete, and the findings are summarized in this report.

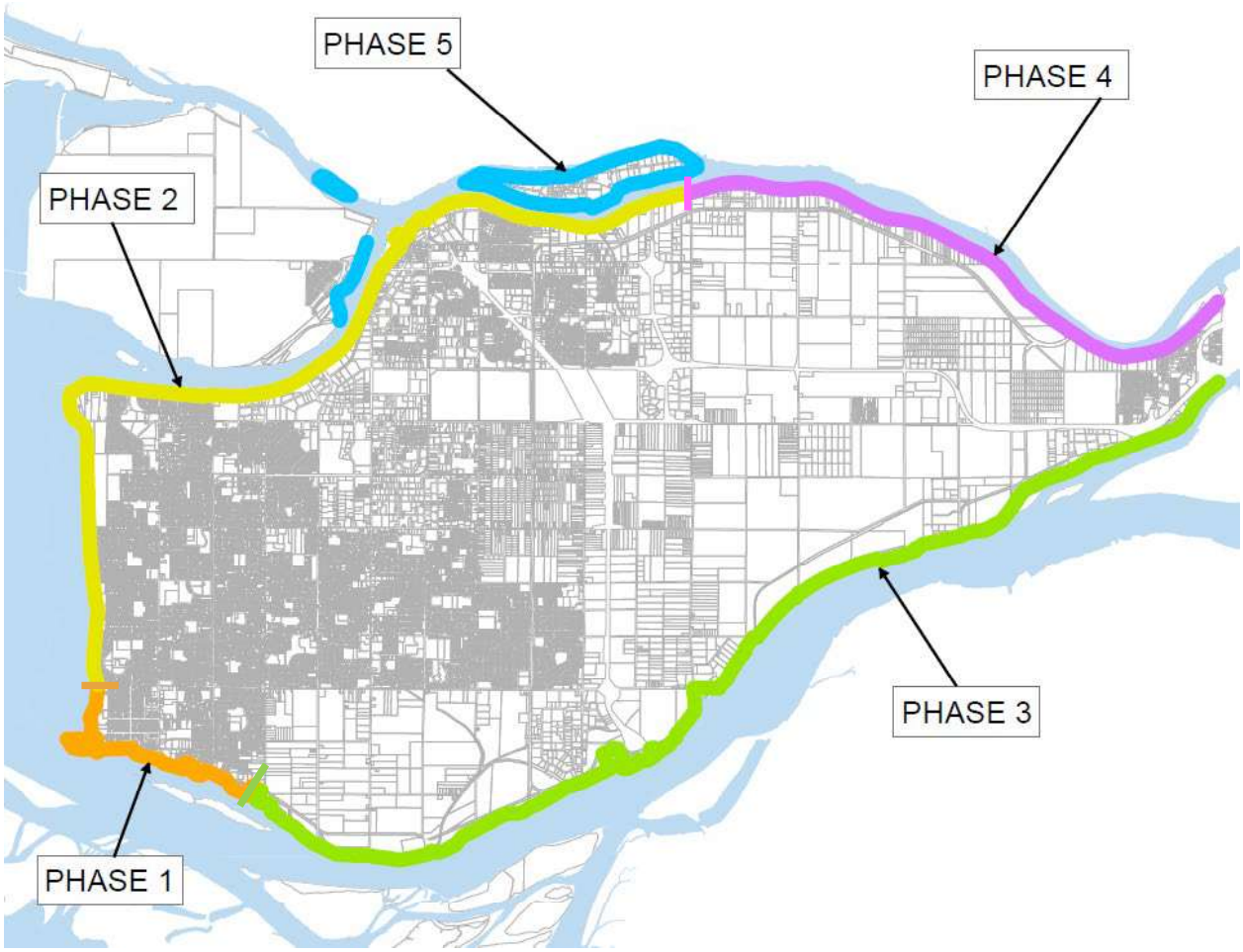

Figure 1: Dike Master Plan Phases

Dike Master Plan Phase 4

The Dike Master Plan Phase 4 report, appended as Attachment 1, provides upgrade recommendations for the north dike along River Road between No. 6 Road and Boundary Road, considering several factors, including adjacent land use, available land for diking, environmental conditions, and potential amenity improvements. It evaluates the various reaches within the study area and recommends upgrade approaches including separated dike and road, standard dike, and superdike.

Public Engagement

There was an extensive Flood Protection Public Engagement Campaign, including in-person and online engagement activities. This campaign was carried out over five months, from May 2022

to September 2022, to collect public feedback on the Dike Master Plan Phase 4. The City's accelerated flood protection program and the City's habitat enhancement initiatives were also highlighted as being integral to the overall program.

The engagement included the following:

- Five community pop-ups (Emergency Preparedness Week, Kwantlen Street Farmers Market, Steveston Farmers & Artisans Market, Burkeville Daze, "Island City, by Bike" tour);
- Two in-person open houses at Hamilton Community Centre;
- Three Works on Wheels bus tours;
- Four online Community Conversation engagement sessions;
- Elementary school presentations;
- 'Walk Richmond' walking tour;
- Updated flood protection webpage on the City's website;
- LetsTalkRichmond.ca flood protection project page;
- New Flood Protection page on StoryMaps; and
- Over 100 door-to-door visits in the Dike Master Plan Phase 4 study area.

Approximately 1,000 people attended the in-person engagement activities and events. Additionally, approximately 2,000 people participated online through the City's flood protection webpage and a Let's Talk Richmond project page that was set up to support community outreach.

Public Feedback

The feedback received through public engagement was generally positive and supportive of the Dike Master Plan Phase 4 and the City's flood protection initiatives. The public is aware of the flood risks and Richmond's flood protection measures, and most are supportive of upgrades that provide other community benefits and amenities. A vast majority of the engaged residents supported the accelerated flood protection program and the associated utility rate increases. Most residents appreciated being included in conversations about flood protection and being provided with the opportunity to ask questions and have them addressed directly at the event.

Based on feedback, the public indicated:

- Strong support for the accelerated flood protection program with a 50-year implementation timeline;
- Support for the actions being taken with regard to community safety;
- Support for environmental considerations in the Dike Master Plan;
- Support for coordination with development to create superdikes;
- Support for improved cyclist experience along River Road;
- Support for amenity upgrades along the dike corridor, including delineated bike lanes, multi-use pathways, benches, washrooms, perimeter dike trail continuity, and traffic calming features;

- Concern regarding the removal of trees and habitat along the dike. Once staff explained how trees in the dike could impact its overall structural integrity, the participants understood why tree removal may be necessary for some situations;
- Concern regarding the uncertainty in sea level rise trends. The participants were assured that the City is continuously monitoring and reviewing the evolving climate change science and adjusting the City's flood protection plans to protect the City well ahead of the sea-level rise;
- Concern regarding New Westminster's dike-raising plans. Staff are coordinating with New Westminster to ensure their dike upgrade plans are in alignment with Richmond's;
- Appreciation for the flood protection public engagement campaign and desire for more similar initiatives in the future;
- Appreciation for all materials available to provide information to residents, including the webpage, online StoryMaps, hand-out flyers, and poster boards; and
- Appreciation for being able to communicate directly with City staff regarding their flood protection concerns.

More details on public engagement and feedback are provided in the 'What We Heard' report appended as Attachment 2.

Key Stakeholder Feedback

Key regulators, community stakeholders, and advisory committees listed below were engaged and invited to provide feedback for the Dike Master Plan Phase 4. Staff mailed out information flyers to the local businesses to invite them to attend the community conversations, and held both in-person and virtual presentations for the advisory committees and some regulators. The other stakeholders were sent the Dike Master Plan Phase 4 report with links to the City's website, information flyers, and a survey on Let's Talk Richmond via email and were invited by staff to provide comments or meet for further discussions.

Community Stakeholders

- Local businesses;
- Agricultural Land Commission;
- Ministry of Transportation and Infrastructure;
- CN Rail;
- Environment Canada;
- Port of Vancouver;
- Urban Development Institute;
- Pembina Pipeline;
- Telus;
- BC Hydro;
- Hamilton Transit Centre; and
- City of New Westminster.

Advisory Committees

- Richmond Food Security and Agricultural Advisory Committee; and
- Richmond Advisory Committee on the Environment.

Regulators

- Department of Fisheries and Oceans;
- Ministry of Forests;
- Ministry of Water, Land and Resource Stewardship;
- Ministry of Emergency Management and Climate Readiness;
- Ministry of Agriculture, Food and Fisheries; and
- BC Inspector of Dikes.

In the past, First Nations were not specifically engaged on the overarching Dike Master Plans. First Nations were engaged on individual projects as required through the Province's permit approval processes. Through the staff report titled "Truth and Reconciliation Update," dated April 11, 2023, from the Director, Intergovernmental Relations and Corporate and Strategic Planning, Council endorsed creating a new position for Manager, Indigenous Relations at the Regular Council Meeting on May 8, 2023. Once this position has been filled, staff will use this opportunity to bring forward future diking and flood protection projects to First Nation groups and conduct meaningful engagements to advance reconciliation efforts.

Stakeholder Feedback

Staff received a limited number of comments and survey responses from the community stakeholder group. The advisory committees and the community stakeholders that returned comments were generally supportive of the findings in Dike Master Plan Phase 4. Some additional comments are provided below:

- Richmond's Advisory Committee on the Environment generally supported dike-raising and noted that New Westminster's dike-raising plans should align with Richmond's. The City is coordinating with the City of New Westminster to ensure that East Richmond will remain protected from flood risks.

- Richmond Food Security and Agricultural Advisory Committee noted that implementing a continuous trail network along the perimeter dike and tree planting for habitat compensation should be prioritized. Additionally, opportunities for accessing the river for water activities should be investigated. The recommendations provided in the Dike Master Plan Phase 4 include a continuous multi-use pathway for dike trail continuity as well as habitat enhancement and compensation recommendations. Staff will also explore water access opportunities during the detailed design phase of the various dike reaches.

- Ministry of Transportation does not have any infrastructure in the Dike Master Plan Phase 4 study area; however, they noted their request to be notified and engaged wherever Richmond's dike project may intersect with Ministry infrastructure.

- Fortis BC also requested a notification for dike upgrades along Reach 1 of Dike Master Plan Phase 4 to relocate or regrade one of their critical pump stations.

Regulatory Feedback

Staff met with the Fish and Fish Habitat Protection Program team at the Department of Fisheries and Oceans to discuss the dike-raising initiative and how impacts on fish and fish habitat are planned to be mitigated or compensated where impact cannot be avoided. They encourage the implementation of more nature-based solutions. Staff are in discussion with the Department of Fisheries and Oceans to implement a habitat bank, per council direction.

The Ministry of Forests commented on habitat impact from potential Riparian Management Area (RMA) watercourse infills along River Road. Staff will be working closely with a Qualified Environmental Professional, in collaboration with the Ministry, during the detailed design phase of the different dike sections to address regulatory requirements that limit impacts where possible and provide adequate high-value habitat compensation where necessary.

The Ministry of Forests also noted that Land Act authorizations would be required for any potential dike infrastructure that may encroach into the river or aquatic areas. Staff will obtain all required authorizations and permits before any dike upgrade works commence.

The plan notes that all other relevant federal and provincial regulatory agencies including, but not limited to, the Department of Fisheries and Oceans, Ministry of Forests, Ministry of Environment, and the Inspector of Dikes will continue to be engaged during the detailed design of the dike reaches.

Recommendations

Following public and key stakeholder consultation, comments received have been reviewed and are incorporated in the finalized report. The City's findings indicate that in addition to strong support for the accelerated dike upgrades, the residents of Richmond and the community stakeholders were most interested in seeing upgraded amenities to increase community safety and for recreational use. These include multi-use pathways, bike lanes, dike trail continuity, and other park features. There was also general support for creating high-value habitat through the City's habitat banking initiative for dike upgrades.

The updated recommendations of Dike Master Plan Phase 4 are summarized as follows:

1. **Separated Dike and Road**— Separate the dike core footprint from River Road footprint and raise River Road to the same elevation as the adjacent dike crest to produce a total width (dike plus road) of over 20 metres, providing robust flood protection, separated multi-use path and linear park sections are desired, and utilities relocated out of the dike. Where feasible, the separated multi-use path will aim to improve pedestrian and cyclist safety and promote dike trail continuity, while linear park sections can incorporate park amenities desired by the community.

2. **Raised Dike Elevation**— Raise the dike crest to allow for 1 metre of sea level rise. West of Nelson Road, the raised dike crest would be 4. 7 metres (CGVD28). East of Nelson Road, the raised dike crest would increase to 5.1 metres at Boundary Road. The plan also allows for longer-term upgrading to accommodate a further 1 metre of sea level rise (i.e. 2 metres of sea level rise). The above noted desired amenities can be integrated at the ultimate dike elevation.

3. **Drainage Upgrades**— Replace the drainage channel immediately inside the dike with storm sewers and swales. This will improve dike stability and provide some of the land needed to relocate River Road. The stakeholders noted concerns regarding changes in the function or loss of open watercourses as they provide habitat value. The Habitat Banking work will consider and respond to these concerns.

4. **Habitat Enhancement**— Overall, maintain a goal to create and maintain high-value habitat to fulfil habitat compensation requirements for dike-raising projects;

5. **Superdikes**— Land and road raising immediately inside the dike (during redevelopment) to improve seismic resilience. This will also improve liveability by allowing residents to look down over the water.

6. **Secondary Dike**— Construct the north section of a secondary dike near Boundary Road.

Next Steps

Dike Master Plan Phase 4 identifies a medium to long-term program for dike improvements on the north dike along the eastern half of River Road. All sections included in the Dike Master Plan will be raised within the next 50 years to meet the target established by the accelerated program to stay ahead of climate change-induced sea level rise and land subsidence. Staff will continue to review the latest climate change predictions and update the plan to keep up with the current trends.

Based on the guidelines provided in the Flood Protection Management Strategy and feedback collected through stakeholder engagement, staff have identified a significant amount of work that can be carried out in the short and medium term in preparation for these upgrades. Should Council endorse this work plan, staff will proceed with the following:

a) Identify and include dike reaches from Phase 4 for detailed design and construction in the future Capital Budgets. The detailed design of these reaches will be guided by the recommendations included in the Dike Master Plan Phase 4 and incorporate the aforementioned public and stakeholder feedback;

b) Explore upcoming senior government funding opportunities for upgrades to dike reaches identified in the Dike Master Plan Phase 4;

c) Continue coordination and discussions with the regulatory entities and engage the First Nations for future dike upgrade initiatives;

d) Continue regular coordination with the City of New Westminster to ensure their flood protection initiatives align with the City's;

e) Advance the habitat banking program to support dike improvement projects;

f) Encourage the construction of superdikes through development;

g) Re-evaluate current and future flood construction levels and development bylaws to reduce flood risk;

h) Strategically acquire properties in support of future dike upgrading;

i) Monitor sea level rise using water level sensors; and

j) Continue public engagement activities for the City's flood protection projects to inform and involve the community.

Financial Impact

Capital projects will be brought forward for Council consideration as part of the budget process.

Conclusion

The Dike Master Plan Phase 4 is the last phase of the Dike Master Plan. Consistent with the City's Flood Protection Management Strategy, it provides medium to long-term dike upgrade recommendations along the north dike between No. 6 Road and Boundary Road. It generally recommends that the City raise the dike to a minimum 4.7 metre dike elevation while allowing for a further height increase to 5.5 metres in the future, integrate the proposed dike concepts within the study areas, pursue superdikes through development, and strategically acquire land required to facilitate the upgrades.

This project's public and stakeholder engagement is complete, and the feedback is generally favourable with support for the Dike Master Plan Phase 4 and the accelerated flood protection program. The feedback collected will be incorporated into capital dike improvement projects as identified in this plan.

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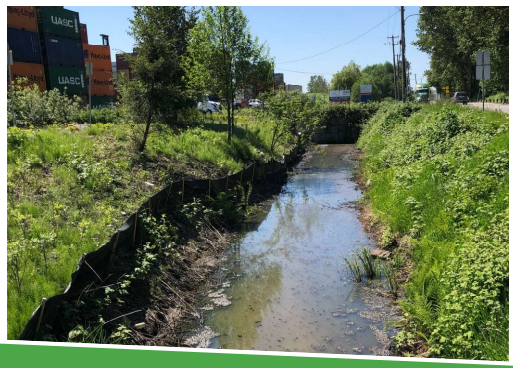
Att. 1: Dike Master Plan Phase 4 – Final Report
2: What We Heard Report

Attachment 1



Final Report

Richmond Dike Master Plan - Phase 4

April 28, 2023
KWL File No. 0651.122-300

Submitted by:

KERR WOOD LEIDAL
consulting engineers

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Executive Summary

The City of Richmond uses a Dike Master Planning program to guide future dike upgrading projects, and to ensure that land development adjacent to the dike is compatible with flood protection objectives. The program includes 4 phases for the 49 km of the Lulu Island perimeter dike that is within Richmond, plus another phase for Sea Island, Mitchell Island, and Richmond Island. The immediate goal is to raise the dikes to allow for 1 m of sea level rise, and to allow for further upgrading in the future. The ultimate goal is to provide the City with a world class level of flood protection to keep pace with the rapidly growing community that relies on the dikes.

Dike Master Plan Phase 4 covers 9 km of the Lulu Island perimeter dike along the Fraser River North Arm, between No. 6 Road and Boundary Road. The dike within Phase 4 is mainly under River Road, with private property inside and outside of the dike. Phase 4 land use along the dike corridor is primarily industrial in the west, agricultural in the middle, and residential/industrial in the east. Specific features within the Phase 4 area that complicate dike upgrading include River Road on top of the dike, driveways to private property inside and outside the dike, pedestrian and bicycle traffic and safety issues along the dike/road, utilities within the dike, large drainage channels immediately inside the dike, a railway trestle crossing above the dike, the North East Bog Forest, and liquefiable soils beneath the dike.

This report describes existing conditions, develops an ideal vision for dike upgrading, presents design criteria, identifies options for dike upgrading, and presents recommended dike upgrading options that appropriately address the challenges. This work can be used as a basis for design of dike upgrading projects, recognizing that site-specific refinement of recommended options will be required in some areas. This work can also be used to assist with land use planning activities along the dike corridor.

The main recommended upgrading option in Phase 4 involves separating the dike and River Road, and raising River Road to the dike crest elevation. This will produce a total crest (dike plus road) width of over 20 m which will provide robust flood protection, separated multi-use paths and a linear park, and utilities relocated out of the dike.

Some of the additional features of the recommended options in Phase 4 are described below:

- Raise the dike crest to allow for 1 m of sea level rise. West of Nelson Road, the raised dike crest would be 4.7 m (CGVD28). East of Nelson Road, the raised dike crest would increase to 5.1 m at Boundary Road. The plan also allows for longer term upgrading to accommodate a further 1 m of sea level rise (i.e. 2 m of sea level rise).
- Replace the drainage channel immediately inside the dike with storm sewers and swales. This will improve dike stability, and will provide some of the land needed to relocate River Road.
- Raise land and roads immediately inside the dike (during redevelopment) to improve seismic resilience. This will also improve liveability by allowing residents to looking down over the water.
- Construct the north section of a secondary dike near Boundary Road.

It is also recommended that the City prepare a comprehensive implementation plan for dike upgrading that incorporates the elements of the Phase 4 Dike Master Plan, and the elements of the other Dike Master Plans.

To address habitat compensation issues associated with dike upgrading, it is further recommended that the City consider development of a habitat banking program that could provide effective large-scale compensation.

1. Introduction

Flood protection in Richmond is guided by the City's 2008-2031 Flood Protection Management Strategy which includes a comprehensive suite of measures including structural measures (e.g. dikes and pump stations), non-structural measures (e.g. flood construction levels), and flood response and recovery plans.

Dike Master Plans are critical components of the City's 2008-2031 Flood Protection Management Strategy and are used to guide the implementation of long-term dike upgrades.

The City of Richmond (City) has retained Kerr Wood Leidal (KWL) to prepare the Richmond Dike Master Plan Phase 4. The report was essentially completed and a draft report submitted in November 2018. The current final submission includes a summary of some additional stakeholder and public feedback received since the 2018 submission. The Flood Protection Management Strategy Update was submitted in May, 2019 and updates the 2008-2031 Flood Protection Management Strategy. Some of the results of this update may not be reflected in the Dike Master Plan Phase 4 because it was written first. Also, cost estimates were completed in 2018 dollars.

Phase 4 covers the north-eastern portion of the Lulu Island perimeter dike, from No. 6 Road to Boundary Road (City of New Westminster). Figure 1-1 presents the extent of the City's Dike Master Plan phases. Phase 4 has been subdivided into 6 reaches with relatively uniform conditions. Figure 1-2 shows the reaches of the Phase 4 Dike Master Plan.

1.1 Background

Richmond has a population of about 220,000 and is situated entirely on islands within the overlapping Fraser River and coastal floodplains (Lulu Island, Sea Island, Mitchell Island, Richmond Island, etc.). The City's continued success is due in part to its flat, arable land and its strategic location at the mouth of the Fraser River and on the seashore. The low elevation of the land and its proximity to the water comes with flood risks.

Lulu Island is the most heavily developed part of Richmond. Lulu Island is bounded by the Fraser River and the Strait of Georgia and is subject to flood risks from the Fraser River and the sea. Lulu Island is also subject to other flood-related hazards, including dike breach, seismic effects, internal drainage, tsunami, and river instability. The typical natural ground elevation[1] is in the range of 1 m to 2 m as shown on Figure 1-1.

The cornerstone of the Lulu Island flood defenses is a 49 km long perimeter dike. Internal drainage is provided by an integrated system of channels and storm sewers that drain to 39 pump stations / floodboxes. Richmond occupies over 90% of Lulu Island. The balance of Lulu Island (the upstream end) is occupied by the Queensborough neighbourhood of the City of New Westminster.

As Richmond is fully situated within the river/coastal floodplain, there is no option to locate development out of the floodplain. The continued success of the City depends on providing a high level of structural and non-structural flood protection measures. Without continued improvements, the flood risk within the City would progressively rise as a result of rising flood levels (due to climate change), subsiding land, and increasing development.

[1] All elevations in this report refer to the Canadian Geodetic Vertical Datum of 1928 (CGVD28), unless stated otherwise.

The 2008-2031 Flood Protection Management Strategy guides the City's flood risk reduction activities across the City's organizational structure and across the spectrum of structural and non-structural flood protection measures.

The Lulu Island perimeter dike is the most critical structural flood protection measure. With essentially unlimited inflow available from the Fraser River and the sea, significant flood damages and impacts could occur in the event of a dike breach.

1.2 Purpose and Objectives

The purpose of the Dike Master Plan is to guide the implementation of dike upgrades and provide a starting point for the City to work with proposed developments adjacent to the dike. The Dike Master Plan defines the City's preferred and minimum acceptable dike upgrading concepts.

The Dike Master Plan facilitates the City's annual dike upgrading program by providing critical information for the design of dike upgrades, including:

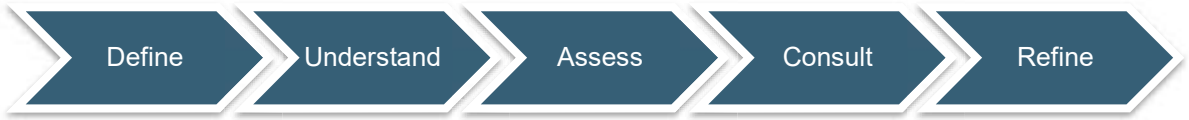
- general design concept;
- alignment;
- typical cross-section (conceptual design);
- footprint and land acquisition and tenure needs;
- design and performance criteria;
- infrastructure changes required for dike upgrading;
- operation and maintenance considerations;
- environmental features and potential impacts;
- social and public amenity considerations;
- guidance for future development adjacent to the dike; and
- guidance on interaction with other structural flood protection measures (e.g. secondary dikes).

The Dike Master Plan is intended to guide dike upgrading over the next 20 to 30 years.

Other flood protection measures, including non-structural measures, are addressed in the City's 2008-2031 Flood Protection Management Strategy.

1.3 Approach and Methodology

The Dike Master Plan has been developed using a 5-step approach presented and described below.



Define: Confirm Dike Master Plan objectives and design/performance criteria.

Understand: Collect and compile relevant information, including spatial data and background reports from the City and several other parties (City of New Westminster, provincial regulators, the port, etc.).

Assess: Develop dike upgrading options and identification of constraints and potential impacts. Desktop and field review of options with City staff to identify preferred options.

Consult: Present to and gather feedback from council and stakeholders on preferred options.

Refine: Develop the master plan informed by consultation and review by the City.

The scope for the Dike Master Plan includes the following main tasks:

- goals and objectives development;
- background data collection and review;
- design criteria development and identification of constraints;
- options development and review;
- site visits;
- drainage impacts assessment;
- desktop habitat mapping and impacts review;
- geotechnical assessment;
- public amenity review;
- stakeholder consultation; and
- report preparation.

1.4 Report Format

This report is organized as follows:

- The executive summary provides a high-level overview of the master plan and key features;
- Section 1 introduces the master plan context and process;
- Section 2 documents the existing conditions;
- Section 3 documents the options development and assessment, and presents the recommended options;
- Section 4 provides implementation strategy, including costs, phasing, and coordination;
- Section 5 is a compilation of 2-page summary sheets highlighting existing conditions and key features of the preferred option for each reach; and
- Section 6 provides general and reach specific recommendations for next steps and implementation.

Appendix A provides figures showing conditions along the existing dike alignment, and the preliminary design footprint for a number of upgrading options discussed in Section 3.

1.5 Project Team

The KWL project team includes the following key individuals:

- Colin Kristiansen, P.Eng., MBA – Project Manager;
- Mike Currie, M.Eng., P.Eng., FEC – Senior Engineer and Technical Reviewer;
- Amir Taleghani, M.Eng., P.Eng. – Project Engineer;
- Laurel Morgan, M.Sc., P.Eng., P.E. – Drainage Engineer;
- Daniel Brown, B.Sc., B.Tech., BIT – Project Biologist; and
- Jack Lau - GIS/CAD Analyst.

This report was primarily written by Amir Taleghani, and reviewed and updated by Colin Kristiansen. The report was reviewed by Mike Currie.

Thurber Engineering Ltd. (Steven Coulter, M.Sc., P.Eng.) provided geotechnical engineering services and Hapa Collaborative (Joseph Fry, BCSLA) provided landscape architecture services.

The project was guided on behalf of the City by:

- Pratima Milaire, P.Eng., PMP - Project Engineer, Engineering Planning.
- Ridhi Dalla, EIT - Project Manager, Engineering Planning; and
- Eric Sparolin, P.Eng. – Manager, Engineering Planning;

Many additional City staff contributed to the project during workshops, site visits, and in reviewing draft report materials.

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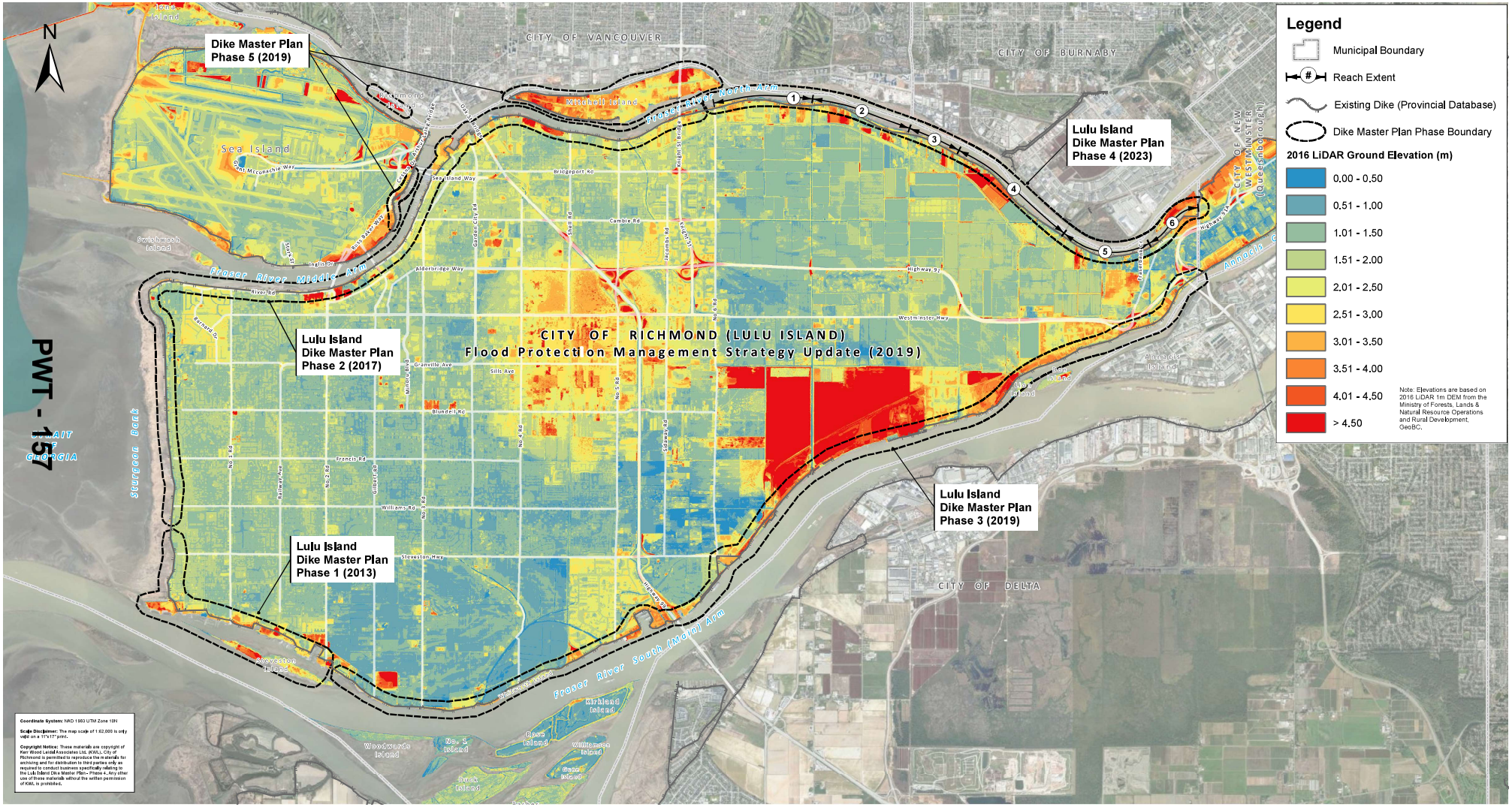
City of Richmond

Lulu Island Dike Master Plan - Phase 4

KERR WOOD LEIDAL consulting engineers



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Dike Master Plan Phases

Figure 1-1

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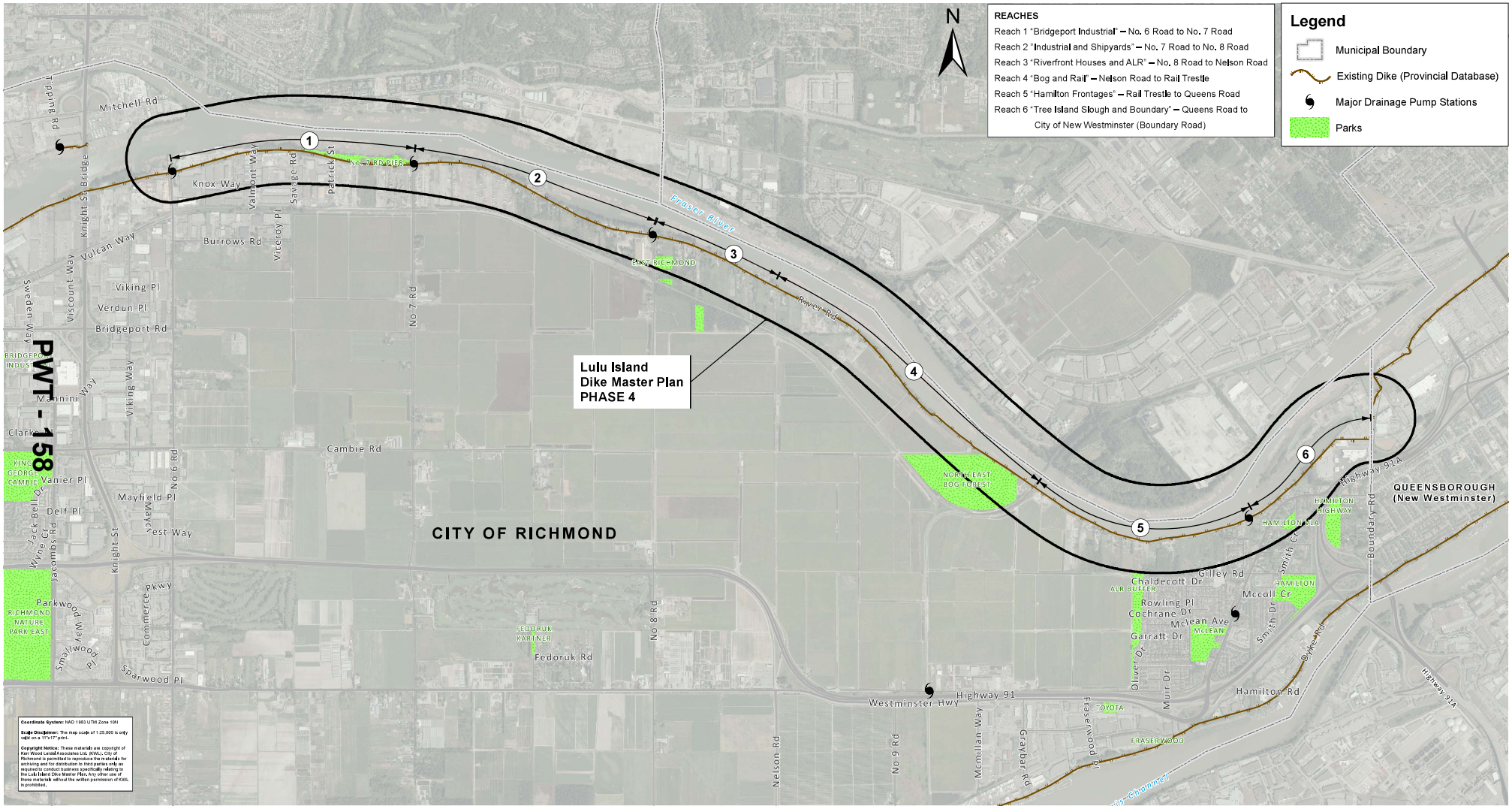
City of Richmond
Lulu Island Dike Master Plan - Phase 4

KERR WOOD LEIDAL consulting engineers



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Dike Master Plan Phase 4 Reaches

Figure 1-2

2. Existing Conditions

This section summarizes the options development process undertaken, including the following components:

- review of existing conditions;
- design considerations;
- upgrading strategies; and
- preferred options and concepts.

2.1 Reaches and Major Features

River Road is a defining feature of the dike in Phase 4 because the road is located on the dike crest for most of the dike alignment. A variety of land uses, structures, and infrastructure are located on either side of the road/dike. Space is limited along the road corridor, presenting unique challenges for the master plan. City staff have identified road safety, including pedestrian and cyclist safety, as an important consideration for the Dike Master Plan.

Land uses adjacent to the dike in Phase 4 comprise industrial, agricultural, and single family residential. Drainage channels run parallel to River Road on the south side. On the north side of River Road, the setback between the river bank and the dike (road) varies from more than 15 m to none where the edge of the dike/road is the river bank and riprap bank protection is in place. Several industrial and single family residential parcels are located on the river-side (north) of the dike (road), and therefore are not protected by the dike. Much of the dike alignment is adjacent to, or in some places on, the Agricultural Land Reserve (ALR).

Phase 4 has been subdivided into 6 reaches with relatively uniform conditions. The reach extents are presented on Figure 1-2.

Table 2-1 describes the existing conditions and features of each reach. It is anticipated that these defined reaches can be subsequently used for dike upgrading implementation phasing.

Appendix A provides a set of figures showing the existing dike alignment, adjacent land tenure, municipal infrastructure, and existing habitat.

Table 2-1: Phase 4 Reaches and Features

Reach ID and Name	Extent / Length	Existing Dike Alignment	Major Features
1 – Bridgeport Industrial	No. 6 Road to No. 7 Road (1.7 km)	River Road	• Drainage pump station at No. 6 Road • Industrial site (Mainland Sand and Gravel) north of River Road • FortisBC gas pipeline river and facility west of No. 7 Road • Drainage channel and pipe south of road • Riparian area north of road • Potential future tie-in with proposed mid-island dike
2 – Industrial and Shipyards	No. 7 Road to No. 8 Road (1.7 km)	River Road	• Water-oriented industrial parcels located north of road (tug boat operation and Tom-Mac Shipyards) • Residential/storage properties located north of road with minimal setback between road and structures • Large industrial parcels located south of road near No. 7 Road • ALR parcels with houses located south of road • Drainage pump station at No. 8 Road
3 – Riverfront Houses and ALR	No. 8 Road to Nelson Road (0.9 km)	River Road	• Residential/storage properties located north of road with minimal setback between road and structures near Nelson Road • ALR parcels with houses located south of road • Metro Vancouver Tilbury watermain crossing near Nelson Road
4 – Bog and Rail	Nelson Road to Rail Trestle (2.2 km)	River Road	• ALR parcels with cranberry farms south of road • Very large agricultural channel south of dike • North East Bog Forest (City park) • Rail trestle river crossing • No space between road edge and river channel (existing riprap bank protection)

Reach ID and Name	Extent / Length	Existing Dike Alignment	Major Features
5 – Hamilton Frontages	Rail Trestle to Queens Road (1.6 km)	River Road	• ALR parcels south of road with houses located close to road • No space between road edge and river channel (existing riprap bank protection) • Metro Vancouver Big Bend forcemain crossing west of 21920 River Road • Queens North drainage pump station west of Westminster Highway
6 – Tree Island Slough and Boundary	Queens Road to City of New Westminster (1.0 km)	River Road until Westminster Highway Riverbank to Hamilton Transit Centre	• River Road dike alignment from Queens Road to Westminster Highway, then a river-bank dike runs north of Westminster Highway houses to edge of new Hamilton Transit Centre • Tree Island Steel site (3933 Boundary Road) creates a slough north of the dike that shelters the road/dike from the river • Backyards of single family homes located south of dike • Dike alignment not well defined from Hamilton Transit Centre to City of New Westminster river-bank dike • Potential tie-in with proposed secondary dike to separate Richmond and New Westminster

2.2 Land Tenure

Most of the existing dike footprint is located within the City's road dedication, on a right-of-way, or on City-owned land parcels. However, there are several areas where the existing dike footprint encroaches onto private property or where space is very limited such that any upgrading would encroach onto private property.

The existing land tenure in Phase 4 is presented on Figure 2-1 and in more detail in Appendix A.

2.3 Infrastructure

There is considerable infrastructure and utilities associated with the existing dike corridor in Phase 4. In addition to the road that runs along the top of the dike for much of the reach, there are also watermains, drainage channels, and storm sewers that run parallel to the dike, predominantly at the landside toe. This infrastructure may need to be moved to accommodate any increases to the dike footprint.

There are 4 pump stations and 1 PRV (water) station that cross through the dike in Phase 4. The pump stations and the associated reach are summarized in Table 2-2. The condition of each pump station was not assessed as part of preparing the master plan.

Table 2-2: Phase 4 Pump Stations and Reach Locations

Pump Station	Reach
No. 6 Road North	1
No. 7 Road North	1
No. 8 Road North	2
Queens North	6

2.4 Habitat

Desktop Review

A desktop review was conducted to assess the ecological setting along and adjacent to the existing dike alignment. Spatial data were used to identify overlap of known environmental values with the Phase 4 study area.

Spatial data reviewed in the desktop study included:

- Fraser River Estuary Management Program mapping (FREMP 2012, 2007) mapping used to identify riparian and intertidal habitat types and quality;
- iMapBC web application (iMapBC 2017); and
- City of Richmond aerial photographs and Riparian Area Regulation 5 m and 15 m buffer layers (Richmond Interactive Map 2017).

The location and extent of high quality Fraser River riparian and intertidal habitat was identified to inform development of dike upgrade options and their potential impacts. FREMP habitat polygons were assigned the following categories: high quality riparian, high quality intertidal, or other. Deciduous tree woodland polygons were categorized as high quality riparian habitat because these communities provide cover and nutrients to fish using nearshore habitat. Mud, sand, and marsh polygons were

categorized as high quality intertidal habitat because of the foraging and nesting habitat they provide for bird species and the foraging, egg deposition and rearing habitat they provide for fish species. Aquatic and riparian habitat on the land side of the existing dike was identified and mapped using the Riparian Area Regulation buffer layers and interpretation of recent aerial photography (City of Richmond 2017).

Aquatic and Riparian Habitat

High quality intertidal and riparian habitat is present in all six Phase 4 reaches on the Fraser River side of the dike. This important habitat provides forage and cover habitat as well as a staging area for anadromous salmonids transitioning from saltwater to freshwater. Conversely, armoured sections of shoreline on the Fraser River side of the existing dike are present in Reaches 1, 4, 5, and 6. These sections provide limited habitat value and construction here would have less of a negative impact on fish.

On the land-side of the dike, drainage channels are present in all six reaches. These channels provide low to moderate quality aquatic and riparian habitat for fish and amphibians.

Two fish habitat compensation projects are present in the Phase 4 study area. These were created in 1986 and 1989 respectively and included the creation of intertidal marsh habitat to compensate for damage to habitat elsewhere.

Wildlife and Terrestrial Habitat

Terrestrial habitat types in Phase 4 include deciduous tree woodland, tall shrub woodland, low shrub woodland, and vascular plant meadow, as well as uncategorized sections (e.g. paved lots; FREMP 2007). These habitat types have potential to provide nesting habitat to migratory birds in all six reaches of Phase 4. Orthoimagery review identified potential raptor nesting trees in all six reaches of the Phase 4 study area.

The internal drainage channels that are mentioned above and are present in all six reaches of Phase 4 are likely used by native amphibian species as breeding habitat as well as by fish species. It is possible that additional amphibian habitat is present in small ponds or channels along the dike that were not identified in the desktop review.

Species and Ecological Communities at Risk

No known occurrences of terrestrial wildlife species at risk are present in the Phase 4 study area, but several occurrences exist on nearby islands in the Fraser River or on the river banks across from Richmond. It is possible that individuals of these species also occur on the Richmond side of the Fraser River. The Lower Fraser River population of White Sturgeon (*Acipenser transmontanus* pop. 4) is known to occur in the Fraser River next to the dike. Mapped critical habitat for at-risk species is not present within 500 m of the Phase 4 study area.

FREMP mapping (2007) indicates the presence of intertidal marsh communities in all six reaches of the Phase 4 study area. Many of these communities in British Columbia are considered at-risk (i.e. Blue-Listed; special concern, or Red-Listed; threatened, or endangered). No ecological communities at-risk are shown in either the study area on BC iMap (2017), but it is likely that some are present in the Phase 4 study area.

Table 2-3 presents the findings of the desktop review on a reach-by-reach basis and separates Fraser River side results from land-side results.

Table 2-3: Environmental Values

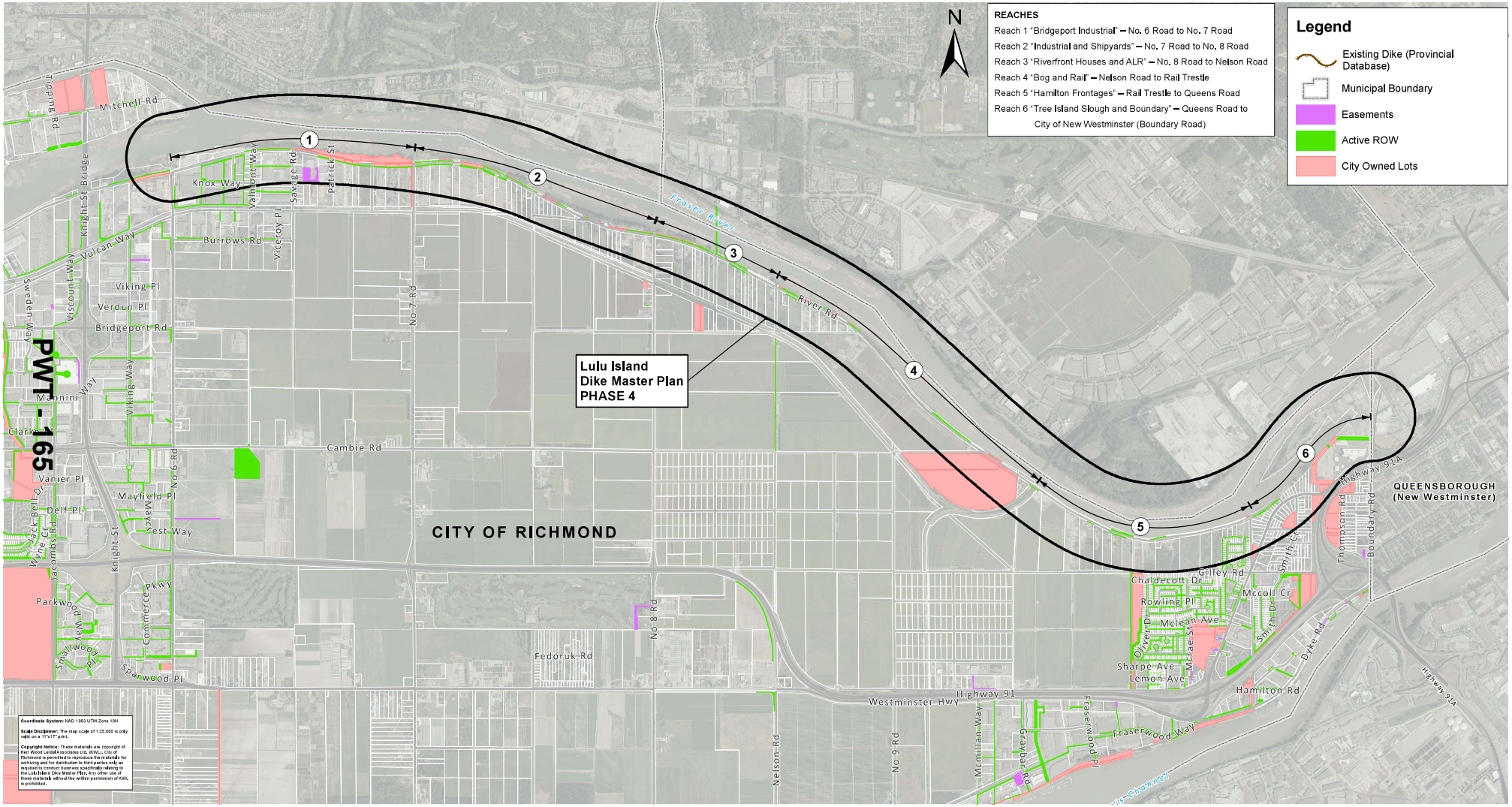
Reach #	Location	Environmental Setting	Construction Constraints	Construction Opportunities	FREMP Habitat Types	Known Species at Risk Occurrence Near Dyke Alignment	Potential Raptor Nesting Trees	Potential Migratory Bird Nesting Habitat	Existing Habitat Compensation Sites Present
1 Bridgeport Industrial	Land Side	• Sections of channelized watercourse (amphibian habitat) • Sections of moderate quality low shrub woodland	Drainage channels and moderate quality habitat	Limited sections without drainage channels or shrub woodland	Low shrub woodland Deciduous tree woodland Meadow	White Sturgeon (Lower Fraser River population) (Acipenser transmontanus pop. 4)	Y	Y	Project: Richmond Plywood Year Created: 1989
	Fraser River side	• Low-quality habitat, gravel lot and armoured bank at west end • High quality deciduous treed woodland riparian habitat along east 3/4 of reach • High Quality marsh and mudflat habitat along east 3/4 of reach	High quality riparian and aquatic habitat in east 3/4 of reach	Low quality habitat at west end of reach	Marsh Deciduous tree woodland Mudflats Meadow				
2 Industrial and Shipyards	Land Side	• Channelized watercourse adjacent to dike (amphibian habitat) along full length of reach	Drainage channels along full length of reach	n/a	Deciduous tree woodland Meadow	White Sturgeon (Lower Fraser River population) (Acipenser transmontanus pop. 4)	Y	Y	N
	Fraser River side	• High-quality deciduous tree woodland riparian habitat along 75% of reach • High-quality marsh and mudflats habitat along 90% of reach	High quality habitat along >90 % length of reach	n/a	Deciduous tree woodland Marsh Mudflats Meadow				
3 Riverfront Houses and ALR	Land Side	• Channelized watercourse adjacent to dike (amphibian habitat) along full length of reach	Drainage channels along full length of reach	n/a	Deciduous tree woodland Meadow	White Sturgeon (Lower Fraser River population) (Acipenser transmontanus pop. 4)	Y	Y	Project: Olofson & Hewitt Compensation Site Year Created: 1986
	Fraser River side	• High-quality deciduous tree woodland riparian habitat along 75% of reach • High-quality marsh habitat along full length of reach	High quality habitat along full length of reach	n/a	Marsh Deciduous tree woodland				
4 Bog and Rail	Land Side	• Channelized watercourse adjacent to dike (amphibian habitat) along full length of reach • High-quality shrubland habitat connected to North East Bog Forest in east end of reach	Drainage channels along full length of reach	n/a	Deciduous tree woodland Meadow Low shrub woodland Tall shrub woodland	Green-fruited Sedge (Carex interrupt) White Sturgeon (Lower Fraser River population) (Acipenser transmontanus pop. 4)	Y	Y	N
	Fraser River side	• High quality deciduous tree woodland riparian habitat along west 60% of reach. • High-quality marsh habitat along west 60% of reach • Low quality armoured bank habitat in east 40% of reach	High quality habitat along west 60% of reach	Low quality habitat at least 40% of reach	Deciduous tree woodland Marsh				
5 Hamilton Frontages	Land Side	• Channelized watercourse adjacent to dike (amphibian habitat) along full length of reach • Moderate quality low shrub woodland and meadow in middle of reach	Drainage channels along full length of reach	n/a	Meadow Low shrub woodland Tall shrub woodland	White Sturgeon (Lower Fraser River population) (Acipenser transmontanus pop. 4)	Y	Y	N
	Fraser River side	• High-quality mudflat habitat and small patches of marsh at east end of reach • Low quality armoured bank habitat along full length of reach	High quality habitat along east half of reach	Low quality habitat at west end of reach	Mudflat Marsh				
6 Tree Island Slough and Boundary	Land Side	• Channelized watercourse adjacent to dike (amphibian habitat) along west end of reach • Mostly low-quality habitat, paved or maintained lawn	Drainage channels along west end of reach	Low quality habitat along most of reach	Tall shrub woodland Deciduous tree woodland	White Sturgeon (Lower Fraser River population) (Acipenser transmontanus pop. 4)	Y	Y	N
	Fraser River side	• High quality mudflat habitat and small patches of marsh at west end of reach • Low quality habitat armoured bank at west half of reach	High quality habitat along full length of reach	Low quality habitat at west end of reach	Mudflat Marsh Meadow				

PWT - 164

Path: P:\0600-0699\651-122\430-GIS\MXD-Rp\Phase4\651122_Phase4_Fig2-1_ExistingLandTenure.mxd Date Saved: 4/25/2023 9:11:44 PM | Author: JLau

City of Richmond
Lulu Island Dike Master Plan - Phase 4

KERR WOOD LEIDAL consulting engineers



Project No. 651-122
Date April 2023
Scale 1:25,000

500 250 0 500 m

Existing Land Tenure

Figure 2-1

3. Options Assessment

This section summarizes the options development process, including the following components:

- design considerations and design criteria;
- upgrading strategies;
- upgrading options and concepts;
- options evaluation; and
- recommended options for implementation.

The next version of the draft report will include a summary of external stakeholder engagement results.

3.1 Design Considerations

This section summarizes the main themes and issues that have informed the development of upgrading strategies and options for Phase 4.

Dike Performance, Maintenance, and Upgrading

Dike performance, maintenance, and upgrading are the most important design considerations for the Dike Master Plan.

The following themes define an ideal vision for dike upgrading:

1. **Level of Protection:** The City's 2008-2031 Flood Protection Management Strategy sets a target level of protection for structural measures. The City is presently developing an updated flood protection management strategy that will have an even more ambitious flood protection level target. The level of protection translates to a hazard-based design flood scenario to be incorporated into the Dike Master Plan. At this time, the proposed design flood scenario for the Lulu Island perimeter dike is the 500-year return period flood event (0.2 % annual exceedance probability, AEP) with climate change allowances including 1 m of sea level rise. However, the Dike Master Plan should be flexible to accommodate a future change in the design flood scenario in the future.
2. **Form and Performance:** The preferred form of the dike is a continuous, compacted dike fill embankment with standard or better geometry. Walls and other non-standard forms are less reliable and are not preferred. The level of performance of the Lulu Island perimeter dike should be in line with the significant population and assets that the dike protects. The dike should meet all relevant design guidelines of the day and in some cases, exceed guidelines to provide a higher level of performance. Dike performance can be expressed in terms of freeboard above the design flood scenario water level, and factors of safety against various failure processes, including flood conditions and internal erosion (piping).
3. **Passive Operation:** Minimal human or mechanical intervention or operation should be required to achieve full dike performance. To achieve this, the dike should not have any gaps, gates, or stop log structures.
4. **Enhance Performance** (slow failure)**:** The likelihood of a catastrophic dike failure causing significant flood damages can be reduced by design features that aim to slow down failure processes, provide redundancy, and provide time to implement emergency repairs. In general, failure can be slowed or controlled with additional setback, crest width, and armouring of the river-side slope, crest, and land-side slope. Such measures can slow the impacts of river erosion, overtopping erosion, and stability failures. Increased monitoring approaches and technology may also be helpful.

5. **Post-earthquake Protection:** The dike should provide adequate protection following a major earthquake until permanent repairs can be implemented. In general, this means avoiding dike conditions where a major earthquake results in a sudden and full failure of the dike cross-section into the river, referred to as a 'flowslide failure'. Other conditions where the dike crest settles, but still provides sufficient freeboard and factors of safety until repairs can be conducted may be acceptable. In general, increased crest width, crest elevation, and setback from the river may be undertaken to help achieve adequate post-earthquake protection. In some cases, improved seismic performance will also require ground improvement and densification works.
6. **Future Upgrading:** Uncertainty in climate change, particularly sea level rise timing, may require the City to further upgrade the dike sooner or higher than anticipated by current guidelines and policies. Sufficient space should be reserved under secured land tenure for future upgrading based on standard geometry. Conceptual design is provided for design flood levels which incorporate 1 m of sea level rise, and proof-of-concept design is provided for design flood levels which incorporate another 1 m water level increase for further climate change impacts (i.e. 2 m of sea level rise).

Some specific design considerations related to the above principles are presented in Table 3-1.

Table 3-1: Ideal Dike Design Principles and Considerations

Design Principle	Ideal Design Principles and Considerations
Level of Protection	• Based on 2008-2031 Flood Protection Management Strategy • Currently proposed: 500-year return period (0.2% AEP) with climate change allowances as per provincial studies
Form and Performance	• Continuous, compacted dike fill with standard or better geometry • Crest elevation and adequate freeboard • Factors of safety against stability • Minimal infrastructure within the dike corridor • Adequate bank protection or setback
Passive operation	• No gaps, gates, or stop logs • Passive monitoring (e.g. SCADA water levels)
Enhance Performance (slow failure)	• Wide dike crest • Armoured river-bank slope to resist erosion • Paved/armoured crest and/or land-side slope to resist overtopping • Wide setback from the river
Post-earthquake Protection	• No loss of full dike geometry into the river ("flowslide failure") up to a return period to be determined • Adequate post-earthquake freeboard and stability until repairs • Wide dike crest and/or wide setback from the river
Future upgrading	• Space and tenure for upgrading (standard or better geometry) • Avoid need for future infrastructure relocation or land acquisition

River Road Safety and Access

The safety of drivers, cyclists, and pedestrians using River Road is a significant consideration in Phase 4. City transportation engineering staff were consulted during the master plan development to provide input on dike upgrading concepts that will also improve road safety. The City's preferred concept for River Road is to provide wider vehicle travel lanes and separated multi-use paths, which may be located on the dike crest. Preferred travel lane and multi-use path widths are documented in the design criteria in Section 3.2. Additionally, the City's goal is to create a continuous path around Lulu Island along the river/on the dike system.

Vehicle access to properties located on both sides of River Road is also a significant consideration. Dike raising along River Road will impact driveway access in some areas. Land use on these properties includes industrial / port-related uses, residential, and agricultural. As such, a variety of vehicles, including semi-trailer trucks, need safe access from River Road to these properties. Currently, these properties are generally at grade with or slightly below River Road, and access is provided via asphalt or gravel driveways. For properties located south of River Road, the driveway crosses the existing drainage channel via a culvert. In some areas where the channel is large, the driveway crossing culvert has a large lock block headwall.

Driveway access was considered in options development by identifying several access upgrading concepts including upgrading driveways with retaining walls, land filling to raise sites to the dike/road level, and providing vehicle parking at the dike/road level. Retaining walls should consider the need for handrails for safety, in accordance with applicable regulations.

Internal Drainage System

As with any diked area, the drainage for the interior protected area must be integrated with the flood protection measures such that the protected area does not experience flooding due to conflicting functions between the drainage of water from the interior area and prevention of flooding from water exterior to the dike system.

In this part of Lulu Island, there are large drainage channels adjacent to the interior (land) side of the existing dike and River Road through much of this area. Most upgrading options (discussed in Section 3.4) will impact these drainage channels throughout Phase 4.

The master plan assesses the potential drainage impacts of filling in the existing channel adjacent to River Road and installing a piped drainage system. The assessment was conducted using East Richmond hydraulic model (MIKE URBAN software) provided to KWL by the City.

Land Raising and Acquisition

Land acquisition is an important consideration for the development and evaluation of dike upgrading options. In many areas, the River Road dike corridor is confined on both sides by private property with no room for expansion of the dike footprint.

The figures in Appendix A present the overlap between the proposed dike footprint and private property for select upgrading options discussed in this section. This overlap can be used to produce a land acquisition plan.

In some locations, an alternative to land acquisition may be to raise private property lots up to the dike elevation to create a much wider land raising platform (similar to recent developments along the Middle Arm (e.g. Olympic Oval).

Environmental Considerations

City of Richmond Bylaws

The City's Official Community Plan (OCP) bylaw (2011) includes an Ecological Network Management Strategy (ENMS) that identifies ecologically important areas in the City's Ecological Network (EN). These areas include Environmentally Sensitive Areas (ESAs), Riparian Management Areas (RMAs), and EN components (hubs, sites, and corridors, shoreline, city parks).

ESAs are designated as Development Permit Areas (DPAs) with specific restrictions and guidelines for development controlled through a review and permitting process (HB Lanarc-Golder and Raincoast Applied Ecology 2012). There are five ESA types, based on habitat, each with specific management objectives. These are summarized in Table 3-2 and more detailed guidelines can be found in HB Lanarc-Golder and Raincoast Applied Ecology (2012). According to Richmond's OCP, dike maintenance is exempt from development permits in ESAs. However, the guidelines provide useful direction that can be used to minimize impacts to these areas and provincial and federal legislation (see below) still applies to these areas.

RMAs are setbacks that were implemented in accordance with the provincial *Riparian Areas Protection Act* and act as pre-determined Streamside and Protection Areas (SPEAs) under the Act. They extend 5 m or 15 m back from the top of bank of the City's higher value drainage channels or more natural watercourses and are to remain free from development unless authorized by the City (City of Richmond, 2017). RMAs are present in all six Phase 4 reaches.

Hubs, sites, and corridors are components of the City of Richmond's EN, which aren't specifically afforded protection, but often overlap ESAs and RMAs, which are protected. These components are present in all 6 reaches of Phase 4.

Dike upgrade options will consider the potential impacts to these areas.

Table 3-2: City of Richmond ESA Type Management Objectives

ESA Type	Reaches Where Present	Management Objectives
Intertidal	All	• Prevent infilling or direct disturbance to vegetation and soil in the intertidal zones • Maintain ecosystem processes such as drainage or sediment that sustain intertidal zones
Shoreline	1, 2, 3, 4, 6	• Preserve existing shoreline vegetation and soils, and increase natural vegetation in developed areas during development or retrofitting
Upland Forest	1	• Maintain stands or patches of healthy upland forests by preventing or limiting tree removal or damage, and maintaining ecological processes that sustain forests over the long-term
Old Fields and Shrublands	None	• Maintain the extent and condition of old fields and shrublands, while recognizing the dynamic nature of these ecosystems • Preservation should recognize the balance between habitat loss and creation with the overall objective of preventing permanent loss of old fields and shrublands

ESA Type	Reaches Where Present	Management Objectives
Freshwater Wetland	None	• Maintain the areal extent and condition of freshwater wetland ESAs by preserving vegetation and soils, and maintaining predevelopment hydrology, drainage patterns, and water quality
		Modified from HB Lanarc-Golder and Raincoast Applied Ecology 2012

Fish Habitat and Offsetting

Fish and aquatic habitat is protected by the federal *Fisheries Act*. Under the Act, *serious harm to fish* must be authorized by the Minister of Fisheries and Oceans and impacts that cannot be avoided or mitigated must be balanced through offsetting. Offsetting plans are negotiated on a case-by-case basis and may require consultation with aboriginal groups and the Province. Offsetting measures include habitat restoration or enhancement and habitat creation and must be proportional to the loss caused by the project.

Often, the amount of offsetting habitat created is greater than the area of habitat impacted. The area of offsetting may need to be increased to account for uncertainty of effectiveness and time lag between impacts and offsetting. Selecting offsetting locations and beginning habitat creation works prior to all impacts occurring can help to reduce requirements for additional offsetting area required due to lag time. Creation of a smaller number of larger area habitat restoration, enhancement, or creation sites would allow for a more efficient use of resources and potentially reduce uncertainty.

Wildlife Considerations

Migratory birds, their eggs, and active nests are protected by the *Migratory Birds Convention Act* and appropriate measures must be taken to avoid incidental take. The most effective and efficient of these measures includes scheduling vegetation clearing outside of the migratory bird nesting season. If this is not possible, bird nest surveys can be completed immediately prior to vegetation clearing to identify active nests and delay vegetation clearing until the nest is no longer active.

The nests of Bald Eagles, herons and other raptors (both active and inactive) are protected under the provincial *Wildlife Act*. It is also prohibited under the *Wildlife Act* to disturb or harm birds and their eggs. The detailed design stage for dike upgrading should attempt to avoid the removal of trees where bald eagle nests are located.

Native amphibian species may use the drainage channels on the land side of the dike at certain times of year. These species are protected by the provincial *Wildlife Act* and detailed design should also consider potential impacts to these species.

Tie-in with City of New Westminster Dike

The Phase 4 dike needs to tie into the City of New Westminster portion of the Lulu Island perimeter dike.

As shown in the Appendix A, the dike alignment within the tie-in area is not well-defined. The alignment crosses between industrial sites including the Tree Island Steel property (3933 Boundary Road) and the recently developed Translink Hamilton Transit Centre property (4111 Boundary Road) to reach the border (Boundary Road) with the City of New Westminster.

The dike alignment on the City of New Westminster side of the boundary also doesn't appear well defined. Coordination between the City and the City of New Westminster is important to confirm the dike tie-in design at the boundary.

Potential Future Secondary Dikes

The City's 2008-2031 Flood Protection Management Strategy identifies potential secondary dike concepts which are important considerations for Phase 4, including the proposed mid-island dike and the proposed Richmond-New Westminster boundary dike. The purpose of these secondary dikes would be to limit flood damage by creating flood cells on Lulu Island which would contain flooding to smaller areas, and prevent complete flooding of the island if dike breaches were to occur.

The Phase 4 Dike Master Plan has been developed to allow tie-ins with the proposed mid-island dike and the proposed Richmond-New Westminster boundary dike. It is understood that the City is also considering implementation of both of these proposed dikes through gradual land raising through development as opposed to a dedicated dike corridor. The City's 2008-2031 Flood Protection Management Strategy provides additional information regarding potential future secondary dikes.

Public Realm and Ecological Enhancement

The dike is a major existing public realm feature providing a variety of recreation opportunities. The Dike Master Plan provides an opportunity to significantly enhance the public amenity of the dike system, particularly in the Phase 4 project area where walking, biking, and resting opportunities along River Road are limited. Additionally, the dike upgrading provides an opportunity to enhance ecological value through the landscaping treatments that will define the dike surface and edges.

Appendix B presents a suite of landscape concepts prepared by Hapa landscape architects to supplement the Dike Master Plan. These include landscape design principles, an overall network connectivity concept for the Lulu Island perimeter dike trail, and design toolkits for ecological enhancement and public realm features. Additionally, the Appendix B also includes descriptions of landscape concepts associated with the upgrading options presented in this section.

3.2 Design Criteria

This section describes the main design criteria used in the Dike Master Plan.

Table 3-3 presents a summary of the design criteria, and is followed by additional discussion. The criteria are presented in terms of both a minimum acceptable level, and a preferred level.

Table 3-3: Design Criteria Summary

Item	Value and Description	
	Minimum Acceptable	Preferred
Proposed Dike Crest Elevation	4.7 m CGVD28 downstream of Nelson Road 4.7 m CGVD28 to 5.0 m CGVD28 between Nelson Road and Boundary Road	
Future Dike Crest Elevation (for proof-of-concept design)	5.5 m CGVD28 downstream of Nelson Road 5.5 m CGVD28 to 6.0 m CGVD28 between Nelson Road and Boundary Road	
Geometry and Stability	4 m wide crest with dike fill core 3H:1V land-side slope 3H:1V river-side slope (or 2H:1V with riprap revetment) Retaining walls minimized Sheetpile walls acceptable only with minimum 4 m wide dike fill core behind wall No standalone flood walls Meet minimum geotechnical factors of safety	Meets or exceed provincial dike standard and City dike standard
Land Tenure	Registered right-of-way	Dike located on City-owned land
Infrastructure in Dike	Crossings designed with seepage control Locate parallel infrastructure to land-side outside of dike core	No infrastructure in dike
Land Adjacent to Dike	Land is raised as much as is practical	Land is raised to meet or exceed dike crest elevation
Seismic Performance	Minimum 3.2 m CGVD28 post-earthquake dike crest elevation and maintain dike core integrity	No damage to dike from earthquakes up to a return period to be determined

Item	Value and Description	
	Minimum Acceptable	Preferred
River-side Slope and Setback	2H:1V bank slope with riprap revetment designed for freshet flow velocities and vessel-generated waves	>10 m setback between river top of bank and dike river-side slope toe 3H:1V river-side bank slope with acceptable vegetation
Crest Surfacing and Land-side Slope Treatment	Crest surfacing: 150 mm thick road mulch Land-side slope treatment: hydraulically seeded grass	Meet or exceed provincial dike standard and City dike standard Consider paved crest and land-side slope vegetation/armouring to add robustness against overtopping
River Road Design Width	From river-side to land-side: 4.0 m multi-use path 0.5 m allowance for barrier 0.6 m min horizontal clearance Two 3.7 m travel lanes 0.6 m min horizontal clearance 0.5 m allowance for barrier Total width: 9.6 m	From river-side to land-side: 4.0 m multi-use path 0.5 m min horizontal clearance 0.5 m allowance for barrier 0.6 m min horizontal clearance Two 3.7 m travel lanes 0.6 m min horizontal clearance 0.5 m allowance for barrier 2.0 m pedestrian walkway Total width: 16.1 m

Dike Crest Elevation

At this time, the Province has not established a Fraser River flood profile and dike design profile that considers sea level rise and climate change. It is understood that the Fraser Basin Council's Lower Mainland Flood Management Strategy project may produce a recommended flood profile in the near future. The most recent available flood profile information is provided in the Province's 2014 study of climate change and sea level rise effects on the Fraser River flood hazard.

The designated flood profile for the purpose of developing the Dike Master Plan is proposed as the maximum of the following flood scenarios:

- 500-year return period coastal water level with 1 m of sea level rise (no wave effects); and
- 500-year return period freshet with moderate climate change impacts and 1 m of sea level rise.

Figure 3-1 shows the estimated flood profile water levels (in CGVD28 vertical datum, excluding freeboard) along the river in the study area. As shown on the figure, the coastal flood scenario governs from the Ocean upstream to approximately Nelson Road.

Design dike crest elevations are derived by adding freeboard and an allowance for land subsidence to the flood level. Table 3-4 presents the components that sum to the proposed dike crest elevation.

Table 3-4: Flood Levels and Dike Crest Elevations

Item	Downstream of Nelson Road (flat profile)	Upstream of Nelson Road (sloped profile)		
		Nelson Road	Boundary Road (Border with City of New Westminster)	Eastern Tip of Lulu Island
Governing Flood Hazard	tide + storm surge	Fraser River freshet		
Level of Performance	500-year return period (0.2% annual exceedance probability)			
Climate Change Allowance	1 m sea level rise	1 m sea level rise and 20% freshet flow increase		
Design Flood Level (m, CGD28)[1]	3.8		4.2	4.6
Wave Effects Allowance	None			
Freeboard (m)	0.6			
Land Subsidence Allowance (m)	0.2			
Dike Crest Elevation[2] (m)	4.6		5.0	5.4

Notes:
1. From (BC MFLNRO, 2014).
2. The City's adopted downstream design crest elevation (4.7 m) exceeds the minimum required elevation (4.6 m). This is a result of updated coastal water level analysis methods (joint probability analysis) that result in a discrepancy when compared to previous methods (additive method).

The Dike Master Plan also allows for further upgrading by providing proof of concept for raising to between 5.5 m downstream of Nelson Road, and 6.0 m at the boundary with the City of New Westminster.

Seismic Performance

The current provincial seismic performance criteria for dikes are difficult to meet without costly and complex ground improvement works. Additionally, the guidelines are considered very conservative in some situations because they require performance under extremely rare scenarios. For example, the guidelines require dikes to maintain 0.3 m freeboard in the event of a 10-year return period flood occurring following a 2,475-year return period earthquake which has a probability of 0.004% in a 1-year period. This is significantly rarer than the design event for the dike crest elevation (500-year return period event has a 0.2% annual exceedance probability). It is understood that the Province is conducting a review of the current criteria and associated guidelines.

For the purpose of the Dike Master Plan, an alternative seismic performance approach that focuses on failure mechanisms and post-earthquake level of protection is proposed. The alternative criteria are presented below.

Table 3-5: Proposed Alternative Seismic Performance Criteria

Criteria	Description / Value
Failure Mechanisms	Flowslides (resulting in full loss of dike cross-section into the river or channel) are not acceptable up to a return period to be determined (e.g. 2475-year return period).
Maximum post-earthquake overtopping probability	0.2% annual exceedance probability Calculate probability through comparison of various post-earthquake dike crest elevations and future flood levels + 0.3 m freeboard. Assume a minimum 1-year exposure period for dike repairs, or longer if local site conditions warrant. In general, this results in a minimum post-earthquake dike crest elevation of 3.2 m which corresponds to the governing scenario of an average annual maximum coastal water level (1.9 m) with 1 m of sea level rise occurring within 1 year of a 475-year return period earthquake. The post-earthquake dike crest would need to provide adequate dike performance and static stability (i.e. no major deformations and cracks).

This approach would make the service level of the dike in a seismic scenario consistent with the service level for the dike crest elevation which is set based on a 500-year return period flood or a 0.2% annual exceedance probability.

For the coastal design dike crest elevation of 4.7 m CGVD28, this approach would allow for up to 1.5 m of vertical settlement, as long as core dike integrity is maintained.

The length of time between earthquake and dike repair will be a critical assumption for analysis to support this approach. The City may wish to specify consistent assumptions through the Dike Master Plan to ensure consistent analyses. For example, reconstruction of a dike that has failed into the river channel following a flowslide failure from an extreme earthquake may take up to 2 years or more, whereas more straightforward compaction and raising of a settled dike could be done in less than a year after an earthquake.

In addition, it should be noted that meeting the seismic performance criteria through increasing the dike crest elevation, as opposed to ground densification, has the added benefit of increasing the level of protection against flood events.

The seismic performance criteria may need to be further reviewed if/when the Province issues updated guidelines for seismic performance of dikes.

3.3 Alternative Upgrading Strategies

Several high-level upgrading strategies, summarized in Table 3-6, were considered to inform the development of specific options for the Dike Master Plan.

Table 3-6: High-level Dike Upgrading Strategies

Strategy	Advantages	Disadvantages
Road Dike *Raise road to dike crest elevation*	• Smaller footprint • Wider crest (more robust) • Smaller impacts to habitat	• Operation and maintenance challenges • Infrastructure within dike • High cost to raise dike in the future
Separated Dike and Road *Conventional dike adjacent to road*	• Operation and maintenance separated from road • No infrastructure within dike	• Larger footprint and impact to infrastructure and habitat
Raise Riverbank Dike *Conventional dike along riverbank*	• Minimize footprint	• Limited space • Impacts to river side riparian and intertidal habitat and land side riparian and aquatic habitat • Reduced seismic performance • Erosion hazard
Fill River-side Dike *Build into river to achieve conventional dike*	• Less impacts to existing development and on-shore infrastructure	• Larger impacts to river side riparian and intertidal habitat • Reduced seismic performance • Erosion hazard
Setback Dike *Realign significantly away from river*	• Increased seismic performance • Reduced erosion hazard • Increased opportunities for riparian and intertidal habitat enhancement	• Increase in unprotected development • High infrastructure impacts • High cost to construct new dike alignment • Would result in 2 dikes (existing and setback) to maintain
Land Raising ("superdike") *Raise development and roads adjacent to dike*	• Wider crest (more robust) • Reduced grading issues (after implementation) • Less impacts to raise a dike in the future	• Timing and phasing depends on development • High cost to raise large lots with low-density land use • Grading and access issues for water-oriented developments

3.4 Options and Concepts

Through a series of meetings and site visits with City staff, the high-level upgrading strategies have been narrowed down to a set of options and concepts for each reach.

The options developed for Phase 4 include:

- Option 1: Raise dike and road, extend land-side (Figure 3-2);
- Option 2: Raise dike and road with retaining walls (Figure 3-3);
- Option 3: Raise dike only and extend river-side (Figure 3-4); and
- Option 4: Raise dike only and extend land-side.

In addition to the above options, the following options have been developed to address site-specific issues at the rail trestle (Reach 4) and at the tie-in with the City of New Westminster (Reach 6):

- Option 6: Rail trestle – raise road/dike under trestle (Figure 3-5);
- Option 7: Rail trestle – fill in between trestle piles (Figure 3-6);
- Option 8: City of New Westminster tie-in – raise Boundary Road (Figure 3-7);
- Option 9: City of New Westminster tie-in – fill Tree Island Steel property to dike level (Figure 3-8); and
- Option 10: City of New Westminster tie-in – new alignment across Tree Island Slough (Figure 3-9).

Table 3-7 presents a summary of the options as applied to each reach based on discussions with City staff and is followed by a discussion of the options. Appendix B includes landscape concepts prepared by Hapa associated with the cross-section options.

Table 3-7: Major Dike and Road Alignment and Cross-section Options

Reach ID and Name	Alignment and Cross-section Options
1 – Bridgeport Industrial	• Option 1: Raise dike and road, extend land-side**
2 – Industrial and Shipyards	• Option 1: Raise dike and road, extend land-side**
3 – Riverfront Houses and ALR	• Option 1: Raise dike and road, extend land-side**
4 – Bog and Rail	• Option 1: Raise dike and road, extend land-side • Option 2: Raise dike and road with retaining walls • Option 3: Raise dike only and extend river-side** *Specific options for rail trestle:* • Option 6: Rail trestle – raise road/dike under trestle • Option 7: Rail trestle – fill in between trestle piles
5 – Hamilton Frontages	• Option 1: Raise dike and road, extend land-side** • Option 3: Raise dike only and extend river-side
6 – Tree Island Slough and Boundary	• Option 3: Raise dike only and extend river-side** • Option 4: Raise dike only and extend land-side *Specific options for tie-in with City of New Westminster dike:* • Option 8: City of New Westminster tie-in – raise Boundary Road • Option 9: Fill Tree Island Steel property to dike level • Option 10: City of New Westminster tie-in – new alignment across Tree Island slough
Notes: ** Option footprint is presented in Appendix A plan figures.	

Raise Dike and Road, and Extend Land-side

The preferred option developed for Reaches 1 to 3 involves separating the dike and River Road, raising both to the dike crest elevation, and extending the footprint of the fill towards the land-side. Figure 3-2 presents a typical cross-section for this option.

Figure 3-2 shows a 10 m wide dike crest to allow for additional future dike raising without the need to reconstruct the road. An alternative approach to reduce the overall footprint at first would be to have a 4 m wide dike crest and to extend the footprint and reconstruct the road in the future.

This option addresses several of the main design considerations including providing a substantially wide dike and improving River Road safety by separating vehicles and cyclists/pedestrians.

Extending the footprint towards the land-side takes advantage of the space currently occupied by drainage channels. This option requires filling in the existing channel and replacing or relocating the drainage conveyance and storage. The preferred approach is to replace the channels with pipes. This will result in a loss of aquatic and riparian habitat and will require habitat creation or enhancement to be completed elsewhere to offset the loss. Drainage modification options are discussed separately below.

Extending the footprint towards the land-side will also require land acquisition where the existing corridor width is insufficient. In general, this would affect a narrow strip of land on the frontage of large lots and should be feasible to implement.

However, there are also areas on both the land-side and the river-side where the upgrade will result in access issues. The areas with the most severe space limitations and potential options to address the access issues are presented in Table 3-8.

Table 3-8: Space Limitations and Access Issues

Reach / Location / Description	Photo	Options to Address Footprint and Access
Reach 1 No. 7 Road Pump Station		• Retaining walls and steeper driveway access • Replace pump station during dike upgrades
Reach 1 15700 River Road FortisBC gas pipeline facility		• Retaining walls and steeper driveway access • Coordinate with FortisBC to raise parcel during next major upgrade

Reach / Location / Description	Photo	Options to Address Footprint and Access
Reach 2 16291 River Road Residential / Office Space		• Retaining walls • Provide parking on land-side (instead of driveway down to lot) • Raise parcel of land at time of redevelopment • Land acquisition / managed retreat (buy-out, relocate, or do not allow redevelopment)
Reach 2 16971 River Road Tom-Mac Shipyard on water side, Residential on inland side		• Retaining walls • Provide parking on land-side (instead of driveway down to lot) • Raise parcel of land at time of redevelopment • Managed retreat (buy-out, relocate, or do not allow redevelopment)
Reach 3 17740 River Road No. 8 Road North Drainage Pump Station		• Retaining walls • Replace pump station during dike upgrades
Reach 3 18871 River Road Storage, and Residential lots (Water Side) Large Channel (Inland Side)		• Retaining walls • Provide parking on land-side (instead of driveway down to lot) • Raise parcel of land at time of redevelopment • Land acquisition / managed retreat (buy-out, relocate, or do not allow redevelopment)

Reach / Location / Description	Photo	Options to Address Footprint and Access
Reach 3 19051 River Road Metro Vancouver Tilbury Watermain Crossing		• Retaining walls and steeper driveway access • Coordinate with Metro Vancouver to raise parcel during next major upgrade
Reach 4 21200 River Road CN Rail Trestle Bridge		• Refer to rail trestle discussion paragraph in this section (page 3-18)
Reach 5 22760 River Road Queen Road North Drainage Pump Station		• Retaining walls and steeper driveway access • Replace pump station during dike upgrades

Filling in Drainage Channels (Extending Land-side)

The interior channels along River Road will generally be filled in the preferred option which involves raising the dike and River Road, and extending the footprint towards the land-side. Options considered to replace the conveyance and storage capacity provided in the channels are described in Table 3-9.

Table 3-9: Options for Replacing Existing River Road Drainage Channels

Option	Comments
1. Relocate channels further inland to new River Road toe	• Would impact the adjacent properties, requiring acquisition of right-of-way or, potentially, of whole lots (depending on extent of impact to the lot) • New channels may not need to be as wide as the existing channel • New channels would be located at the toe of the road and outside the dike section • It is not ideal to have a channel near the toe of the dike and the option of locating a channel near the toe of the dike would need to be evaluated by a geotechnical engineer for seepage concerns
2. Replace channels with pipe	• Would involve replacing the channel functions with a pipe below the road • Pipe would be located within the road base but must be outside of the dike cross-section or toe of the dike • The size of pipe that could be fit into the available space in the road cross-section is a potential limitation • Would result in a loss of land side aquatic and riparian habitat
3. Reconstruct channels at rear of lots along River Road	• Would require re-grading of lots and re-connection of lot drainage to rear of lot • Property acquisition for drainage right-of-way would be required • Road drainage would need to be accommodated in additional infrastructure – likely a pipe below the road on the inland side

The option expected to be both the simplest to implement and the least cost is to replace the existing channels along River Road with pipes. As noted, this option is limited by the size of the pipe that can fit within the road cross-section and outside of the dike cross-section in the preferred option for the dike upgrades. It is estimated that maximum pipe size is approximately 1.2 m diameter, and a circular pipe will fit better than a box section in the available space.

Drainage from both River Road and the interior lots adjacent to the road would be directly connected to the new drainage pipes. The new pipes would drain to the existing north-south channels that convey runoff to the pump stations.

A preliminary assessment of the replacing the drainage channel with a piped system was done to determine whether it could provide the necessary conveyance and storage functions to replace the existing channels along River Road. The existing hydraulic model of the east Richmond drainage system was provided to KWL for this purpose by the City. The preliminary assessment indicates that replacement of the existing River Road channels with 1.2 m diameter concrete pipes would provide adequate conveyance and storage for drainage of the design storms from the interior drainage system.

The internal drainage system in the eastern part of Lulu Island provides irrigation service as well as drainage service. The system of channels allows water from intakes on the Fraser River to flow into Lulu Island and distribute through the drainage conveyance system to provide irrigation water to the farmlands in eastern Lulu Island. This use of the drainage conveyance system relies on the storage capacity within the channels to provide adequate water to the farmlands. The system was reviewed relative to the impacts on irrigation functions with the proposed removal of the large storage channels along River Road and their replacement with pipe infrastructure. The function of these channels for the irrigation system was discussed with City staff (Derek Hunter, Pump Station Manager). From an irrigation perspective, these changes to the system along River Road are not expected to impact the irrigation functions of the system. The east-west running channels along River Road have one-way flow gates at the junctions with the north-south running channels that convey flow to and from the pump stations and the irrigation intake points. These one-way gates allow the water to drain out of the east-west channels along River Road to flow to the pump stations, but they block irrigation water from entering the east-west channels when the irrigation function of the channels is in use during the growing season. Therefore, the proposed replacement of the channels along River Road with pipe infrastructure should not impact the irrigation system. Similar one-way gates should be used on the new pipe infrastructure to allow the irrigation flow in the north-south channels to continue to bypass the drainage infrastructure that will provide drainage service along the new River Road.

Infilling drainage channels will remove a large amount of aquatic and riparian habitat important for fishes and amphibians. This will require a significant amount of habitat creation, restoration, and/or enhancement to offset this loss.

North East Bog Forest (Reach 4)

In Reach 4, raising both the dike and River Road to the design dike elevation and extending the footprint towards the land-side (Option 1) would encroach onto the north-east Bog Forest, and is generally not preferred from an environmental perspective. The bog is a unique feature on Lulu Island, and impacts to the bog need to be carefully considered.

To avoid encroaching onto the bog, the following additional options are considered for Reach 4:

- Option 2: Raise dike and road with retaining walls; and
- Option 3: Raise dike only and extend river-side.

Option 2 would limit the encroachment onto the bog by retaining the road land-side slope using retaining walls. Settlement may be a significant concern with Option 1 and Option 2 because the soils adjacent to the bog may experience significant settlement.

By filling towards the river-side instead of the land-side, Option 3 would avoid encroachment and filling in the bog. Building into the river would cause an impact to existing riparian and aquatic habitat and require offsetting. However, the desktop habitat review (Section 2.4) shows that there are existing areas of low quality riparian and aquatic habitat in the eastern portion of Reach 4. As such, building into the river provides an opportunity to replace the low quality riparian habitat with higher quality riparian habitat. One concept to achieve this is to build out a shallow river-side slope with riparian and marsh benches, as shown in Figure 3-4. A shallow river-side slope would also reduce the erosion concern and reliance on riprap bank protection. Aquatic habitat loss will have to be offset elsewhere.

Since this option would involve filling in a portion of the river channel, it may have some impact on channel conveyance or navigation. However, the existing trestle piles and piers located upstream already limit the conveyance and navigation in this area. These impacts should be considered further if this option is preferred.

Rail Trestle (Reach 4)

The existing rail trestle structure at eastern end of Reach 4 is an obstacle to conventional dike upgrading due to limited space for widening the dike and road, and due to limited overhead clearance space for raising the road – as shown on the photo below.

The existing maximum road clearance below the structure is posted at 5.88 m. Raising the road/dike would reduce the clearance.

The following options have been developed for dike upgrading at the rail trestle:

- Option 6: Rail trestle - raise road/dike under trestle; and
- Option 7: Rail trestle – fill in between trestle piles.

To achieve Option 6, the trestle structure may need to be modified to achieve a minimum acceptable overhead clearance (to be confirmed with City staff).

Option 7 would avoid reducing the overhead clearance by leaving the road as-is and constructing a new dike on the river-side filling in between the trestle piers. The feasibility of this option needs to be confirmed from geotechnical engineering and constructability perspectives. Additionally, this option would involve filling in a portion of the river channel and may have an impact on channel conveyance or navigation. However, the existing trestle piles and piers already limit the conveyance and navigation in this area. These impacts should be considered further if this option is preferred.

Hamilton Frontages (Reach 5)

Upstream of the rail trestle, in Reach 5, the primary option is the same as Reach 1 to 3. This involves raising the road and the dike to the design dike elevation, and extending the footprint to the land-side (Option 1). This will remove a large amount of aquatic and riparian habitat and will require a significant amount of habitat creation, restoration and/or enhancement to offset the loss.

However, Option 3, raise dike and extend to river-side, is also considered because of the opportunity to convert the existing low quality riparian and aquatic habitat into higher quality habitat (see Section 2.4). One concept to achieve this is to build out a shallow river-side slope with riparian and marsh benches, as shown on Figure 3-4. A shallow river-side slope would also reduce the erosion concern and reliance on riprap bank protection. Additionally, this option is considered in both Reach 4 and Reach 6, and would allow for continuity in alignment. This option would involve filling in a portion of the river channel and may have an impact on channel conveyance or navigation.

Tree Island Slough and Tie-in with City of New Westminster Dike (Reach 6)

Near the western end of Reach 6, River Road intersects Westminster Highway. The existing dike runs along the river bank, and is separated from River Road. The existing dike runs east until it reaches the recently developed Hamilton Transit Centre. The existing dike alignment is not well defined from the Hamilton Transit Centre to Boundary Road where jurisdiction of the Lulu Island perimeter changes to the City of New Westminster.

The following options have been developed for Reach 6:

- Option 3: Raise dike only and extend river-side; and
- Option 4: Raise dike only and extend land-side.

The following specific options have been developed for tie-in with the City of New Westminster dike:

- Option 8: City of New Westminster tie-in – raise Boundary Road;
- Option 9: Fill Tree Island Steel property to dike level; and
- Option 10: City of New Westminster tie-in – new alignment across Tree Island Slough.

Options 3 and 4 address dike upgrading along the existing dike alignment from Reach 5 to the Hamilton Transit Centre, from which there are 2 compatible options for tie-in with the City of New Westminster dike:

- construct a dike along the right-of-way north of the Hamilton Transit Centre and raise Boundary Road (Option 8); and
- fill the Tree Island Steel property (3933 Boundary Road) up to the dike elevation through redevelopment.

Option 3 (extend river-side) would involve impacts to existing intertidal habitat, but also presents the opportunity to improve river side riparian habitat, while Option 4 would have private property impacts.

Raising Boundary Road (Option 8) may be difficult to achieve through a standard dike design because there is a railroad access line to the Tree Island Steel property that crosses Boundary Road. This may require a rail gate, which is not desired.

Raising the land elevation of the Tree Island Steel property (Option 9) would create a wide and robust dike at the tie-in, but this option is dependent on redevelopment of the site and may have feasibility issues due to access requirements.

Option 10 provides an alternative approach that realigns the dike to cross over the slough and runs along the Tree Island Steel property and directly connects to the City of New Westminster dike along the river bank. Option 10 would involve partially or completely closing off the slough and presents the opportunity to construct a large habitat enhancement project. One concept for this is to create an intertidal marsh in the slough and have a tide gate installed on the dike crossing at the outlet of the slough.

3.5 Stakeholder Engagement

Stakeholder engagement for Phase 4 was completed in four stages. This included internal (City) stakeholder review, Council review, external stakeholder engagement, and then public engagement.

Prior to City Council review, initial stakeholder engagement included meetings with internal City departments and some regulatory agencies. This initial stakeholder engagement provided input from City groups on options developed, additional background, and future coordination, with the goal of

informing the preferred upgrade options. City departments included Transportation, City of Richmond Parks, Planning, and Sustainability.

Following Council review, additional stakeholder engagement was conducted, including meetings with specific stakeholder groups.

External stakeholder feedback was received originally received in 2018 from the City of New Westminster and the Ministry of Forests, Lands, Natural Resource Operations, and Rural Development (MFLNRORD), including Inspector of Dikes, Flood Safety, and Water Authorizations staff. In 2022 and 2023, additional feedback was received from the Department of Fisheries and Oceans, Ministry of Transportation, Fortis BC, and the Ministry of Forests, Richmond's Advisory Committee on the Environment, and Richmond's Food Security and Agricultural Advisory Committee.

The Department of Fisheries and Oceans (DFO) originally declined to meet with the City in 2018, stating that input would be provided during later stages in the established review and approvals process. However, at a later date City staff met with the Fish and Fish Habitat Protection Program team at the Department of Fisheries and Oceans to discuss the dike-raising initiative and how impacts on fish and fish habitat are planned to be mitigated or compensated, where impact cannot be avoided. They encourage the implementation of more nature-based solutions. Staff are in discussion with the Department of Fisheries and Oceans to implement a habitat bank, per council direction.

Richmond's Advisory Committee on the Environment generally supported dike-raising and noted that New Westminster's dike-raising plans should align with Richmond's. The City is coordinating with the City of New Westminster to ensure that east Richmond will be protected from flood risks.

Richmond Food Security and Agricultural Advisory Committee noted that implementing a continuous trail network along the perimeter dike and tree planting for habitat compensation should be prioritized. Additionally, opportunities for accessing the river for water activities should be investigated. The dike cross-section recommended in the Dike Master Plan includes a continuous multi-use pathway for dike trail continuity and

The Ministry of Transportation does not have any infrastructure in the Dike Master Plan Phase 4 study area; however, they noted their request to be notified and engaged wherever Richmond's dike project may intersect with Ministry infrastructure. Staff will consult with the Ministry staff for any dike reaches where their infrastructure is located.

Fortis BC requested to be notified in advance of dike upgrades along Reach 1 of Dike Master Plan Phase 4, which is between No. 6 Road and No. 7 Road, to relocate or regrade one of their critical pump stations. They also noted the potential impact to their DP gas main along the rest of Reach 1. A preload and impact memo was requested during design to determine if there are impacts and mitigative measures needed.

Ministry of Forests expressed concerns about habitat impact from potential Riparian Management Area (RMA) ditch infills along River Road. They also noted that Land Act authorizations would be required for any potential dike infrastructure that may stretch over the river or aquatic areas. Staff will obtain all required authorizations and work closely with a Qualified Environmental Professional, in collaboration with the Ministry, during the detailed design phase of the different dike sections to limit impacts where possible and provide adequate habitat compensation, as necessary.

Public Feedback

The City sought and received feedback from the public. The engagement is described in the November 2022 report by the City titled City of Richmond Flood Protection What We Heard Report. The

engagement was conducted by the City over a five month period from May to September, 2022. "Approximately 1,000 people attended in-person engagement activities and events. Over 2,000 people participated online, both through the City's flood protection webpage and Let's Talk Richmond project page that was set up to support community outreach." The received feedback included:

- Strong support for the accelerated flood protection program with a 50-year implementation timeline;
- Support for the actions being taken with regard to community safety;
- Support for environmental considerations in the Dike Master Plan;
- Support for coordination with development to create superdikes;
- Support for improved cyclist experience along River Road;
- Support for amenity upgrades along the dike corridor, including delineated bike lanes, multi-use pathways, benches, washrooms, perimeter dike trail continuity, and traffic calming features;
- Concern regarding the removal of trees and habitat along the dike. Once staff explained how trees in the dike could impact its overall structural integrity, the participants understood why tree removal may be necessary for some situations;
- Concern regarding the uncertainty in sea level rise trends. The participants were assured that the City is continuously monitoring and reviewing the evolving climate change science and adjusting the City's flood protection plans to protect the City well ahead of the sea-level rise;
- Concern regarding New Westminster's dike-raising plans. Staff are coordinating with New Westminster to ensure their dike upgrade plans are in alignment with Richmond's;
- Appreciation for the flood protection public engagement campaign and desire for more similar initiatives in the future;
- Appreciation for all materials available to provide information to residents, including the webpage, online StoryMaps, hand-out flyers, and poster boards; and
- Appreciation for being able to communicate directly with City staff regarding their flood protection concerns.

3.6 Options Evaluation and Selection

The options described in Section 3.4 have been evaluated based on the design considerations and feedback from the stakeholder meetings held to date.

Recommended options have been identified and are described below. Environmental impacts and geotechnical considerations associated with the recommended options are also summarized below.

It is understood that the recommended options will be confirmed through Council and additional stakeholder consultation.

Recommended Options

In general, the recommended option is to separate River Road from the dike, and have both the road and the dike at the dike crest elevation. This is referred to as the "separated dike and road" option and is presented as Option 1 in Section 3.4.

The main features of this option are described below.

- Separate the dike and roadway such that there is an over-wide dike and separate travel areas for vehicles and cyclists/pedestrians.
- Raise the dike crest and road surface to the design dike crest elevation and extend the footprint of fill towards the land-side.
- Retain the land-side toe of the road with retaining walls (e.g. MSE) where necessary (e.g. to minimize impact to North East Bog Forest).
- Fill existing land-side drainage channel and replace with a piped drainage system.
- Modify driveways and access ramps into adjacent properties where reasonable (some constrained areas may require major modifications, redevelopment, or property acquisition).
- Incorporate public space, linear park, and multi-use path features appropriate for a dike crest.
- Install bank protection works on the river-side to match existing (may not be required where the alignment is setback from the river-bank).

The dike portion of the overall crest would be 10 m wide to accommodate future dike raising without having to modify the road. This option is recommended because it is the most robust of the options considered as it produces an earth fill embankment (dike and road) that would be approximately 22 m wide at the crest. This is a significant increase above the standard dike crest width of 4 m and is expected to reduce the likelihood of failure for a variety of processes. Additionally, separating the dike and road would provide several community benefits including improved pedestrian, cyclist, and vehicle safety, and the opportunity for a linear park/multi-use path.

Other options are recommended below in areas which are constrained and do not allow for the separated dike and road option.

- **Riverbank Dike** (Option 4):
  - Use in eastern end of Phase 4 where there is no road associated with the dike.
  - Raise the dike crest to the design height and extend the footprint of fill towards the land-side.
  - Install bank protection works on the river side to match existing.
- **Combined Dike and Road Below Trestle** (Option 6):
  - Use only at the CP rail trestle crossing where there is not enough space for a separated dike and road.
  - There is sufficient clearance to raise the road to the design dike elevation based on discussion with City transportation staff.
  - Install bank protection works on the river side to match existing.
- **Construct Dike Between Tree Island Steel and Hamilton Transit Centre, and Raise Boundary Road** (Option 8):
  - Use to tie-in with the City of New Westminster's portion of the Lulu Island perimeter dike.
  - Use existing right-of-way between Tree Island Steel property (3933 Boundary Road) and the Hamilton Transit Centre (4111 Boundary Road).
  - Raise Boundary Road from Tree Island Steel property towards river bank to tie into City of New Westminster's portion of the Lulu Island perimeter dike.

- Boundary Road raising will require road and possible intersection changes.
- The existing rail spur line servicing Tree Island Steel will need to be addressed (e.g. rail dike gate, raise rail spur, etc.).
- Alternatively, if redevelopment of the Tree Island Steel property occurs during the implementation period of the Dike Master Plan, then the recommended alternative option is raise the property (or a portion of it) to the dike crest elevation as per Option 9.

In addition to the options listed above, another recommendation for flood protection in all areas of Phase 4 is to target land raising of the areas behind the dike.

Table 3-10 below presents a summary of the recommended options for each reach.

Table 3-10: Recommended Dike Upgrading Options

Reach # and Name	Recommended Options
1 – Bridgeport Industrial	• Option 1: Separated dike and road
2 – Industrial and Shipyards	• Option 1: Separated dike and road
3 – Riverfront Houses and ALR	• Option 1: Separated dike and road
4 – Bog and Rail	• Option 1: Separated dike and road[1] *Site specific option at rail trestle crossing:* • Option 6: Combined dike and road below trestle
5 – Hamilton Frontages	• Option 1: Separated dike and road
6 – Tree Island Slough and Boundary	• Option 4: Riverbank dike *Site specific option for tie-in with City of New Westminster dike:* • Option 8: Raise boundary road
1. Retaining walls (Option 2) may be required to minimize impacts to the bog.	

Environmental Impacts of Recommended Options

In total, the estimated impact for the selected Phase 4 options is 3,300 m^2 of high quality Fraser River intertidal habitat, 1,900 m^2 high quality Fraser River riparian habitat, 28,500 m^2 drainage channel aquatic habitat, and 106,200 m^2 drainage channel riparian habitat. These areas represent an estimate based on FREMP habitat mapping (2007), and City of Richmond orthoimagery interpretation (2017). Not all Fraser River riparian and intertidal habitat was quantified. The desktop review only quantified high-quality riparian and intertidal habitat types on the Fraser River side of the existing dike. The remaining habitat area, while not calculated here, would also be required in calculations for determining offsetting requirements. Calculation of the exact area of impact of selected options will require an aquatic habitat survey and aquatic effects assessment.

Table 3-11 presents the summary of habitat impacts for the recommended options by reach.

Table 3-11: Reach-by-Reach Summary of Habitat Impacts

Reach # and Name	High-Quality Fraser River Intertidal (m^2)	High Quality Fraser River Riparian (m^2)	Drainage Channel Aquatic (m^2)	Drainage Channel Riparian (m^2)
1 - Bridgeport Industrial	-	500	3,300	14,800

Reach # and Name	High-Quality Fraser River Intertidal (m²)	High Quality Fraser River Riparian (m²)	Drainage Channel Aquatic (m²)	Drainage Channel Riparian (m²)
2 - Industrial and Shipyards	-	800	5,900	28,000
3 - Riverfront Houses and ALR	50	300	3,000	16,100
4 - Bog and Rail	100	300	10,200	23,500
5 - Hamilton Frontages	900	-	5,900	23,700
6 - Tree Island Slough and Boundary	2,200	-	-	-

Geotechnical Considerations for Recommended Options

The proposed dike improvements were assessed with consideration for the BC Seismic Design Guidelines for Dikes.

Thurber Engineering Ltd. (Thurber) assessed 3 sample cross-sections to estimate the potential deformation resulting from seismic events. The cross-sections were based on the preferred cross-section at what was judged to be the most susceptible areas for deformation. Soil conditions were determined by cone penetration tests. Seismic performance was assessed on the basis of existing foundation conditions, (i.e. no additional ground improvement/densification) to determine the need for ground improvement or alternative approaches. The analysis included seismic events representing 100, 475 and 2475-year return period events. Seismic performance was assessed using 2 methods: 1-D (i.e. flat ground) liquefaction assessment to estimate reconsolidation settlements, and 2-D numerical deformation assessment to estimate dynamic deformations. The methods are complimentary, and the results are interpreted together.

The preliminary geotechnical report is attached in Appendix C.

The key results of the geotechnical analysis are summarized below.

- Proposed dike cross-sections will not meet the performance requirements of the seismic design guidelines, without ground improvement or alternative approaches, based on the results of both assessment methods.
- The liquefaction hazard is considered insignificant for earthquakes up to the 100-year return period event.
- The liquefaction hazard is considered moderate and high for the 475 and 2475-year return period events respectively. The resulting deformations would be large.
- Liquefaction may result in a flowslide into the river for dike alignments along the river-bank due to lateral spreading, whereas it would result only in vertical deformation for dike alignments significantly set back from the river bank.
- The deformation analysis indicates that dikes may meet the performance requirements of the seismic design guidelines if they are typically set back 50 m to 100 m from the river-bank and have flat slopes or some localized ground improvement.

Options to address seismically induced deformations, and opinions on each, include:

- **Densification –** The typical approach to densification is to install stone columns. To be effective against the liquefaction expected to follow the 2475-year return period event, densification would have to extend the depth of the liquefaction zone, and for a similar width. In a typical scenario, this can be considered as a 30 m (width) by 30 m (depth) densification located at the river-side toe of

the dike. Densification can be very costly (e.g. $9,000 to $18,000 per lineal metre of dike). Alternate experimental techniques are being tested by the City that may offer a more economic solution.

- **Higher Crest –** For the 100-year return period event, additional crest elevation may compensate for deformations caused by settlement. For events that cause liquefaction, added height just results in added deformation, so it would be less effective. This is not an effective strategy by itself for return periods above 100-year due to lateral spreading and large vertical deformations.
- **Setback and Slope –** Flatter side slopes on the dike improves seismic stability. However, to prevent large deformations in the 2475-year return period event, the maximum acceptable slope between the river channel invert and the dike crest would need to be approximately 2%, which would require a significant setback between the dike and river.
- **Wide Crest** ("superdikes") **–** A very wide dike (e.g. crest width of 100 m to 200 m) could be used to extend the dike beyond the limit of significant lateral spreading due to liquefaction. A portion of the wide crest could be considered sacrificial in the even to major lateral spreading. Raising the land for approximately 200 m inland of the dike is desirable for related flood protection reasons, and may be desired by the City for other reasons such as land use planning. It has already been done as part of multiple family, commercial, and industrial development projects along the waterfront. Buildings within this area must already account for liquefaction in their foundation design.
- **Dike Relocation / Secondary Dikes –** Place the dike inland of the liquefaction lateral spreading zone (similar to set back approach) or place a secondary dike inland of the liquefaction lateral spreading zone. The wider option above would essentially include a secondary dike. Relocating the primary dike inland would be a form of retreat and would leave property and buildings exposed outside of the dike.
- **Post-earthquake Dike Repair –** Dike reach specific plans could be developed for post-earthquake dike repairs. These would need to consider the feasibility of dike repair construction following a major earthquake. In general, it is likely not feasible to quickly repair a dike that has failed due to a flowslide induced by liquefaction lateral spreading, especially if the breach results flooding from regular high tides. However, it may be feasible to prepare dike repair plans for dikes where a flowslide is not anticipated.

Additionally, the City may wish to use alternative seismic performance criteria, such as the criteria discussed in Section 3.2 which aims to develop a consistent level of performance between seismic scenarios and flood level scenarios (i.e. an overall 0.2% annual exceedance probability of failure across all hazards).

Recommendations to manage the seismic risk include:

- Consider the proposed alternative seismic performance criteria provided in Section 3.2. Review the criteria if/when the Province issues updated guidelines for seismic performance of dikes.
- Fill land for approximately 200 m inland of the dike to dike crest elevation. Buildings in this zone should be built above the dike crest elevation and have densified foundations capable of withstanding liquefaction. The required distance requires some additional evaluation and may be addressed in the pending updated to the Flood Protection Management Strategy.
- Continue to investigate practical densification options and consider earthquake induced dike deformations in emergency response and recovery planning.

3.7 Cost Opinions

Cost opinions for the recommended option in each reach are provided to help the City consider the financial implications for planning and comparing options. A breakdown is provided to help understand the proportional cost for recommendations such as separating and raising the road.

Costs are based on unit rate cost estimates and tender results for similar works. Costs are presented in 2018 dollars. They have not been updated between the original draft submission in 2018 and the current final report. The most relevant rates are from the City's Gilbert Road dike project. The City provided a summary of the cost estimate prepared by WSP for this project.

Rates from recent tenders for diking on the Lower Fraser River and other locations within the Lower Mainland were used to check the reasonableness of the rates and estimate other features such as sheet piles or large diameter drain pipes.

The costs were broken down by reach so that unit rates could be applied to similar typical cross-sections. They were also broken down into the main features that coincide with options that the City may wish to consider further. These features are described below.

- **Dike Raising –** this is the core element required to provide flood protection. It includes a 10 m crest width that can be raised while still achieving a 4 m crest width. This includes site preparation, fill, and erosion protection.
- **Road Structure and Utilities –** this includes stripping, subgrade preparation, pavement structure, drainage and utilities. Where the existing road is atop the dike, most of this cost would be incurred regardless of where it gets relocated.
- **Road Raising To Dike Crest –** this includes the additional fill required to raise the road to the dike crest elevation.
- **Other –**This category was used to capture pathways and utilities if the option did not include road construction.
- **Contingency –** A 40% contingency is provided because the costs are based on concept plans only.

Table 3-12 presents a summary of all reaches with cost breakdowns for the items described above. Costs for each reach are also provided in the Reach Summary Sheets in Section 5.

Table 3-12: Summary of Construction Costs ($ in Millions)

Item	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Total
Dike Raising	$7.6	$7.7	$4.1	$10.5	$7.3	$4.7	$41.9
Road Structure & Utilities	$12.3	$12.6	$6.6	$16.8	$11.8	$1.5	$61.4
Raise Road to Dike Height	$3.2	$3.3	$1.7	$4.3	$3.1	$1.6	$17.2
Other*	$1.5	$2.0	$1.1	$2.0	$1.5	$4.6	$12.8
Contingency (40%)	$9.8	$10.2	$5.4	$13.5	$9.5	$5.0	$53.3
Total	$34.3	$35.8	$18.9	$47.1	$33.1	$17.4	$186.6
*Other - includes utilities if there is no road							

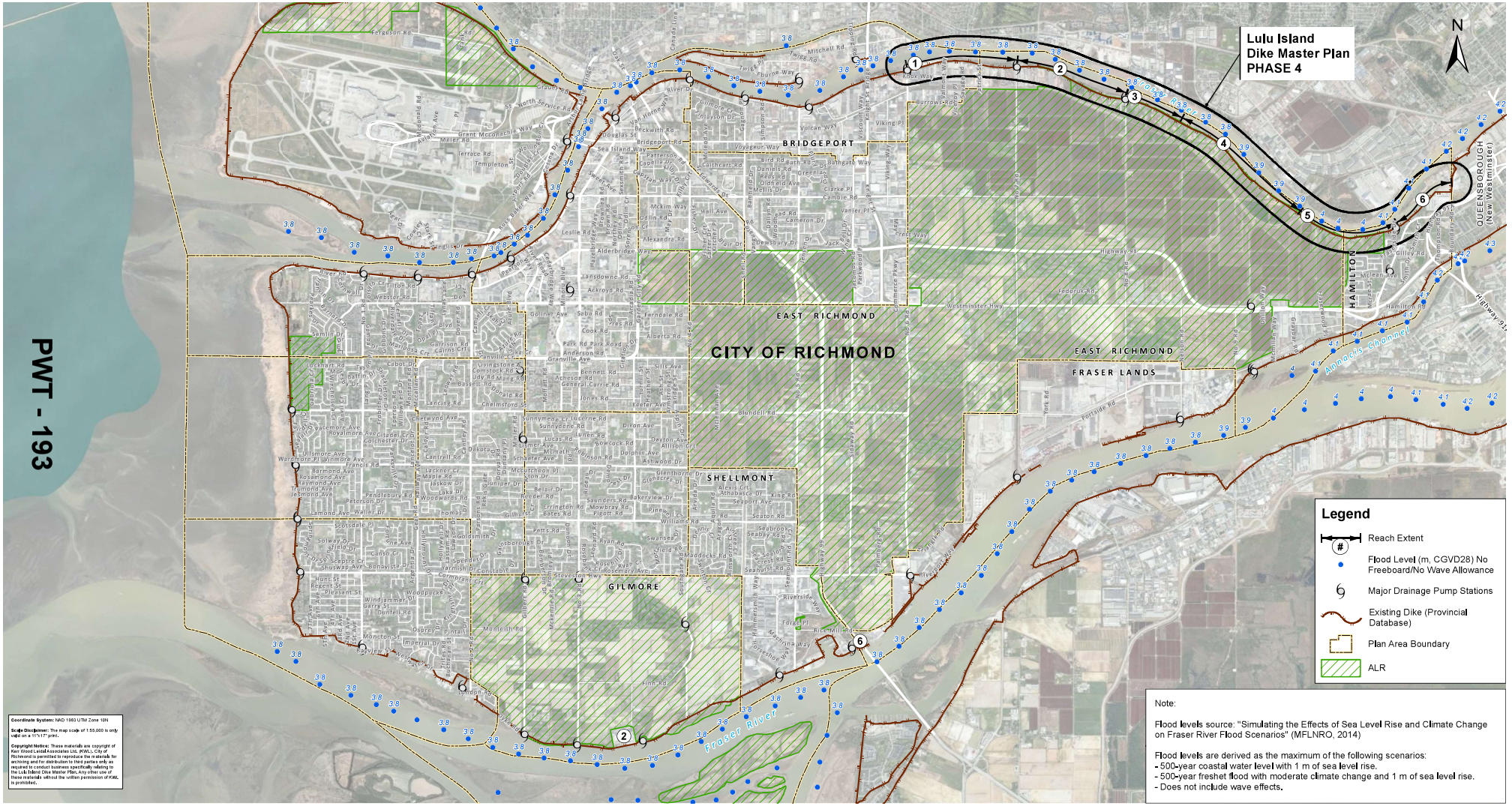
Costs that are not included are noted below.

- Land acquisition is not included. Ideally, land will be acquired during redevelopment. Similarly, there may be opportunities to have dike improvements tied to adjacent development.
- Densification is not included. The recommendation is to fill 200 m back from the dike face as a preferred strategy to deal with liquefaction. If the road and land behind the dike is not raised, then densification is recommended. Current techniques such as stone columns would cost approximately $9,000 to $18,000 per metre of dike.
- Off-site habitat projects (that may be needed beyond the habitat enhancement provided along the dike corridor) are not included. Such cost could be roughly 5% of the construction cost. It is understood that a separate Dike Master Plan may be prepared to address habitat compensation by identifying and developing medium to large habitat compensation concepts.
- Raising the land behind the dike is not included. This is proposed to be a condition of development behind the dike, with the cost and benefit attributed to the property owner.
- Professional fees (engineering, surveying, environmental, archeological, etc.) are not included. Such costs could be in the range of 10% to 15% of the construction cost.
- Inflation since 2018.

Path: P:\0600-0699\651-122\430-GIS\MXD-Rp\Phase4\651122_Phase4_Fig3-1_FraserRiverFloodElevations.mxd Date Saved: 4/25/2023 9:16:44 PM | Author: JLau

City of Richmond
Lulu Island Dike Master Plan - Phase 4

KERR WOOD LEIDAL consulting engineers



Note:

Flood levels source: "Simulating the Effects of Sea Level Rise and Climate Change on Fraser River Flood Scenarios" (MFLNRO, 2014)

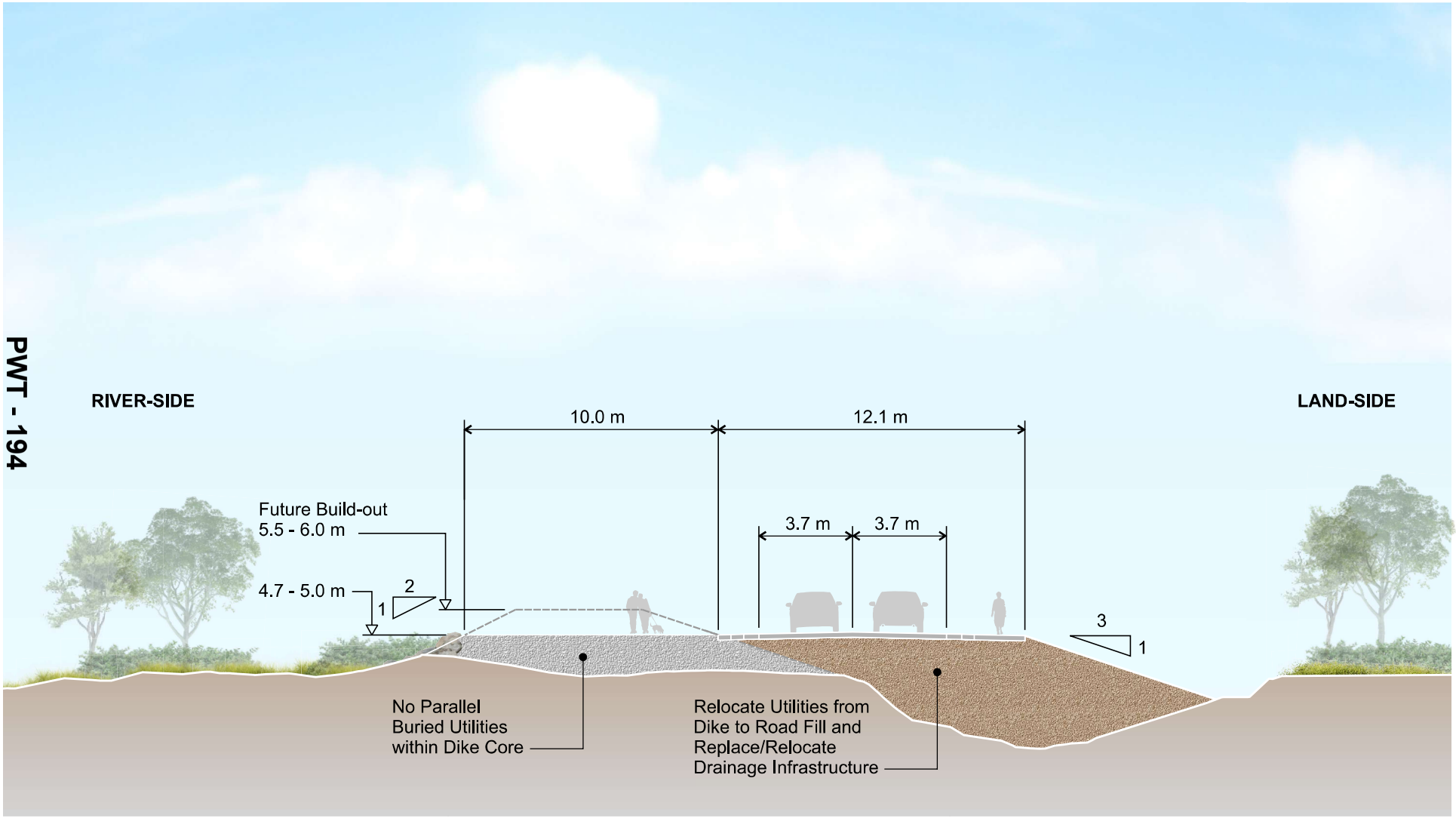
Flood levels are derived as the maximum of the following scenarios:
- 500-year coastal water level with 1 m of sea level rise.
- 500-year freshet flood with moderate climate change and 1 m of sea level rise.
- Does not include wave effects.

Project No.	651-122
Date	April 2023
Scale	1:55,000

1,000 500 0 1,000 m

Fraser River Flood Elevations

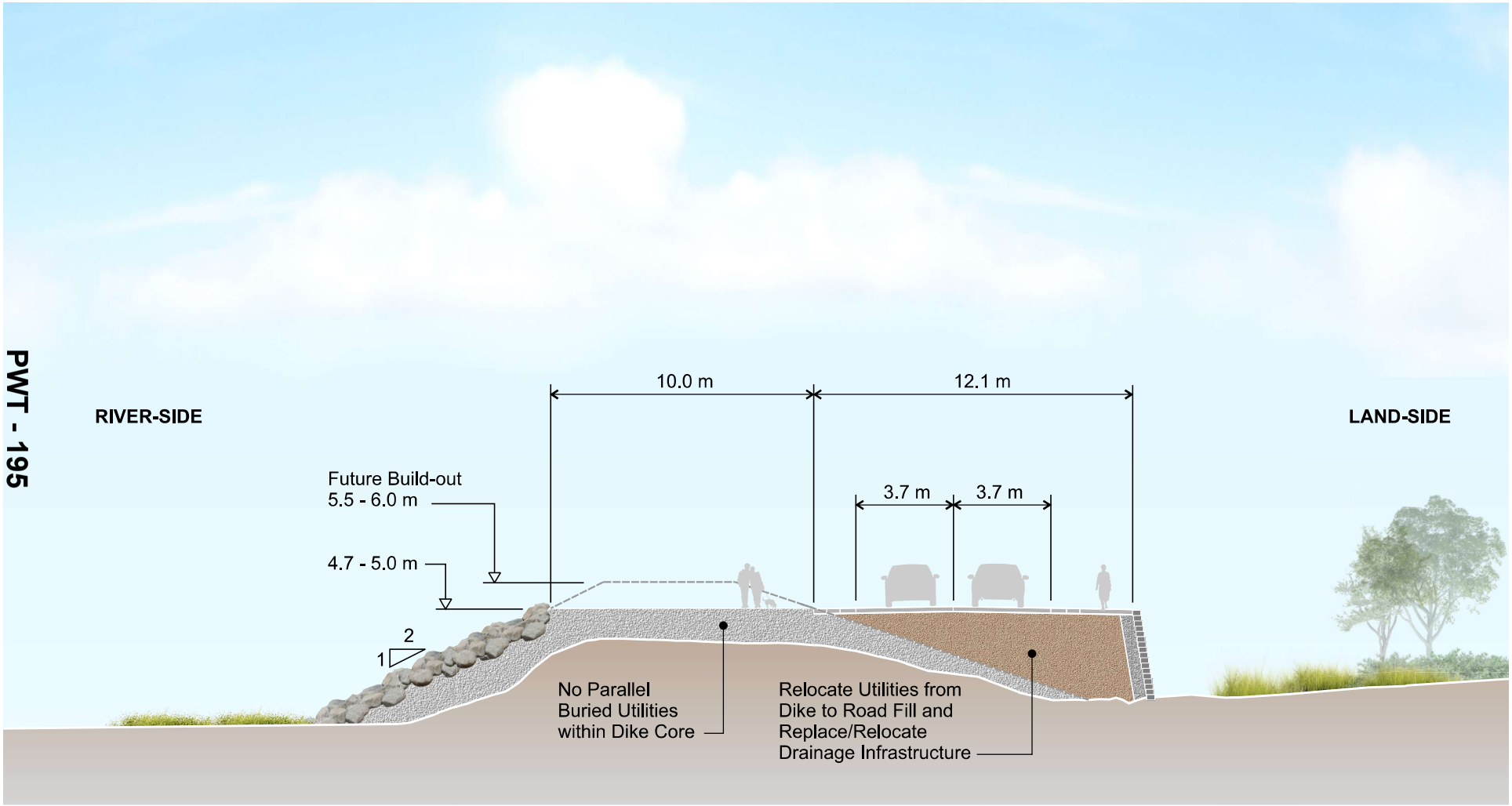
Figure 3-1



Project No.	651.122
Date	April, 2023
Scale	Not to Scale

Option 1: Raise Dike and Road and Extend Land-side (Reaches 1-5)

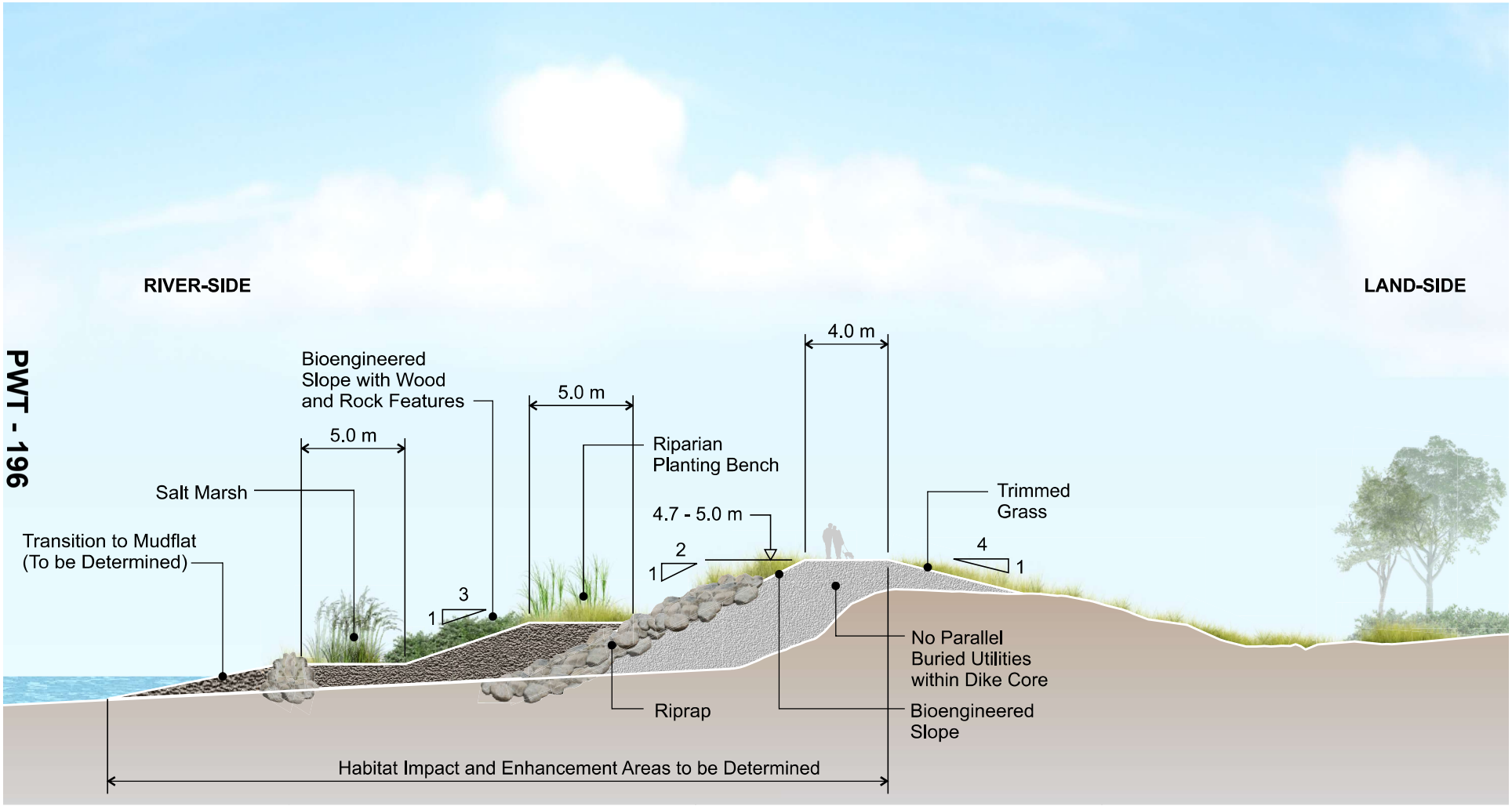
Figure 3-2



Project No.	651.122
Date	April, 2023
Scale	Not to Scale

Option 2: Raise Dike and Road with Retaining Walls (Reach 4)

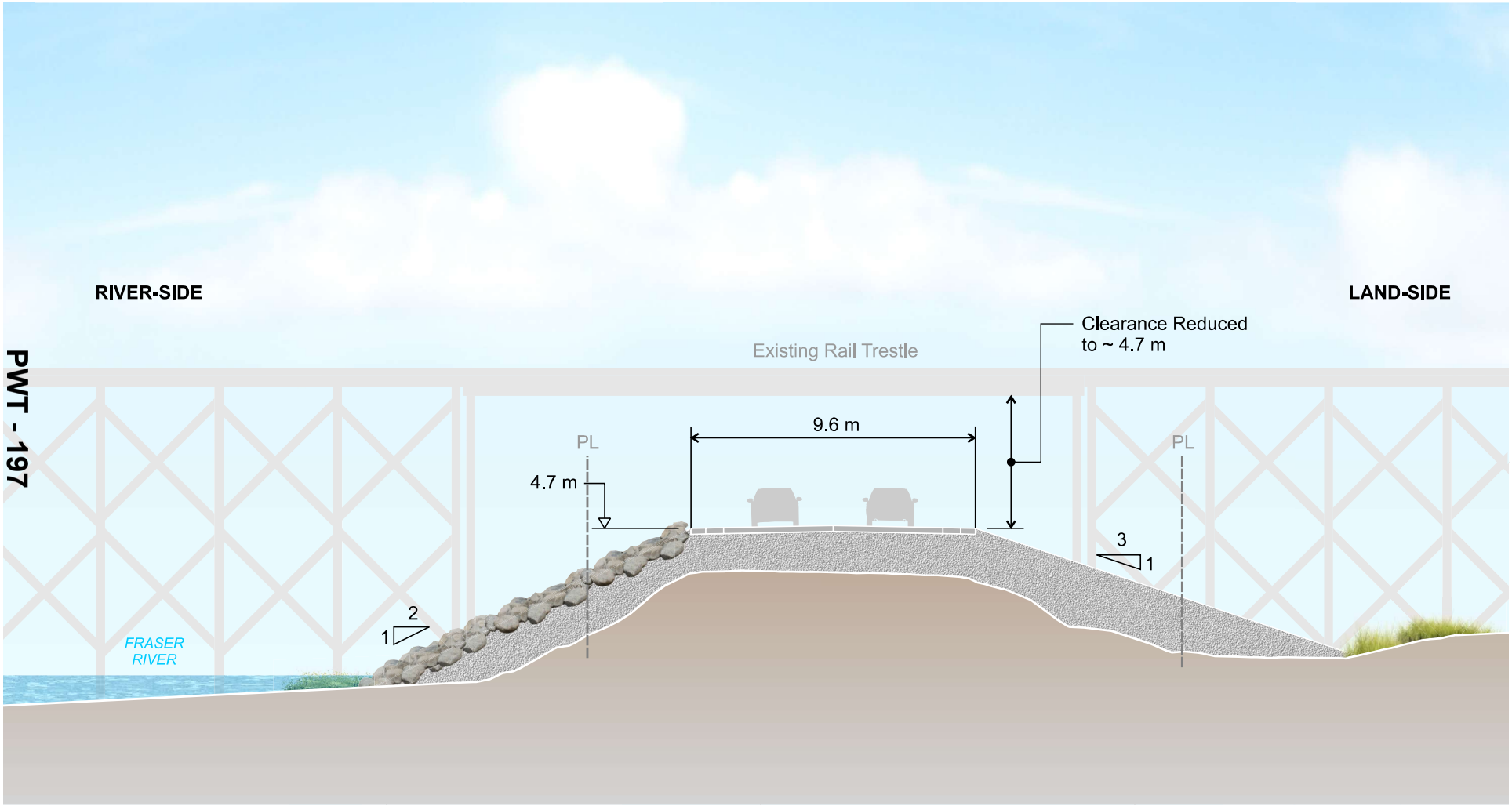
Figure 3-3



Project No.	651.122
Date	April, 2023
Scale	Not to Scale

Option 3: Raise Dike Only and Extend River-side (Reaches 4-6)

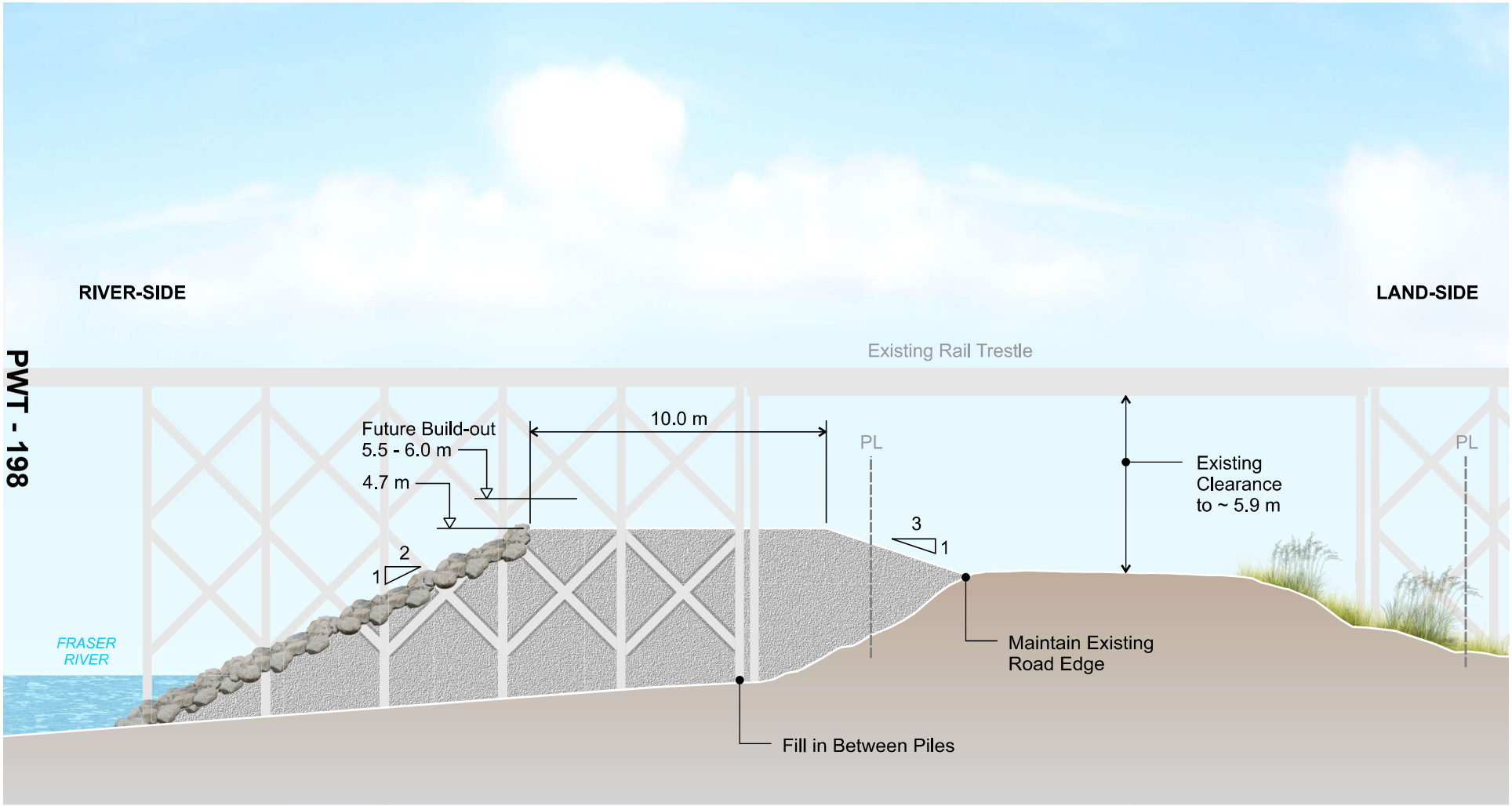
Figure 3-4



Project No.	651.122
Date	April, 2023
Scale	Not to Scale

Option 6: Rail Trestle - Raise Road/Dike Under Trestle (Reach 4)

Figure 3-5



Project No.	651.122
Date	April, 2023
Scale	Not to Scale

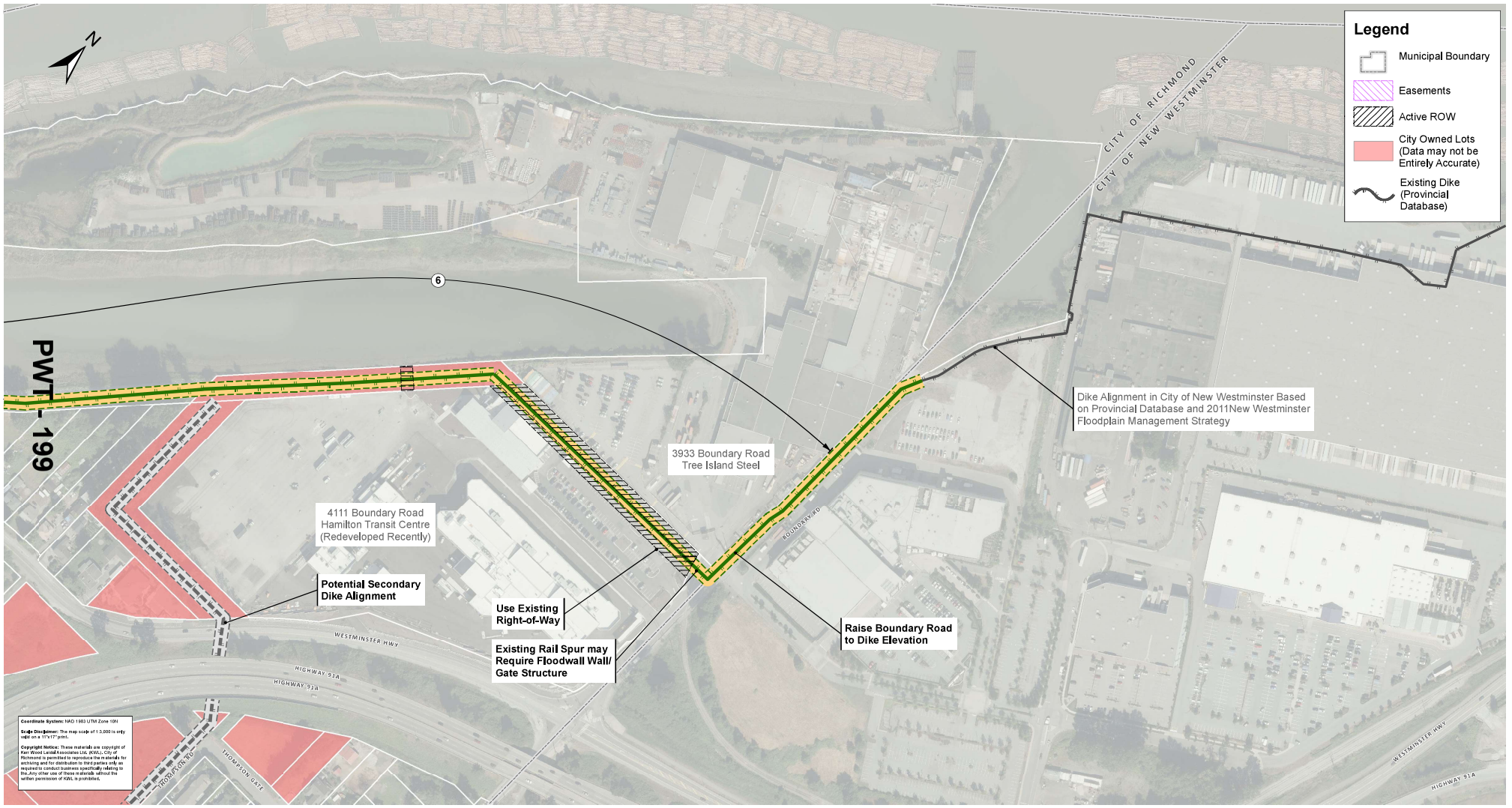
Option 7: Rail Trestle - Fill In-between Trestle Pile (Reach 4)

Figure 3-6

Path: P:\0600-0699\651-122\430-GIS\MXD-Rp\Phase4\651122_Phase4_Fig3-7_EastEndTieinOptions_RaiseBoundaryRoad.mxd Date Saved: 4/25/2023 9:20:26 PM | Author: JLau

City of Richmond
Lulu Island Dike Master Plan Phase 4

KERR WOOD LEIDAL consulting engineers



Project No. 651.122
Date April 2023
Scale 1:3,000

50 25 0 50 m

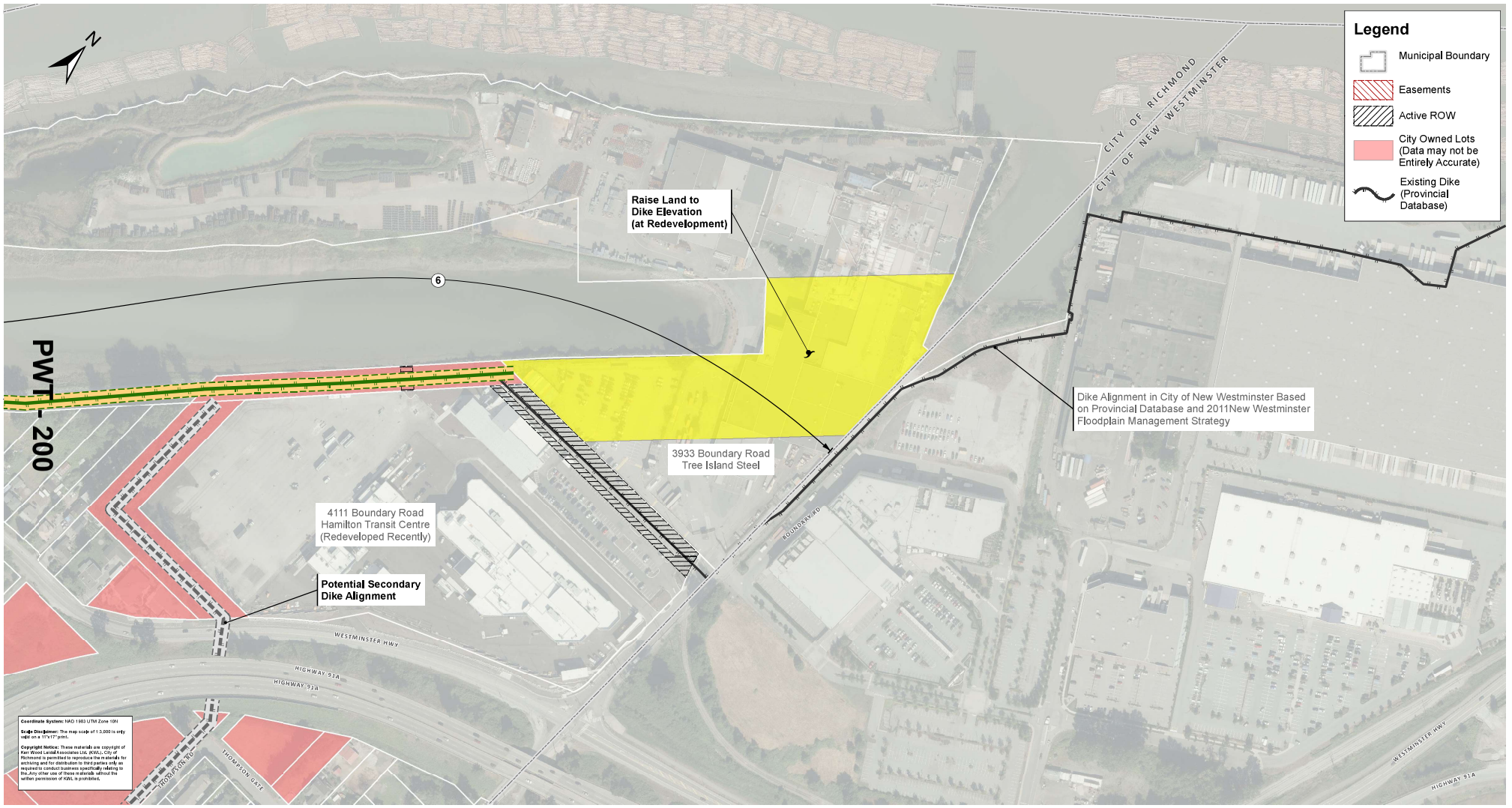
Option 8 - City of New Westminster Tie-in
Raise Boundary Road

Figure 3-7

Path: P:\0600-0699\651-122\430-GIS\MXD-Rp\Phase4\651122_Phase4_Fig3-8_EastEndTieinOptions_FillTreeIsland.mxd Date Saved: 4/25/2023 9:24:23 PM | Author: JLau

City of Richmond
Lulu Island Dike Master Plan Phase 4

KERR WOOD LEIDAL consulting engineers



Project No. 651.122
Date April 2023
Scale 1:3,000

50 25 0 50 m

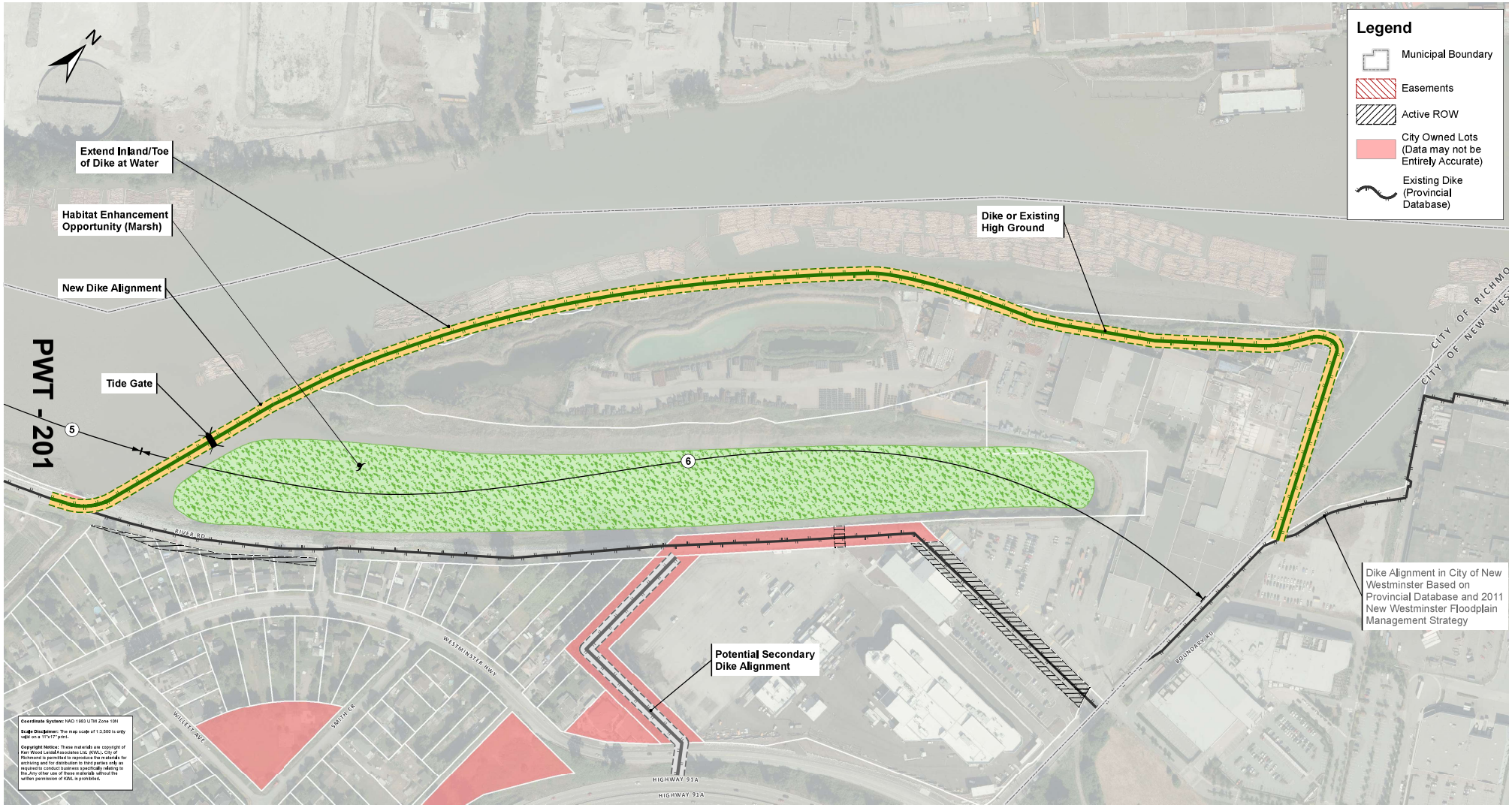
Option 9 - City of New Westminster Tie-in
Fill Tree Island Steel Property

Figure 3-8

Path: P:\0600-0699\651-122\430-GIS\MXD-Rp\Phase4\651122_Phase4_Fig3-9_EastEndTieinOptions_NewAlignment.mxd Date Saved: 4/25/2023 9:27:57 PM | Author: JLau

City of Richmond
Lulu Island Dike Master Plan Phase 4

KERR WOOD LEIDAL consulting engineers



Project No.	651.122
Date	April 2023
Scale	1:3,500

50 25 0 50 m

Option 10 - City of New Westminster Tie-in New Alignment Across Tree Island Slough

Figure 3-9

4. Implementation Strategy

The implementation strategy has three parts:

- pre-design measures;
- construction sequencing for a typical reach; and
- prioritization of reaches for construction.

4.1 Pre-design Measures

Before construction can be implemented, the following steps are recommended.

- Use the Dike Master Plan as a planning tool with City land use planning to acquire land during redevelopment, and to rezone land with conditions for land raising inland of the dike.
- Acquire land prior to construction.
- Seek habitat compensation projects to bank credits in preparation for drainage channel and associated riparian area impacts. A separate mater plan for habitat compensation could be prepared to identify and develop medium to large habitat enhancement concepts to serve as compensation for multiple reaches.
- Assess required drainage system modifications (e.g. filling drainage channels and constructing a piped drainage system) in additional detail.
- Design with consideration for construction sequencing noted below.
- Advance public space and multi-use path design concepts further.
- Consider the need for an appropriate building setback from the land-side toe of any future flood protection works in view of the current BC setback guideline of 7.5 m. This should consider the planned dike upgrade to 4.7 m CGVD28, as well as future buildout to 5.5 m CGVD28. This may require consultation with the Inspector of Dikes.

4.2 Construction Sequence

The construction sequence for a typical reach is provided below. A typical reach currently has a road atop the dike, and utilities within the dike.

1. Secure land.
2. Coordinate third party utility relocations. This is mainly hydro on poles. Coordination with rail needed at trestle.
3. Install storm sewer (approximately 1200 mm dia., to be confirmed through at design) in proximity to existing channel.
4. Fill over storm sewer to underside of road structure. The fill placement may be followed by a settlement period depending on geotechnical recommendations. If so, this fill may include a preload depth in excess of the road fill.
5. Install new utilities (typically water and hydro, with some sewer).
6. Construct new road with parking where access outside the dike will be impacted.

7. Divert traffic to new road.
8. Remove existing road and utilities. Don't abandon utilities within dike.
9. Fill dike to crest elevation. Excavation of sub-grade may be required to remove unsuitable materials.
10. Complete armouring, trail, and landscaping.

Larger projects will result in less temporary road diversion works. As an alternate, the entire road could be reconstructed first, in phases, before the dike is built later. This would work with the new road being raised to dike crest elevation.

4.3 Prioritization

Priority for construction will depend on which section is the lowest and therefore most urgent to raise, opportunities such as site development or road improvement plans, level of preparedness for issues such as land acquisition and habitat offsets, and adjacent residents' receptiveness to a higher dike. A preliminary priority list is provided below. Opportunities may shift the order, and the reaches may be broken down into smaller or larger projects.

Table 4-1: Priority by Reach

	Reach ID and Name	Extent / Length	Notes
1	3 – Riverfront Houses and ALR	No. 8 Road to Nelson Road	• Low section and road safety issues.
2	4 – Bog and Rail	Nelson Road to Rail Trestle	• Low section and road safety issues. Rail coordination takes time.
3	5 – Hamilton Frontages	Rail Trestle to Queens Road	• Relatively straightforward.
4	2 – Industrial and Shipyards	No. 7 Road to No. 8 Road	• Seek redevelopment opportunities for land acquisition and to resolve access issues.
5	1 – Bridgeport Industrial	No. 6 Road to No. 7 Road	• Seek redevelopment opportunities for land acquisition and to resolve access issues.
6	6 – Tree Island Slough and Boundary	Queens Road to City of New Westminster	• Coordinate with planned park, road realignment, and redevelopment. Seek revised alignment with Tree Island Steel site, and further investigate Tree Island Slough habitat enhancement.

5. Reach Summary Sheets

This section contains 2-page, reach-by-reach summary sheets that summarize the existing conditions, design considerations and potential constraints for each reach of Phase 4. The second sheet will summarize the features of the master plan through each reach including typical cross-sections, plan features, costs and priority for upgrade.

Reach 1: Bridgeport Industrial

Existing Conditions

The existing dike in this reach is located in River Road. A watermain and overhead utilities run along the southern portion of the road.

This reach has wide vegetated channels on the inland side of the dike, and a wide vegetated riparian zone on the riverside.

Industrial lots and associated infrastructure exist throughout the reach, including warehouses and container storage.

No. 6 Road is the tie-in location with Phase 2 of the Dike Master Plan, and is also a potential tie-in location for the proposed mid-island dike.

Unique Features

- Drainage pump station at No. 6 Road.
- Industrial sites with water access north of River Road (e.g. Mainland Sand and Gravel).
- FortisBC gas pipeline river crossing and facility west of No. 7 Road.
- Drainage channel and pipe south of road.
- Riparian area north of road.
- Potential future tie-in location with proposed mid-island dike.

Considerations

Flood Protection

- Dike alignment
- Dike crest elevation
- Erosion protection
- Seismic performance
- Static stability and seepage
- River toe stability and setbacks
- Boat waves

Industrial

- Water access industrial sites north of road/dike
- Road design and driveway grade to accommodate large trucks

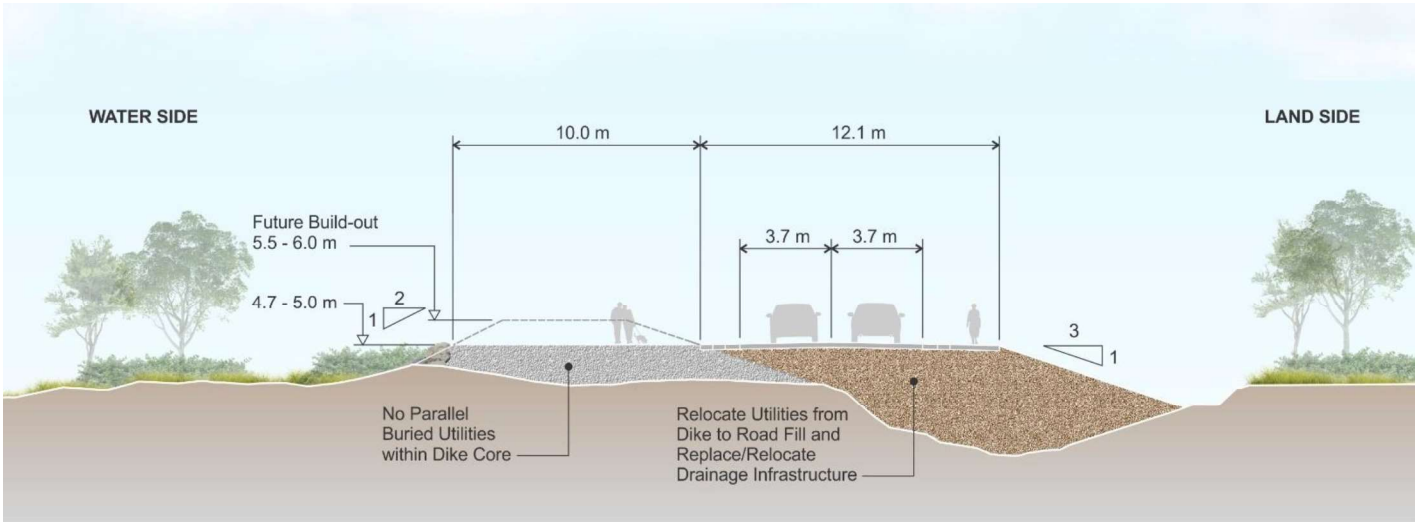
Social

- No. 7 Road Pier Park
- Align with 2009 Waterfront Strategy
- Connect to existing and planned trails and public amenities
- Wayfinding and public information signs

Environmental

- Fraser River side habitat includes high quality intertidal habitat and high quality riparian habitat
- Land side includes drainage channels adjacent to dike
- No. 7 Road Pier Park

Reach 1: Bridgeport Industrial - Recommended Improvements



Master Plan Features

Flood Protection

Raise dike to 4.7 m and separate and raise road inland of the dike as illustrated above.

Dike alignment will typically extend up from the current face of dike, and widen inland.

Provide erosion protection along the face of the dike, typically consisting of rip rap revetment.

Raise properties 200 m inland to 4.7 m or densify to the depth of potential liquefaction.

Replace channels with storm sewers and swales to improve stability and reduce seepage.

Industrial

Raise road to dike crest elevation to permit access over tide to industrial sites north of dike.

Raise industrial sites to dike crest elevation during redevelopment.

For lower sites, driveway ramps may need to extend into lots with grades that accommodate large trucks. Ramps may require retaining walls to limit footprint.

Social

Construct multi-use path on top of dike, separate from road. Link to parks, trails, public amenities, and wayfinding.

Environmental

The proposed footprint would impact an estimated 500 m^2 of high quality Fraser River riparian habitat, 14,800 m^2 of drainage channel riparian habitat, and 3,300 m^2 of drainage channel aquatic habitat

NOTE: This is an estimate based on 2007 FREMP mapping and 2017 orthoimagery interpretation. Exact numbers will require an aquatic habitat survey and aquatic effects assessment

Priority

Priority is ranked 5th out of 6 reaches.

This is one of the lower priority reaches due to relatively good existing height, and benefits to coordinating with future land redevelopment. The dike is at a higher elevation than the high priority reaches. Required land may be secured through redevelopment opportunities. Land raising during redevelopment will also reduce the width required for dike and road work, and the need for interim access ramps.

Construction Cost

Costs below are for 1.7 km of dike similar to cross-section above.

Item	Cost per metre	Cost
Dike Raising	$4,500	$7.6 Million
Road Structure & Utilities	$5,300	$8.9 Million
Raise Road to Dike Height	$1,900	$3.2 Million
Pathway	$600	$1 Million
Other (Driveways, Ramps or Road Reconstruction)		$.5 Million
Utilities (Drainage, Water)	$2,000	$3.3 Million
Contingency (40%)		$9.8 Million
Total		$34.3 Million

Cost opinions are in 2018 Canadian Dollars.

Reach 2: Industrial and Shipyards

Existing Conditions

The existing dike alignment in this reach is a dike in River Road. This reach has industrial lots, shipyards and a narrow riparian strip on the water side of the dike.

The inland side of the dike has access to industrial lots and residential lots to the east side of the reach.

Currently, there is parking along the dike for the shipyard employees.

Unique Features

- Water-oriented industrial parcels located north of road (tugboat operation and Tom-Mac Shipyards).
- Residential/storage properties located north of road with minimal setback between road and structures.
- Large industrial parcels located south of road near No. 7 Road.
- ALR parcels with houses located south of road.
- Drainage pump station at No. 8 Road.

Considerations

Flood Protection

- Dike alignment
- Dike crest elevation
- Erosion protection
- Seismic performance
- Static stability and seepage
- River toe stability and setbacks
- Boat waves

Industrial

- Water access for tugboats, and shipyards.
- Road design and driveway grade to accommodate large trucks
- Drainage pump station at No. 8 Road
- Parking for shipyards is along River Road

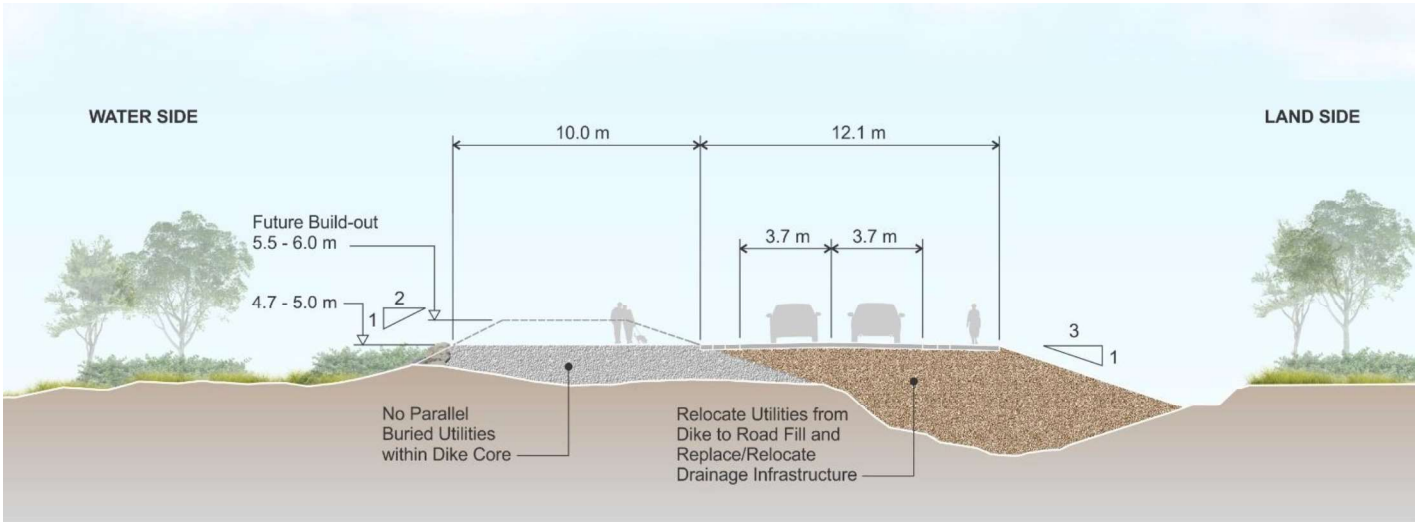
Social

- Align with 2009 Waterfront Strategy
- Connect to existing and planned trails and public amenities
- Wayfinding and public information signs

Environmental

- Fraser River side habitat includes narrow deciduous treed woodland high-quality habitat
- Western portion of Land side includes drainage channels adjacent to dike; eastern portion of land side has trees/hedges along residential lots

Reach 2: Industrial and Shipyards - Recommended Improvements



Master Plan Features

Flood Protection

Raise dike to 4.7 m and separate and raise road inland of the dike as illustrated above.

Dike alignment will typically extend up from the current face of dike, and widen inland.

Provide erosion protection along the face of the dike, typically consisting of rip rap revetment.

Raise properties 200 m inland to 4.7 m or densify to the depth of potential liquefaction.

Replace channels with storm sewers and swales to improve stability and reduce seepage.

Industrial

Raise road to dike crest elevation to permit access over tide to industrial sites north of dike.

Raise industrial sites to dike crest elevation during redevelopment.

For lower sites, driveway ramps may need to extend into lots with grades that accommodate large trucks.

Social

Construct multi-use path along dike, separate from road. Link to parks, trails, public amenities, and wayfinding.

Environmental

The proposed footprint would impact an estimated 800 m^2 of high quality Fraser River riparian habitat, 28,000 m^2 of drainage channel riparian habitat, and 5,900 m^2 of drainage channel aquatic habitat

NOTE: This is an estimate based on 2007 FREMP mapping and 2017 orthoimagery interpretation. Exact numbers will require an aquatic habitat survey and aquatic effects assessment

Priority

Priority is ranked 4th out of 6 reaches.

This is one of the lower priority reaches due to relatively good existing height, and benefits to coordinating with future land redevelopment. The dike is at a higher elevation than the high priority reaches. Required land may be secured through redevelopment opportunities. The adjacent industrial land is less developed than Reach 1, so opportunities for land acquisition and land raising through redevelopment may arise earlier than for Reach 1. Land raising during redevelopment will also reduce the width required for dike and road work, and the need for interim access ramps.

Construction Cost

Costs below are for 1.7 km of dike similar to cross-section above.

Item	Cost per metre	Cost
Dike Raising	$4,500	$7.7 Million
Road Structure & Utilities	$5,300	$9.1 Million
Raise Road to Dike Height	$1,900	$3.3 Million
Pathway	$600	$1 Million
Other (Driveways, Ramps or Road Reconstruction)		$1 Million
Utilities (Drainage, Water)	$2,000	$3.4 Million
Contingency (40%)		$10.2 Million
Total		$35.8 Million

Cost opinions are in 2018 Canadian Dollars.

Reach 3: Riverfront Houses and ALR

Existing Conditions

The dike in this reach is a dike in River Road, with a combination of residential and industrial lots on either side of the dike.

The inland side of the dike has large residential lots separated from the road by a large channel and hedges. The water side of this reach has access to docks, storage, drainage pump station.

There is a major Metro Vancouver pipe river crossing in this reach.

Unique Features

- Residential/storage properties located north of road with minimal setback between road and structures near Nelson Road.
- ALR parcels with houses located south of road.
- Metro Vancouver Tilbury watermain crossing near Nelson Road.

Considerations

Flood Protection

- Dike alignment
- Dike crest elevation
- Erosion protection
- Seismic performance
- Static stability and seepage
- River toe stability and setbacks
- Boat waves

Industrial

- Drainage pump station at east side of the reach
- Storage and water access on the north side of River Road
- Metro Vancouver watermain crossing
- Road design and driveway grade to accommodate large trucks

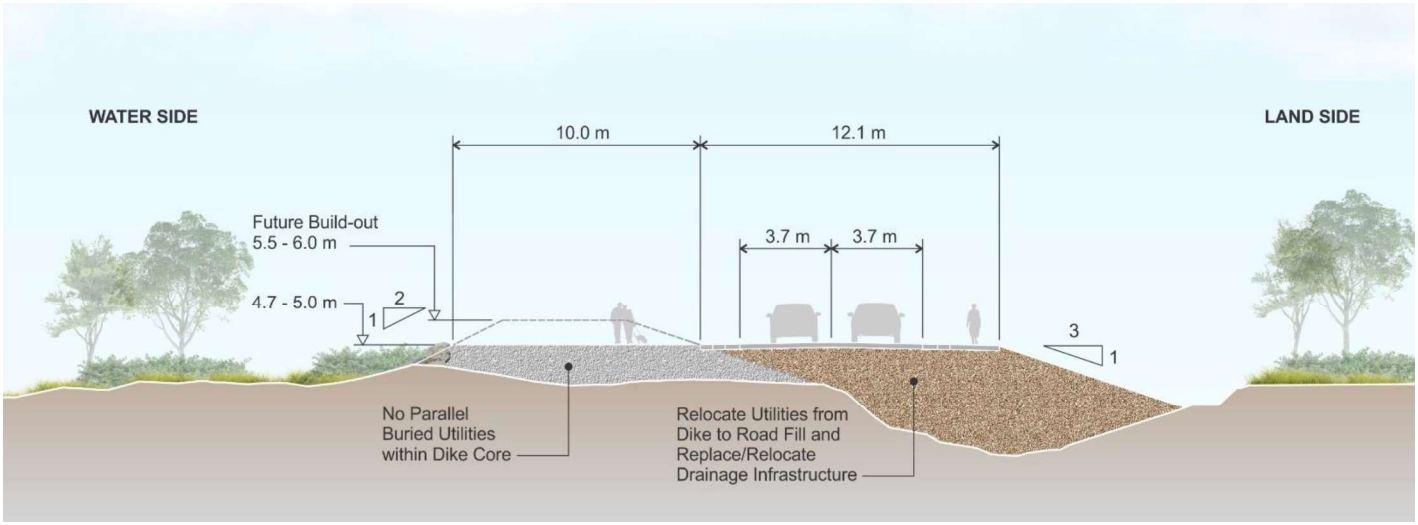
Social

- Align with 2009 Waterfront Strategy
- Connect to existing and planned trails and public amenities
- Wayfinding and public information signs

Environmental

- Fraser River Side habitat includes narrow deciduous treed woodland high-quality habitat along the 75% of the reach
- Land side has tree/hedges along residential lots and drainage channels

Reach 3: Riverfront Houses and ALR - Recommended Improvements



Master Plan Features

Flood Protection

Raise dike to 4.7 m and separate and raise road inland of the dike as illustrated above.

Dike alignment will typically extend up from the current face of dike, and widen inland.

Provide erosion protection along the face of the dike, typically consisting of rip rap revetment.

Raise properties 200m inland to 4.7m or densify to the depth of potential liquefaction.

Replace channels with storm sewers and swales to improve stability and reduce seepage.

Industrial

Raise road to dike crest elevation to permit access over tide to properties north of dike.

Parking for properties north of dike to be provided at side of road, or with driveways and ramps or raised parking on private property.

Social

Construct multi-use path along dike, separate from road. Link to parks, trails, public amenities, and wayfinding.

Environmental

The proposed footprint would impact an estimated 300 m^2 of high quality Fraser River riparian habitat, 50 m^2 of high quality Fraser River intertidal habitat, 16,100 m^2 of drainage channel riparian habitat, and 3,000 m^2 drainage channel aquatic habitat

NOTE: This is an estimate based on 2007 FREMP mapping and 2017 orthoimagery interpretation. Exact numbers will require an aquatic habitat survey and aquatic effects assessment

Priority

Priority is ranked 1st out of 6 reaches.

This is highest ranked priority due to low crest elevations and road safety issues.

Land acquisition may be required, but the large agricultural/residential lots typically include adequate setbacks to provide enough space without redevelopment.

Land raising during redevelopment will also reduce the width required for dike and road work, and the need for interim access ramps.

Construction Cost

Costs below are for 0.9 km of dike similar to cross-section above.

Item	Cost per metre	Cost
Dike Raising	$4,500	$4 Million
Road Structure & Utilities	$5,300	$4.8 Million
Raise Road to Dike Height	$1,900	$1.7 Million
Pathway	$600	$.5 Million
Other (Driveways, Ramps or Road Reconstruction)		$.6 Million
Utilities (Drainage, Water)	$2,000	$1.8 Million
Contingency (40%)		$5.4 Million
Total		$18.9 Million

Cost opinions are in 2018 Canadian Dollars.

Reach 4: Bog and Rail

Existing Conditions

The dike in this reach is within River Road.

There are environmental and agricultural constraints along either side of the dike. Outside of the dike on the riverside, there is a narrow strip of riparian zone and riprap along the Fraser River.

Informal agricultural (cranberry) dikes are located along the south edge of the road/dike. The drainage channel in this reach is very wide.

The North East Bog Forest is a city park/conservation area located south of the road/dike.

The east side of the reach includes a rail trestle bridge that crosses the dike and Fraser River.

Unique Features

- ALR parcels with cranberry farms south of road.
- Very large agricultural channel south of dike.
- North East Bog Forest (City park).
- Rail trestle river crossing.
- No space between road edge and river channel (existing riprap bank protection).

Considerations

Flood Protection

- Dike alignment
- Dike crest elevation
- Erosion protection
- Seismic performance
- Static stability and seepage
- River toe stability and setbacks
- Boat waves
- Soft soils (bog)

Industrial

- Water access and parking for docks.
- Road and Driveway access will need to be regraded.
- Train rail trestle located at east side of reach.
- Farm dike on the inside of the current dike.

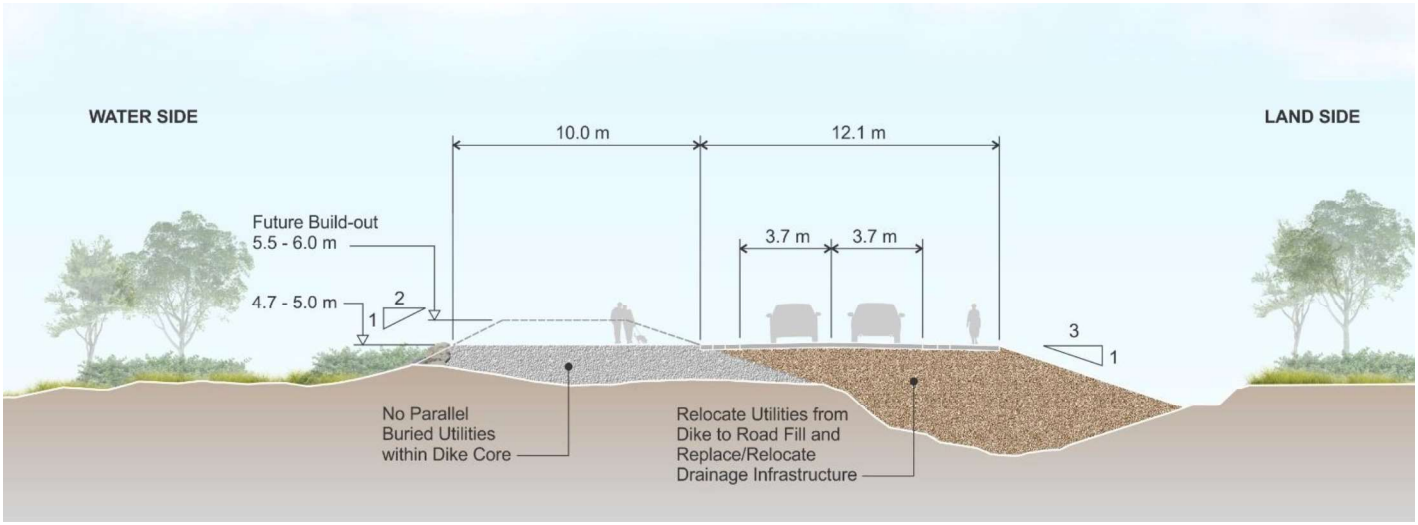
Social

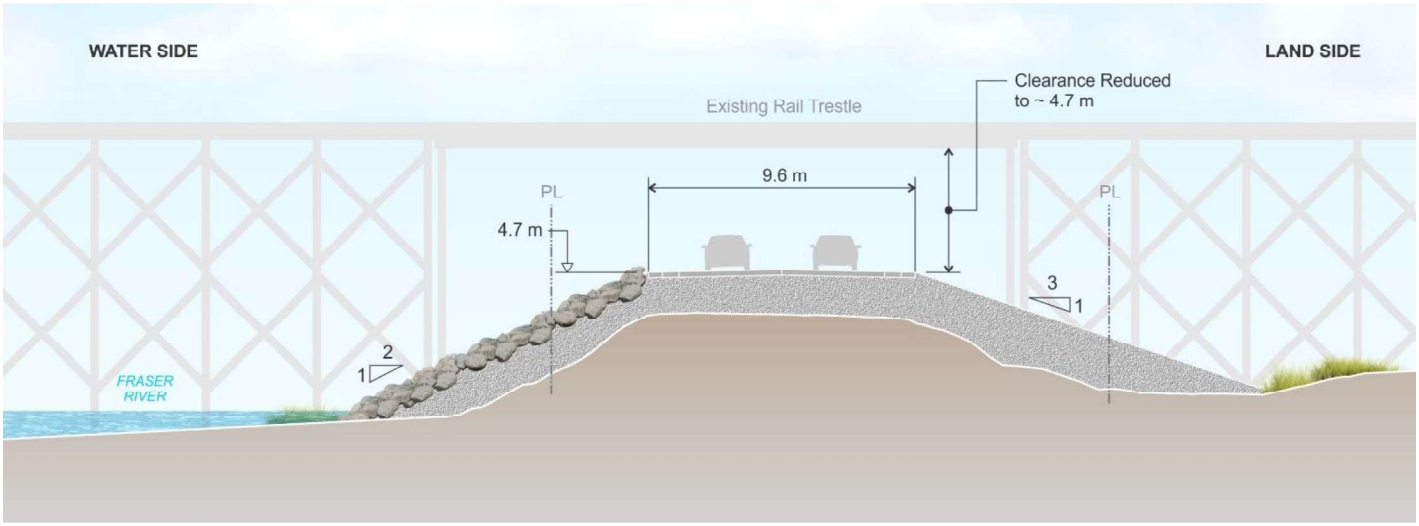
- North East Bog Forest
- Align with 2009 Waterfront Strategy
- Connect to existing and planned trails and public amenities
- Wayfinding and public information signs

Environmental

- Fraser River side habitat includes narrow low-brush riparian zone on ½ of reach
- Land side includes drainage channels adjacent to and North East Bog Forest at eastern end of the reach

Reach 4: Bog and Rail - Recommended Improvements





Master Plan Features

Flood Protection

Raise dike to 4.7 m and separate and raise road inland of the dike as illustrated above.

Dike alignment will typically shift into the river, with some widening inland.

Provide erosion protection along the face of the dike, typically consisting of rip rap revetment.

Industrial

Coordinate work around rail trestle with rail company.

Social

Construct multi-use path along dike, separate from road. Link to parks, trails, public amenities, and wayfinding, per Lululoop concept developed in Phase 3. Ensure barriers are in place where the road and path narrow into closer proximity at the rail trestle.

Environmental

The proposed footprint would impact an estimated 300 m^2 of high quality Fraser River riparian habitat, 100 m^2 of high quality Fraser River intertidal habitat, 23,500 m^2 drainage channel riparian habitat, and 10,200 m^2 drainage channel aquatic habitat

NOTE: This is an estimate based on 2007 FREMP mapping and 2017 orthoimagery interpretation. Exact numbers will require an aquatic habitat survey and aquatic effects assessment

Reach 4: Bog and Rail - Recommended Improvements

Priority

Priority is ranked 2nd out of 6 reaches.

This is ranked high due to low crest elevations and road safety issues.

Regulatory and rail company approvals may take extra time due to proposed widening into river and work around the trestle structure.

Land acquisition may be required, but the large agricultural/residential lots typically include adequate setbacks to provide enough space without redevelopment.

Land raising during redevelopment will also reduce the width required for dike and road work, and the need for interim access ramps.

Construction Cost

Costs below are for 2.2 km of dike similar to cross-section above.

Item	Cost per metre	Cost
Option 1		
Dike Raising	$4,500	$10.3 Million
Road Structure	$5,300	$12.1 Million
Raise Road to Dike Height	$1,900	$4.3 Million
Pathway	$600	$1.4 Million
Other (Driveways, Ramps or Road Reconstruction)		$.6 Million
Utilities (Drainage, Water)	$2,000	$4.8 Million
Option 6 Only at Rail Trestle Crossing		
9.6 m wide Dike Crest at 4.7 m c/w riprap with 15-20 m widening at base	$4,500	$.3 Million
9.6 m wide asphalt road with 2x1.1 m shoulder	$1,900	$1 Million
Contingency (40%)		$13.5 Million
Total		$47.1 Million

Cost opinions are in 2018 Canadian Dollars.

Reach 5: Hamilton Frontages

Existing Conditions

This reach of the dike is located on a narrow strip of right-of-way between the Fraser River, and agricultural/residential lots.

On the Fraser River side of the dike, there is a strip of riprap for bank protection. The inland side of the dike includes a minor drainage channel, agricultural land and residential lots at the east side of the reach.

There is a major Metro Vancouver pipe crossing in this reach.

Unique Features

- ALR parcels south of road with houses located close to road.
- No space between road edge and river channel (existing riprap bank protection).
- Metro Vancouver Big Bend forcemain crossing west of 21920 River Road.
- Queens North drainage pump station west of Westminster Highway.

Considerations

Flood Protection

Dike alignment
Dike crest elevation
Erosion protection
Seismic performance
Static stability and seepage
River toe stability and setbacks
Boat waves

Industrial

Pump station on waterside of dike
Road design and driveway grade

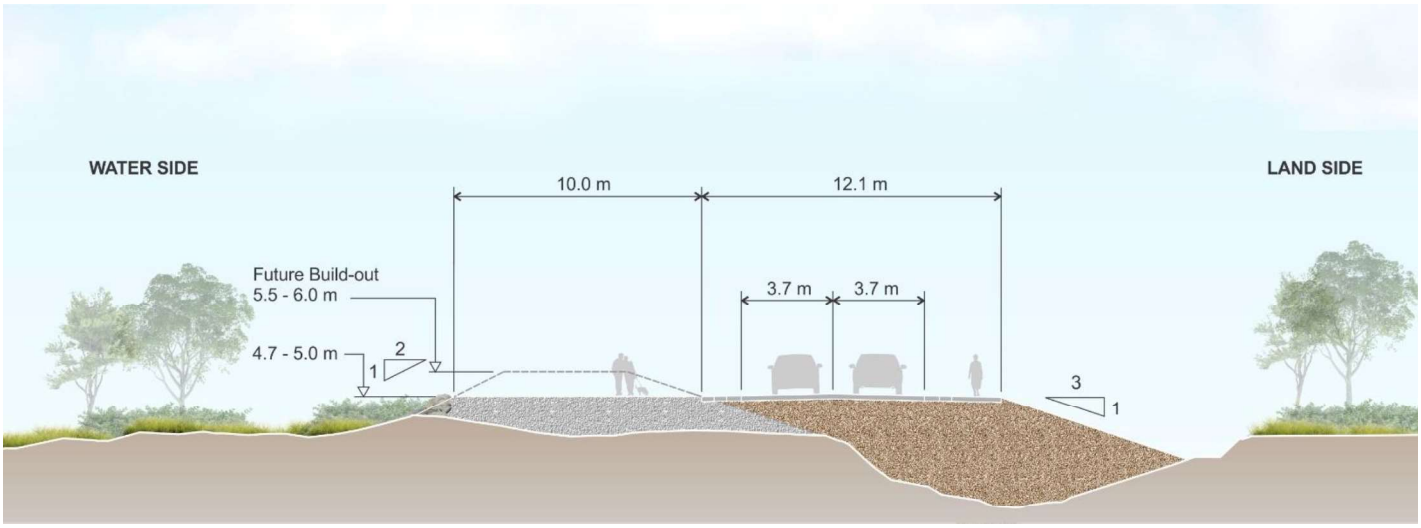
Social

Align with 2009 Waterfront Strategy
Connect to existing and planned trails and public amenities
Wayfinding and public information signs

Environmental

Fraser River side has narrow riprap slope, with low-quality habitat
Land side includes agricultural land for ½ of reach, and low-quality habitat and maintained lawn (residential) for remainder of reach. Drainage channels and associated riparian and aquatic habitat area present along the full length of the reach

Reach 5: Hamilton Frontages - Recommended Improvements



Master Plan Features

Flood Protection

Raise dike to 4.7 m and separate and raise road inland of the dike as illustrated above.

Dike alignment will typically extend up from the current face of dike, and widen inland.

Provide erosion protection along the face of the dike, typically consisting of rip rap revetment.

Raise properties 200 m inland to 4.7 m or densify to the depth of potential liquefaction.

Replace channels with storm sewers and swales to improve stability and reduce seepage.

Industrial

Driveway ramps required to extend to access private properties until properties raised.

Social

Construct multi-use path along dike, separate from road. Link to parks, trails, public amenities, and wayfinding.

Environmental

The proposed footprint would impact an estimated 900 m^2 of high quality Fraser River intertidal habitat, 23,700 m^2 of drainage channel riparian habitat, and 5,900 m^2 of drainage channel aquatic habitat

NOTE: This is an estimate based on 2007 FREMP mapping and 2017 orthoimagery interpretation. Exact numbers will require an aquatic habitat survey and aquatic effects assessment

Priority

Priority is ranked 3rd out of 6 reaches.

This is ranked just above average high due to moderate elevations, but relatively straightforward implementation.

There are some active redevelopment plans for the area, including road realignment at the east end of the reach. Road and development changes may change the priority of this reach.

Land acquisition may be required, but the large agricultural/residential lots typically include adequate setbacks to provide enough space without redevelopment.

Land raising during redevelopment will also reduce the width required for dike and road work, and the need for interim access ramps.

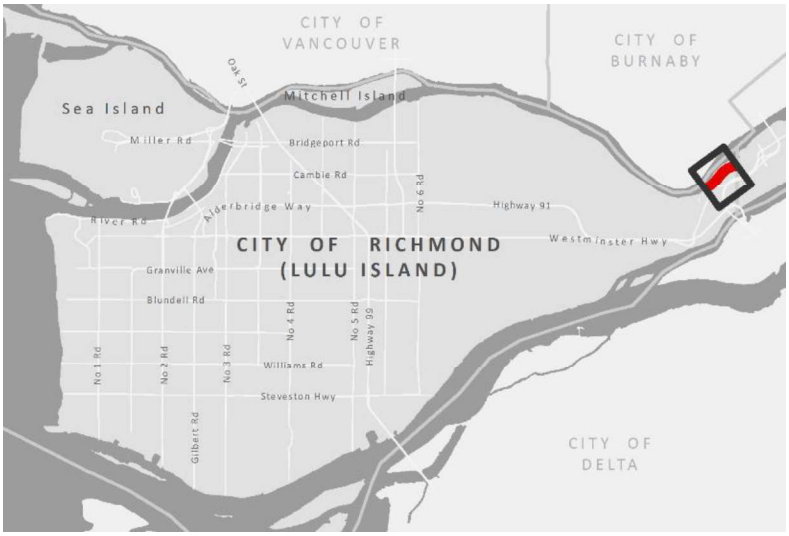
Construction Cost

Costs below are for 1.6 km of dike similar to cross-section above.

Item	Cost per metre	Cost
Dike Raising	$4,500	$7.3 Million
Road Structure & Utilities	$5,300	$8.6 Million
Raise Road to Dike Height	$1,900	$3. Million
Pathway	$600	$1. Million
Other (Driveways, Ramps or Road Reconstruction)		$.6 Million
Utilities (Drainage, Water)	$2,000	$3.2 Million
Contingency (40%)		$9.5 Million
Total		$33.1 Million

Cost opinions are in 2018 Canadian Dollars.

Reach 6: Tree Island Slough and Boundary



Existing Conditions

The dike system in this reach is between a slough and the backyards of single family residential homes. Riprap bank protection exists along the river-side slope.

The slough on the Fraser River side of the dike provides high-quality marsh and mudflat habitat.

The existing dike alignment is not well-defined east of the Hamilton Transit Centre. It is understood that the current tie-in with the City of New Westminster's portion of the dike is along Boundary Road. The Tree Island Steel property (3933 Boundary Road) has rail access across Boundary Road which may be an obstacle to dike raising.

Existing city-owned lots provide an opportunity for a Richmond-New Westminster boundary secondary dike.

Unique Features

- River Road dike alignment from Queens Road to Westminster Highway, then a river-bank dike runs north of Westminster Highway houses to edge of new Hamilton Transit Centre.
- Tree Island Steel site (3933 Boundary Road) creates a slough north of the dike that shelters the road/dike from the river.
- Backyards of single family homes located south of dike.
- Dike alignment not well defined from Hamilton Transit Centre to City of New Westminster river-bank dike.
- Potential tie-in with proposed secondary dike to separate Richmond and New Westminster.

Considerations

Flood Protection

Dike alignment
Dike crest elevation
Erosion protection
Seismic performance
Static stability and seepage
River toe stability and setbacks
Boat waves

Industrial

Hamilton Transit Centre
Tree Island Steel with rail connection

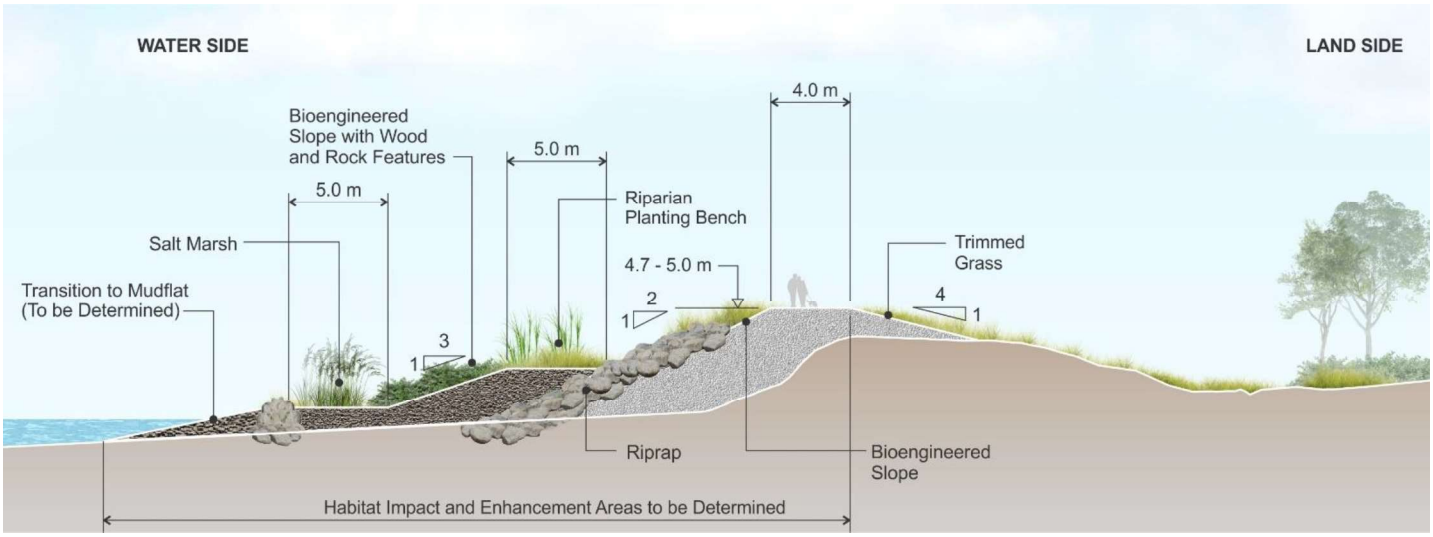
Social

Align with 2009 Waterfront Strategy
Connect to existing and planned trails and public amenities
Wayfinding and public information signs

Environmental

Slough located on the Fraser River side of the dike
High-quality mud flats and marsh found within the slough
Land side of dike includes maintained backyards for the western portion of the reach

Reach 6: Tree Island Slough and Boundary



Master Plan Features

Flood Protection

Raise dike to 4.7 m as illustrated above.

Dike alignment will typically extend up from the current face of dike, and widen inland.

Provide erosion protection along the face of the dike, typically consisting of rip rap revetment.

Raise properties 200 m inland to 4.7 m or densify to the depth of potential liquefaction.

Construct north section of secondary dike near Boundary Road.

Industrial

Seek shift of dike alignment to include the Tree Island Steel side and Tree Island Slough if and when this site redevelops.

Raise the dike through the Hamilton Transit Centre during future redevelopment.

Social

Construct multi-use path along dike. Link to parks, trails, public amenities, and wayfinding, per Lululoop. Develop trail link to south dike at Boundary Road, plus links to New Westminster dike trail.

Environmental

The proposed footprint would impact an estimated 2,200 m^2 of high quality Fraser River intertidal habitat

NOTE: This is an estimate based on 2007 FREMP mapping and 2017 orthoimagery interpretation. Exact numbers will require an aquatic habitat survey and aquatic effects assessment

Reach 6: Tree Island Slough and Boundary

Priority

The is the lower ranked priority reach. This dike is higher than other sections. Stalling construction increases the chance that a realignment opportunity could arise with Tree Island Steel. Alternatively, Hamilton Neighbourhood Plan implementation may provide early opportunities to raise the dike along with road realignment, park development, and some property development.

Construction Cost

Costs below are for 1 km of dike similar to cross-section above.

Item	Cost per metre	Cost
Option 4		
Dike Raising	$4,500	$3.6 Million
Pathway	$600	$.5 Million
Bioengineering Slopes	$1,000	$.8 Million
Marsh Benches	$100	$.08 Million
Utilities (Drainage, Water)	$2,000	$1.6 Million
Other (Driveways, Ramps or Road Intersection Reconstruction)		$.3 Million
Option 8 – Through ROW between Hamilton Transit Centre and Tree Island Slough		
Dike Raising	$4,500	$1.1 Million
Pathway	$600	$.1 Million
Retaining Walls	$1,500	$.8 Million
Utilities (Drainage, Water)	$2,000	$.5 Million
Option 8 – Raise Boundary Road from ROW between Hamilton Transit Centre and Tree Island Steel River Bank		
Raise boundary road to become dike	$5,400	$1.6 Million
Road Structure	$2,850	$.9 Million
Utilities (Drainage, Water)	$2,000	$.6 Million
Contingency (40%)		$5 Million
Total		$17.4 Million

Cost opinions are in 2018 Canadian Dollars.

6. Recommendations

It is recommended that the City adopt the Phase 4 Dike Master Plan as documented in this report, including the main features described below.

- Raise the dike crest to allow for 1 m of sea level rise. West of Nelson Road, the raised dike crest would be 4.7 m (CGVD28). East of Nelson Road, the raised dike crest would increase to 5.1 m at Boundary Road. The plan also allows for longer term upgrading to accommodate a further 1 m of sea level rise (i.e. 2 m of sea level rise).
- Widen the dike on the land side rather than into the Fraser River North Arm.
- Move River Road inside the dike to facilitate short-term and long-term dike upgrading. This will require the road to be reconfigured and reconstructed, with some additional need for land tenure. Moving the road will allow removal of utilities within the dike.
- Raise the relocated River Road to the dike crest elevation. This will facilitate driveway access over the dike to riverside properties. It will also be compatible with the desire to raise land inside the dike.
- Replace the drainage channel immediately inside the dike with storm sewers and swales. This will improve dike stability, and will provide some of the land needed to relocate River Road.
- Raise land and roads immediately inside the dike (during redevelopment) to improve seismic resilience. This will also improve liveability by allowing residents to looking down over the water, rather than at the backside of a dike.
- Improve pedestrian and cyclist safety by constructing a separate multi-use path along the dike. This would be consistent with the City Parks vision for a perimeter trail system (Appendix B)
- Construct the north section of a secondary dike near Boundary Road.

It is also recommended that the City prepare a comprehensive implementation plan for dike upgrading that incorporates the elements of the Phase 4 Dike Master Plan, and the elements of the other Dike Master Plans.

To address habitat compensation issues associated with the Dike Master Plans, it is further recommended that the City consider development of a habitat banking program that could provide effective large-scale compensation for the environmental impacts of dike upgrading. This could include the potential Tree Island Slough project identified in this report.

For all phases of the Dike Master Plan, continue to research alternative densification strategies for seismic stability, consider the proposed alternative seismic performance criteria in Section 3.2, and plan to fill land for approximately 200 m inland of the dike to crest elevation. The required fill distance requires additional evaluation and may be addressed in the pending update to the Flood Protection Management Strategy.

Report Submission

KERR WOOD LEIDAL ASSOCIATES LTD.

Colin Kristiansen, MBA, P.Eng.
Project Manager

Reviewed by:

Mike V. Currie, M.Eng., P.Eng., FEC
Project Director and Technical Reviewer

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Revision History

Revision #	Date	Status	Revision	Author
0	April 28, 2023	Final	Add stakeholder and public engagement summary	CAK

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Appendix A

Plans and Sections for Richmond Dike Master Plan – Phase 4

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City of Richmond

Lulu Island Dike Master Plan - Phase 4

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Legend

- Parcel (from BC Data Catalogue Parcel Map BC)
- Easements
- Active ROW
- City Owned Lots
- Dike Footprint Encroachment onto Non-municipal Parcels

Water Network
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- Fish Habitat Compensation Sites

Habitat Quality
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- High Quality Riparian Habitat

Concept Linework
- Dike Concept
- Road Concept
- Dike/Road Slope
- Dike/Road Fill Extent

Note: 2016 Imagery Shown.

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PWT - 223

Potential Secondary Dike Alignment (Mid-Island Dike)

Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:2,500 is only valid on a 11"x17" print.

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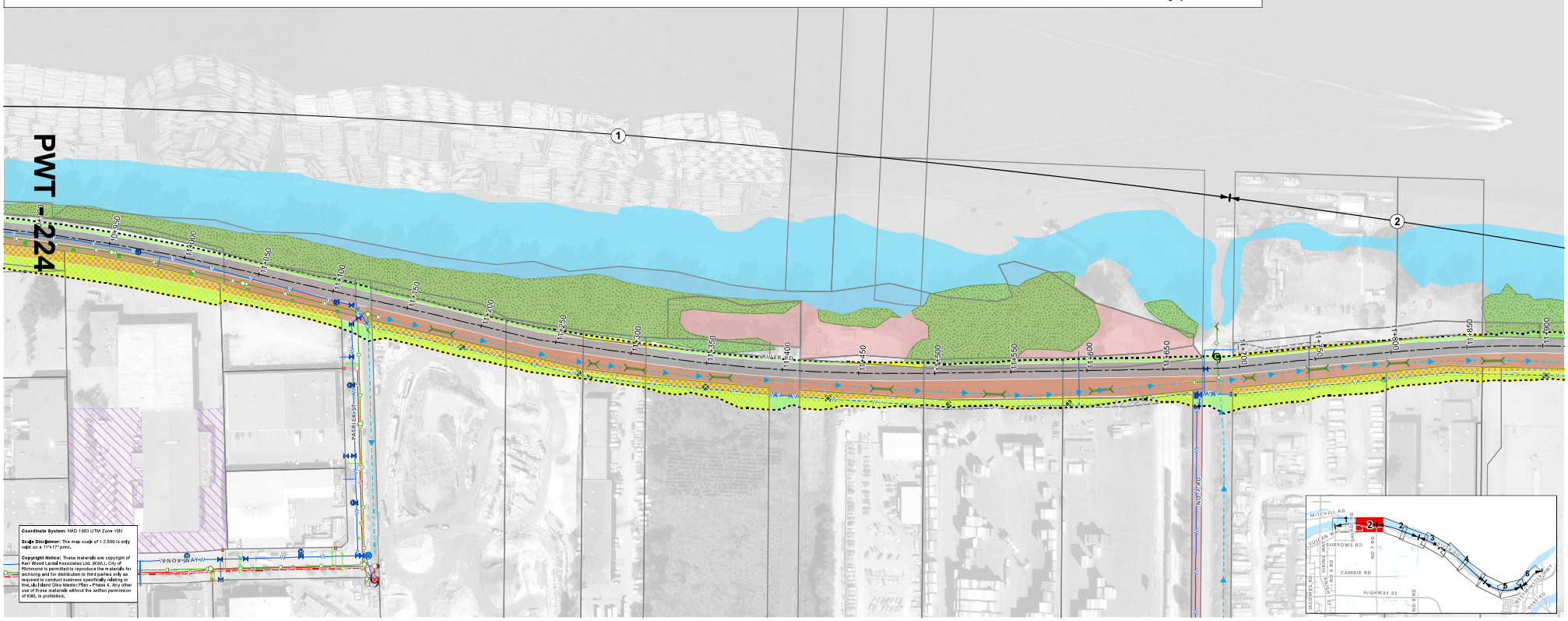

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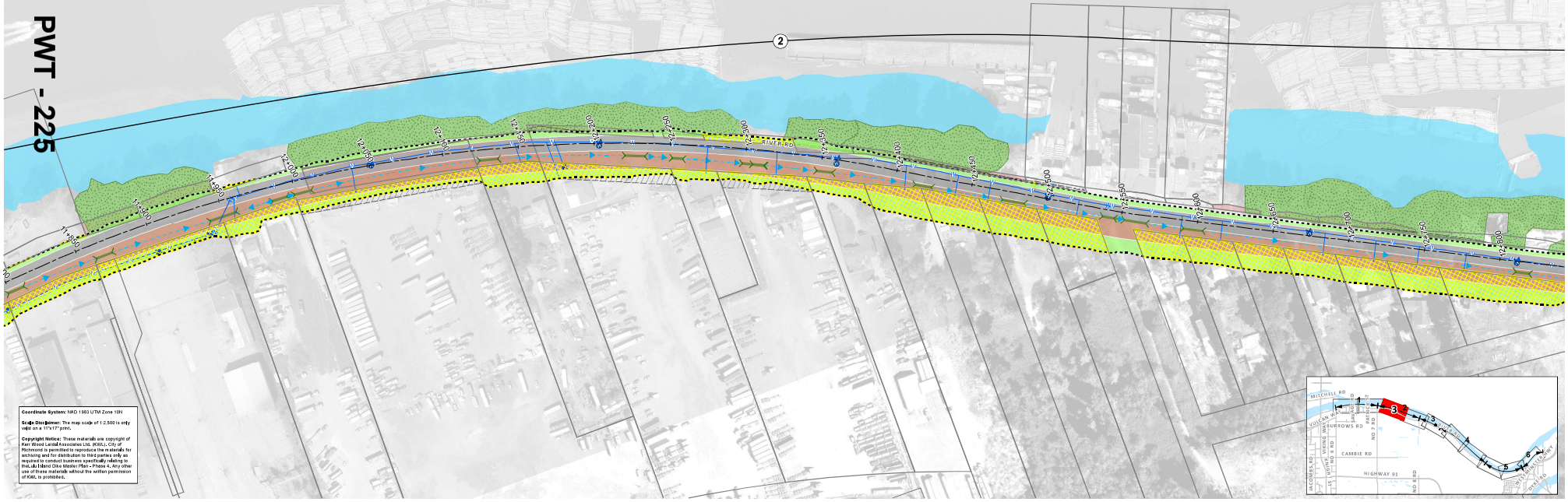

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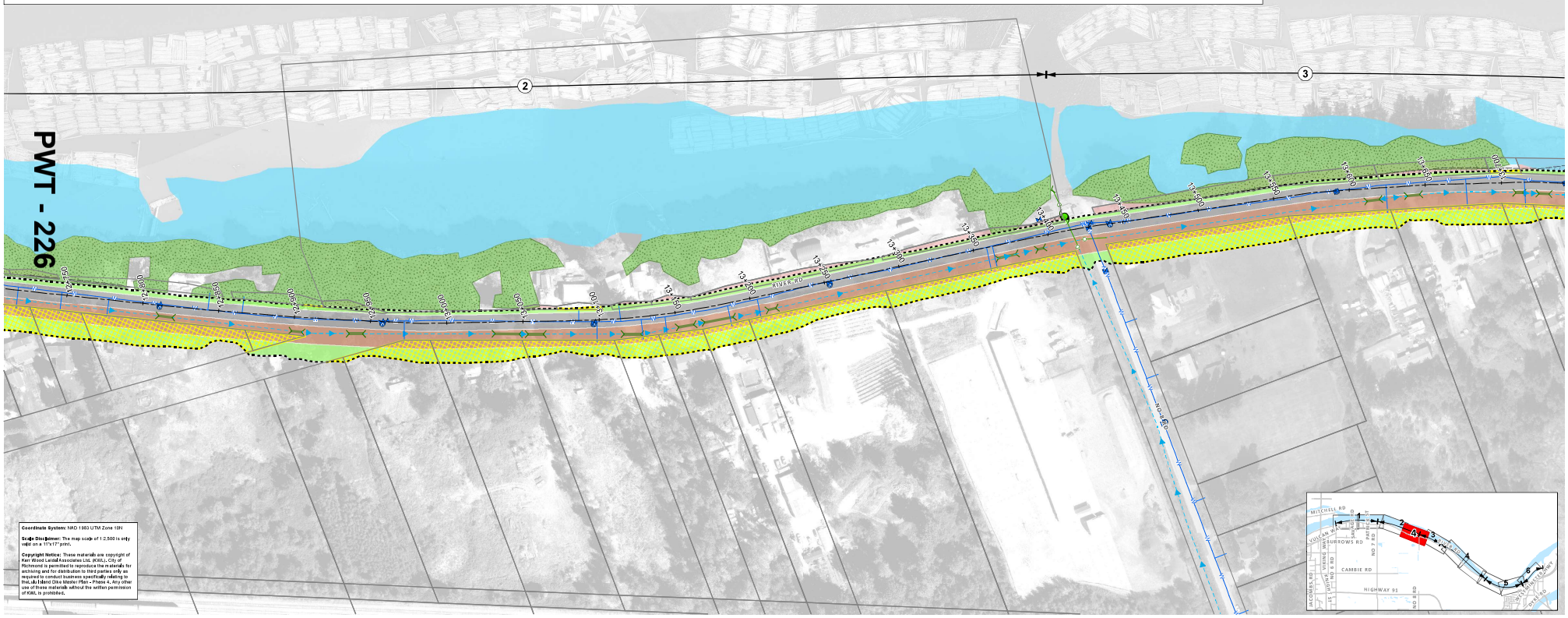

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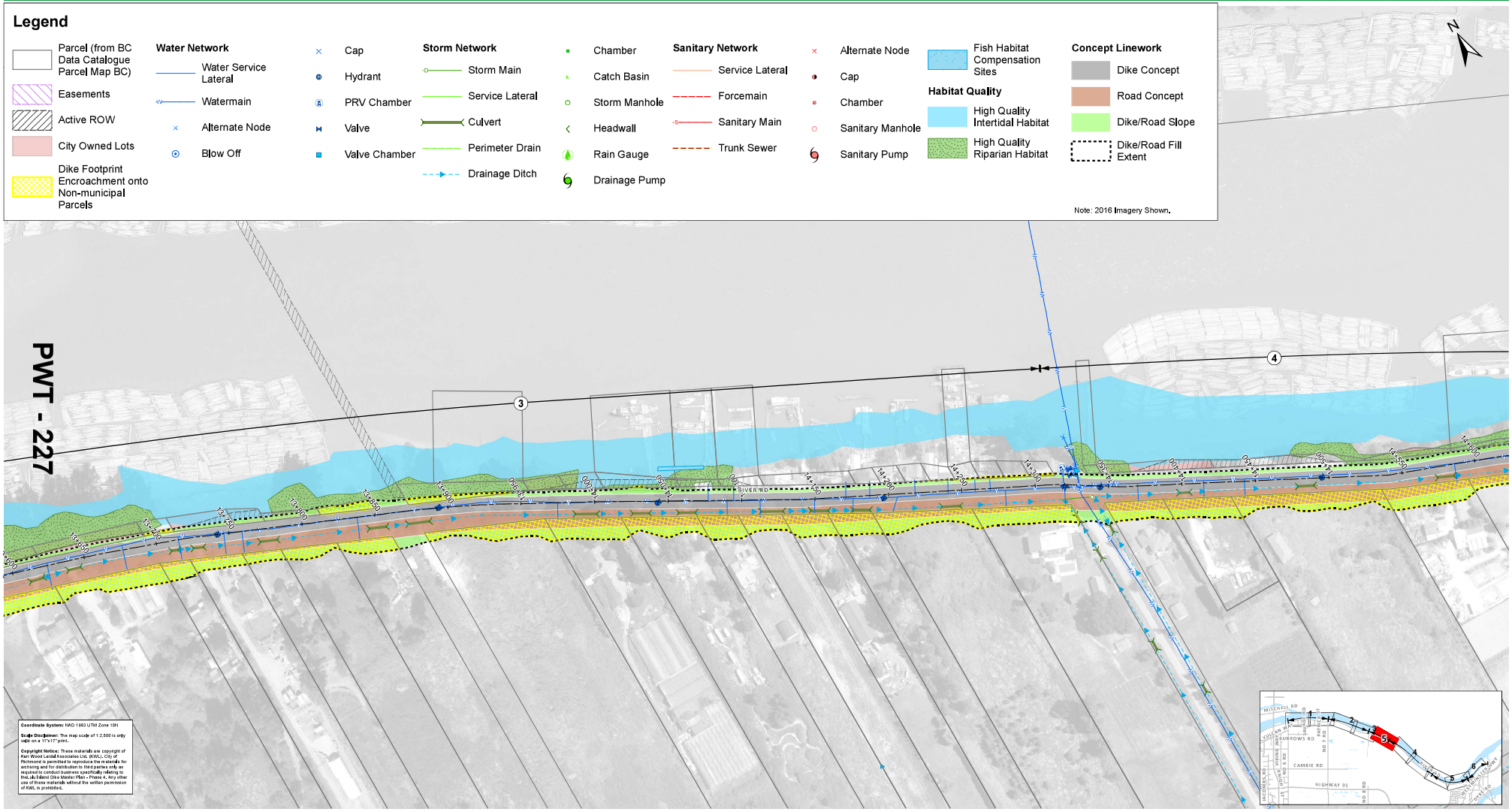

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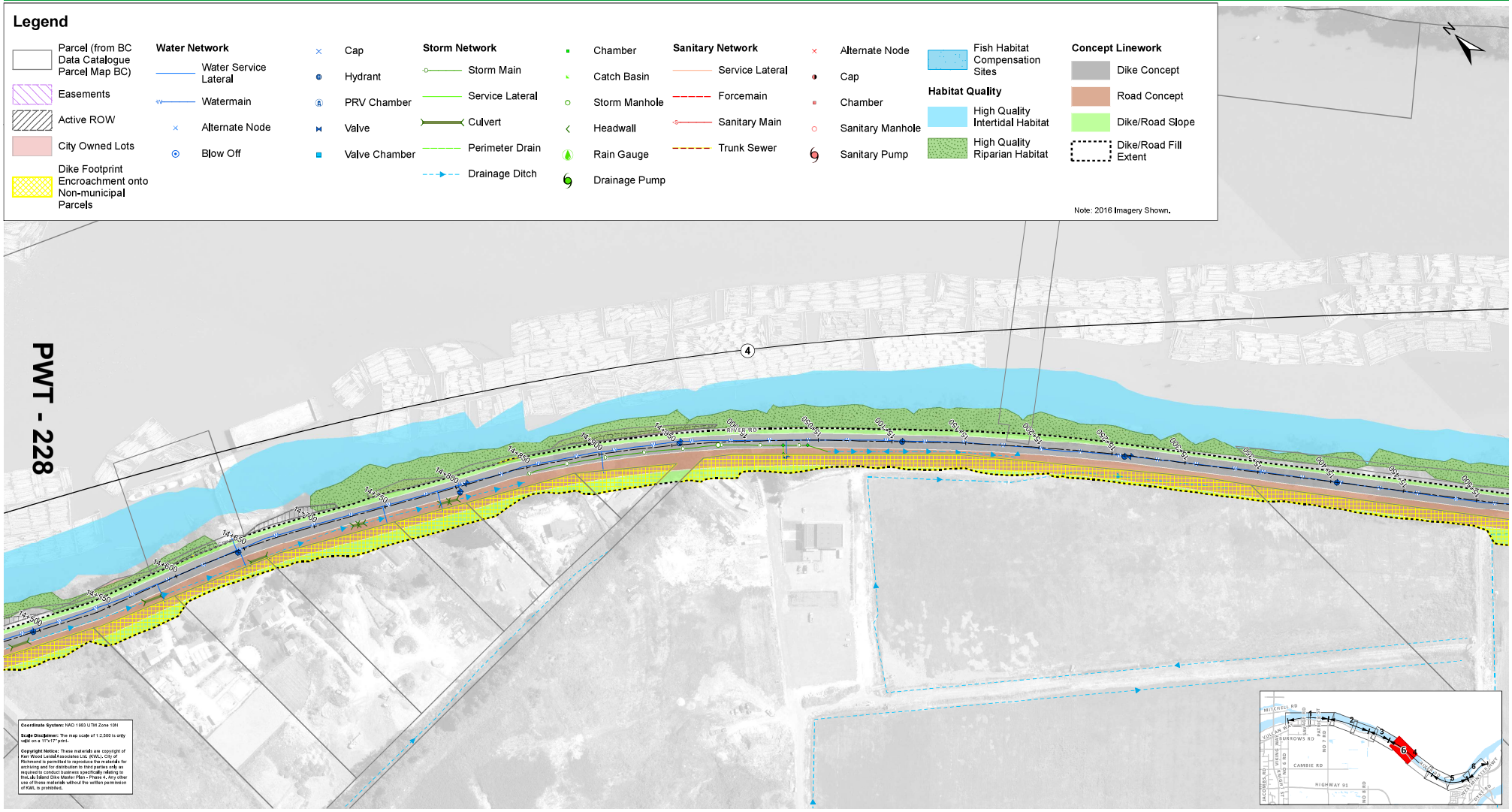

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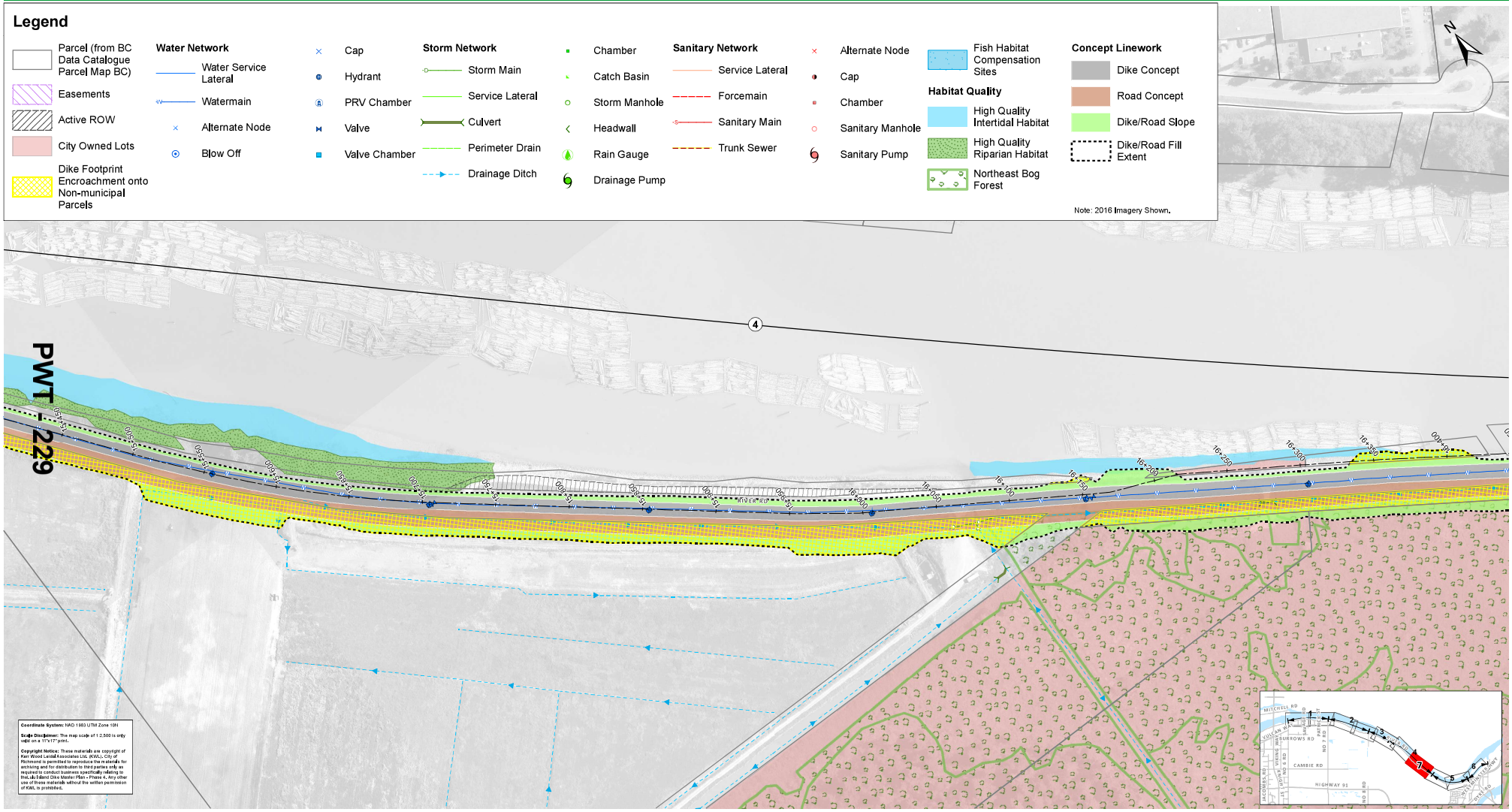

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Note: 2016 Imagery Shown.

PWT - 230

Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:2,500 is only valid on a 11"x17" print.

Project No.	651.122
Date	April 2023
Scale	1:2,500

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Lulu Island Dike Master Plan - Phase 4

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City of Richmond

Lulu Island Dike Master Plan - Phase 4

KERR WOOD LEIDAL consulting engineers

Legend

- Parcel (from BC Data Catalogue Parcel Map BC)
- Easements
- Active ROW
- City Owned Lots
- Dike Footprint Encroachment onto Non-municipal Parcels

Water Network
- Water Service Lateral
- Watermain
- Alternate Node
- Blow Off
- Cap
- Hydrant
- PRV Chamber
- Valve
- Valve Chamber

Storm Network
- Storm Main
- Service Lateral
- Culvert
- Perimeter Drain
- Drainage Ditch
- Chamber
- Catch Basin
- Storm Manhole
- Headwall
- Rain Gauge
- Drainage Pump

Sanitary Network
- Service Lateral
- Forcemain
- Sanitary Main
- Trunk Sewer
- Alternate Node
- Cap
- Chamber
- Sanitary Manhole
- Sanitary Pump

- Fish Habitat Compensation Sites

Habitat Quality
- High Quality Intertidal Habitat

Concept Linework
- Dike Concept
- Road Concept
- Dike/Road Slope
- Dike/Road Fill Extent

Note: 2016 Imagery Shown.

N

PWT - 231

RIVER RD

Hamilton Area Proposed Park

FRASERBANK CR

FRASERWOOD DR

MITCHELL RD

CAMBIE RD

HIGHWAY 91

Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:2,500 is only valid on a 11"x17" print.

Project No. 651.122
Date April 2023
Scale 1:2,500

50 25 0 50 m

Lulu Island Dike Master Plan - Phase 4

Path: P:\0600-0699\651-122\430-GIS\MXD-Rp\Phase4\651122_Phase4_Appendix_Mapping.mxd Date Saved: 4/25/2023 6:59:25 PM | Author: JLau

City of Richmond
Lulu Island Dike Master Plan - Phase 4

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- Road Concept
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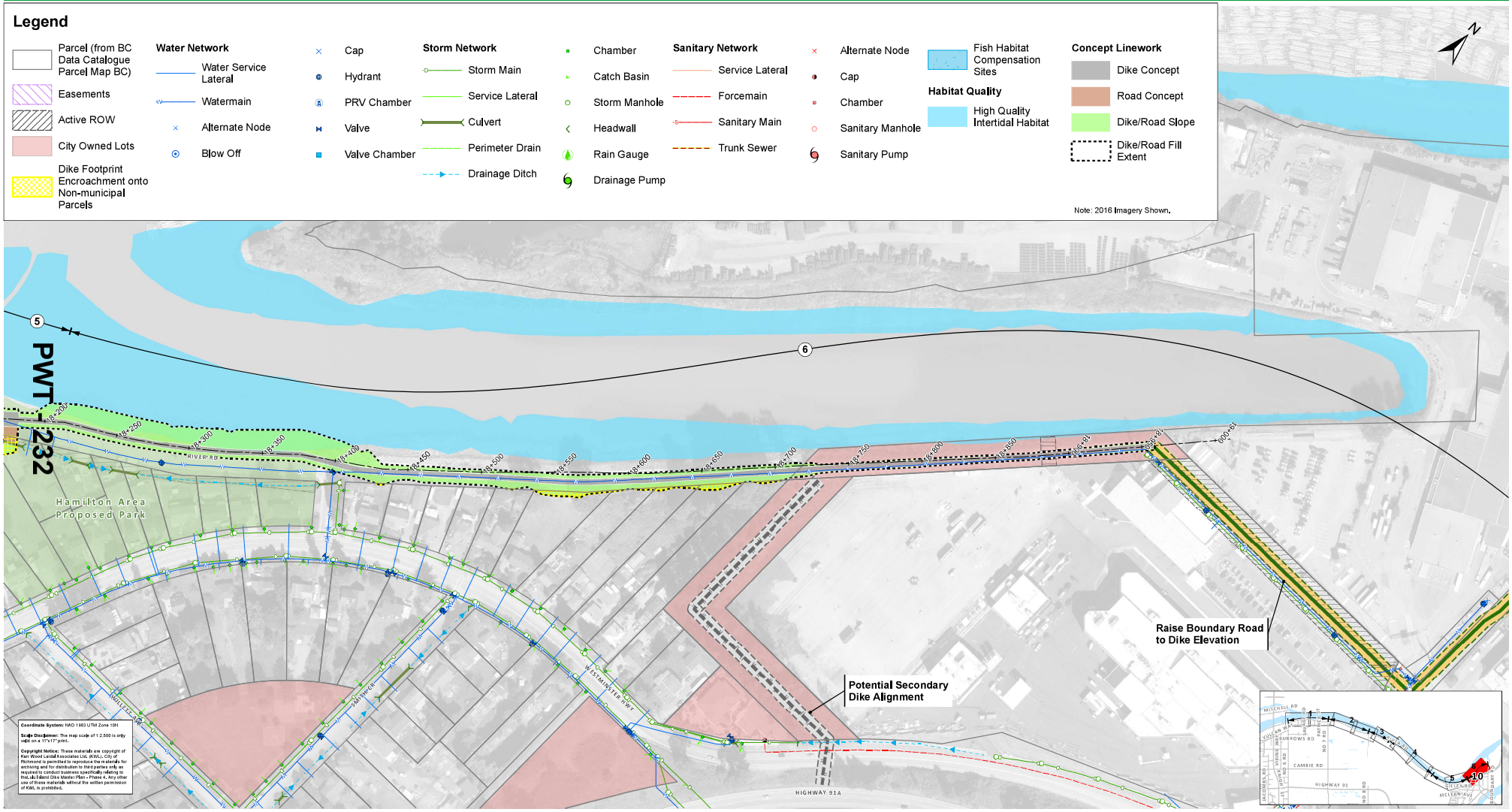
Note: 2016 Imagery Shown.



Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:2,500 is only valid on a 11"x17" print.

Project No.	651.122
Date	April 2023
Scale	1:2,500

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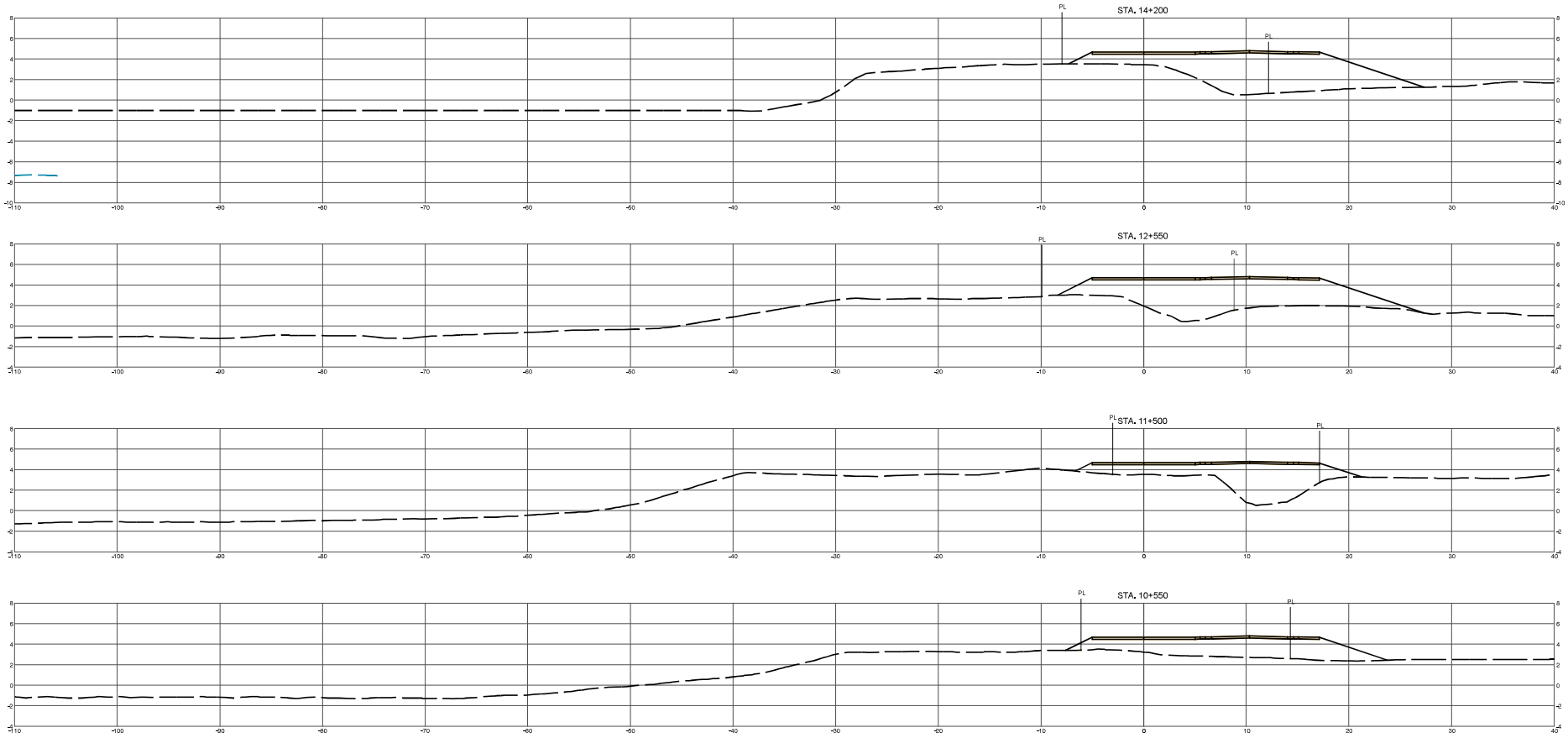
Lulu Island Dike Master Plan - Phase 4

City of Richmond
Lulu Island Dike Master Plan - Phase 4

KERR WOOD LEIDAL consulting engineers

PWT - 233



Project No.	651.122
Date	April 2023
Scale	1:400

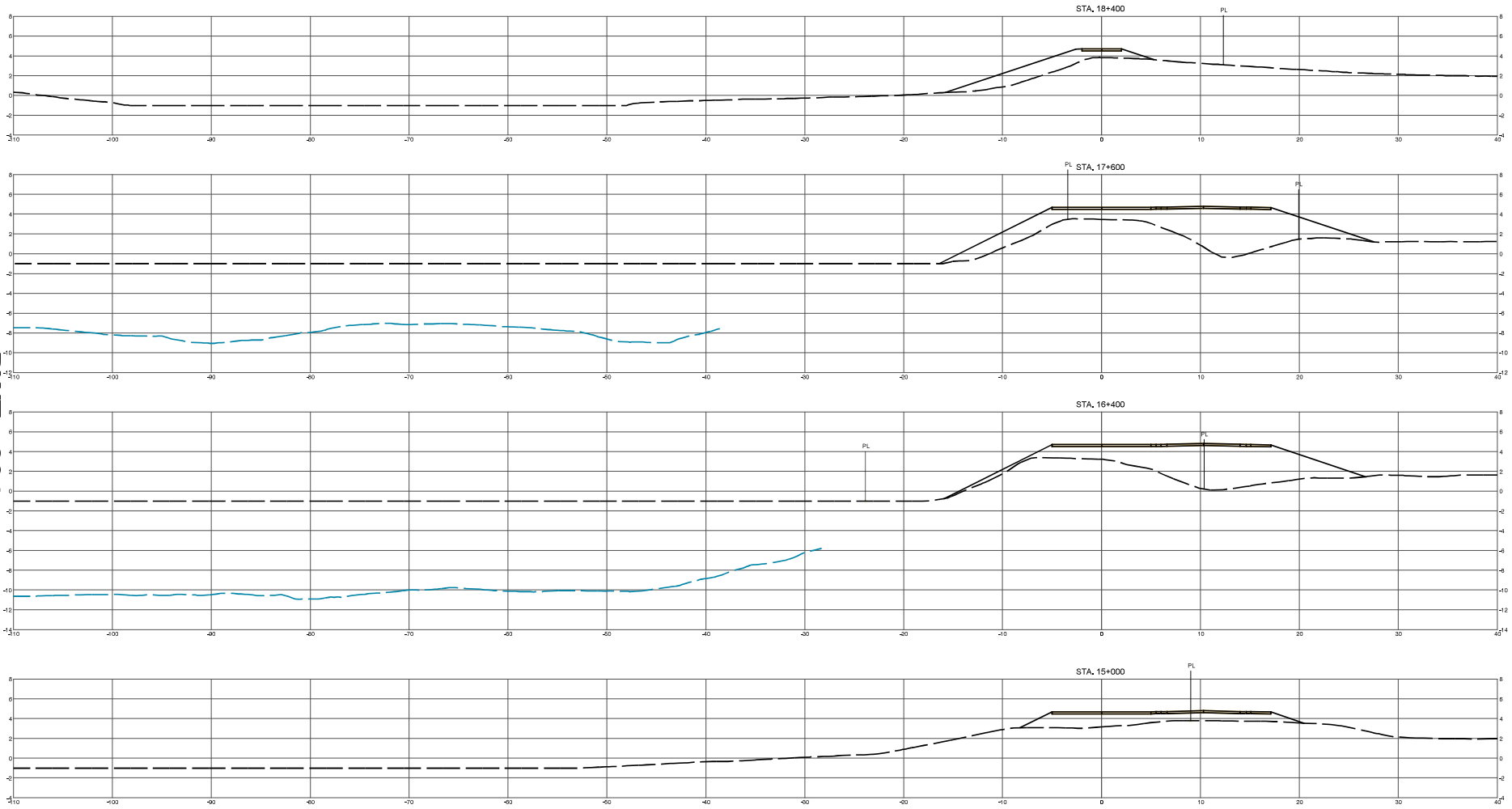
NOTE:
2016 1m DEM SURFACE FROM EMBC LIDAR DATA - 2016 LOWER MAINLAND

5 2.5 0 5 m

BATHYMETRY DATA FROM PWGSC, DATE OF SURVEY 2015

Lulu Island Dike Master Plan - Phase 4
Cross-sections

Figure 1



PWT - 234

Project No.	651.122
Date	April 2023
Scale	1:400

NOTE:
2016 1m DEM SURFACE FROM EMBC LIDAR DATA - 2016 LOWER MAINLAND

BATHYMETRY DATA FROM PWGSC. DATE OF SURVEY 2015

5 2.5 0 5 m

Lulu Island Dike Master Plan - Phase 4
Cross-sections

Figure 2

KERR WOOD LEIDAL
consulting engineers

Appendix B

Richmond Dike Master Plan
Landscape Concepts and Dike Typologies

LULULOOP

PWT - 236

RICHMOND DIKE MASTER PLAN

LANDSCAPE CONCEPTS

August 8th, 2018

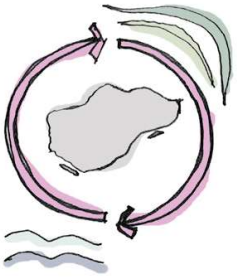
Richmond

KERR WOOD LEIDAL consulting engineers

HAPA

RICHMOND DIKE MASTER PLAN

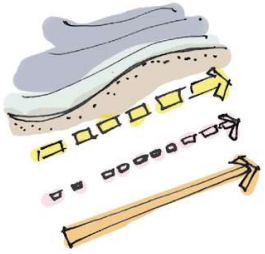
LANDSCAPE DESIGN PRINCIPLES



THE TULU LOOP

Connect a network of paths to create a continuous public trail along the new dike:

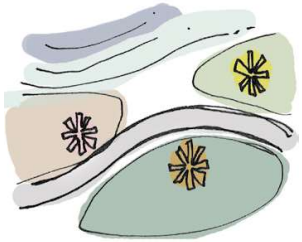
- circumnavigate Richmond and observe how infrastructure supports the island and its nature;
- resolve gaps in the trail, threading together tricky connections;
- delight the trail user from start to finish with attention to the unique places along the way.



ALL TOGETHER NOW

Integrate the movement of pedestrians, bikes, and vehicles safely and respectfully:

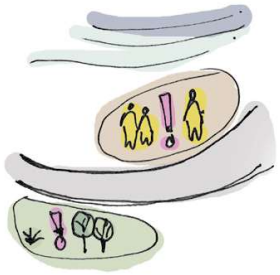
- mark out pedestrian areas with bollards, lighting, and furnishings;
- ensure the safety of cyclists by separating paths or providing safe road shoulders;
- include parking where appropriate and allow accessible transitions between modes of travel.



A PATH WORTH TAKING

Enhance the edges of roads, trail, and river with durable, maintainable materials that are also beautiful:

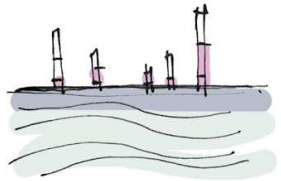
- utilize planting to soften hardscape and infiltrate stormwater;
- look for opportunities for street trees to provide a rhythm and buffer to roads;
- provide furnishings as points of rest, observation, and wayfinding.



ISLAND INTEREST

Activate special areas of public realm with a deployable toolskit sharing a consistent design language:

- determine best locations for public space based on context, connectivity, and distribution;
- leverage areas of ecological, industrial, and cultural value for social connection;
- find opportunities for wonder in constrained spaces.



THE STORY OF THE RIVER

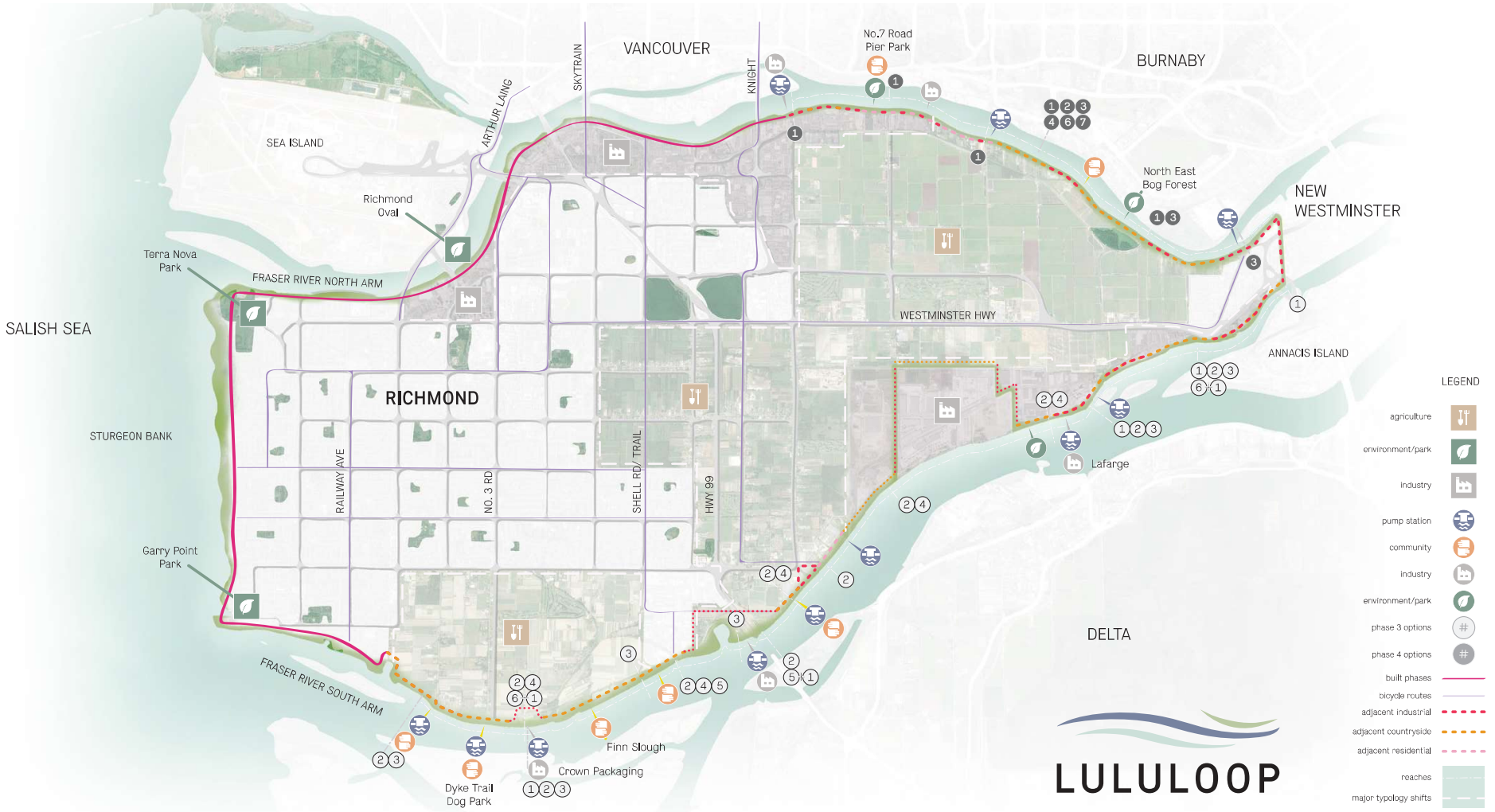
Illustrate the river's changing nature through features that allow glimpses of its past and future:

- reveal the important systems of the river and weather through interactive installations;
- acknowledge the diverse cultures that have gathered and modified the shoreline;
- educate the public on adaptations to sea level rise.

RICHMOND DIKE MASTER PLAN

CONCEPT PLAN

PWT - 238



TOOLKIT

ECOLOGICAL ENHANCEMENT

WATER SIDE

Approaches to treatment of the water side of dike; sites and planting to be developed with biologists and subject to environmental review:

- planting exclusively with native species;
- consideration of Ecological Network Management Strategy, Waterfront Strategy and applicable Provincial Acts;
- important habitat for 'charismatic' wildlife such as salmon, White Sturgeon, and migratory birds that hold public interest.

PWT - 239

SUB-AQUATIC

At or in the water, sometimes interspersed in rip-rap or driftwood:

- aquatic and semi-aquatic plants;
- low-lying and submersive, following the water's edge;
- home to fish including salmon and sturgeon, and the foraging grounds of wading birds.

INTERTIDAL

Frequently inundated by water, characteristic of river's edge:

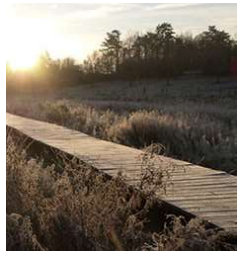
- bullrushes and shrubs with small trees at the edges;
- long and with variable width;
- teeming with song birds and hunting hawks, a common sight along the dike.

RIPARIAN

Interface between river and land with high ecological value:

- rich variety of plantlife;
- expanding width following intertidal zone;
- sensitive habitat but with a terrestrial connection that allows it to be more habitable by people under the right conditions.

PRECEDENTS



TOOLKIT

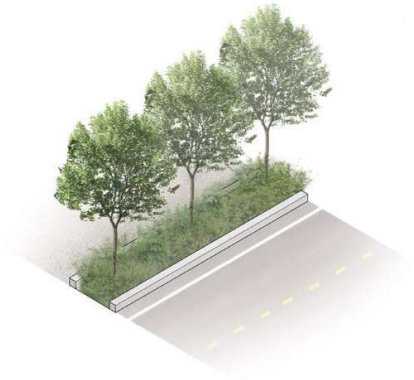
ECOLOGICAL ENHANCEMENT

ROAD EDGES

Contained, maintainable planting along road edge, without conflict with dike fill profile:

- drought-tolerant native and adaptive species;
- adherence to Street Tree and Planting guidelines and Urban Forestry Management Strategy;
- creation of softscape buffers with ecological function between traffic and pedestrians.

PWT - 240



RAINGARDEN

Roadside infiltration of stormwater with grasses, sedges, and shrubs :

- native plant species that can withstand inundation but also summer drought;
- linear with suitable sloped depressions;
- permeable function but clean, maintainable design.

HARDY SHRUB BUFFER

Durable shrub planting suited to high-use areas:

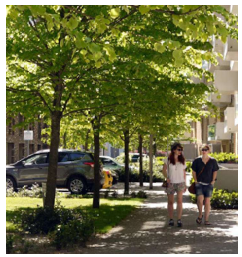
- heavy duty shrubs that are resistant to damage;
- below waist height for clear sightlines but as soft, barrier swathes;
- planted median between road and path through shrub density.

STREET TREES

Providing consistent element and canopy cover along urban edges:

- urban tolerant decidious trees;
- tightly spaced with consistent canopies, straight leaders, and shallow roots;
- species selected to withstand roadside pressures but fit rural and natural context.

PRECEDENTS



TOOLKIT

ECOLOGICAL ENHANCEMENT

LAND SIDE

Land side approaches to natural space using medium to larger scale areas of habitat:

- contextual and sensitive interventions to enhance existing ecologies and unique natural features;
- consideration of Ecological Network Management Strategy and Parks and Open Space Strategy along with Tree Protection Bylaw;
- opportunity to increase public access to nature through trails and public realm features.

MEADOW

Open grassland with seasonal flowering interest:

- native grasses and forbs with pollinator-favoured species;
- flowing, elongated shapes accented with blooms;
- idyllic and appealing planting with low impact on ground and sightlines.

WOODLAND

Layered plant community with texture and small trees:

- native grasses, shrubs, and deciduous trees;
- more concentrated and concentric than meadow and with clusters of short trees and shrubs;
- less penetrable, but ecologically important to nesting birds and small mammals.

FOREST

Densest, most vertical patches of planting along wildlife corridor:

- native deciduous and coniferous trees, shrubs, and ground cover;
- tight and somewhat tall, with shorter edges for windbreak, taking a clustered and wide shape;
- occuring in specific areas where land provides suitable space.

PRECEDENTS

TOOLKIT

PUBLIC REALM

REST AND RELAX

Small scale features to accomodate pedestrians and people on bikes along the dike trail:

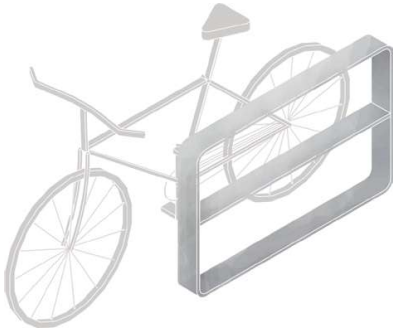
- aim to provide seating as much as every 200m in high pedestrain use areas;
- review of Waterfront Strategy, Trail Plan, and Parks and Open Space Strategy;
- situate elements with consideration of context: views to river, traffic noise, and connected parks or other areas of public interest.

PWT - 242

BENCH

Heavy timber wood benches spaced to provide frequent resting:

- cedar timbers with powdercoated exposed steel and galvanized components;
- heavy, durable form but comfortably tuned to human body;
- references logs washed up on river bank.



BIKE RACK

Steel bike rack for two bikes, side by side:

- powdercoated steel;
- simple, functional form easy to manufacture and difficult to vandalize;
- industrial character but obviously legible as a place to lock your bike.

LONG TABLE

The ultimate picnic table, tailored to the linear form of the trail:

- cedar timber table and seats with powdercoated exposed steel and galvanized components;
- long, linear form with mass and presence;
- evocative of river industry.

PRECEDENTS






TOOLKIT

PUBLIC REALM

ACCESSIBLE GRADES

Small scale features to accomodate pedestrians and people on bikes along the dike trail:

- means for accessibly taking people from the dike crest down to lower areas on water side and land side;
- respect BC Accessibility Handbook;
- combine features with other elements of observation or exploration to create destinations and reduce negative impact on sensitive constructions and habitats.

PWT - 243

RAMP

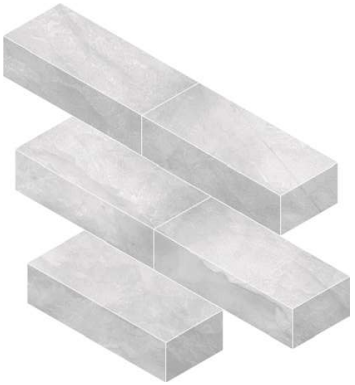
Graded wood ramp for rolling accessibility to lower area:

- tight, level wood members run lengthwise;
- unobtrusive form but securely constructed on foundation and drain rock;
- practical, functional feature without ornament.

STEPS

Heavy timber steps for access to area of interest:

- cedar timbers marked for slip resistance;
- simple form with guardrails where appropriate, and securely embedded in landscape;
- characteristically familiar to bench and table furnishings.

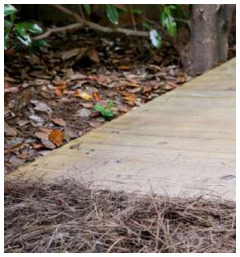


SEAT STEPS

Stone or heavy timber seat steps where view and context allows:

- granite stone or large cedar timbers;
- cascading form sized for presence and comfortale depth of seating;
- industrial or geologic reference to river edge conditions of rip rap or glacial erratics.

PRECEDENTS





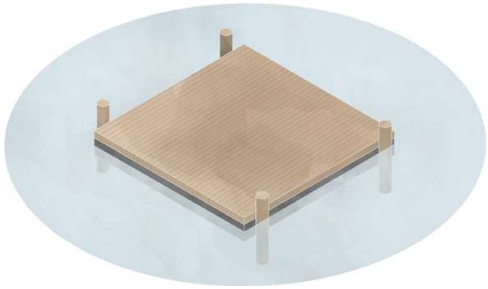

TOOLKIT
PUBLIC REALM
OBSERVE

Medium scale features for observation and connection to larger landscapes:

- habitable and sometimes sheltered elements for larger or longer public gatherings;
- acknowledge Waterfront Strategy and Parks and Open Space Strategy;
- situate in well-used areas and park spaces, especially with connection to event or sports areas (especially fishing and kayaking), important spaces for birdwatching, and places of historic or cultural importance.

SHELTER
A shaded or warming respite from the weather and place of gathering:

- post and beam structure with tin roof;
- simple form with sloped roof and seating around a hearth;
- contemporary boathouse feel.



VIEWPOINT
Deck and boardwalk to allow viewing of the river from its banks:

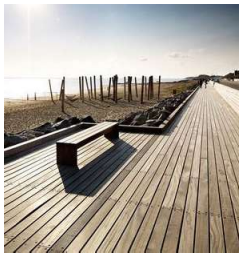
- cedar boards with simple guardrail;
- geometric alignment of boards or slats into different planes for sitting and leaning;
- appearing like a deconstructed boat deck oriented to bridge the river and bank.

TOWER
Vantage point up a set of stairs for looking out and birdwatching:

- cedar posts, deck, and cladding;
- zig-zagging or spiral stairs leading up to a shielded bird blind with sightholes and shelter;
- referencing the historic radar reflectors on Sturgeon Bank or stilted fishing shacks.

PRECEDENTS



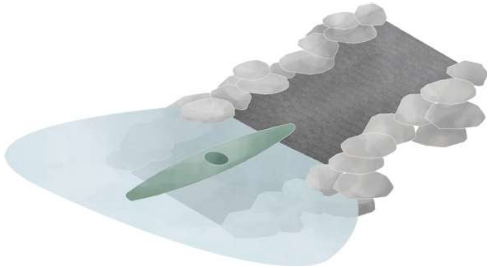



TOOLKIT
PUBLIC REALM
EXPLORE

Special features for fun and exploration, for all ages and abilities:

- use principles of nature play and adventure playgrounds;
- understand Trail Plan, Waterfront Strategy, and Parks and Open Space Strategy;
- consideration of safety but also the importance of risky play and challenge to provide positive developmental engagement with landscapes.

PWT - 245

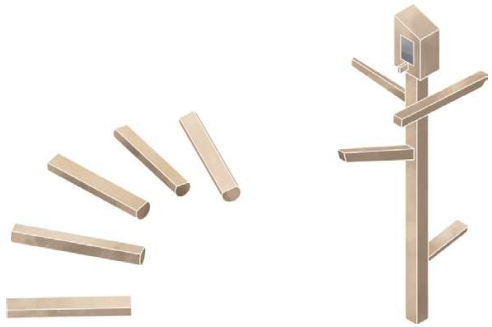


KAYAK LAUNCH
For launching and landing small self-propelled water craft:

- wood with stainless steel details;
- floating pier or slip with covered area;
- clean, minimal intrusion into the water that adapts to ebb and flood of tide.

BIKE JUMPS
Short ramps for small thrills along the path:

- graded dirt or asphalt with bright warnings;
- height geared towards younger rides or the young at heart;
- undeniable features for the aspiring daredevil.



LOG JUMP + CROW'S NEST
Nature play features for jumping and climbing:

- dried timbers structurally supported and textured for slip-resistance;
- placed seemingly randomly but within reach;
- evoking driftwood and raptor perches.

PRECEDENTS






TOOLKIT

SPECIAL FEATURES

LIGHTING AND FENCES

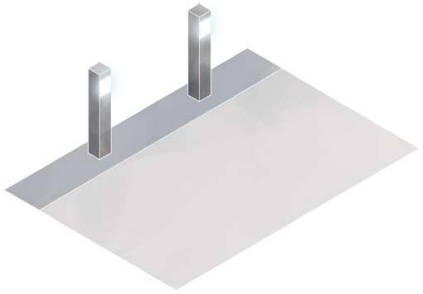
Safety features for providing light and vertical or barrier separation of travel modes:

- mediating between automobile movement and the slower speeds and scale of pedestrian and people on bikes;
- acknowledge Urban Design Guidelines and also dark sky principles;
- engage cycling groups to provide safe solutions to conflicts between user groups, slowing traffic, increasing visibility, and ensuring pedestrians feel safe.

PEDESTRIAN LIGHT POLE

Highest output lighting for urban edges and darkest zones:

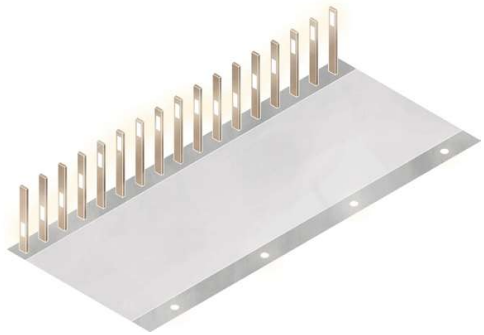
- wooden pole or light gray steel;
- 5m high with dual lumenaire design between bike and walking pathes;
- wooden pole or light gray steel and sleek, modern fixture.



BOLLARD

Vertical separation of paths with option for safety lighting:

- heavy timber with powdercoated steel;
- simple design with stable, secure presence;
- industrial or shipbuilding aesthetic through contemporary lens.

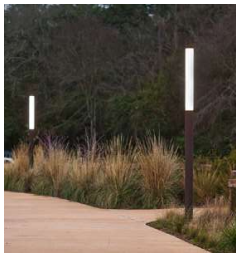


SCREEN/BARRIER

For creating a safe barrier or noise wall between two conditions:

- vertical wood slats;
- 1.1m high with durable construction;
- simple, contemporary design.

PRECEDENTS



TOOLKIT

SPECIAL FEATURES

WAYFINDING AND DATA STATIONS

Small, repeatable elements for wayfinding, services, and education:

- consistent design language to tie the trail together as a linear park;
- use Trail Plan, Waterfront Strategy, and Parks and Open Space Strategy;
- tie together existing bike routes, paths, and park spaces to the dike and provide amenity and interest along the course of the trail with respect to the landscape and infrastructure as it relates to sea level rise.

PWT - 247

WAYFINDING

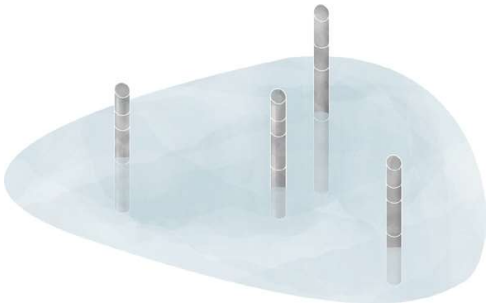
Mapboard with clear, legible graphics and consistent design language:

- cedar with steel or resin board;
- post-like and visible from a distance but human-scaled;
- simple character with bold colour allowing quick reading by diverse groups.

BIKE REPAIR/WATER FOUNTAIN

Refill with air or water from a multi-use checkpoint:

- concrete and powdercoated steel construction;
- durable, tamperproof design with overflow water well-drained;
- utilitarian industrial aesthetic with discrete design accents.



WEATHER/TIDE STATION

Marker reflecting weather and tide changes in analog form:

- stainless or powdercoated steel;
- simple, legible form with playful metaphor;
- inspiring curiousity and return to track the river's changes.

PRECEDENTS

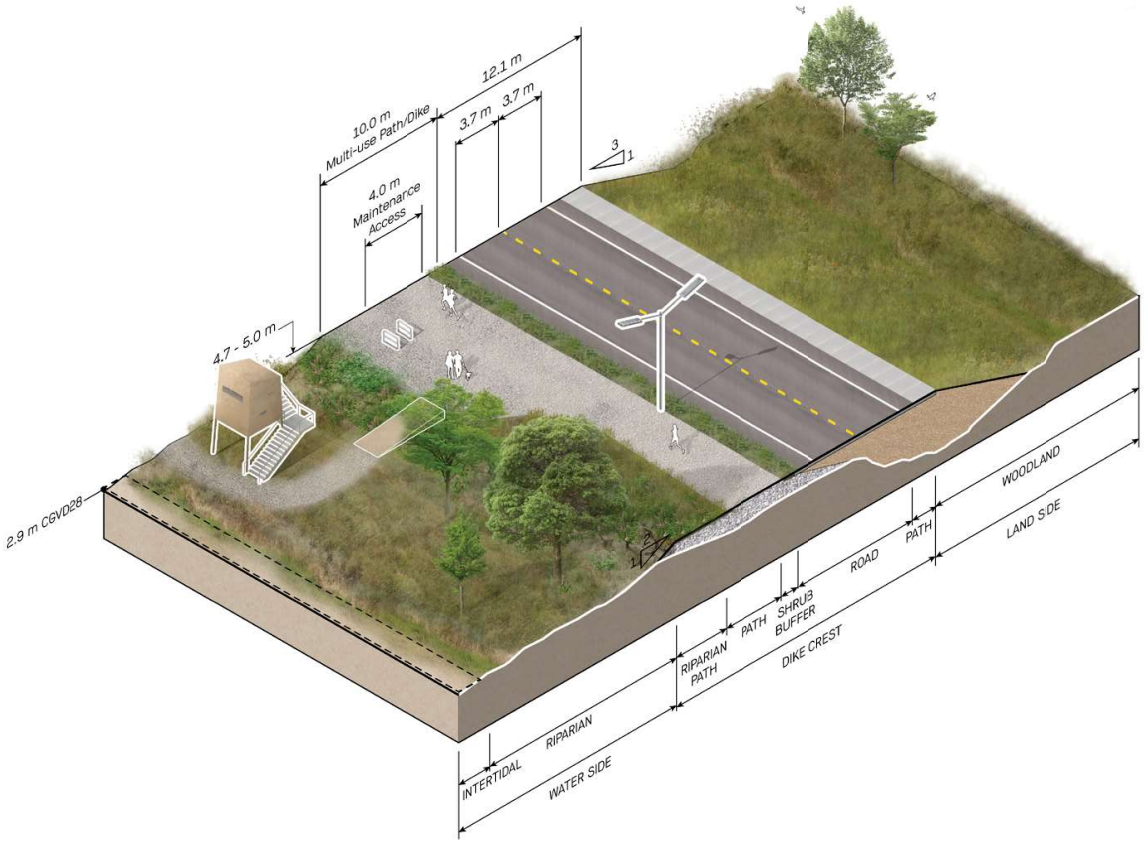
DIKE TYPOLOGIES

PHASE 4, OPTION 1

RAISE DIKE AND ROAD AND EXTEND LAND-SIDE (REACHES 1-5)

Excellent public realm opportunity within interesting stretch of riverfront landscape:

- provide observation features where appropriate - existing parks, pump stations, and road pullouts where habitat already exists;
- reduce scale of path through planted edges and light features in areas without significant development;
- connect to new bog park, local agriculture including roadside fruit stands, and river-based businesses.



Phase 4, Fig 3-2

DIKE TYPOLOGIES

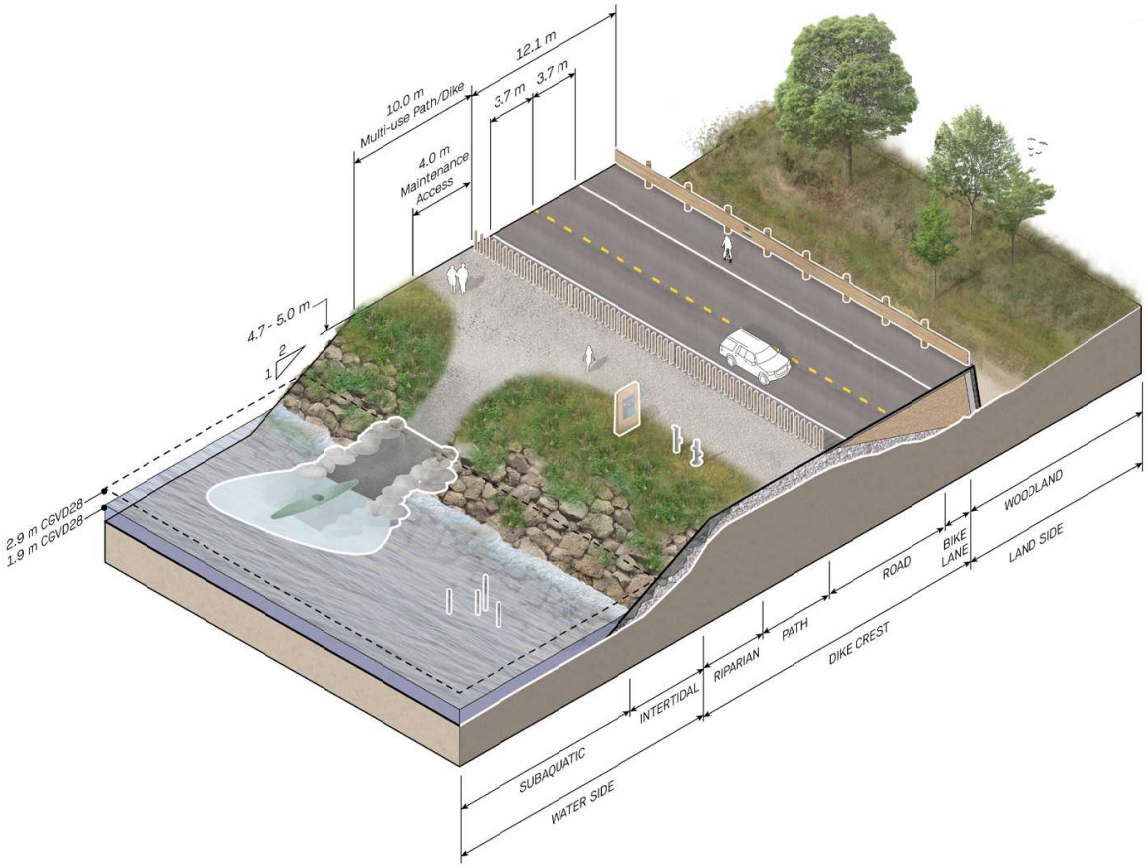
PHASE 4, OPTION 2

RAISE DIKE AND ROAD WITH RETAINING WALLS (REACH 4)

Constrained road shoulder provides opportunities for mediating traffic speeds and providing access to adjacent areas:

- explore use of special barrier to provide safety at retaining wall while reducing vehicle speeds for people on bikes and contributing to local character;
- provide safe division between roadway and path to make most of path experience
- key areas of riverfront could be provided with access for non-motorized boating, observation, or interpretive feature at location higher up the river;

PWT - 249



Phase 4, Fig 3-3

DIKE TYPOLOGIES

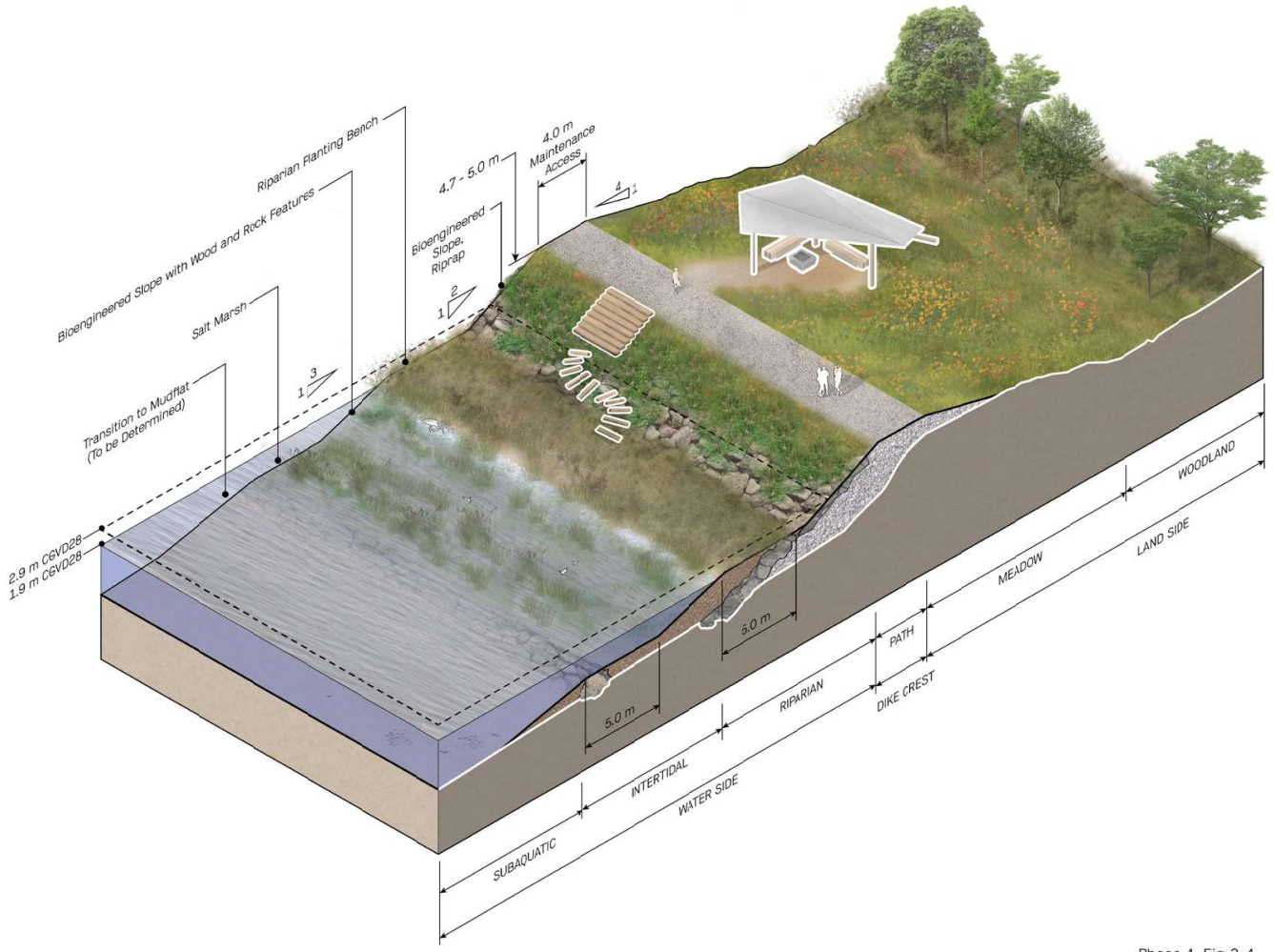
PHASE 4, OPTION 3

RAISE DIKE ONLY AND EXTEND RIVER-SIDE (REACHES 4-6)

Highly naturalized condition with opportunity for public engagement with river ecology and dike enhancement:

- provide public gathering elements to encourage public use of special conditions;
- provide access off of dike crest where appropriate, consider natural play features;
- enhance connections to bog forest, riverside pullout areas, and intertidal habitat through sensitive pathways and connections that augment natural spaces with a public engagement component.

PWT - 250



Phase 4, Fig 3-4

DIKE TYPOLOGIES

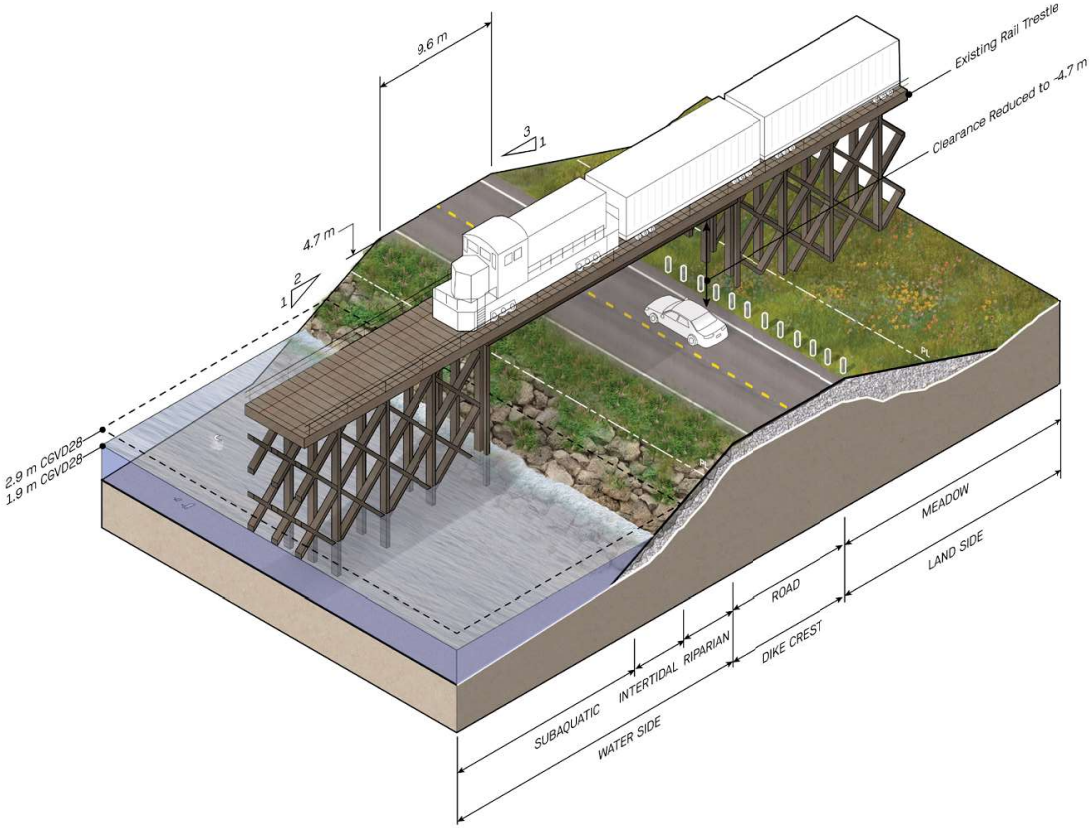
PHASE 4, OPTION 6

RAIL TRESTLE - RAISE ROAD / DIKE UNDER TRESTLE (REACH 4)

Constrained roadway under rail trestle:

- look to routing path around area, possibly nearer bog forest;
- explore innovative approaches to the trestle under structure including public art or incorporated wayfinding;
- provide lighting and barriers around structure for protection but also to draw attention to its unique character.

PWT - 251



Phase 4, Fig 3-5

DIKE TYPOLOGIES

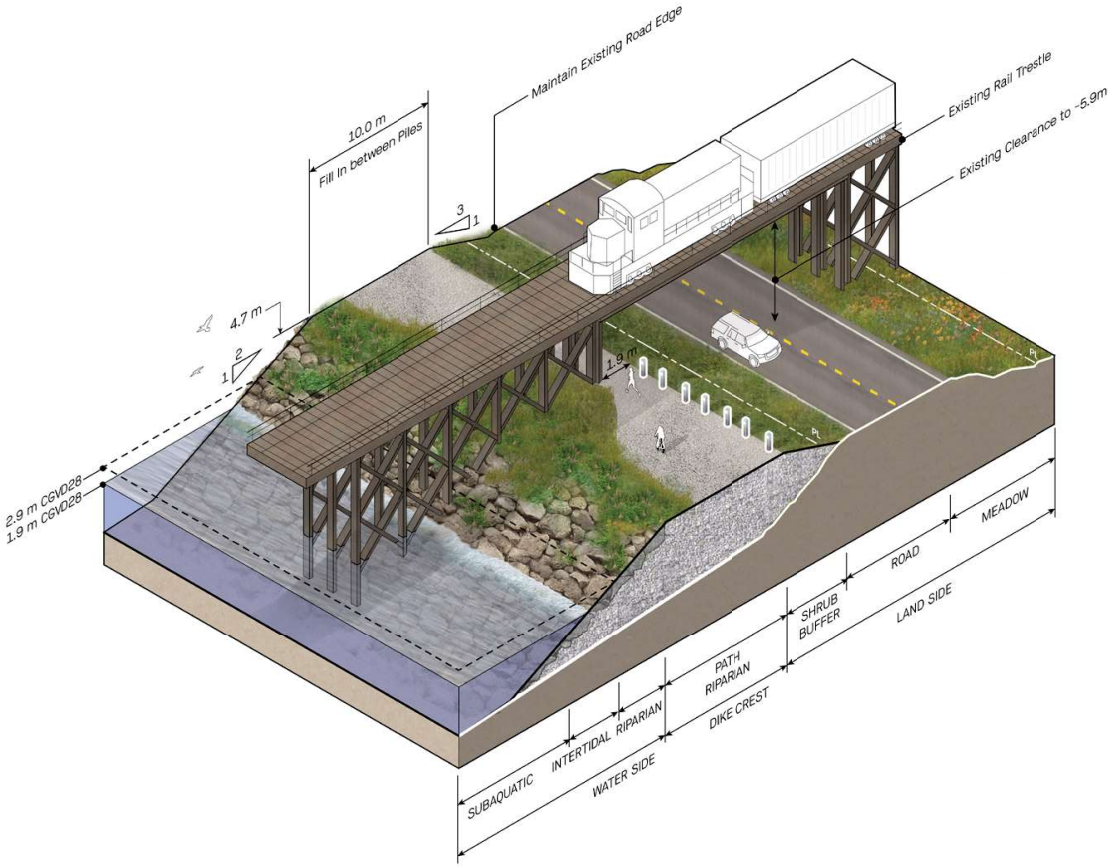
PHASE 4, OPTION 7

RAIL TRESTLE - FILL IN-BETWEEN TRESTLE PILE (REACH 4)

Path below rail trestle on water side:

- rail trestle and river provide excellent opportunities for incorporating public art or wayfinding features;
- wide path funnels into narrower space at trestle to encourage people on bikes to dismount and others to proceed with caution but also enjoy the unique character of the train line;
- provide bollards for pedestrian safety and protection of structure.

PWT - 252



Phase 4, Fig 3-6

Attachment 2

City of Richmond

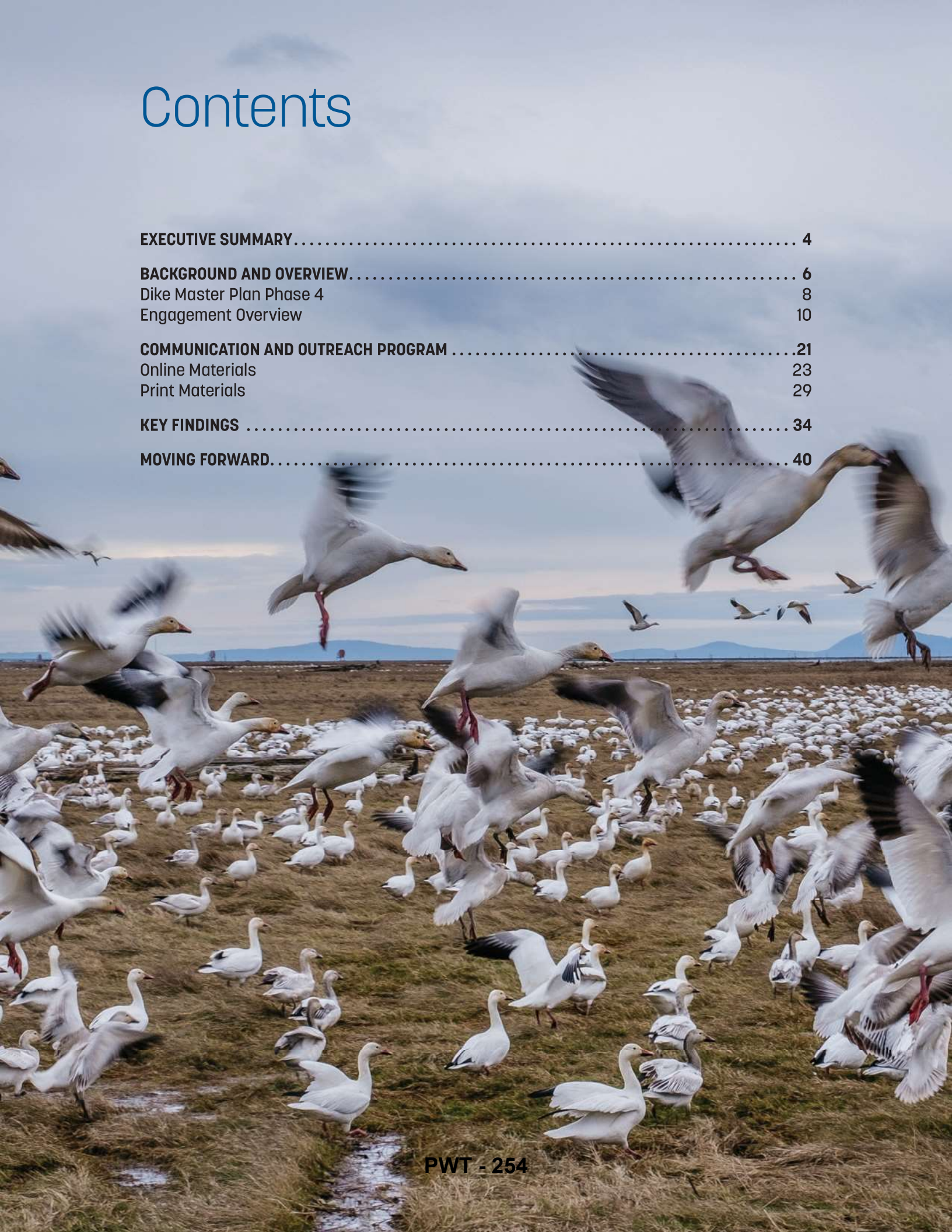
FLOOD PROTECTION

What We Heard Report

November 2022

Richmond

Contents



List of Figures

Executive Summary

This report summarizes the public engagement that was conducted for the City of Richmond's flood protection program and *Dike Master Plan Phase 4*. The engagement campaign was carried out over a five-month period from May 2022 to September 2022. The purpose of this outreach and engagement was to:

- Inform residents about the accelerated timelines of the flood protection program.
- Gauge and improve community awareness of climate change impacts and flood protection plans and initiatives in Richmond.
- Gather feedback on the amenities, features, and design of the upgraded dikes.

The feedback will be used to inform the City's budget process and support the *Dike Master Plan Phase 4 Report*.

The public engagement was designed to reach a wide range of residents and interested parties. Activities included community pop-ups, online and in-person engagement events, the production of online materials, and the development of physical materials that were distributed at in-person events, community venues, and facilities. In total, approximately **1,000 people attended in-person** engagement activities and events. Over **2,000 people participated online**, both through the City's flood protection webpage and a *Let's Talk Richmond* project page that was set up to support community outreach.

Feedback from all engagement activities revealed the following key findings:

The public is aware of the City of Richmond's flood protection measures and is supportive of the City's flood protection work and efforts.

- Residents and other stakeholders found that the public information materials were useful and wanted to learn more.
- Participants were generally aware of Richmond's flood protection work. However, there is room for continued outreach and education on Richmond's flood risk mitigation and management plans, and climate change induced flood risks (e.g., sea level rise, increased frequency and intensity of extreme weather).

The public is supportive of the City of Richmond's accelerated flood protection program and the associated utility rate increases.

- Residents and stakeholders were fully supportive of Richmond's plan to expedite flood protection improvements projects and the associated rate increases.
- Many residents and other stakeholders would like to stay involved/up to date on future implementation work and detailed planning work.

The public is most supportive of upgrades that provide other community benefits and amenities.

- Environmental features (e.g., habitat areas and habitat benches), recreational amenities (e.g., seating, bike racks, signage – wayfinding and information), and multi-modal transportation improvements (e.g., separated bike lanes, improved wayfinding and walking paths) are the most highly rated and sought-after features for new and upgraded flood protection measures.
- Many participants would like to see improvements to pedestrian and bicycle safety along River Road.

Comments received during the public engagement for the 2018 Dike Master Plan Phase 2, 2019 Dike Master Plan Phase 3, and 2019 Dike Master Plan Phase 5 were generally consistent with the feedback received during the engagement for this project. In particular, the topics of proactive planning and flood protection improvements, dike aesthetics and recreational use, and environmental and habitat considerations.

During the public engagement for Dike Master Plan Phase 2, Phase 3 and Phase 5, comments and questions were received regarding climate science and climate change projections. Such questions and comments were not received during this round of outreach and engagement. Anecdotally, in-person public engagement reported more conversations around people's personal experiences of climate change-related incidents, including the November 2021 atmospheric rivers and flooding, the June/July 2021 heat dome and wildfires, and the 2020 wildfires and smoke/air quality issues. Collectively, these direct and personal experiences with climate change impacts and the climate emergency are enhancing public awareness of climate change and reinforcing public support for Richmond's accelerated flood protection program.

Background and Overview

Surrounded by the Fraser River and the Strait of Georgia, the City of Richmond is situated approximately one metre above sea level and is subject to flood hazards, such as climate change induced sea level rise. Richmond is planning for 1 metre of sea level rise by 2100. During this same period, land in Richmond is expected to subside by 0.2 metres.

The City currently has 49 kilometres of dikes and 39 drainage pump stations that can withstand high water events, such as spring freshet, storm surges, and king tides and are designed to handle an extreme 1:500 return period Fraser River freshet events. Upgrades of the City's flood protection system are required to protect the City's residents, infrastructure, and economic vitality.

Richmond's Flood Protection Management Strategy and dike master plans provide a guiding framework for upgrades and improvements to this flood protection system and to address climate change-induced sea level rise and heightened flood risks. Dike Master Plan Phase 4 (DMP4) provides flood protection from the north arm of the Fraser River and spans from No. 6 Road to Boundary Road.

Currently, Richmond is focusing on raising the perimeter dikes from, on average, 3.5 metres to 4.7 metres. The City recently accelerated the implementation timeline for its flood protection program from 75 years to 50 years to improve diking infrastructure in advance of currently anticipated climate change impacts. The strategy plans for approximately 1 km of dikes being upgraded per year and may be further accelerated if sea level rise intensifies.

From May 2022 to September 2022, the City of Richmond carried out a public engagement campaign on the City's flood protection work and DMP4. The purpose of this outreach and engagement was to:

- Inform residents about the accelerated flood protection program.
- Gauge and improve community awareness of flood protection and climate change impacts and plans in Richmond.
- Gather feedback on the amenities, features, and design of the upgraded dikes.

This report summarizes the engagement campaign and key findings that emerged about participants' awareness and support of the flood protection program and their ideas of how dike upgrades could simultaneously address other community and user needs.

FLOOD PROTECTION INFRASTRUCTURE

49 KM OF DIKES

39 DRAINAGE PUMP STATIONS

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DIKE MASTER PLAN PHASE 4

DMP4 is the final phase of a five-phase plan to upgrade the City's dikes to prepare for sea level rise, climate change, and flood impacts. Phases 1-3 and 5 are completed. DMP4 encompasses the north dike between No. 6 Road and Boundary Road, which is a unique area given it is largely agricultural with few residences and businesses, including both marine businesses on the Fraser River and some industrial operations.

DMP4 recommends the following typical dike upgrade approaches:

- Separated dike and road.
- Standard dike in areas without existing roads.
- Superdike (land behind the dike built up to the same elevation as the dike itself).

Ongoing dike upgrades around the City of Richmond, including those included in DMP4, provide ample opportunity to engage with the public about challenges and opportunities that are posed by sea level rise and other climate change impacts. Additional future public engagement will also shape how the upgrades are enacted.

The figure illustrates locations for each phase of the dike master plan and the year completed.

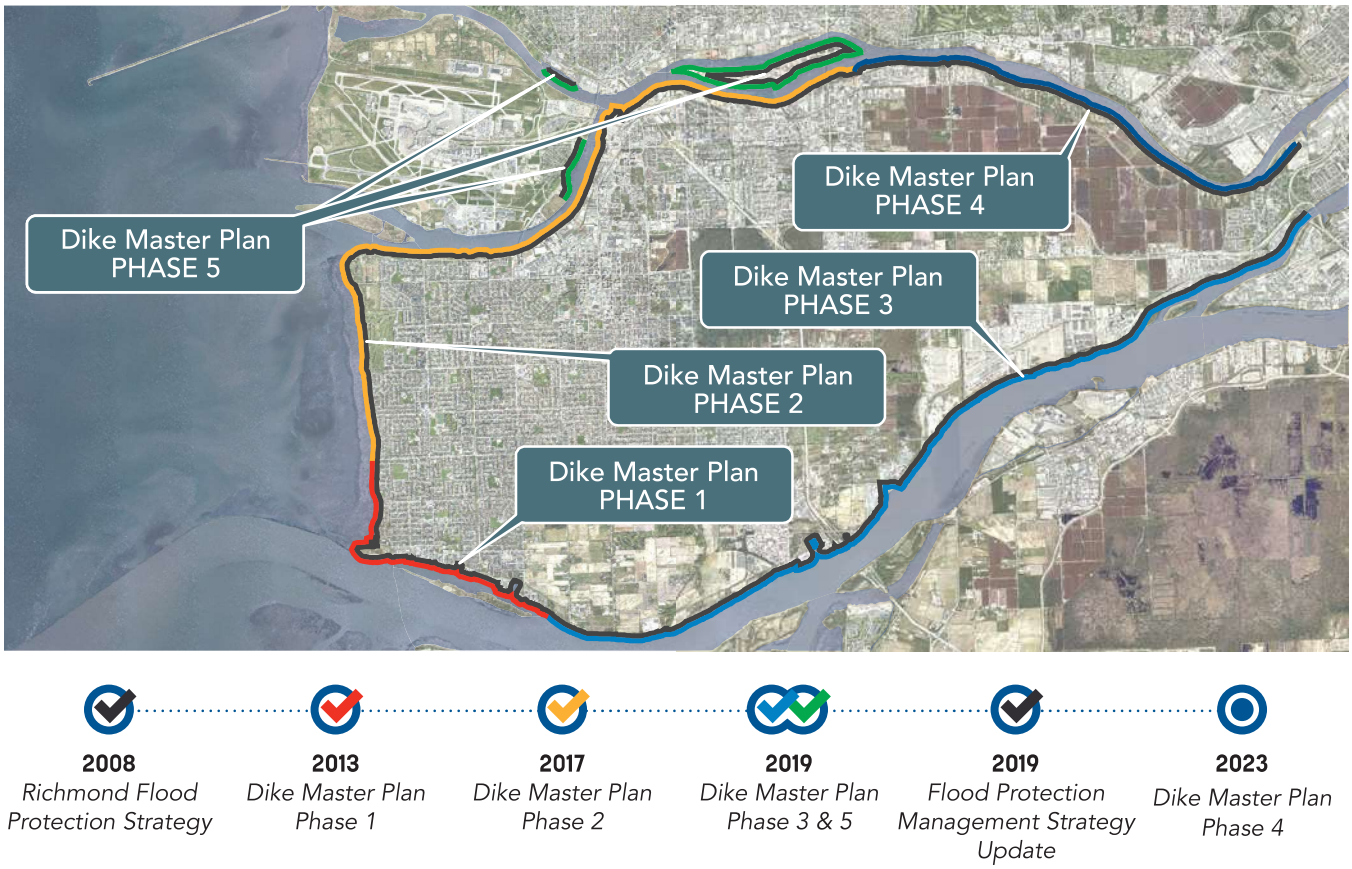

FIGURE 1: *Dike Master Plan Timeline*

RICHMOND FLOOD PROTECTION

TIMELINE

FUNDING: The City of Richmond has been successful in securing senior government grants that have helped fund flood protection improvements

PUMP STATION UPGRADES AND REBUILDS:

2000-2005	2006-2010	2011-2015	2016-present
· Peace Arch	· Francis Road West	· No. 4 Road North	· No. 2 Road North
· Tipping Road South	· Cambie Road West	· Williams Road	· Horseshoe Slough
· No. 1 Road South	· Comstock Road	· No. 1 Road North	· Shell Road Slough
· Gilbert Road North	· Gilbert Road South	· Bath Slough	· No. 7 Road South
	· Duck Island	· Woodward Slough	· Steveston Hwy & Gilbert Road
			· Steveston Hwy & No. 3 Road

FIGURE 2: *Richmond flood protection timeline*

ENGAGEMENT OVERVIEW

Community engagement and outreach took place over a five-month period from May 2022 to September 2022.

Engagement was designed to reach a wide range of residents and interested parties. Engagement activities in this phase included community pop-ups, online, and in-person engagement events and the production of a wide range of new information materials that were distributed online at in person events, and at different community venues and facilities. Engagement included the following, which are also summarized in the following figure.

- 5 community pop-ups (Emergency Preparedness Week, Kwantlen Street Farmers Market, Steveston Farmers & Artisans Market, Burkeville Daze, "Island City, by Bike" tour)
- 2 in-person open houses (Hamilton Community Centre)
- 3 bus tours (Works on Wheels)
- 4 online Community Conversation engagement sessions
- 1 elementary school presentation
- 1 walking tour (Walk Richmond)
- Updated and expanded flood protection page on Richmond.ca
- LetsTalkRichmond.ca flood protection project page
- 1 new Flood Protection StoryMap

RICHMOND FLOOD PROTECTION

ENGAGEMENT AND COMMUNICATIONS SUMMARY

1
PROJECT OPEN HOUSE
at Hamilton Community Centre
40+ participants

6
COMMUNITY POP-UPS
1000 visitors

4
COMMUNITY CONVERSATIONS
online

3
WORKS ON WHEELS BUS TOURS
66 paricipants

100+
DOOR-TO-DOOR VISITS
in Hamilton / River Road area

5
NEW FLOOD PROTECTION INFORMATION PRODUCTS
print and online

36
SOCIAL MEDIA POSTS
with over 800 engagements

630
ONLINE INTERACTIONS
and over 80 comments from 4 weekly polls, online Q&As, and an interactive mapping tool

1
NEW FLOOD PROTECTION STORYMAP

20
FLOOD PROTECTION LAWN SIGNS
distributed along popular dike trails

1200
UNIQUE VISITS TO LET'S TALK RICHMOND
flood protection page

1
WALK RICHMOND WALKING TOUR
23 attendees

2000
PROJECT POSTCARDS
distributed

28
ELEMENTARY SCHOOL STUDENTS
attended project presentation

10
TRANSIT SHELTER ADS

FIGURE 3: Richmond Flood Protection Engagement Summary

ACTIVITY TYPE	EVENT DETAILS	SUMMARY
Community Pop-ups *In Person* *May 7, 2022 – September 9, 2022*	**Emergency Preparedness Week** Location: Brighouse Fire Hall No. 1 Date: Saturday, May 7 11:00am-5:00pm Visitors: Approximately 200 **Kwantlen Street Farmer's Market** Location: Brighouse Neighbourhood Park Date: Tuesday, May 24 12:00pm-4:00pm Visitors: Approximately 50 **Steveston Farmer's & Artisans Market** Location: 4320 Moncton St Date: Sunday, June 5 10:30am-3:30pm Visitors: Approximately 450 **Island City, by Bike Tour** Location: Minoru Centre for Active Living Date: Sunday, June 12 9:30am – 12:30pm Attendees: 100 **Burkeville Daze** Location: Burkeville Neighbourhood Park Date: Sunday, June 26, 3:00pm-6:00pm Visitors: 40 **Hamilton Night Out** Location: Hamilton Community Centre Date: Friday, September 9 5:30pm-8:00pm Visitors: Approximately 250	· In total, there were approximately 1,000 interactions with residents at the community pop-up events · Passers-by and interested residents had the opportunity to attend or stop by at a pop-up event and learn more about flood protection measures in Richmond, including the DMP4 · Materials included interactive poster boards (with sticky notes and dots to share and vote on ideas), flyers, postcards with a QR code to Richmond.ca, flood protection-themed stickers, and reusable shopping bags · Each pop-up resulted in more community members becoming aware of Richmond's flood protection measures in general, with some becoming informed by interacting with pop-up staff and the poster boards, and some engaging with the DMP4 project by taking materials home to review, leaving a sticky note comment on the poster, signing up for the newsletter, or connecting through the QR code · Hamilton Night Out was one of the busiest events, with approximately 60 public interactions and over 250 people dropping by the tent
Open Houses *In Person* *September 9, 2022*	**Dike Master Plan Phase 4 Community Open House** Location: Hamilton Community Centre Date: Tuesday, June 21 11:30am-1:00pm Participants: 40	· 40 people attended the first open house which included lunch for participants and a project presentation from City staff · Materials included interactive poster boards (with sticky notes and dots to share and vote on ideas), flyers, postcards

ACTIVITY TYPE	EVENT DETAILS	SUMMARY
Blair Elementary School presentation *In Person* *May 17, 2022*	**School Presentation** Location: Blair Elementary School Tuesday, May 17 Students: 28	· City of Richmond staff presented to a grade 5/6 split class · Activities included a presentation, Mentimeter trivia questions, and a drawing exercise.
Walking and bus tours *In person* *May 21, 2022 – June 19, 2022*	**South Dike Walking Tour** Location: South Dike Trail Date: Saturday, May 21 10:00am – 11:00 am Attendees: 23 **Works on Wheels Bus Tour** Location: Richmond Public Works Yard Dates: June 11, 18, and July 9 11:00am – 2:00pm Attendees: 66 (22 each tour)	· Approximately 90 residents participated in the tours. · *Walk Richmond* walking tour was a free guided walk coordinated by the City of Richmond. City of Richmond Staff attended the walk where they shared project materials and spoke about flood management and other areas of interest. · Three interactive *Works on Wheels* bus tours showcasing Richmond's flood protection projects were held in June, and due to popular demand, a third date was held in July · The tours offered a behind-the-scenes visit to a recent dike upgrade, a recently built pump station, and the Britannia flood wall in Steveston · Each tour was fully booked and there were 23 people on the waitlist
Community Conversations *Online* *June 21, 2022 – June 22, 2022*	**Dike Master Plan Community Conversation** Date: Monday, June 20 12:00pm – 1:00pm **Flood Protection Community Conversations** Date: Wednesday, June 22 12:00pm – 1:00pm 2:30pm – 3:30pm Date: Thursday, June 23 12:00pm – 1:00pm	· In total, there were 10 attendees at the Community Conversations · Participants attended an hour-long presentation where staff introduced the City's flood protection program and provided space for discussion and questions · Attendance was limited, but the participants provided positive feedback and were able to ask staff questions about the project

ACTIVITY TYPE	EVENT DETAILS	SUMMARY
Richmond.ca *Online* *May 2022 – September 2022*	Project and flood protection information was available from May 2022 – September 2022 at Richmond.ca, including: · Project overview videos · StoryMap · PDF versions of all information materials	· Approximately 1,957 visitors accessed the Flood Protection materials on the *Let's Talk Richmond* website
Let's talk Richmond *Online* *May 2022 – September 2022*	Online opportunities for engagement and information were available from May 2022 – September 2022 at LetsTalkRichmond.ca **Engagement tools:** · Weekly polls · Question and Answer · Mapping tool	· Approximately 848 visitors accessed the Flood Protection materials on the *Let's Talk Richmond* website · Interactive tools available on the website included an ArcGIS StoryMap, weekly polls, interactive mapping features, videos, downloadable information write-ups and a place to ask questions
Advisory Committee on the Environment	Location: Richmond City Hall May 11, 2022	· 13 committee members · Members offered their feedback of their priorities based on the Advisory Committee mandate

FIGURE 4: *Steveston Farmers Market Community Pop-up*

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FIGURE 5: *Community Pop-up at Emergency Preparedness Week*

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FIGURE 6: *Burkeville Daze Community Pop-up*

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FIGURE 7: *Blair Elementary School presentation*

FIGURE 8: *Blair Elementary School student drawings envisioning flood protection in the City of Richmond*

FIGURE 9: *Works on Wheels bus ride and site visit*

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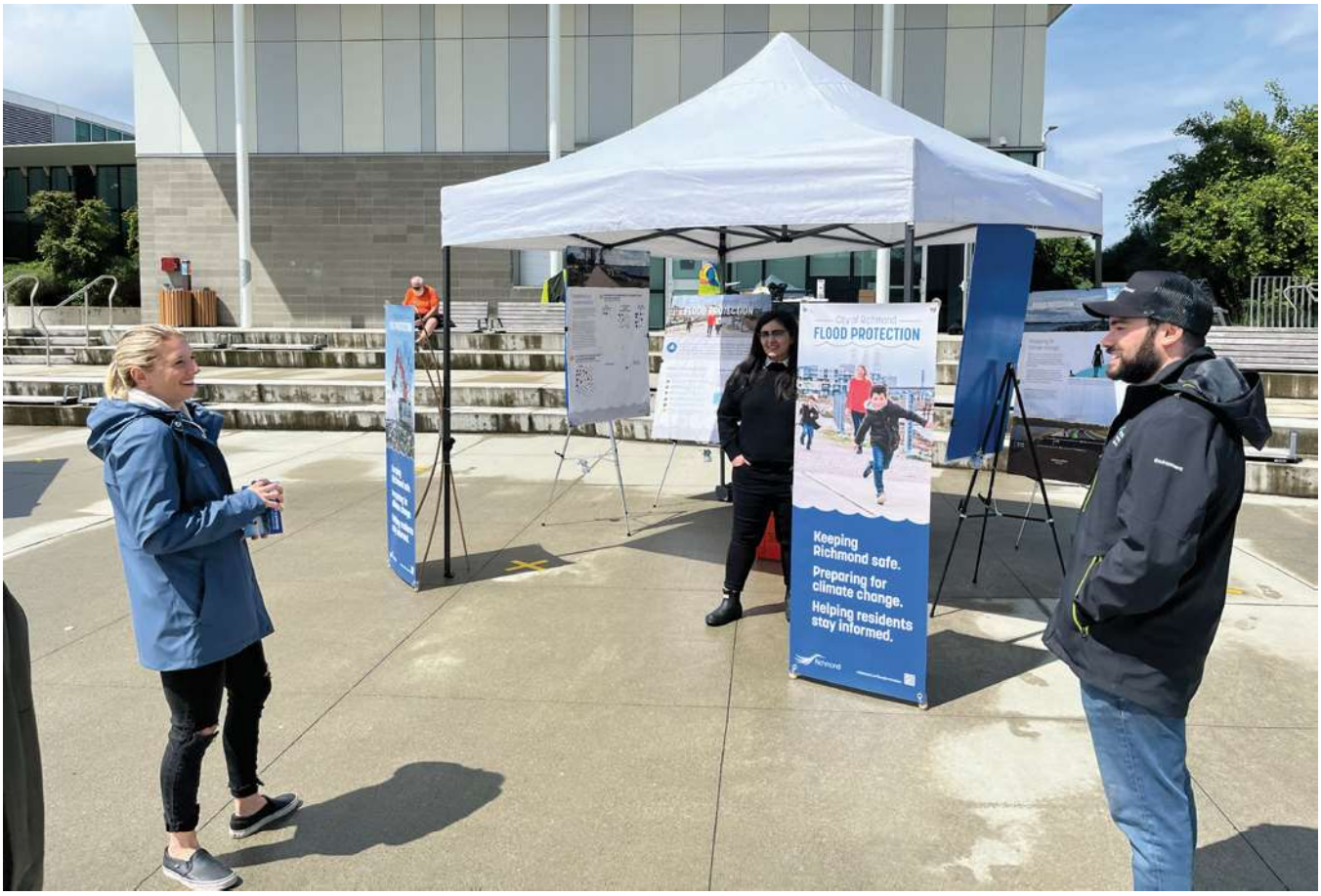


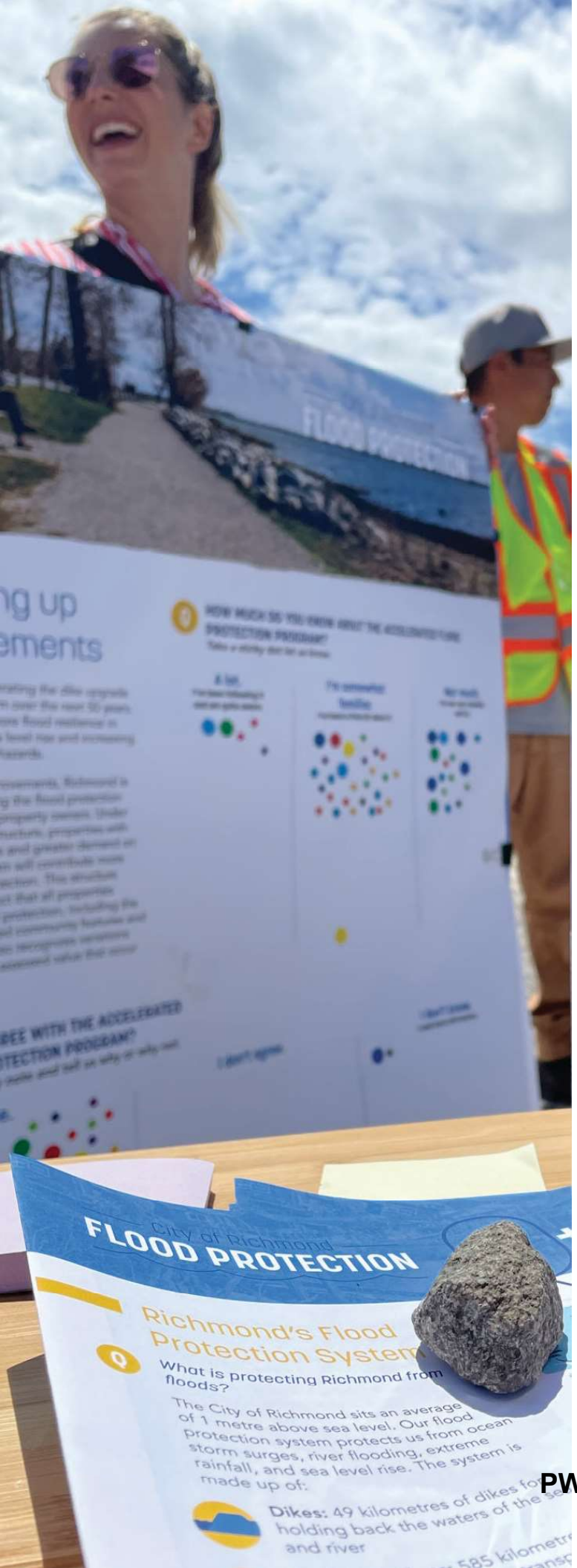
FIGURE 10: *Posters at the Island City bike tour*

PWT - 271

FIGURE 11: *Dike Master Plan Phase 4 Community Conversation*

FIGURE 12: *Final Open House at Hamilton Community Centre, marking the end of a successful engagement and outreach period*

PWT - 272



Communication and Outreach Program

From May 2022 to September 2022, staff ran a communications and outreach program to share information about Richmond's flood protection program and to promote outreach events and activities. Materials included:

- Social media posts
- Updated and expanded flood protection page on Richmond.ca
- LetsTalkRichmond.ca flood protection project page
- A new flood protection StoryMap
- Five new Flood Protection information products – print and online (Fact Sheets, Q&A, Richmond Flood Protection Overview in English and Traditional Chinese, Flood Protection Timeline)
- Transit shelter ads
- Lawn signs
- Postcards

FIGURE 13: Summary timeline of the communications and outreach program

COMMUNICATIONS AND OUTREACH PROGRAM SUMMARY TIMELINE	APR	MAY	JUN	JUL	AUG	SEP
Online Materials						
Social Media						
Richmond.ca Flood Protection						
Let's Talk Richmond Flood Protection						
E-Newsletter						
Print Materials for Distribution						
Postcards						
Information materials						
Print Materials for Promotion						
Transit Shelter Ads						
Lawn Signs						

Communication and outreach materials are described in the following sections.

ONLINE MATERIALS

City of Richmond staff used online materials to share information with the public about flood hazards and protection measures in Richmond and to promote engagement events and other project updates. The purpose of many of the online materials was also to create a Flood Management information hub to be updated and added to as Richmond implements the Flood Protection Management Strategy.

Richmond.ca Flood Protection

The flood protection webpage at Richmond.ca is a hub for all things related to flooding and flood protection in the City of Richmond. In addition to project overview videos and a new flood protection StoryMap, the site also includes PDF versions of all information materials (fact sheets, Q&A, flood protection overview flyers, etc.).

FIGURE 14: *The City of Richmond's Flood Protection animation*

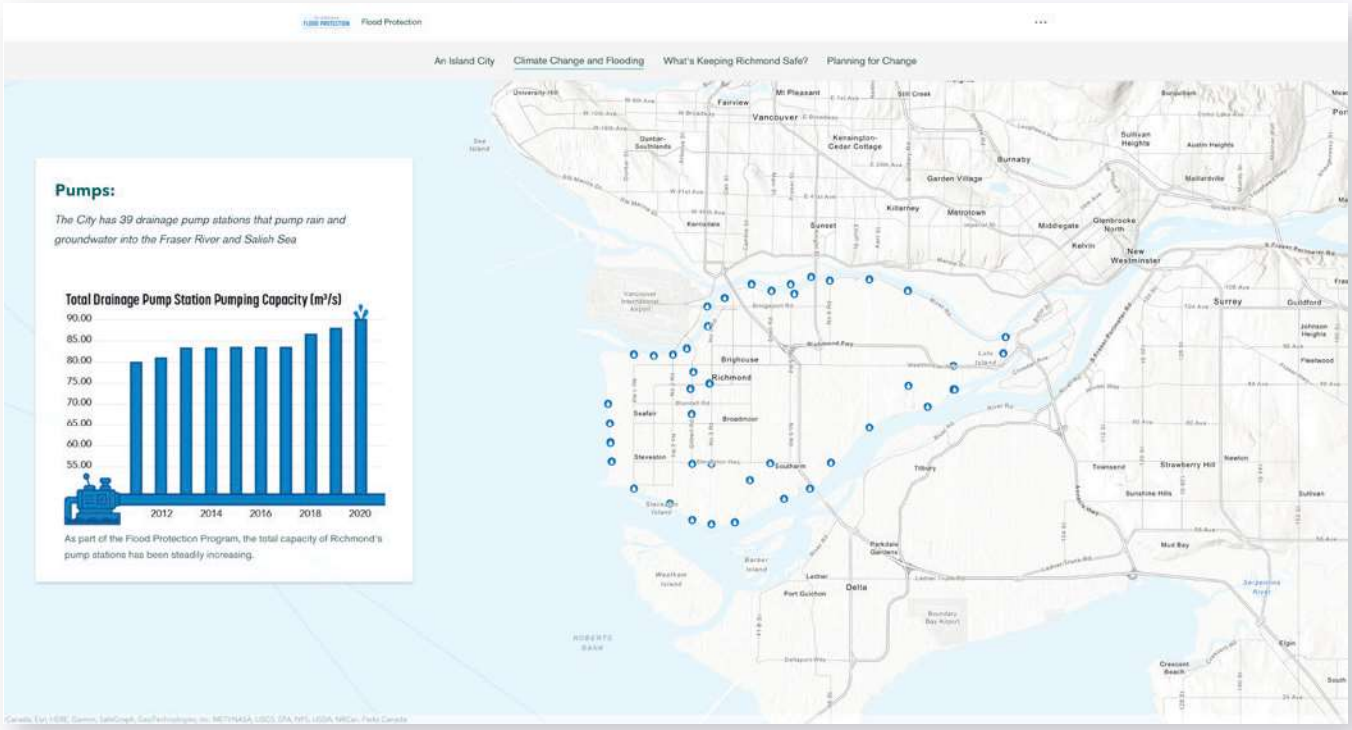
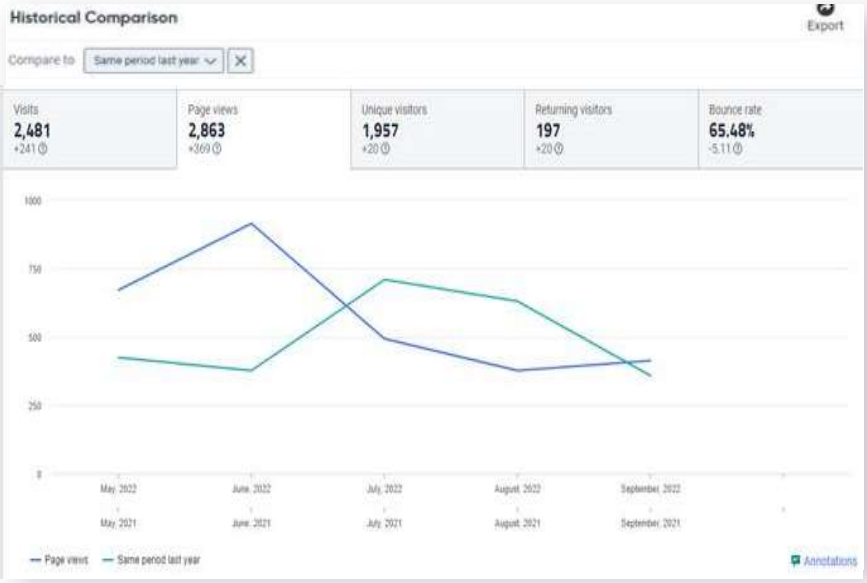


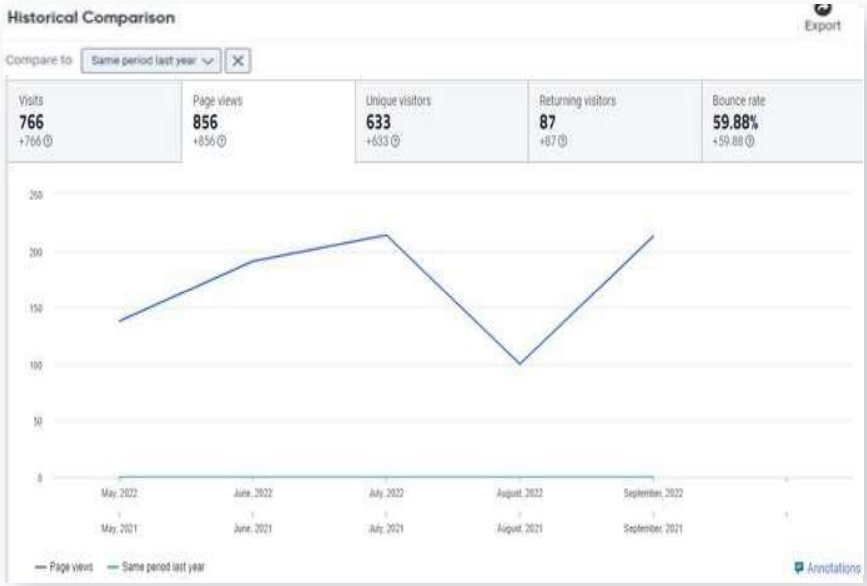
FIGURE 15: *Image of Richmond's flood protection StoryMap providing information about the City's drainage pumps. An ESRI StoryMap is a web map that has been thoughtfully created, given context, and provided with supporting information so it becomes a stand-alone resource. It integrates maps, legends, text, photos, and video and provides functionality, such as swipe, pop-ups, and time sliders, that helps users explore this content.*

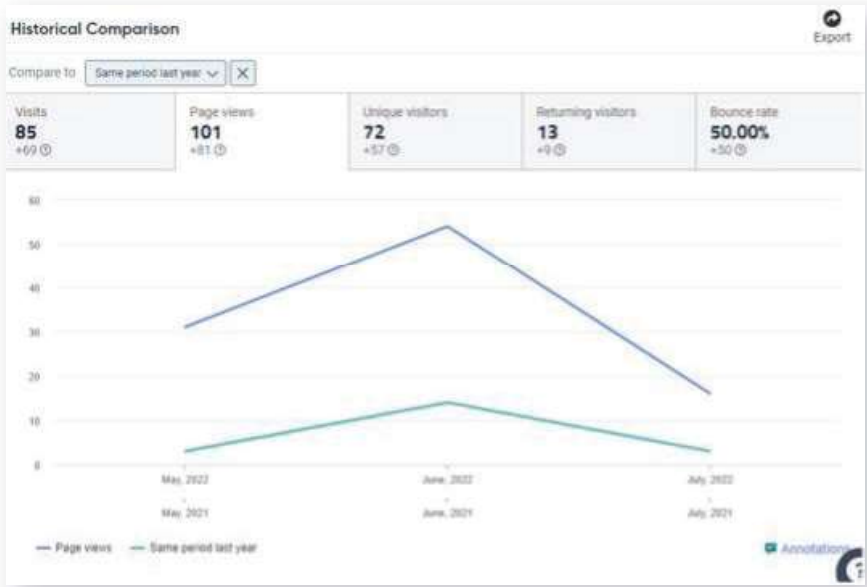
From May to mid-September 2022, the total number of page views was 369 more than this same period in 2021. In total, there were 2,863 views and 1,957 unique visitors. Views peaked at the beginning of June when outreach efforts and engagement events were highest.

The page also included links to the Dike Master Plan webpage and the Flood Protection Strategy. A new webpage, the Dike Master Plan page experienced 856 page views from 633 unique visitors who visited the site between May and September 2022. Dike Master Plan views peaked in July. From May to July 2022, the Flood Protection Strategy had 101 page views from 72 unique visitors.

The Richmond.ca Flood Management webpage also included a link to the *Let's Talk Richmond* flood protection page, where visitors could learn more about the project and provide input and feedback on flooding and flood management in Richmond.







TOP FIGURE 16: *Number of page visits to the main Richmond.ca Flood Management hub: https://www.richmond.ca/services/rdws/dikes.htm*

MIDDLE FIGURE 17: *Number of page visits to the Dike Master Plan webpage (May 2022 – September 2022)*

BOTTOM FIGURE 18: *Number of page visits to the Flood Protection Strategy*

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Let's Talk Richmond Flood Protection

May 2022 – September 2022

In mid-May, an informative and interactive webpage about flood protection went live on the City of Richmond's engagement website, *Let's Talk Richmond*. The *Let's Talk Richmond* Flood Protection webpage is a place to "Learn about events and opportunities to have your say" (an online stakeholder engagement service). Here, visitors could learn more about Richmond's flood protection measures and the accelerated flood protection program by reading informational materials, or become engaged by participating in interactive tools that included:

- Weekly quick polls about knowledge of flood management and support for the accelerated program
- A mapping tool to indicate places for amenities and features to priorities with the dike upgrades
- A place to submit specific questions for the project team to answer

Since going live, the webpage experienced a steady flow of visitors daily, with a peak of 104 in a single day near the beginning. As of September 20, more than 1,000 people visited the *Let's Talk Richmond* Flood Protection webpage at least once. Of these visitors, more than 260 learned about the project by clicking on informational materials, while more than 90 participated by interacting with the tools.

Climate Change and Flooding

FACTSHEET SERIES

The City of Richmond is a collection of islands with an average height of 1 metre (3 feet) above sea level and is part of the historic floodplain of the Fraser River. The City relies on a network of dikes, pumps, and other systems to protect it from flooding. Richmond is exposed to flooding from the river, the ocean, and from heavy rainfall events. Sea levels are rising due to global warming, and the frequency and intensity of storms are increasing. As climate change continues, Richmond's exposure to coastal and river flood hazards will increase.

Richmond Flood Hazards

SEA LEVEL RISE

With climate change, warmer temperatures melt glaciers and ice caps and increase the temperature of the ocean, causing water to expand. As a result, global sea levels are rising. Sea level rise increases flood risks posed by:

- **king tides:** the highest tides of the year;
- **coastal storm surges:** high tides mixed with high water levels caused by wind and waves.

The Province of British Columbia advises municipalities to plan for 1 metre of sea level rise by 2100. During this same period, land in Richmond is expected to move downwards by 0.2 metres as land settles into the Fraser River delta.

FRESHET

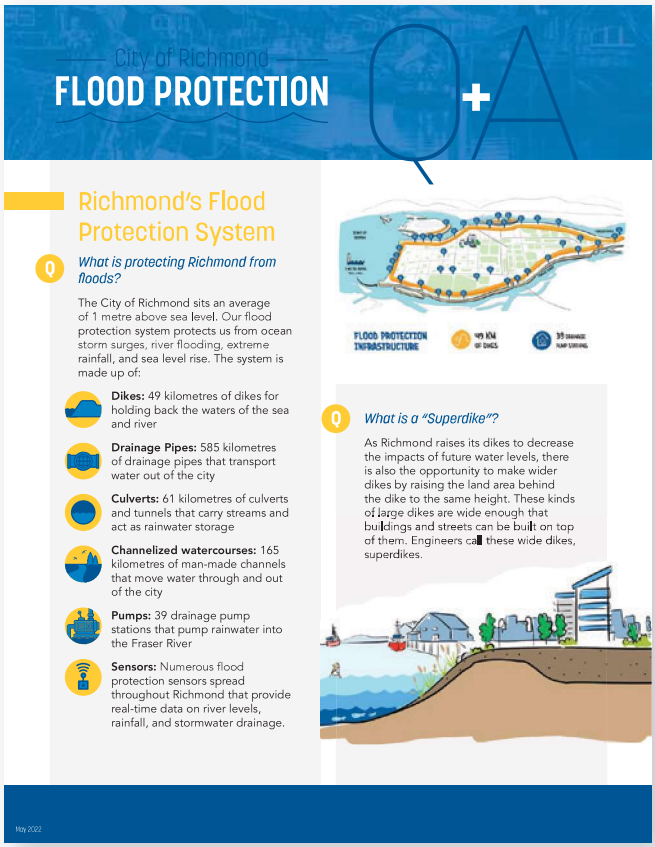
Freshet is the term used to describe river floods caused by snowmelt that typically occurs in the spring. Changes in snowmelt and precipitation patterns in the Fraser Basin are expected to contribute to larger and more frequent floods on the Fraser River. Sea level rise will heighten water levels in the lower Fraser River during spring freshet.

RAINFALL

Over the past 20 years, the average intensity of rainfall events in Richmond has increased by approximately 15 per cent. With climate change, this trend is expected to continue. Extreme rainfall events can increase the flow, speed, and height of the water in the Fraser River.

▲ *SALISH SEA RISING: A child born today can expect 50 centimetres of sea level rise by the time they're 30 and 1 metre by the time they are 80. The lighter shaded area shows a higher range of sea level rise that could occur if global emissions reduction targets are not met.*

▲ *RICHMOND ATMOSPHERIC RIVER: The atmospheric river events that hit the province in November 2021 are examples of extreme rainfall events that can lead to flooding. While Richmond did not experience the same level of rainfall or flooding as some areas of the Fraser Valley, it did receive over 130 millimetres of rain in a three-day period, which is the biggest storm Richmond has faced in half a century. The image shows the flooded low-lying park fields around Walter Lee elementary during the atmospheric river events in November 2021. Low lying areas like this park help store excess rainwater during extreme events and will drain when the system has capacity to do so. Carlos Silva photo, via Twitter.*



City of Richmond

FLOOD PROTECTION

Q + A

Richmond's Flood Protection System

Q *What is protecting Richmond from floods?*

The City of Richmond sits an average of 1 metre above sea level. Our flood protection system protects us from ocean storm surges, river flooding, extreme rainfall, and sea level rise. The system is made up of:

- **Dikes:** 49 kilometres of dikes for holding back the waters of the sea and river
- **Drainage Pipes:** 585 kilometres of drainage pipes that transport water out of the city
- **Culverts:** 61 kilometres of culverts and tunnels that carry streams and act as rainwater storage
- **Channelized watercourses:** 165 kilometres of man-made channels that move water through and out of the city
- **Pumps:** 39 drainage pump stations that pump rainwater into the Fraser River
- **Sensors:** Numerous flood protection sensors spread throughout Richmond that provide real-time data on river levels, rainfall, and stormwater drainage.

FLOOD PROTECTION INFRASTRUCTURE

Q *What is a "Superdike"?*

As Richmond raises its dikes to decrease the impacts of future water levels, there is also the opportunity to make wider dikes by raising the land area behind the dike to the same height. These kinds of large dikes are wide enough that buildings and streets can be built on top of them. Engineers call these wide dikes, superdikes.

May 2022

FIGURE 19: *Frequently asked questions and facts sheets made available at the Richmond.ca and Let's Talk Richmond Flood protection webpages*

Aware, Informed, Engaged – What it means on the web

AWARE: An aware visitor has made at least one single visit to the project webpage project.

INFORMED: An informed visitor has taken the 'next step' from being aware if they:

- *Viewed a video*
- *Viewed a photo*
- *Downloaded a document*
- *Visited the Key Dates page*
- *Visited a FAQ list page*
- *Visited multiple project pages (that means clicking from one project into the next or clicking on pages within the project, for example into a forum discussion)*

ENGAGED: Every webpage visitor that contributes to a tool is noted as being 'engaged' if they:

- *Contributed to a Forum*
- *Participated in a Survey*
- *Participated in Quick Polls*
- *Posted a comment on the guestbook*
- *Asked Questions*
- *Placed Pins on Maps*
- *Contributed to Ideas*

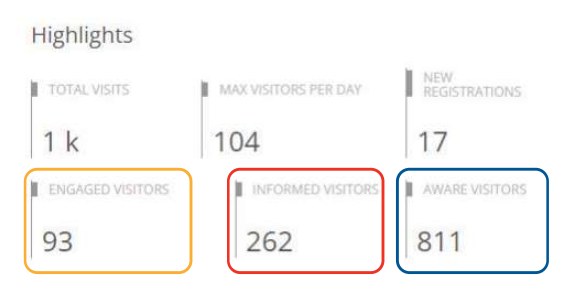


FIGURE 20: *Highlights of visitor interactions with Let's Talk Richmond Flood Protection webpage (May 2022 – September 2022)*

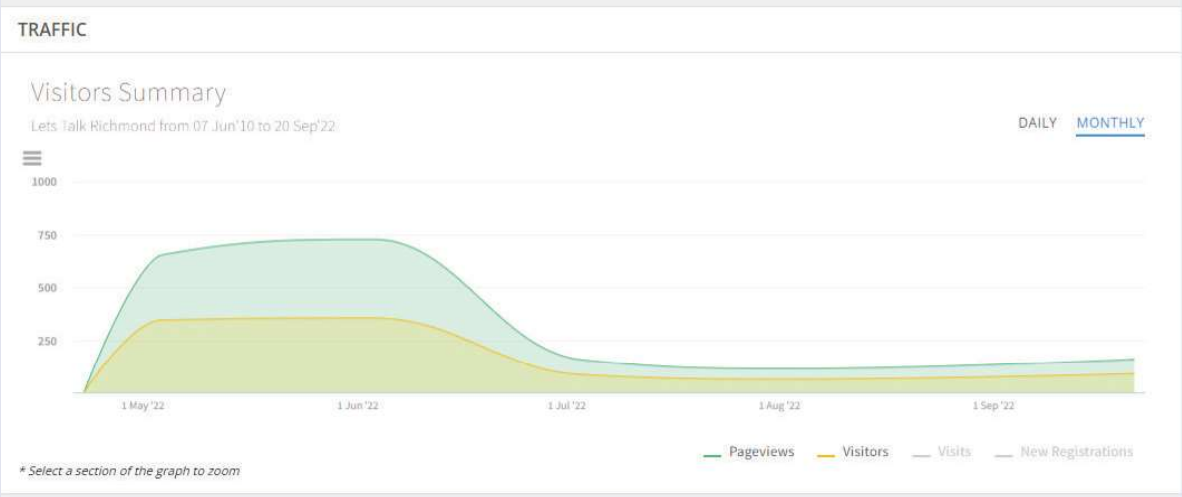


FIGURE 21: *Visitors to Let's Talk Richmond Flood Protection webpage, by month (May 2022 – September 2022)*

FIGURE 22: *Summary of visitors to the Let's Talk Richmond Flood Protection webpage. By September 20, 811 people visited the webpage (aware). Of these visitors, 226 clicked on webpage tools (informed), and 93 provided input in the tools (engaged).*

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Social Media

The flood protection project team promoted upcoming engagement events via social media including Facebook, Instagram, and Twitter. Some posts included hyperlinks to a webpage with a full list of upcoming events and opportunities to be in involved. Social media included animated reels and gifs.

In total, between May 11 and September 3, there were 36 social media posts with over 800 engagements (e.g., likes, comments, shares):

- 11 Facebook posts with 312 engagements
- 13 Twitter posts with 251 engagements
- 12 Instagram posts with 239 engagements

Posts that were boosted outperformed non-paid content. The social media content did not generate significant comments or discussion from audiences on the City's social media platforms.

To encourage more engagement, the City of Richmond partnered with the Richmond Public Library to offer participants a change to win a $100 gift card by liking the June 8 Facebook post, following the City's and Library's Facebook pages, and registering for an engagement session.

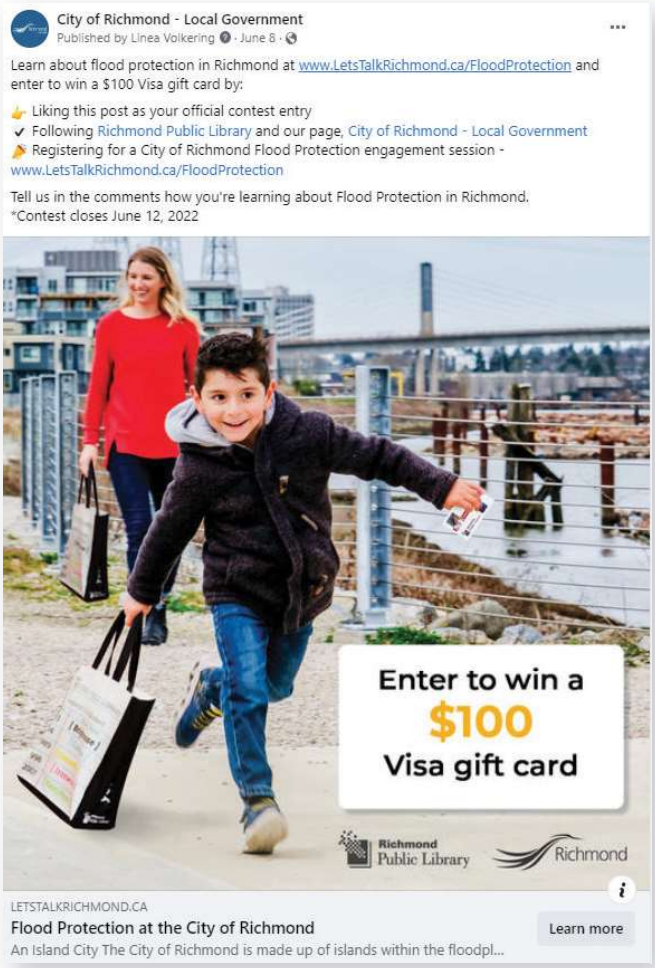

FIGURE 23: *Facebook post example with rules for contest to engage in Richmond Flood Protection Activities and be entered to win a $100 Visa gift card*

FIGURE 24: *Twitter post example*

FIGURE 25: *Instagram post example*

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FIGURE 26: *Instagram story example*

Climate Action E-Newsletter

The City of Richmond's spring Climate Action e-newsletter promoted in-person and virtual event series to raise awareness and understanding of the importance of flood protection in Richmond as a response to climate change. The e-newsletter included a link to the Richmond.ca Flood Protection webpage.

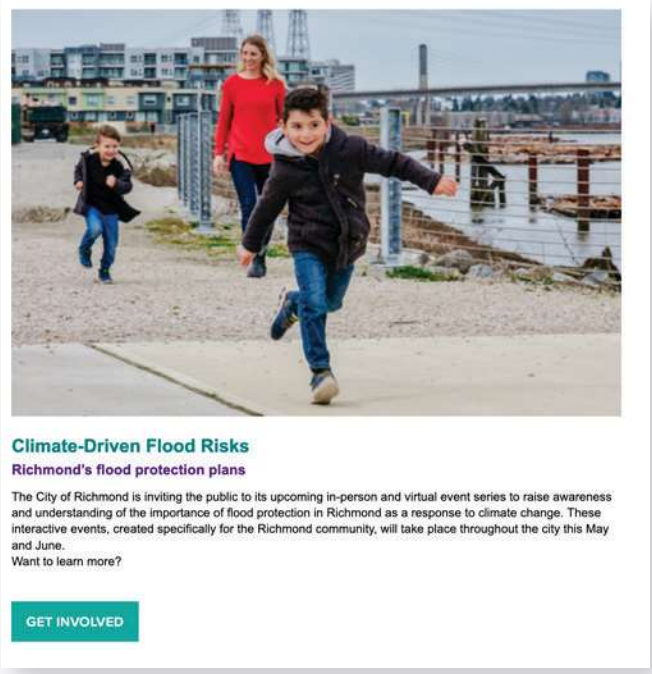

FIGURE 27: *Richmond Flood Protection engagement promoted in the Climate Action spring e-newsletter*

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PRINT MATERIALS

A range of print materials were developed to support outreach and engagement. These materials educated people about local flood hazards and provided information about flood protection and dike upgrades, including the DMP4 process. Materials included:

- Project Postcards
- Fact Sheets (Climate Change and Flooding, Flood Protection and Coastal Ecology)
- Flood Protection Q&A brochure
- Flood Protection Overview (English and Traditional Chinese)
- Flood Protection Timeline

These materials were available for hand out at community pop-ups, for downloading online, and for pick up at community venues (Hamilton Community Centre, Library – Brighouse Branch, City Hall.

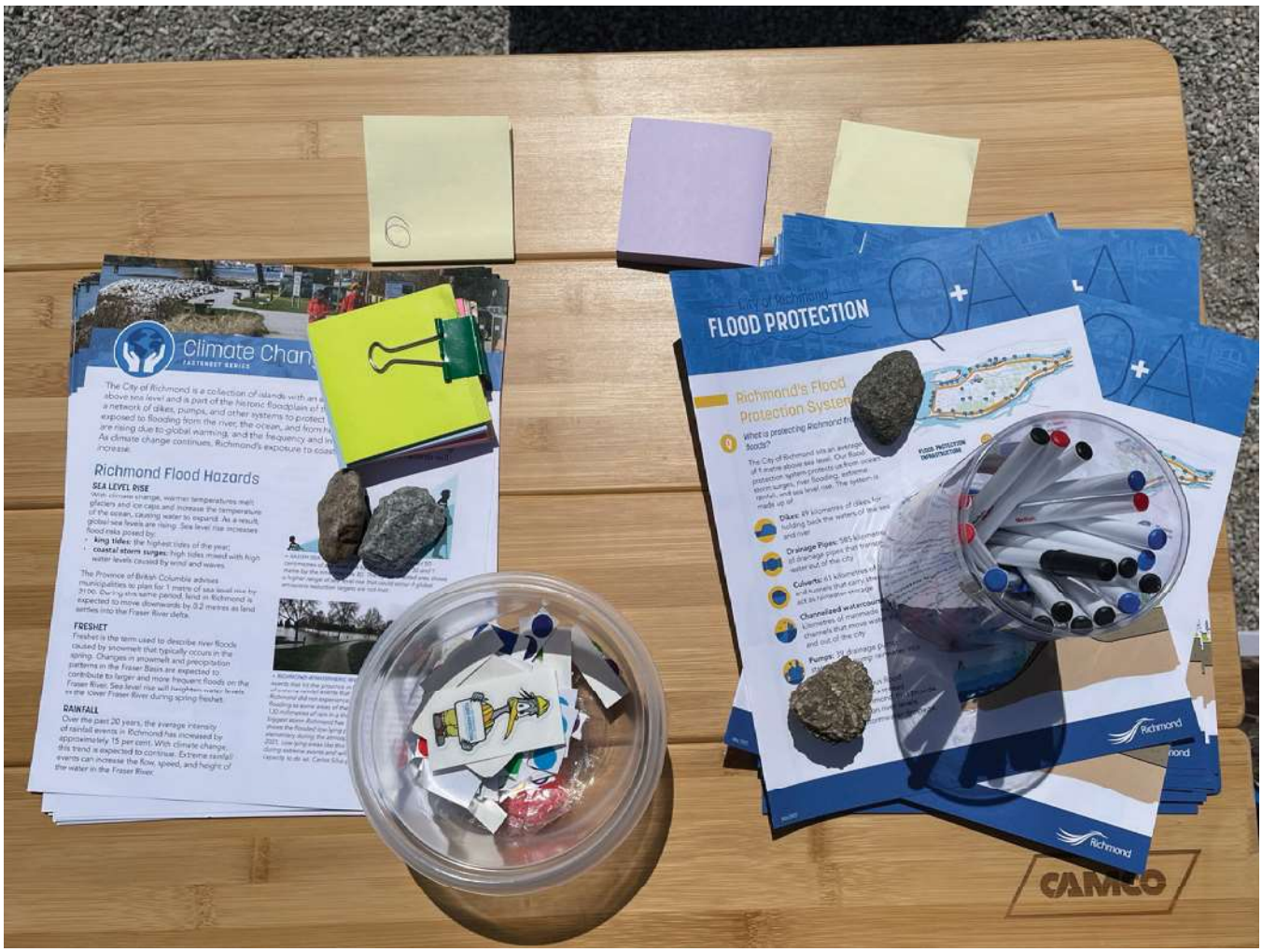

FIGURE 28: *Climate Change Fact Sheet and Flood Protection Q&A brochure*

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Postcards

Approximately 2,000 postcards were distributed with project information and a brief explanation of flood management in the City of Richmond. A QR code linked to more information at Richmond.ca.

The postcards were handed-out at community pop-ups, door-to-door, and at other events around the DMP4 area. They were also available online and for pick up at City Hall.

FIGURE 29: *Front and back of the Richmond flood protection postcard*

Information Flyers

A one-page information flyer that promoted upcoming engagement events and where to find more information about the project. A QR code linked to more information at *Richmond.ca*.

In the Hamilton neighbourhood, City staff went door-to-door distributing the information flyers and postcards. Staff also spoke with residents who were home. In total, approximately 100 households, farms, and businesses were visited.

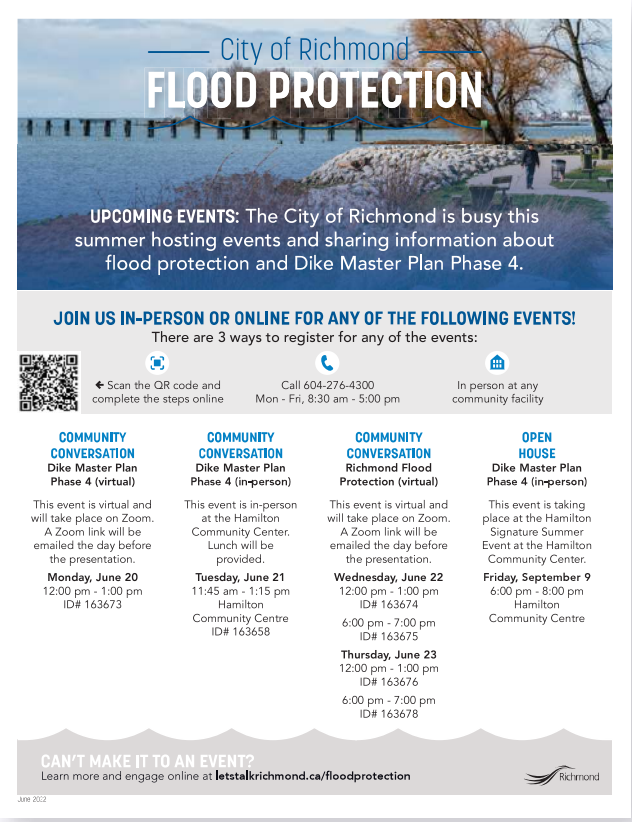

FIGURE 30: *One-pager distributed in the Hamilton neighbourhood*

Posters

A large format 11X17 poster was developed. They provided an overview of the challenges Richmond is facing from climate change-driven flooding and the actions the city has taken to address them. A QR code linked to more information at *Richmond.ca*.

Posters were displayed at the Hamilton Community Centre and other locations, including City Hall and the Brighouse Public Library.

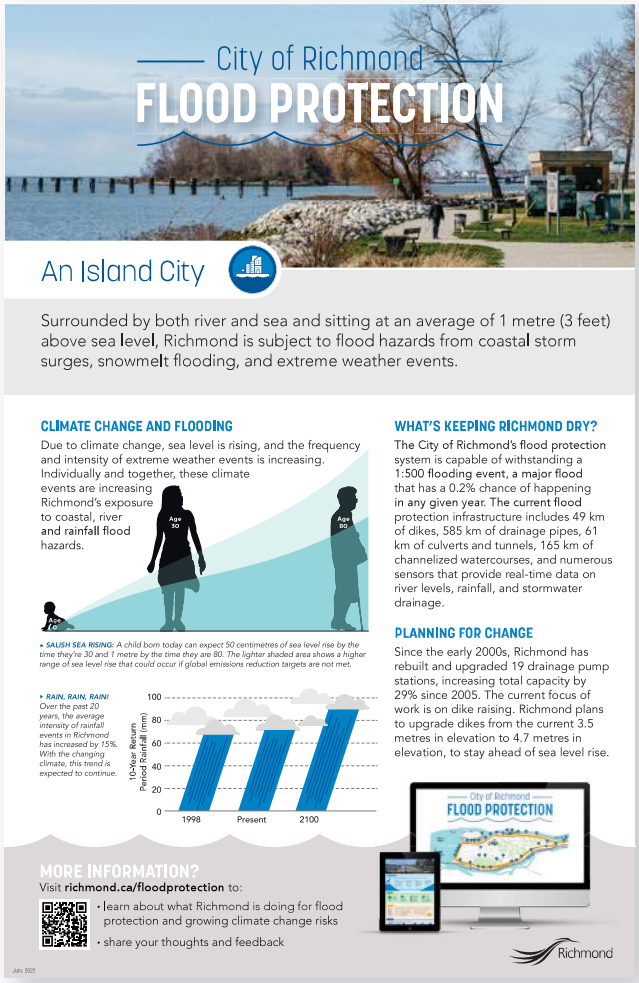

FIGURE 31: *Community poster*

Transit Shelter Ads

From June 2022 to September, ads promoting the project were posted at 10 transit shelters. There was also a digital version that was played on transit shelters with digital ad capability. The transit shelter ads included information about flooding and flood management in the City of Richmond and a link and QR code to the project hub webpage on Richmond.ca.

FIGURE 32: *Transit shelter ads in the community*

FIGURE 33: *Map showing the location of the transit shelters where flood protection materials were posted from June to September 2022*

Lawn Signs

Twenty graphically compelling H-frame lawn signs with a simple "think" message and a QR code that linked to the main project website on *Richmond.ca* were printed for distribution. Signs were in English on one side and Traditional Chinese on the other.

Signs were placed around popular Richmond walking dikes in the project area.

FIGURE 34: *Image of a lawn sign with the message, "Sea levels are rising, Richmond is preparing"*

Key Findings

Feedback from both in-person and online activities determined the following key findings:

The public is aware of the City of Richmond's flood protection measures and is supportive of the City's flood protection work and efforts.

- Residents and other stakeholders found that the public information materials were useful and wanted to learn more.
- Participants were generally aware of Richmond's flood protection work. However, there is room for continued outreach and education on Richmond's flood risk mitigation and management plans, and climate change induced flood risks (e.g., sea level rise, increased frequency and intensity of extreme weather).

The public is supportive of the City of Richmond's accelerated flood protection program and the associated utility rate increases.

- Residents and stakeholders were fully supportive of Richmond's plan to expedite flood protection improvements projects and the associated utility rates.
- Many residents and other stakeholders would like to stay involved/up to date on future implementation work and detailed planning work.

The public is most supportive of upgrades that provide other community benefits and amenities.

- Environmental features (e.g., habitat areas and habitat benches), recreational amenities (e.g., seating, bike racks, signage – wayfinding and information), and multi-modal transportation improvements (e.g., separated bike lanes, improved wayfinding and walking paths) are the most highly rated and sought-after features for new and upgraded flood protection measures.
- Many participants would like to see improvements to pedestrian and bicycle safety along River Road.

Comments received during the public engagement for the 2018 Dike Master Plan Phase 2, 2019 Dike Master Plan Phase 3, and Dike Master Plan Phase 5 were generally consistent with the feedback received during the engagement for this project. In particular, the topics of proactive planning and flood protection improvements, dike aesthetics and recreational use, and environmental and habitat considerations.

During the public engagement for Dike Master Plan Phase 2, Phase 3 and Phase 5, comments and questions were received regarding climate science and climate change projections. Such questions and comments were not received during this round of outreach and engagement. Anecdotally, in-person public engagement reported more conversations around people's personal experiences of climate change-related incidents, including the November 2021 atmospheric rivers and flooding, the June/July 2021 heat dome and wildfires, and the 2020 wildfires and smoke/air quality issues. Collectively, these direct and personal experiences climate change impacts emergency may be enhancing public awareness of climate change and reinforcing public support for Richmond's accelerated flood protection program.

Each finding is expanded in the following sections.

The public is aware of the City of Richmond's flood protection measures and is supportive of the City's flood protection work and efforts.

In general, most engagement participants said they were somewhat familiar with Richmond's existing flood protection measures. Very few knew a lot about Richmond's flood protection measures and several engagement participants said they were not very familiar with the accelerated program. Just under half of the *Let's Talk Richmond* weekly poll participants indicated that they did know about the accelerated dike upgrade program, which indicate that there is a continued need for communication and education about flooding and dike upgrades in the City of Richmond.

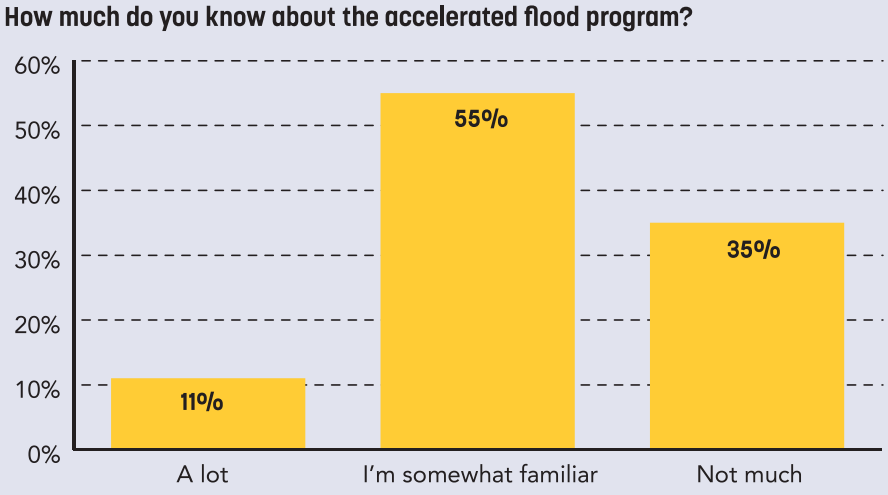

FIGURE 35: *Community pop-up feedback about awareness of the accelerated flood program*

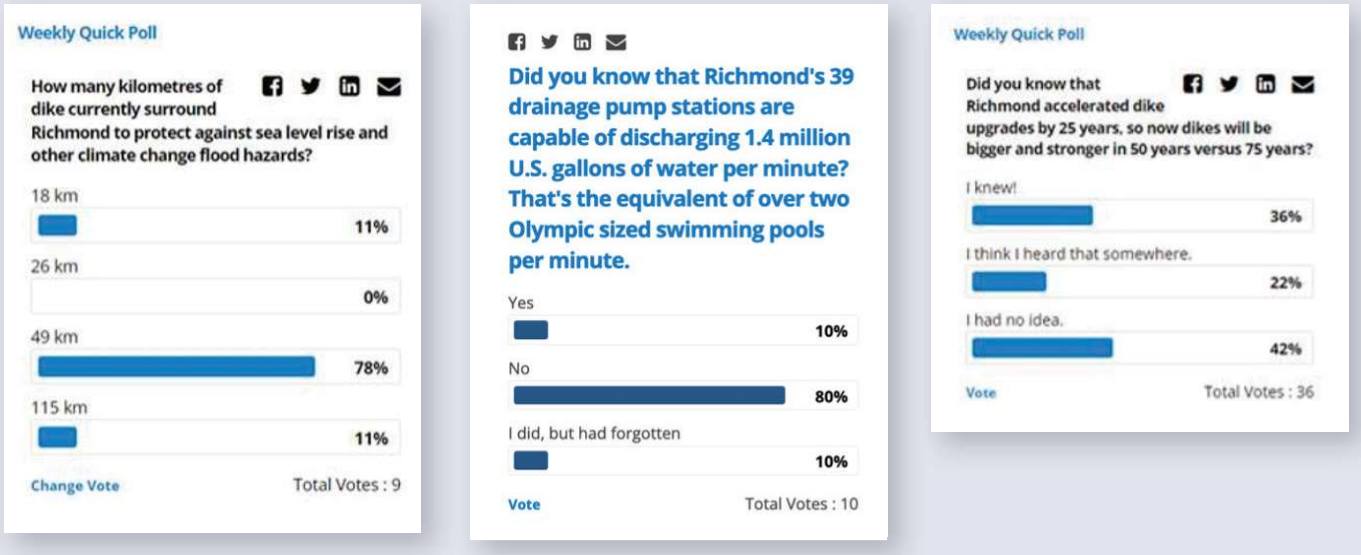

FIGURE 36: *The Let's Talk Richmond Flood Protection webpage quizzed general knowledge about the City's flood protection measures*

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The public is supportive of the City of Richmond's accelerated flood protection program and the associated utility rate increases.

Although information about Richmond's flood protection measures was new to some engagement participants, feedback received through the engagement campaign generally supported the accelerated program. There was no negative reaction to the expedited rate increase. Some comments even suggested accelerating the program even more and upscaling work by partnering with neighbouring waterfront municipalities (e.g., New Westminster). Many participants requested more information sessions to keep updated on the project, especially related in the Hamilton neighbourhood.

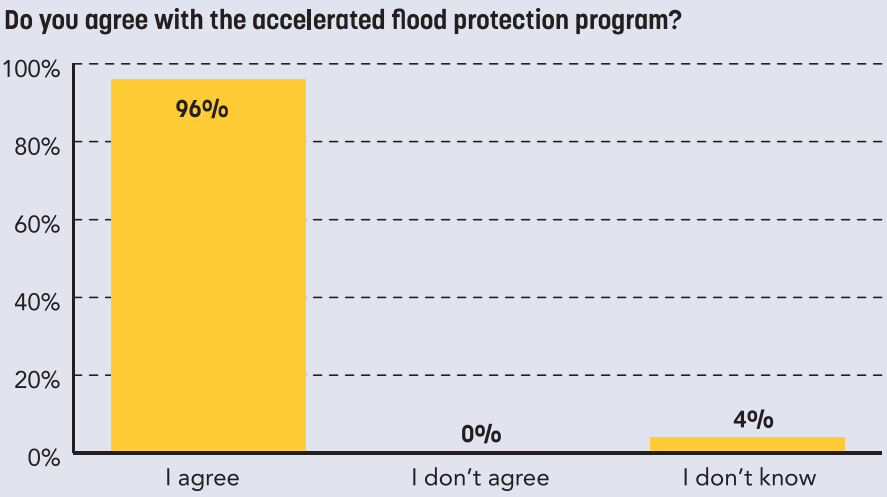

FIGURE 37: *Community pop-up feedback about support of the accelerated flood program*

FIGURE 38: *Weekly quick poll questions on the Let's Talk Richmond Flood Protection webpage asked about resident's support of the accelerated Flood Protection Program*

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The public is most supportive of upgrades that provide other community benefits and amenities.

Participants were asked about their ideas and suggestions on how the dike upgrades could be implemented to better meet the community's and users' needs.

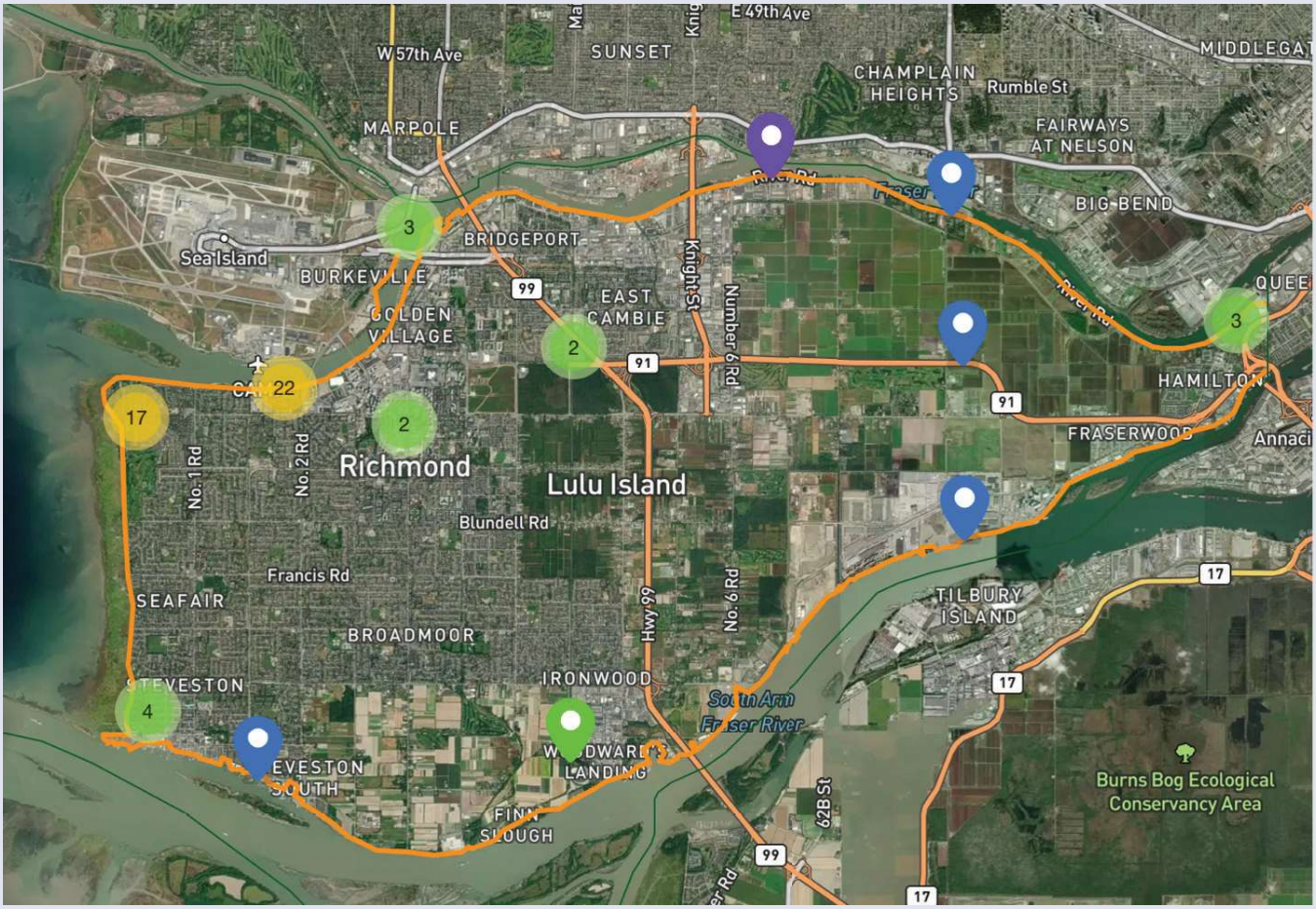

FIGURE 39: *Collaborative mapping tool on Let's Talk Richmond that shows where participants want to see changes and amenities with the dike upgrades*

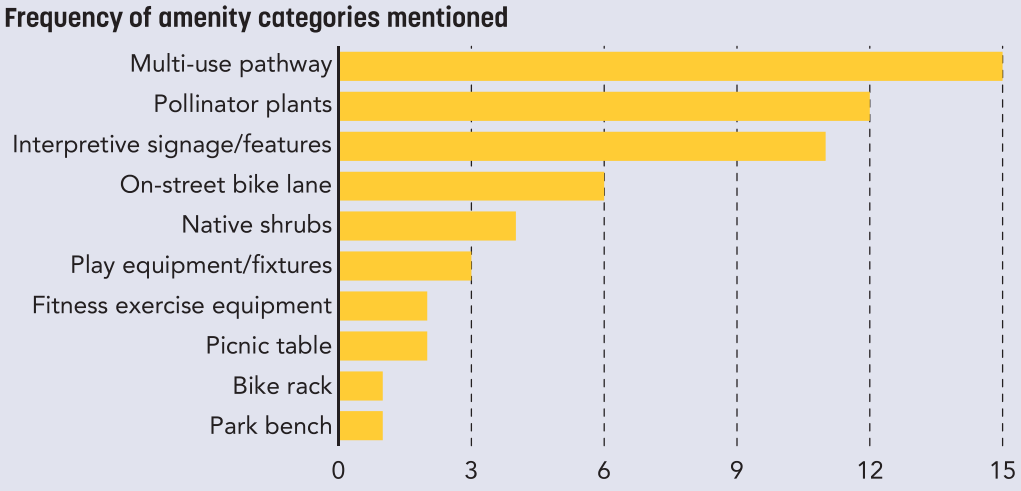

FIGURE 40: *Frequency of amenity categories mentioned on the Let's Talk Richmond mapping tool. The mapping tool provided Let's Talk Richmond webpage visitors the opportunity to indicate what types of amenities and changes they would like to see implemented and where, as the flood protection system is upgraded. Visitors could place a pin on the map, choose a category that the pin represents, and explain their idea.*

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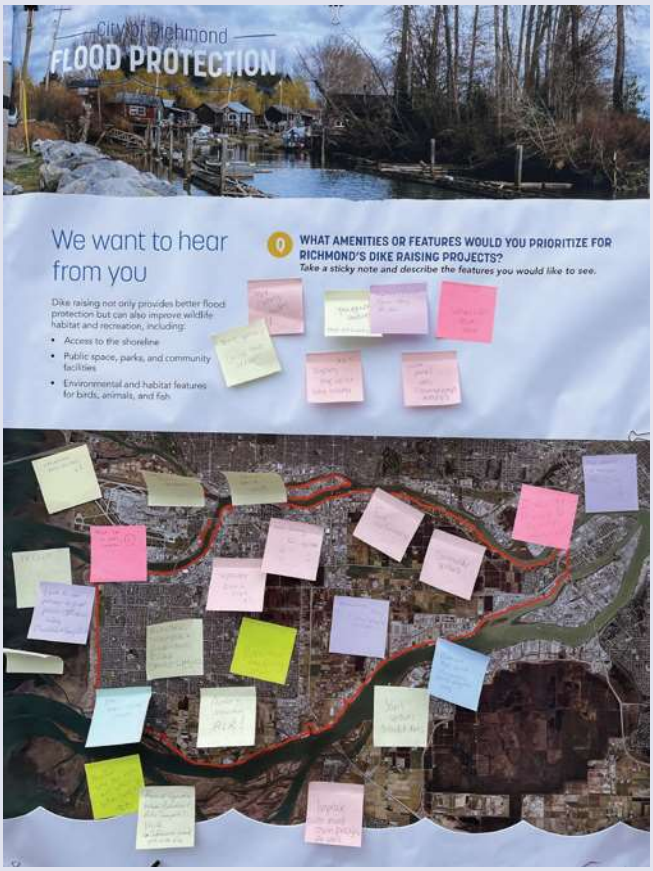

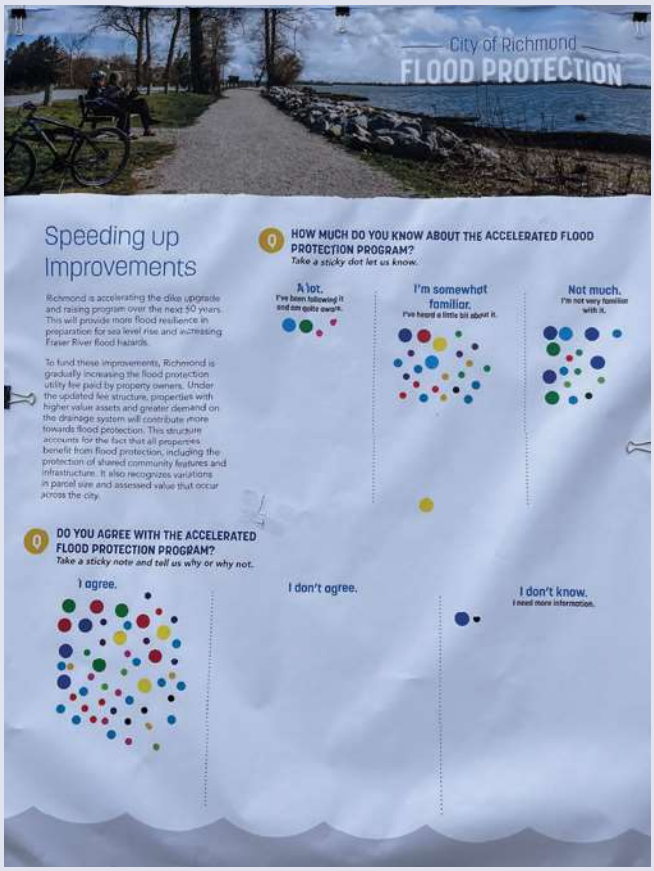

FIGURE 41: *Poster board with sticky note comments and dots at the Steveston Farmers Market Community Pop-up*

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The following summarizes ideas shared by participants, organized by common topic themes.

TRANSPORTATION AND MOBILITY

Most ideas shared at the Community pop-ups, Community Conversations, and *Let's Talk Richmond* and other engagement focused on transportation, mobility, and connectivity for pedestrians, bikes, and motorized vehicles. Collectively, most comments were about:

- **Multi-use pathway –** ways to make the path safer (e.g., avoid pedestrian-vehicle conflicts, improve slippery and uneven surfaces), and increase access to walk by the water.
- **Bike lanes and amenities –** where to add, extend, or improve on-street bike lanes, increasing bike safety on River Road, bike repair at pump stations.
- **Traffic and Roadways –** use dike upgrades to improve traffic conditions and road upgrades for River Road and fix traffic safety (especially truck safety) concerns. Expand Bridgeport Road and National Avenue to remove trucks from River Road.
- **River Road improvements –** truck traffic, cyclist safety, and wildlife impacts resulting from traffic speeds need to be addressed on River Road.

CLIMATE CHANGE MITIGATION

Many comments suggested finding ways to reduce emissions and mitigate climate change with the dike upgrades.

- **Clean energy –** incorporate renewable energy opportunities with upgrades (e.g., solar, offshore wind power)

NATURE AND THE ENVIRONMENT

Several comments focused on nature, including enjoying, protecting, and enhancing the natural environment. Common ideas include:

- **Ecosystems and Wildlife –** Protect the trees and bird/eagle nests along River Road where possible. Replace trees that are removed further inland and consider river depth and sediment when constructing the dikes. Consider removing log storage near important habitat areas.
- **Natural features –** Use natural features for environmental benefits and wildlife concerns. Plant pollinator plants (e.g., lilac, borage, wild roses) and other native shrubs for their ecosystem benefits (e.g., beauty, shade, erosion control, and sound dampening).

RECREATION

Participants noted a range of recreation and play opportunities they would like to see prioritized with the dike upgrades. Ideas included playgrounds, fitness equipment, and seating areas. Another key recreation opportunity focused on food, including opportunities to dine and to grow food.

- **Play elements/features –** Build playgrounds, fishing piers, and paths, as well as where to place exercise equipment (dip bar and pullup bar), and bike racks (with surveillance).
- **Spaces to rest –** Build benches and sheltered areas. Having seating and washrooms along the waterfront is important.
- **Spaces to eat –** Develop picnic spaces and areas with food and drink vendors.
- **Growing food –** Plant fruit bearing trees and establish community gardens. Comments also acknowledged the importance of protecting the Agricultural land reserve.

SIGNAGE AND WAYFINDING

Participants noted places to add signage about heritage, emergency preparedness, transit, and dike upgrades.

- **Interpretive signage/features –** Added signage on heritage (e.g., Britannia shipyards), educational (e.g., habitat), emergency warning (e.g., tsunami), transit schedules (e.g., ferries real time signage), and directions.
- **Pedestrians, cyclists, and motor vehicles –** Include speed limits and signage to keep bikes and pedestrians separate.
- **Dike upgrade notices –** Create signage/notices and further engagement to explain why trees need to be removed around dike areas or build park areas and plant trees behind dikes.

Moving Forward

Overall, many engagement participants shared that they have little-to-moderate knowledge of flood protection and the accelerated dike upgrades in Richmond but are strongly supportive of the accelerated program, recognizing the importance of these actions in the face of climate change.

Moving forward, information sharing about challenges and opportunities that are posed by sea level rise and climate change impacts, as well as progress on Richmond's Flood Protection Management Strategy and Dike Master Plans will continue to be important.

Common questions from engagement participants that could inform future materials included:

- *Will homes with water access on their property retain safe access?*
- *Is truck traffic safe along dike roads, or will it cause seismic/erosion problems?*
- *How does the program manage for inland flooding? (Specifically for the Hamilton area).*
- *Do the pumps have backup generators and are they resilient to earthquakes, storms, and power outages?*
- *Is Richmond preparing for long-term sea level rise, with 2 metres of sea level rise considered unavoidable?*
- *How is the City of Richmond working with The City of New Westminster?*
- *Will the City add more washrooms and trails?*
- *When will upgrades will occur and how they are prioritized?*
- *Can the program be further accelerated?*
- *Does dredging impacts flood hazards?*
- *Does sea level rise affect groundwater levels?*
- *Where will land be raised and by how much?*

Overall, participants expressed positive sentiments towards the Richmond's ongoing flood protection work and expedited dike improvement project. Participants look forward to learning more about flooding and flood management in the City of Richmond as the accelerated project unfolds.


Richmond