City of Richmond

Report to Committee

To:	Parks, Recreation and Cultural Services Committee	**Date:**	October 31, 2019
From:	Todd Gross Director, Parks Services	**File:**	06-2345-20-GCIT1/Vol 01
Re:	**Garden City Lands Update and Site Activation Plan**		

Staff Recommendation

That the staff report titled "Garden City Lands Update and Site Activation Plan," dated October 31, 2019, from the Director, Parks Services, be received for information.

Todd Gross
Director, Park Services
(604-247-4942)

Att. 2

REPORT CONCURRENCE	
CONCURRENCE OF GENERAL MANAGER	
REVIEWED BY STAFF REPORT / AGENDA REVIEW SUBCOMMITTEE	INITIALS: CJ
APPROVED BY CAO	

Staff Report

Origin

At the Council meeting held on May 14, 2018, staff received the following referral:

> *That staff work with Kwantlen Polytechnic University and others to explore alternate farming methods and paludiculture and windrows for future farming on the Garden City Lands.*

The purpose of this report is to respond to the referral and update Council on staff's efforts to explore viable options which would facilitate farming in the approximately 8 ha (20 acres) agricultural fields in the southwest corner of the Garden City Lands (the "Lands"), and identify the recommended directions to provide public access throughout the site.

Background

In 2010, the City purchased the 55 ha (136 acres) Garden City Lands from the Federal Government, and the planning for the future of the Lands began in 2012. As a result of a robust public consultation process, the Legacy Landscape Plan was developed and subsequently endorsed by Council in June 2014. The Legacy Landscape Plan provides a framework for the future development of the Lands based on the site's ecology, history, civic context and agricultural status as part of the Agricultural Land Reserve (ALR).

A Park Development Plan (the "Plan") (Attachment 1) was created based on the direction provided by the Legacy Landscape Plan. The Plan guides staff's implementation of the park program and vision of the Legacy Landscape Plan, including approximately 16 ha (40 acres) of agricultural fields on the western half of the site. Portions of the Plan implemented to date include the development of the 8 ha (20 acres) farm leased to Kwantlen Polytechnic University (KPU), the perimeter recreational trail, extensive plantings and the construction of a pond. In the southwest corner of the Lands, an 8 ha (20 acres) field is envisioned to become incubator farm plots, demonstration gardens and community gardens. The entire agricultural zone on the Lands will be managed according to organic farming best practices.

In 2017, the Agricultural Land Commission (ALC) approved the placement of soil on the farm area leased to KPU. The placement of soil was a condition of the Licence to Use Agreement between the City and KPU. The ALC's approval was based on low level contamination being present in the existing soils and that the placement of imported soils over the predominantly peat-based soil would minimize the release of sequestered carbon.

In summer of 2017, the City imported soil suitable for agricultural purposes onto the Lands to establish the first phase of the KPU research and teaching farm measuring approximately 2.6 ha (6 acres). Initially there were challenges with the quality of the soil that was imported (e.g., low fertility and electrical conductivity) but they have been addressed with the addition of soil amendments and the implementation of a quality control procedure. Since that time, KPU has begun actively farming the site and implementing site infrastructure improvements, including a greenhouse, hoop houses and processing area. When a viable source of soil is identified, the remaining 5.4 ha (13 acres) of KPU's leased lands will receive soil for the purposes of farming.

Parks staff have been active on the site with regular maintenance activities such as mowing and ongoing watering of planting installed in late 2017 and early 2018. As of summer 2018, no new capital improvements have proceeded on the Lands.

Analysis

In order to explore all viable farming practices on the Garden City Lands, staff conducted a review of alternatives to placing soil, farming practices suited to the existing peat based soils and remediation techniques to manage existing site contamination. The review focused on the following three key characteristics of the soil on the site:

i) **Soil Properties**: peat based soils with a high water table;

ii) **Remnant Peat Bog**: sequestered carbon embodied in the peat; and,

iii) **Impacts of Historic Activities**: historic activities have resulted in low-level contamination throughout the site.

Based on these site characteristics, the following two studies were commissioned:

1) Review of the Rationale for Fill Material: A review of the data collected on the existing contaminants in the area proposed for agricultural production, the viable remediation methods and the recommended next steps following current Contaminated Site Regulations (CSR) best management practices (Attachment 2). Additionally, staff commissioned an update to the 2017 Human Health and Ecological Risk Assessment (HHERA).

2) Review of Peat-Based Farming Practices: An agricultural feasibility study which evaluated the existing soils, all potential soil and water management strategies which would result in viable agriculture, and which crops might be grown according to the potential soil and water management strategies, including limiting the release of sequestered carbon.

Site Soil Review

Soil concentrations of certain substances currently exceed the applicable BC Contaminated Sites Regulation (CSR) Agricultural Land (AL) standard and remediation of the soil is required. These standards are set by the Provincial Ministry of Environment and Climate Change Strategy (Ministry) and so the City must follow these regulations for the management of contaminated materials on the Garden City Lands.

The Ministry has defined several industrial or commercial activities which have a high likelihood of resulting in a site becoming contaminated. Two specific activities which have occurred at the Lands in the past include:

1) Rifle or Pistol Firing Ranges: A firing range operated in the central portion of the Lands in the early 1900s for approximately 30 years; and

2) Petroleum Product in Above-Ground or Underground Storage Tanks: As part of the former Transport Canada communications towers, there were diesel underground storage tanks (UST) on site.

At the Garden City Lands, several of the samples contained lead concentrations that exceeded the AL standards along with one or more of antimony, arsenic and molybdenum. The high concentrations of these metals indicate that these substances are likely associated with the former firing range and are not naturally occurring. In diesel UST associated areas and where historical communications towers were located, soil samples indicated higher hydrocarbon concentrations than AL standards. These findings are summarized in a map locating where the samples were taken and the identified contaminates in each sample's location.

The soil contamination is widely distributed throughout the site, but remediation is recommended for only the area west of the central dike currently bisecting the Lands from north to south. This area is designated for agricultural field crop production. In order to effectively manage the contamination and make it safe for agricultural activity, the site needs to be remediated. Due to the level of contamination in the remaining portion of the site, less intensive remediation strategies will be explored on a site specific basis. Remediation is defined as the management strategy utilized to make the site suitable for the planned uses whereby the contamination levels are addressed to meet applicable environmental standards. There are a number of remediation strategies based on industry standard best management practices that would be appropriate to use on the Lands to facilitate the proposed agricultural activities.

The four recommended options for the agricultural fields are:

- excavate and dispose contaminated soil off-site;
- cap with plastic liner;
- phytoremediation; or
- cap with uncontaminated imported soil.

Of these four options, only phytoremediation does not involve the importation of uncontaminated soil as part of an effective remediation strategy. The table on the following page summarizes the strategy and the respective pros and cons.

Table 2: Pros and Cons of Remediation Strategies for Garden City Lands (Abridged) (Source: Hemmera Inc, 2019)

#	Remediation Strategy	Pros	Cons
1	Excavate and dispose contaminated soil off-site	• The farm area will meet numerical AL standards rather than risk-based standards removing the stigma that can be associated with leaving contamination in-situ • Reduces long term liability by removing contamination from GCL	• This is the most expensive option due to the cost of excavating, transporting, and disposing of this soil • Additional investigation of soil, groundwater, and soil vapour quality will be required to plan this work • Fill material would still be required to backfill the void left behind by excavation
2	Cap with a plastic liner	• Contaminated soil will be isolated from contact with humans and the environment, thereby, reducing the exposure risk to acceptable levels	• Does not reduce the existing contaminant volume or long-term liability • Hydraulic issues with groundwater and stormwater management will need to be addressed and mitigated; drainage will be adversely impacted • Fill material will still be required on top of the liner to create a growing medium for the farm
3	Phytoremediation (a process that uses plants to uptake contaminants from soil)	• Potentially cost effective if conducted as part of an experiment or thesis • Conducted in-situ • Environmentally friendly	• Requires further analysis to determine feasibility • May increase the presence of invasive species • Not applicable for high concentrations of contaminants • Slower than other treatments and often conducted in conjunction with additional treatment • Restricted to growing the correct type of plants depending on efficacy • Disposal of contaminated biomass to an approved facility required • Requires regular re-testing of the soil to determine if soils meet AL standards

Table 2: Pros and Cons of Remediation Strategies for Garden City Lands (Abridged) (Source: Hemmera Inc, 2019) (continued)

#	Remediation Strategy	Pros	Cons
4	Cap the farm area with uncontaminated imported fill material	• Clean imported soil separates the growing medium from the contaminated soil • Contaminated soil will be isolated from contact with humans and the environment by clean imported fill, thereby, reducing the exposure risk to acceptable levels • A more sustainable approach to the traditional "dig and dump", which consists of excavation of contaminated soil and transport to a licensed disposal facility	• Does not reduce the existing contaminant volume in the existing parent material

Agricultural Capability Study

McTavish Resource and Management Consultants (McTavish) completed the Agriculture Capability Assessment study in their capacity as the City's third-party certified agrologist for the Garden City Lands project. The primary goal of the study was to determine the soil characteristics and potential limitations to agriculture in the native peat soils currently on the site. Growing non-food crops were also considered.

McTavish concluded the agricultural capability of the site is currently poor (Class O4 and O5 per BC Agricultural Capability Classification system) with restrictions due to excess water, high acidity and the presence of soil contamination. Notwithstanding the soil contamination and the adverse impacts on peat based soils, the existing soils could be improved with the installation of drainage and addition of mineral soil, amendments and lime to offset the acidic conditions. This would improve the soils to a slightly higher classification (Class O3 and O4).

With this information, McTavish considered potential farming approaches including:

- farming the peat "as-is" (including *windrows*[1]);

[1] An elongated mound made from compostable material. Richmond farmers have commonly utilized this method in soils with standing water to raise the rooting zone above the existing grade and thus permit planting to proceed. It is also commonly used as a method of producing co[illegible]
(Source: https://www.buschsystems.com/resource-center/knowledgeBase/glossary/what-is-a-windrow)

- the traditional method of draining peatland;
- controlled drainage (known as *druckdrainage*[2]);
- flooding peatland (known as *paludiculture*[3]); and
- the placement of mineral soil over the peat.

The infrastructure requirements, crop suitability, capital investment requirements and greenhouse gas production were considered. The following table summarizes the evaluation criteria and conclusions of the various methods for improvement of the site's agricultural capability.

Table 1: Garden City Lands Agricultural Capability Summary Table (Source: McTavish, 2019)

Method	Requirements	Cost	Crop suitability	GHG production	Contamination	Feasibility
Farming peat "As-Is"	Water table management Soil amendment	Low	Few crops suitable	Moderate	Risk to human health.	**Moderate.** Not recommended due to human health risk, GHG production, and low crop suitability.
Peatland drainage	Drainage Soil amendment	Moderate	Pasture	High	Risk to human health.	**Moderate.** Not recommended due to human health risk and high GHG production.
Controlled drainage (*Drukdrainage*)	Drainage system and pumping system	High	Pasture Some food crops	Low	Risk to human health.	**Low.** Not recommended due to infrastructure requirements and high cost.
Flooding (*Palludiculture*)	Water source Specialized equipment	High	Grasses and sedges No food crops	Low	Risk to human health unknown. Requires input from contaminated sites specialist.	**Low.** Not recommended due to infrastructure requirements, high cost and low crop suitability.
Mineral soil placement	Clean, non contaminated fill Drainage system	Low	Wide variety of crops	Low	Risk mitigated by placement of clean, non-contaminated fill over peat.	**High.** Recommended to mitigate human health risk, low GHG emissions, and high crop suitability.

[2]A controlled drainage system developed in the Netherlands whereby the water table is maintained at precise level utilizing a pressurized drainage system. (Source: McTavish, 2019)

[3] The practice of crop production on wetted predominantly peat-based soils whereby past practices drained peat soils prior to commencing agricultural production. Maintaining the flooded peatland reduces greenhouse gas production and maintains biomass production. (Source: https://en.wikipedia.org/wiki/Paludiculture)

In order to fully realize the site's maximum agricultural capability to grow the widest range of crops while minimizing the potential for human exposure and risk, McTavish recommends placing one metre of uncontaminated soil to maximize the agricultural capability of the site. Placement of soil would still require an investment in a sub-grade field drainage system.

Next Steps

Soil Characterization and Delineation Study

As stated, contamination is widely distributed throughout the site. The four remediation strategies have been evaluated to address the identified soil contamination. To facilitate the capacity for the broadest agricultural production, the site needs to be remediated to Agricultural Land standards. The most feasible option was determined to be capping of the agricultural area with uncontaminated fill material; however, it would be premature to proceed with this option without additional testing of the existing soils.

In order to fully understand the existing contaminants in the soil and groundwater and to provide the most appropriate soil remediation strategy recommendation, staff will be proceeding with a comprehensive soil testing study. A Soil Characterization and Delineation Study would define the nature and extent of the contamination in the soil. The study will provide staff with an in depth report on the contaminations of the site and assist staff in defining the most appropriate soil remediation plan. Any remediation program would be reviewed in consideration of the agricultural activities envisioned to occur on the site. Until the study is completed and the plan is defined, no new soil will be imported to the southwest portion of the Lands.

Public Access and Site Activation

While the agricultural fields in the southwest corner of the site undergo further analysis and a remediation plan is completed, the remainder of the site is to be developed with the end goal of welcoming visitors to explore, learn and enjoy the Garden City Lands, including the construction of community gardens.

The City must submit a Non-Farm Use Application to the ALC to gain approval for all non-agricultural related activities and site features planned to be constructed on the Lands, including public access throughout the site. A Non-Farm Use Application will follow the standard City process, including reviews by the Food Security and Agricultural Advisory Committee and City Council prior to consideration by the ALC's South Coast Panel.

In March 2019, Council approved the construction of up to 100 community garden plots at the Garden City Lands. They will be included in the application to the ALC but with the understanding that they will be constructed as raised plots in order to separate them from the existing soil. The objective is to construct the community garden plots and related support infrastructure in 2020.

Financial Impact

None.

Conclusion

In order to fully understand the nature and extent of the contaminated material on the Lands, staff will be proceeding with a robust testing program of the southwest agricultural fields. This review will also consider how any potential remediation programs would maximize the agricultural production of the site with the end goal of having the Lands be a demonstration of sustainable agricultural and land management practices.

Concurrent to this testing program, staff would like to proceed with construction on the Lands with the end goal of providing a functioning and well programmed park for Richmond residents. Approval from the ALC is required in order to begin this process and permit full public access onto the site in a manner that is both safe for visitors as well as protecting the sensitive habitat on the site. Implementing aspects of the Park Development Plan, which do not require the importation of large volumes of soil onto the Lands, can still proceed and provide Richmond residents access to enjoy the entire Garden City Lands.

Alex Kurnicki
Research Planner 2
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Jamie Esko
Manager, Parks Planning, Design
and Construction
(604-233-3341)

Att. 1: Garden City Lands Park Development Plan
2: Memorandum: Rationale for Fill Material (Hemmera)

Attachment 1

LEGEND

THE AGRICULTURAL LANDS
1 Multi-Functional Building and Parking
2 Rainwater Storage for Agricultural Irrigation
3 Farm Drainage Ditch
4 Agricultural Fields
5 Orchard
6 Demonstration Orchard
7 Community Gardens
8 Hedgerows & Beetle Banks
9 Sliding High Tunnels
10 Farm Fields
11 Soil Amendment Trials

THE BOG
12 Bog Conservation Area
13 The Fen
14 Boardwalk with Rest Points

THE RISE
15 Meadow / Informal Recreation
16 Children's Play

THE NODES
17 Garden City Lands Main Entrance
18 Entry Node
19 Entry Allée
20 Viewing Platform
21 Crosswalk
22 Parking Lot with Accessible Stalls
23 Parallel Parking with Accessible Stalls

THE DYKE
24 Multi-use Path with Farm Access

THE PERIMETER TRAILS
25 Native Forest Plantings
26 Street Trees
27 Perimeter Trails - Separated Paths
28 Rain Garden

Hemmera
An Ausenco Company

MEMORANDUM

Date:	November 4, 2019
To:	Alex Kurnicki, City of Richmond
From:	Hemmera
File:	989645-04
Re:	Garden City Lands – Rationale for Fill Material

Hemmera Envirochem Inc. (Hemmera), a wholly owned subsidiary of Ausenco Canada Inc (Ausenco), is pleased to submit this memo explaining the rationale for fill material within the proposed farm area at Garden City Lands (GCL), located in Richmond, BC. The location of GCL is shown on the attached **Figure 1**.

This memo will summarize the contaminated sites regime in British Columbia (BC) and explain how the BC Contaminated Sites Regulation (CSR) was used to identify contamination within the farming area at GCL related to historical activities, and why fill material is necessary to cover portions of the GCL farm area with uncontaminated fill before using them for agricultural purposes.

1.0 CONTAMINATED SITES REGIME IN BRITISH COLUMBIA

To understand why fill material is required, it's important to understand how GCL was deemed contaminated in the first place. This requires an understanding of how BC regulates contaminated sites. Properties like GCL, under municipal ownership, are governed by the environmental laws and regulations set out by the BC Ministry of Environment and Climate Change Strategy (Ministry). The overarching legislation for environmental work in BC is the *Environmental Management Act* (EMA) (2003), which regulates industrial and municipal waste discharge, pollution, hazardous waste, and contaminated sites remediation. Under EMA, the BC Contaminated Sites Regulation (CSR) (1997) regulates the identification and cleanup of contaminated sites.

The Ministry defines a **contaminated site** as an area of land in which the soil or underlying groundwater or sediment contains an amount or concentration that exceeds provincal environmental quality standards set up by the EMA and the CSR. To help with identification of such contaminated sites, the Ministry has created a list of industrial and commercial activities that have a high potential to contaminate sites. From this list, there are two activities of importance for the farming areas of GCL: 1) rifle or pistol firing ranges, because a firing range operated in the central portion of GCL in the early 1900s for approximately 30 years; 2) petroleum product in above-ground or underground tanks, because there was a diesel underground storage tank (UST) in use by the former communications operation. The identification of these commercial uses indicates a potential for contamination and was the impetus for the subsequent and ongoing environmental investigation.

2.0 ENVIRONMENTAL FINDINGS AT GARDEN CITY LANDS

Environmental investigations have been conducted at GCL since at least 2001 by several different consulting firms. Most recently, Hemmera compiled all the historical data and compared it to current CSR standards and prepared a Draft Soil and Groundwater Management Plan dated March 14, 2019. The relevant results are briefly summarized below.

To investigate the potential for contamination associated with the past historical uses including a firing range and communications towers, soil samples were collected across the proposed farm area. The main contaminants identified were lead and antimony, which are two of the primary metals associated with firing ranges. The contamination at firing ranges comes predominantly from the metals that are present in bullets and bullet jackets left on the ground after firing practices. Bullets are made primarily of lead with a copper-jacket, which includes copper as a gliding material over the lead core to help bullets withstand higher velocities. Over the years, other metals have been included in the lead alloy such as arsenic, cadmium, copper, silver, bismuth, molybdenum, tungsten and tin. Each of these elements, if present, typically makes up less than 1% of the total lead alloy that constitutes the bullet.

At GCL, several of the samples contained lead exceeding the CSR agricultural land use (AL) standard along with one or more of antimony, arsenic, and molybdenum. The high concentrations of these metals, known to be associated with bullets, indicates these substances are likely associated with the former firing range and are not naturally occurring. The locations where metal contamination was found to exceed CSR AL standards are shown on **Figure 1**.

The Draft Soil and Groundwater Management Plan also shows that hydrocarbon concentrations greater than CSR AL standards were identified in soil where the diesel UST associated with the historical communications tower was located. The location of this hydrocarbon contamination is illustrated on the attached **Figure 1**.

In conclusion, soil contamination has been identified within the proposed farming area at GCL. Identified contamination consists of metals associated with an historical firing range and hydrocarbons related to a former UST associated with the historical communication towers. Soil concentrations exceed the applicable CSR AL standard.

3.0 REMEDIATION STRATEGIES

Remediation refers to how the contamination will be addressed to make a site suitable for the planned uses, and the remediation strategy must be selected with the planned use in mind. In this case, the City of Richmond (City) has already started construction activities for urban farm fields, educational farm plots, and a demonstration orchard in the western portion of GCL. To determine whether the identified soil contamination beneath the farming area presents a risk to human health or the environment, Hemmera was commissioned to complete a risk assessment. This risk assessment concluded that risks were acceptable provided the soil contamination was removed or capped with uncontaminated fill material. Four remediation strategies were considered for the Site. **Table A** contemplates the pros and cons of these four strategies.

Table A Pros and Cons of Remediation Strategies for GCL

#	Remediation Strategy	Pros	Cons
1	Excavate and dispose contaminated soil off-site	• The farm area will meet numerical AL standards rather than risk-based standards removing the stigma that can be associated with leaving contamination in-situ • Reduces long term liability by removing contamination from GCL	• This is the most expensive option due to the cost of excavating, transporting, and disposing of this soil (see **Table B**, below for an order of magnitude estimate of these costs) • Additional investigation of soil, groundwater, and soil vapour quality will be required to properly plan this work. • Fill material would still be required to backfill the void left behind by excavation
2	Cap with a plastic liner	• Contaminated soil will be isolated from contact with humans and the environment, thereby, reducing the exposure risk to acceptable levels.	• Does not reduce the existing contaminant volume or long-term liability. • The existing ecosystem will likely be adversely affected. • Hydraulic issues with groundwater and stormwater management will need to be addressed and mitigated; drainage will be adversely impacted. • Fill material will still be required on top of the liner to create a growing medium for the farm.
3	Phytoremediation (a process that uses plants to uptake contaminants from soil)	• Potentially cost effective if conducted as part of an experiment or thesis. • Conducted in-situ. • Environmentally friendly.	• Highly dependent on soil properties and environmental conditions and therefore requires further analysis to determine feasibility. • May increase the presence of invasive species due to the less intensive farming. • Not applicable for high concentrations of contaminants. • Slower than other treatments and often conducted in conjunction with additional treatment such as nutrient enrichment. • Restricted to growing the correct type of plants meaning the planned farming activities will be delayed by at least one growing season if not more depending on efficacy. • Need to properly dispose of contaminated biomass to an approved facility at the end of each growing season at an added cost. • Requires regular re-testing of the soil to determine if residual contaminant concentrations have dropped to less than AL standards.

#	Remediation Strategy	Pros	Cons
4	Cap the farm area with uncontaminated imported fill material	• Fill material is already required to provide better quality growing medium making this the most cost-effective strategy. • Clean imported soil separates the growing medium from the contaminated soil • Contaminated soil will be isolated from contact with humans and the environment by clean imported fill, thereby, reducing the exposure risk to acceptable levels. • A more sustainable approach to the traditional "dig and dump", which consists of excavation of contaminated soil and transport to a licensed disposal facility.	• Does not reduce contaminant volume or long-term liability.

Below is more information about remediation strategies 1 and 3 - "Excavate and dispose contaminated soil off-site" and "Phytoremediation".

Phytoremediation

Phytoremediation refers to a technology that uses various plants to degrade, extract, contain or immobilize contaminants from soil and water. Phytoremediation started to gain popularity within the scientific community in the early 1990s. Numerous academic studies have been conducted over the years, however, a widespread commercial use as a remediation technique has not been achieved to date. The general reasons behind the lack of implementation are listed in **Column 4** of **Table A** above. Given these barriers, there are no long-term studies that document costs required for the process on a commercial level.

The same factors that have prevented phytoremediation from widespread use apply for the Site as well:

- The effectiveness of the process is dependant on environmental factors (physical and chemical), which are uncertain. Environmental conditions and competing chemical reactions in nature may delay or impede the uptake of contaminants;
- The timeline of remediation is unknown. It is a long-term process that may take place over several growing seasons;
- The type of plant used in the processes is specific for the type of contaminant. For example, in the scientific community poplar and alfalfa seem to be considered most suitable for lead remediation in soil. However, this is based on limited field tests.
- Metals, as opposed to hydrocarbons, are not biodegradable. As such, the metals contaminants are stored within the plant biomass. This creates secondary contamination in the form of biomass that must be disposed in an approved facility that accepts metals contamination.
- The cost of remediation via phytoremediation for the Site is hard to determine given the lack of commercial applications of the method.

After considering the limitations, phytoremediation does not appear to be a viable remediation option for the Site. A possible exception might be in partnership with an academic institution keen to try and further develop this remedial strategy.

Excavate and dispose contaminated soil off-site

This remediation option would involve several tasks outlined in **Table B**, below.

Table B Tasks and Approximate Costs Associated with Excavation and Disposal

Task	Description	Estimated Order of Magnitude Cost
Additional Characterization and Delineation	• Chromium speciation in soil • Background assessment of arsenic and molybdenum in soil in the farm field areas • Soil and groundwater characterization in the proposed KPU Creek and Lansdowne Canal • Horizontal and vertical delineation of the metal contamination at sample location GCL14 • Horizontal and vertical delineation of hydrocarbon contamination in TP01-2 (the Rise) • Horizontal and vertical delineation of the hydrocarbon contamination in the former diesel UST area • Investigation of all data gaps identified in the Draft Soil and Groundwater Management Plan	$80K - $120K
Remedial Planning	• Develop Remedial Plan • Support with preparation of specifications and tender documents to solicit contractor bids for soil excavation and disposal	$20K
Excavation and Soil Disposal	• Excavate KPU Farm Areas of the Site to 0.5 m depth and backfill to grade. (36-90K tonnes at $55/tonne for excavation, disposal, and backfill – actual amount is dependent on the additional characterization and delineation task)	$2M - $5M
Confirmation of Remediation	• Confirmatory sampling program and Confirmation of Remediation Report	$35K - $50K
	Total	**$2.1M – 5.2M**

After considering the four options, Hemmera recommends **Option 4: Capping the farm area with uncontaminated fill material**. Option 4 is the most feasible from the perspective of operations (capping with fill is substantially already complete and is required to improve the growing medium), finances (it is the most cost-effective), and sustainability (it avoids the need for excavation, trucking, and relocating the contamination to another location). Of note, three of the four most viable remediation options require sourcing and placement of clean soil at GCL.

4.0 SUMMARY

The farming area of GCL was utilized as a firing range for 30 years during the early 1900s and a diesel UST was in use by the former telecommunication operation. The Ministry considers the firing range and the former diesel UST as having high potential to cause contamination. As such, several environmental assessments were completed at GCL to investigate the potential for contamination. Metal soil contamination, specifically lead, antimony, arsenic and molybdenum - all metals associated with bullet manufacturing, was identified in several locations across the farm area. Hydrocarbon soil contamination was also identified in the vicinity of the former diesel UST associated with the communication operation. Four remediation strategies have been evaluated to address the identified soil contamination. The most feasible option was determined to be capping of the farm area with uncontaminated fill material. Of note, three of the four most viable remediation options require the placement of clean soil at GCL.

5.0 CLOSURE

The Work contained herein was performed in accordance with the Professional Services Agreement between Hemmera and City of Richmond, dated January 25, 2016 ("Contract"). This Report has been prepared by Hemmera, for sole benefit and use by the City of Richmond. In performing this Work, Hemmera has relied in good faith on information provided by others and has assumed that the information provided by those individuals is both complete and accurate. This Work was performed to current industry standard practice for similar environmental work, within the relevant jurisdiction and same locale. The findings presented herein should be considered within the context of the scope of work and project terms of reference; further, the findings are time sensitive and are considered valid only at the time the Report was produced. The conclusions and recommendations contained in this Report are based upon the applicable guidelines, regulations, and legislation existing at the time the Report was produced; any changes in the regulatory regime may alter the conclusions and/or recommendations

We have appreciated the opportunity of working with you on this. Please feel free to contact the undersigned regarding any questions or further information that you may require.

Prepared by:
Hemmera Envirochem Inc.

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Project Manager

Reviewed by:
Hemmera Envirochem Inc.

Karey Dow, P.Ag., PMP
Business Leader

6.0 REFERENCES

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FIGURE