



Economic Impacts from Remediated Low to Moderate Risk Contaminated Sites

**Prepared for
The Society of Contaminated Sites Approved Professionals of British Columbia (CSAP)**

Mansfield Consulting Inc.

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EXECUTIVE SUMMARY

Study Purpose

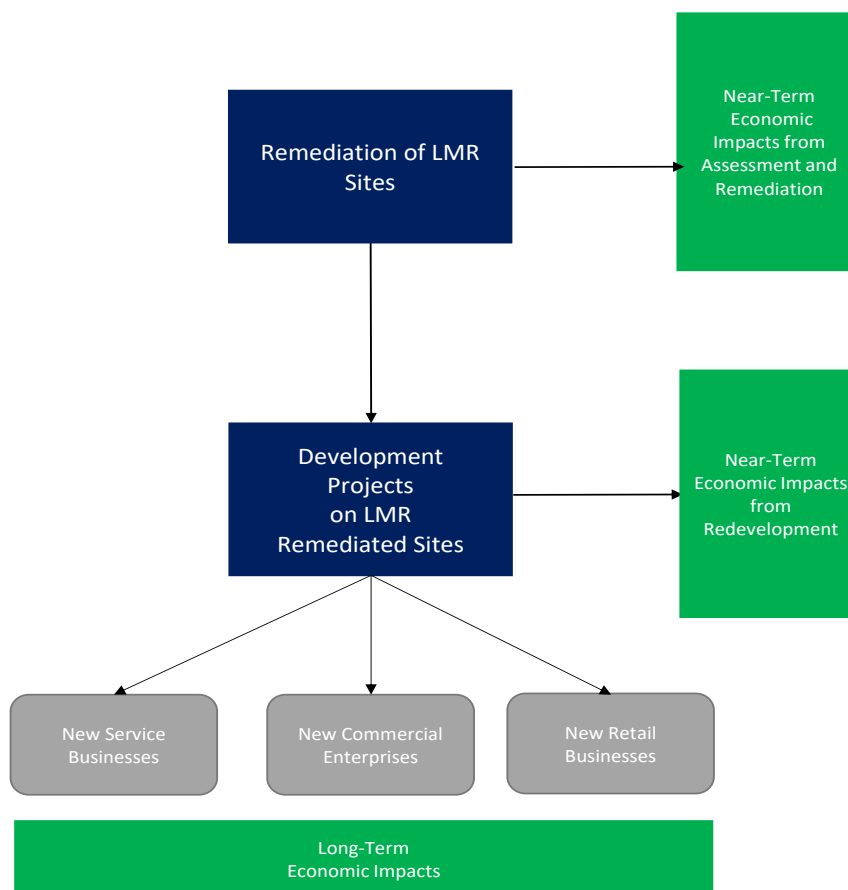
Low to moderate risk (LMR) contaminated sites are found in regions and communities throughout BC. Although the exact number of such sites is not known, it is estimated to be well in excess of 6,000. Remediation and redevelopment of LMR sites has been shown to create substantial economic impacts but the extent of those impacts has not previously been studied in a systematic way. As a result, the Society of Contaminated Sites Approved Professionals of British Columbia (CSAP) engaged Mansfield Consulting Inc. to carry out a study on the economic impacts that are created through the assessment and remediation of LMR sites and their subsequent redevelopment for residential, commercial, and other purposes.

Economic Impacts from Remediated LMR Sites

There are three categories of economic impacts that are created through the assessment and remediation and redevelopment of LMR sites:

- Near-term economic impacts created during the assessment and remediation process. These are economic impacts that result from site assessment and remediation.
- Near-term economic impacts created from redevelopment of the remediated LMR site. These are economic impacts that result from construction and other forms of redevelopment on the site.
- Long-term economic impacts created from new businesses that locate to the remediated LMR site. These are economic impacts that result from ongoing commercial, retail, and service activities on the remediated and redeveloped site.

The following figure illustrates the three categories of impacts.



Near-term Economic Impacts Created During the Assessment and Remediation Process

Near-term economic impacts created during the assessment and remediation of LMR sites were studied previously in a 2012 report prepared for CSAP by TyPlan Consulting.¹ TyPlan based its economic impact calculations on an estimated average cost for assessment and remediation of \$300,000 per LMR site. Based on information provided by CSAP members and other sources, we have updated the cost estimate to the present, with a resulting 2021 estimated average cost for assessment and remediation of \$520,000 per LMR site.²

The estimated average economic impacts³ arising from assessment and remediation of an LMR site are:

- Total output of \$0.835 million per site.
- Total Gross Domestic Product (GDP) of \$0.540 million per site.
- Total Employment of 4.5 full time equivalent positions (FTEs) per site.
- Total Tax Revenues of \$0.116 million per site.

The estimated average economic impacts created during assessment and remediation are summarized in Table A.

¹ BC Contaminated Sites Sector – Economic Benefit Analysis Economic Benefit of the Contaminated Site Assessment and Review Sector in British Columbia. TyPlan Consulting, 2012.

² This estimate is believed to be conservative. In some instances, much higher costs may occur.

³ For definitions of economic impact terms please see the glossary in Appendix A.

Table A. Estimated Average Economic Impacts Per LMR Site Created During Assessment and Remediation

Economic Impact	Output	GDP	Employment (FTEs)	Federal Tax	Provincial Tax	Municipal Tax
Direct	\$520,000	\$347,880	3.0	\$38,103	\$21,400	\$639
Indirect	\$163,800	\$95,160	0.8	\$10,531	\$7,512	\$1,822
Induced	\$151,320	\$97,240	0.7	\$15,450	\$17,174	\$3,739
Total	\$835,120	\$540,280	4.5	\$64,084	\$46,086	\$6,200

Near-term Economic Impacts Created From Redevelopment on Remediated LMR Sites

Near-term economic impacts that arise from redevelopment on remediated LMR sites have not been previously studied in a systematic manner. Consequently, a new approach was developed for this study which involved the creation of five detailed case studies believed to be typical of redevelopment projects that commonly occur on remediated LMR sites.

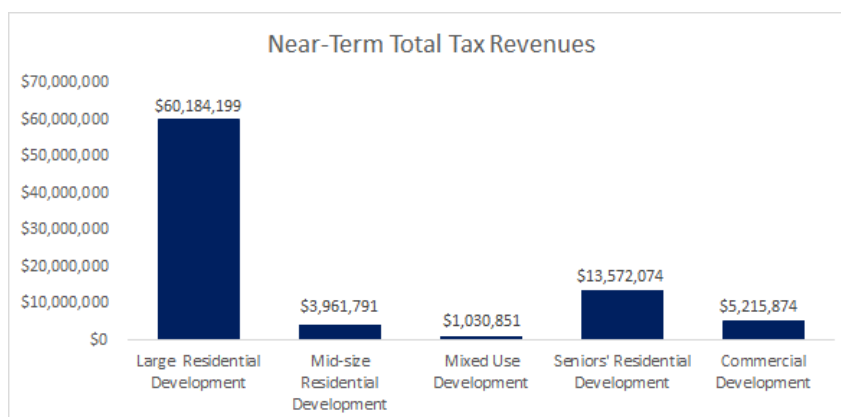
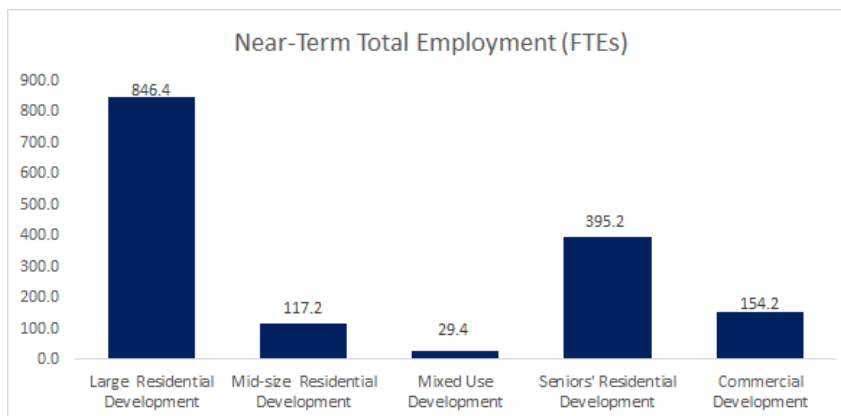
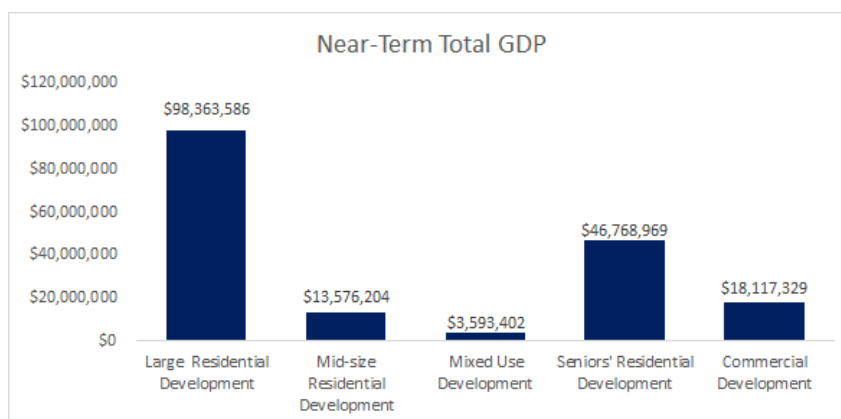
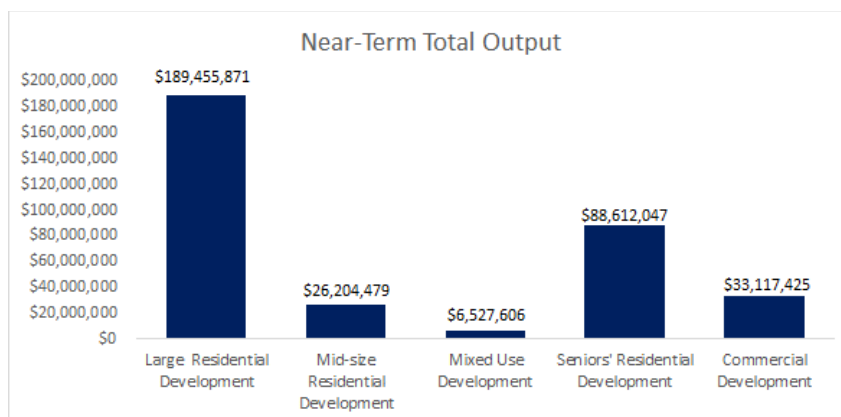
The case studies consisted of:

1. A large residential development.
2. A mid-size residential development with retail space.
3. A small, mixed-use (residential/retail) development.
4. A seniors' residence with retail space.
5. A commercial development.

As the case studies illustrate, redevelopment on remediated LMR sites produces substantial near-term economic impacts. The magnitude of the impacts depends on the size and type of redevelopment. For the five cases studies, the ranges of near-term economic impacts created from redevelopment are:

- Total output from \$6.5 million to \$189.5 million.
- Total GDP from \$3.6 million to \$98.4 million.
- Total employment from 29.4 FTEs to 846.4 FTEs.
- Total government tax revenues from \$1.0 million to \$60.2 million.

The following figures display the estimated near-term total output, GDP, employment, and government tax revenues created by each of the five case studies.



Average Near-term Economic Impacts Created From Redevelopment on a Remediated LMR Site

At present, redevelopments that occur on remediated LMR sites are not tracked in a standardized way. As a result, the average near-term economic impacts created from redevelopment cannot be calculated precisely. However, estimates can be made by weighting the results of the five case studies by the proportion of redevelopments that each is believed to represent. Under that approach, the estimated average near-term economic impacts created from redevelopment on a remediated LMR site are:

- Average total output of \$47.5 million per site.
- Average total GDP of \$24.8 million per site.
- Average total employment of 213.1 FTEs per site.
- Average total government revenues of \$11.9 million per site.

The estimated average near-term economic impacts created from redevelopment on a remediated LMR site are summarized in Table B.

Table B. Estimated Average Near-term Economic Impacts Created From Redevelopment on a Remediated LMR Site

Economic Impact	Output	GDP	Employment (FTEs)	Federal Tax	Provincial Tax	Municipal Tax
Direct	\$28,334,273	\$13,936,718	116.7	\$1,791,509	\$1,587,648	\$5,260,211
Indirect	\$11,621,189	\$6,067,410	57.8	\$766,300	\$504,998	\$98,033
Induced	\$7,509,739	\$4,824,730	38.5	\$809,469	\$863,707	\$184,190
Total	\$47,465,201	\$24,828,858	213.1	\$3,367,279	\$2,956,353	\$5,542,433

Long-term Economic Impacts Created from New Businesses on Remediated LMR Sites

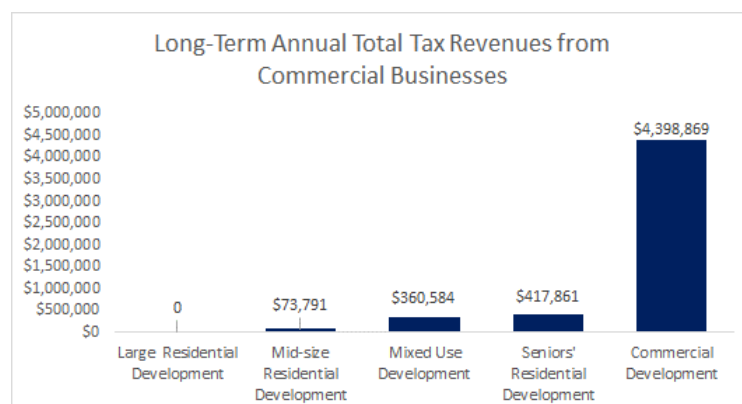
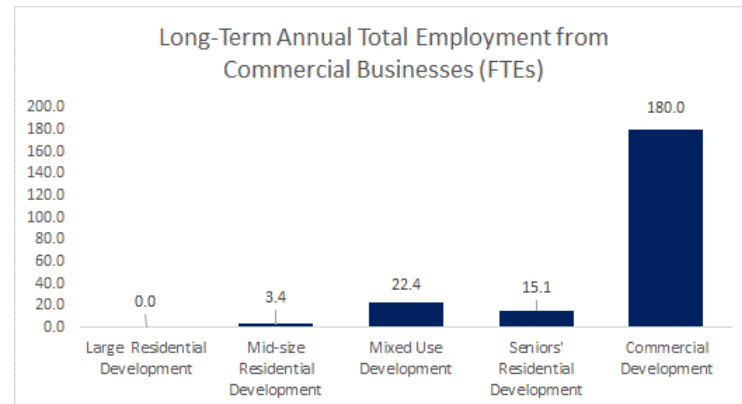
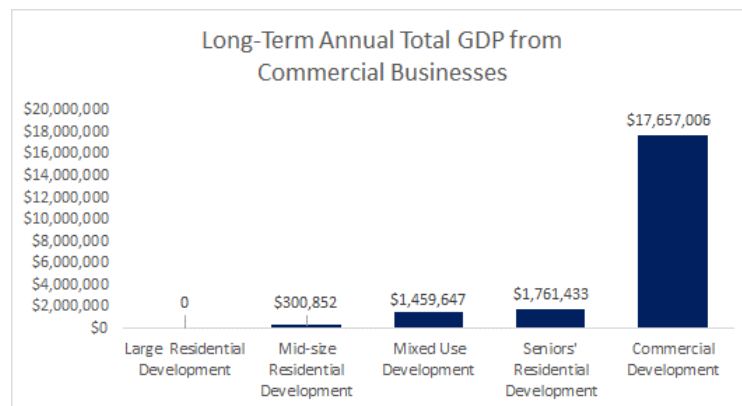
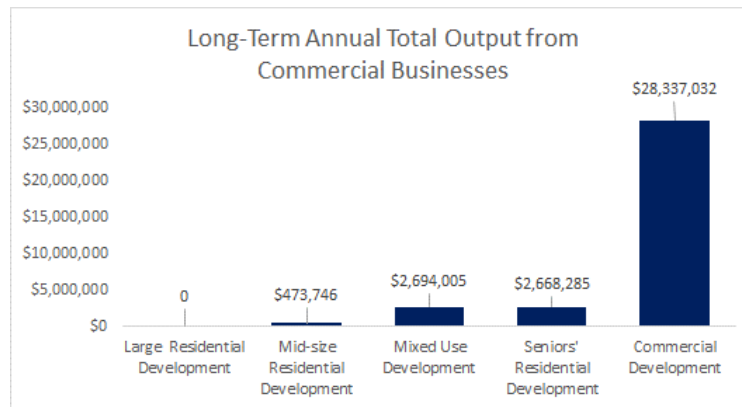
The long-term economic impacts that arise from new businesses locating on remediated LMR sites have also not been previously studied in a systematic manner. Consequently, the five detailed case studies were used to form estimates of the long-term economic impacts that arise from new businesses locating on remediated LMR sites.

As the case studies illustrate, new businesses that locate on remediated LMR sites produce ongoing, long-term economic impacts. The magnitude of the impacts depends on the size and type of business. For the four case studies that contain retail and commercial space⁴, the ranges of long-term economic impacts created from new businesses are:

- Annual total output of \$0.5 million to \$28.3 million.
- Annual total GDP of \$0.3 million to \$17.7 million.
- Annual total employment of 3.4 FTEs to 180.0 FTEs.
- Annual total government tax revenues of \$0.1 million to \$4.4 million.

The following figures display the long-term annual total economic impacts for the case studies.

⁴ One case study (a large residential development) is assumed to have no retail or commercial space; consequently, there are no long-term economics from new businesses for that case study. Residents of such a development also create economic impacts through their personal spending. However, those impacts are not included in the long-term impacts examined in this report.



Average Annual Long-term Economic Impacts Created From New Businesses on a Remediated LMR Site

Similar to near-term economic impacts from redevelopment, an estimate of the average long-term economic impacts can be made by weighting the results of from the five case studies by the proportion of redevelopments that each is believed to represent. Under that approach, the estimated average annual long-term economic impacts created from new businesses on a remediated LMR site are:

- Average annual total output of \$5.4 million per site.
- Average total GDP of \$3.3 million per site.
- Average total employment of 36.6 FTEs per site.
- Average total government revenues of \$0.8 million per site.

The estimated average long-term economic impacts created from redevelopment on a remediated LMR site are summarized in Table C.

Table C. Estimated BC Average Annual Long-term Economic Impacts Created From Redevelopment on a Remediated LMR Site

Economic Impact	Output	GDP	Employment (FTEs)	Federal Tax	Provincial Tax	Municipal Tax
Direct	\$3,064,248	\$1,888,686	24.0	\$219,219	\$127,602	\$23,076
Indirect	\$1,105,727	\$626,479	5.9	\$74,146	\$57,247	\$18,531
Induced	\$1,267,116	\$815,906	6.6	\$132,946	\$143,480	\$30,124
Total	\$5,437,090	\$3,331,072	36.6	\$426,311	\$328,329	\$71,731

Summary of Economic Impacts

Table D summarizes the average total estimated near-term and long-term economic impacts from the remediation process, redevelopment, and new businesses on a LMR site.

Table D. Summary of Average Economic Impacts Per Remediated LMR Site

	Average Total Output	Average Total GDP	Average Total Employment	Average Total Government Revenues
Assessment and Remediation	\$835,120	\$540,280	4.5	\$116,370
Redevelopment	\$47,465,201	\$24,828,858	213.1	\$11,866,066
Total Near-Term Impacts	\$48,300,321	\$25,369,138	217.6	\$11,982,436
Annual Long-Term Impacts	\$5,437,090	\$3,331,072	36.6	\$826,372

1 INTRODUCTION

1.1 Study Purpose

In BC, the Ministry of Environment and Climate Change Strategy (the Ministry) is responsible for regulations detailing safe and legal levels of soil and water contaminants. The Society of Contaminated Sites Approved Professionals (CSAP) is an independent professional organization that is mandated by the Ministry to review environmental certification applications for contaminated sites that are deemed to be of low to medium environmental risk (LMR sites). CSAP credentials its members and recommends they be appointed to the Ministry's Roster of Approved Professionals (APs).

CSAP engaged Mansfield Consulting Inc. to carry out a study on the economic impacts that are created through the remediation of LMR sites and their subsequent repurposing for residential, commercial, and other purposes. The specific scope for the study encompassed:

- Assessing the near-term economic impacts that are created from the assessment and remediation and subsequent redevelopment of LMR sites.
- Assessing the long-term economic impacts that are created from new businesses that locate to the remediated and redeveloped LMR sites.

1.2 About the Study Team

Mansfield Consulting Inc. provides specialized consulting services on economic and statistical issues. Mansfield Consulting Inc. was founded by Ed Mansfield Ph.D., who has more than thirty years of experience providing consulting services to public and private companies, professional associations, industry organizations, and government agencies. For more information on Mansfield Consulting Inc. please see Appendix F or our company website (www.mansfieldconsulting.ca).

Working with Mansfield Consulting on this study was Denise Mullen, MPA, BA, CCR, CPL. Denise is the President of DMD Management Ltd and has worked in the environmental, energy, and natural resources sectors for over twenty years.

Throughout the study, assistance was provided by CSAP staff and members, who kindly provided data and other information, and who graciously agreed to participate in interviews and other conversations.

1.3 Report Limitations

The report is provided for information purposes and is intended for general guidance only. It should not be regarded as a substitute for personalized business or investment advice. In preparing the report, Mansfield Consulting Inc. has relied upon information and data obtained from CSAP and public sources believed to be accurate. The accuracy and reliability of the findings and opinions expressed in the report are conditional upon the completeness, accuracy, and fair presentation of the information underlying them. As a result, we caution readers not to rely upon any findings or opinions for business or investment purposes and disclaim any liability to any party that relies upon them as such.

The findings and opinions expressed in the report constitute judgments as of the date of the report and are subject to change without notice. Mansfield Consulting Inc. is under no obligation to advise of any change brought to its attention which would subsequently alter those findings or opinions.

2 CONTAMINATED SITES IN BC

2.1 Contaminated Sites Defined

Contaminated sites are areas of land in which the soil or underlying groundwater or sediment contains a hazardous waste or substance in an amount or concentration that exceeds provincial environmental quality standards.⁵

2.2 Risk Categories of Contaminated Sites⁶

Contaminated sites are categorized as being either high-risk or low to moderate risk (LMR) sites. The categorization of a contaminated site depends on the amount of environmental and human health risk associated with it. High-risk sites present the greatest amount of contamination and are relatively few in number. Examples of high-risk sites include former mines, coal tar operations, and other types of heavy industrial businesses. LMR sites present lower levels of contamination and constitute the majority of contaminated sites in BC. Examples of LMR sites include former gas stations, automobile repair shops, and other types of light industrial and commercial businesses.

The BC Ministry of the Environment and Climate Change (the Ministry) has established a detailed set of procedures for the classification of contaminated sites based on an evaluation of risk to human health and the environment. A description of the Ministry's procedures is contained in its publication *Protocol 12 for Contaminated Sites, Site Risk Classification, Reclassification and Reporting*.⁷ Appendix C contains a flowchart taken from that publication which outlines the Ministry's classification procedures.

2.3 Professional Reliance

The Ministry directly manages all aspects of the remediation of high-risk sites. For LMR sites, the Ministry often relies on Approved Professionals (APs) to provide sound and impartial advice and recommendations in relation to requirements or applications under the Environmental Management Act and Contaminated Sites Regulation. APs must have the necessary knowledge, skills, and objectivity to support the best environmental outcomes for a site and to protect public interests.

APs are registered professional agrologists, biologists, chemists, engineers, and geoscientists that have been appointed to the Ministry's Roster of Approved Professionals and who are members of CSAP. At present there are approximately 110 APs in BC.

2.4 Number of LMR Sites in BC

The exact number of LMR sites in BC is not known but is believed to be in the many thousands. Some estimates put the number of LMR sites as being over 6,000 while others place it at well over 10,000.

⁵ BC Ministry of Environment and Climate Change Strategy, Fact Sheet 1: An Introduction to Contaminated Sites in British Columbia. (Retrieved from <https://www2.gov.bc.ca/assets/gov/environment/air-land-water/site-remediation/docs/fact-sheets/fs01.pdf>).

⁶ Information retrieved from CSAP website, April 2021.

⁷ The material in this section is from the BC Ministry of Environment and Climate Change Strategy, Protocol 12 for Contaminated Sites, Site Risk Classification, Reclassification and Reporting, Version 3.0, Effective date: February 1, 2021 (https://www2.gov.bc.ca/assets/gov/environment/air-land-water/site-remediation/docs/protocols/p12_jan_2021_revisions_final_signed.pdf).

According to the Ministry there are currently over 14,000 sites being tracked in government records,⁸ which include:

- Sites that are still going through the screening process.
- High-risk sites that need remediation or which are being remediated.
- LMR sites that need remediation, or which are being remediated.
- Sites awaiting final confirmation that remediation is complete.
- Sites confirmed as remediated.

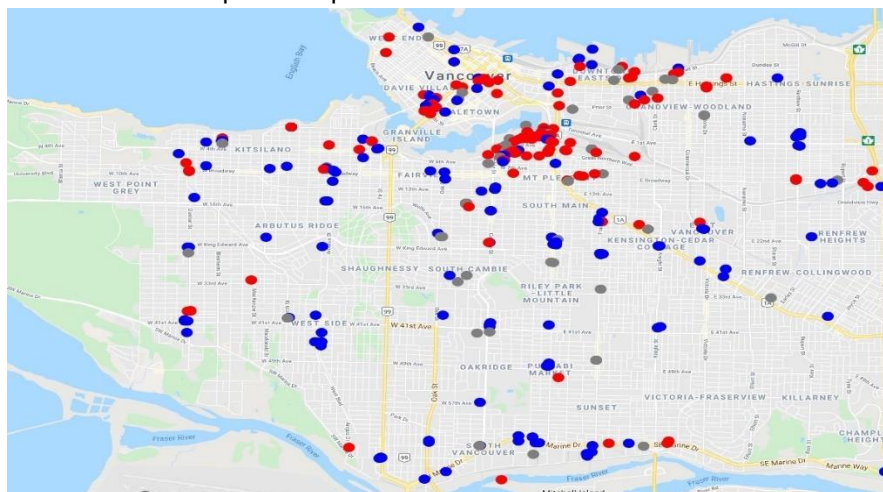
2.5 Locations of LMR Sites in BC

LMR sites occur in all regions of BC and are found in both urban and rural locations.⁹ To illustrate the widespread locations of LMR sites, the following maps display the locations of sites that have completed submissions through CSAP in the following five regions:

- City of Vancouver.
- Metro Vancouver.
- Vancouver Island.
- Southern Interior.
- Northern Interior.

Please note that the blue dots indicate that drinking water assessment is applicable, red dots indicate that drinking water is not applicable, and grey dots indicate that drinking water status is unknown.

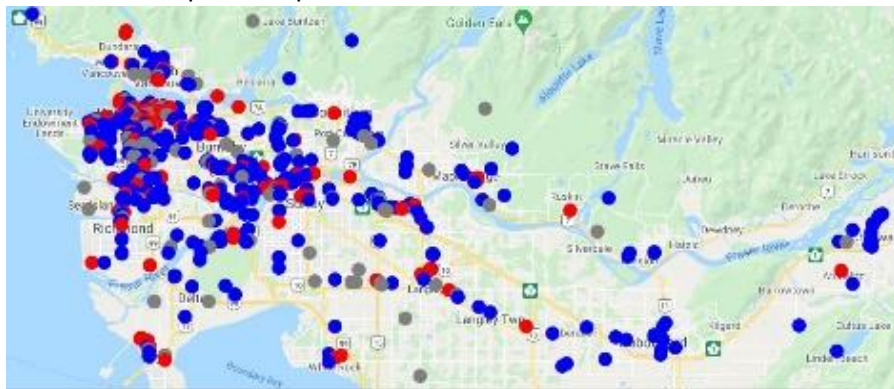
Map 1. Completed Submissions - Vancouver



⁸ Contaminated sites - Province of British Columbia. <https://www2.gov.bc.ca/gov/content/environment/air-land-water/site-remediation/contaminated-sites>

⁹ The number and locations of sites by year that involved APs, and which received a CoC is contained in Appendix D.

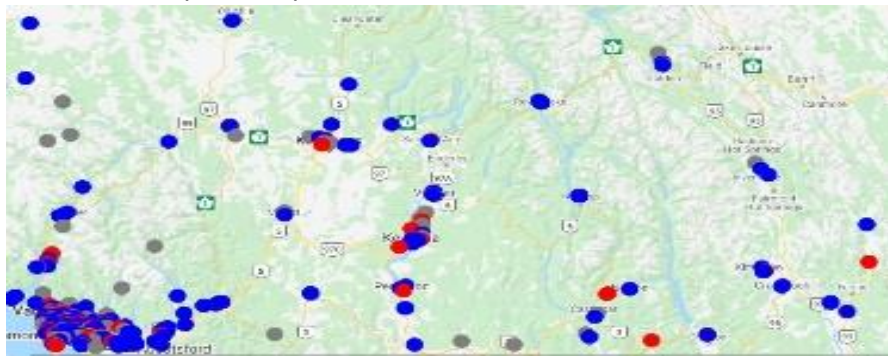
Map 2. Completed Submissions - Metro Vancouver



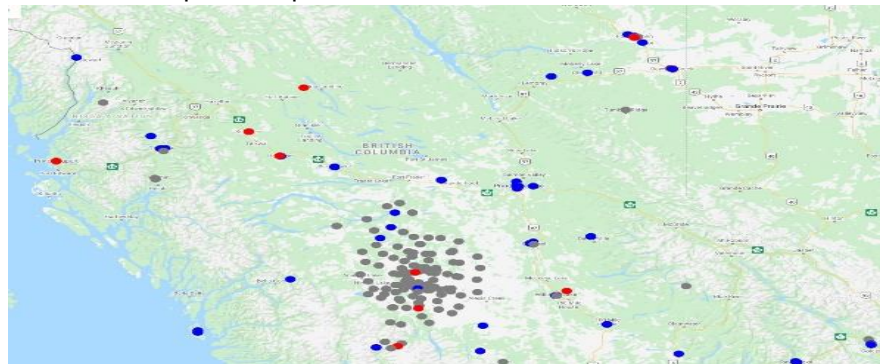
Map 3. Completed Submissions - Vancouver Island



Map 4. Completed Submissions – Southern Interior



Map 5. Completed Submissions – Northern Interior



2.6 Benefits from Remediated LMR Sites

Benefits from remediated LMR sites have been described in many publications and reports. In brief, remediated LMR sites are known to produce a wide range of economic, community, and environmental benefits.¹⁰

Among the economic benefits that have been reported are:

- Employment creation.
- New business creation.
- Increased tax revenues for government.
- Increased property values.

Among the environmental benefits that have been reported are:

- Reduced environmental risks.
- Improved air, soil, and water quality.
- Reducing urban sprawl and related greenhouse gas emissions.
- Preservation of agricultural land by reducing pressure for greenfield development.

Among the social benefits that have been reported are:

- Improved public health and safety.
- Neighborhood revitalization.
- Enhanced community aesthetics.
- Improved community infrastructure and public spaces.
- Reduced illegal dumping and vandalism.

¹⁰ The Basics of Brownfield Redevelopment. A Guide for Local Governments in British Columbia.

3 REMEDIATION AND REDEVELOPMENT OF LMR SITES

3.1 Main Steps

There are four main steps in the remediation and redevelopment of an LMR site:

- Step 1. Site assessment.
- Step 2. Site remediation.
- Step 3. Site redevelopment.
- Step 4. Ongoing business activities at the redeveloped site.

The following is a brief description of the activities conducted during each step.¹¹

Step 1. Site Assessment

Site assessment typically encompasses three components:

- Stage 1 Preliminary Site Investigation. This includes historical research, interviews, and a site visit to establish activities and areas that may pose an environmental concern.
- Stage 2 Preliminary Site Investigation. This involves sampling of soil, groundwater, vapor, surface water, and sediment as available at the site, and analyzing the samples for concentrations of environmental contaminants at an accredited laboratory. The analysis results are compared with regulated standards for each environmental media (soil, water, etc.) according to the land use and water uses pertaining to the site. If concentrations of the analyzed substances exceed the regulated standards, the site is considered contaminated and potentially subject to mandated investigation and remediation requirements.
- Detailed Site Investigation. If a site is contaminated, the next step is to conduct a Detailed Site Investigation. This involves collecting and analyzing more samples to delineate the contamination both in horizontal extent and vertical depth. A Detailed Site Investigation can often involve several rounds of environmental investigation.

Step 2. Site Remediation

Site remediation typically encompasses four components:

- Remediation Planning or Risk Assessment. After delineating the extent of contamination, a remediation plan can be prepared to arrest or remove the contamination, risk assessment to evaluate site-specific risk-based standards for a site or apply one or more treatment methods in situ that will reduce the contaminant concentrations or break down the contamination into less harmful substances.
- Implementation of a Remediation Plan. Implementation of the remediation plan or conducting the risk assessment constitutes the next step
- Confirmation of Remediation. After remediating the site, confirmatory environmental sampling is required to show that the contamination has been removed or mitigated.
- Application for a Certificate of Compliance (CoC). A Certificate of Compliance (CoC) can be issued by the Ministry when a site meets either the numerical or risk-based standards following remediation. Issuance of a CoC demonstrates compliance with the remediation standards.

¹¹ Materials in this section have been provided by CSAP members.

- A CoC will typically identify the types of substances for which remediation has been satisfactorily completed and for which the certificate is valid. It will also describe the standard to which the property has been remediated. There are two general types of standards:
 - Numerical standards are the generic standards applied to properties based on their land use. These standards are used to determine whether a property is contaminated.
 - Risk-based standards are a site-specific standard determined for a particular property. These standards are based on risk levels to human health and ecological receptors (such as plants and wildlife) from exposure to substances at contaminated sites.

A property that is remediated to a numerical standard is no longer considered a contaminated site. If the remediation is completed to risk-based standards, the property is still considered a contaminated site, but the impacts of the contamination have been managed such that the risks to human health and ecological receptors are deemed low.

Step 3. Site Redevelopment

Site redevelopment encompasses the construction and fit-out of new buildings, along with landscaping and other related costs. These activities may extend over multiple years depending on the size of the redevelopment.

Step 4. Ongoing Business Activities at the Redeveloped Site

Businesses that locate on the redeveloped site employ staff and purchase goods and services from suppliers. These businesses activities occur each year on an ongoing basis.

3.2 Role of Approved Professionals

During each step, an AP advises on the scope of the investigation, sampling plans, substances to analyze, remediation methods, risk assessment, regulatory requirements, and reporting of results.

One of the key duties of an AP is to make recommendations to the Ministry for issuance of a CoC. An AP reviews and provides final approval of a Summary of Site Condition and other forms and reports supporting the application for a CoC

AP review and recommendations are also involved for other regulatory instruments for a site, such as an Approval in Principle (AiP) of a remediation plan, or other applications for releases from the Ministry that allow local municipalities and approving officers to grant subdivisions, and issue development permits, building permits, and rezoning.

4 ECONOMIC IMPACTS

4.1 Overview of Economic Impact Analysis

The goal of an economic impact study is to quantify the economic contributions that an industry, business, or project makes to a region. In general, economic impacts are viewed as consisting of well-established, quantitative measures of economic activity. The most common of these measures are output, GDP, employment income, employment, and government tax revenue:

- **Output** is the total gross value of goods and services produced by a given organization, industry, or project, measured by the price paid to the producer. This is the broadest measure of economic activity.
 - *Example: A manufacturer buys aluminum from a metals producer for \$100 and adds value to it by producing airplane parts, which are then sold for \$300. Economic output would total \$400 which is the value of all sales in the chain of activity. The value of the aluminum is therefore counted twice, once as an intermediate good for the manufacturer, and again in the value of the parts.*
- **Gross Domestic Product (GDP)**, or value added, refers to the additional value of a good or service over the cost of inputs used to produce it from the previous stage of production. As a result, GDP is equivalent to the unduplicated value of goods and services produced.
 - *Example: A manufacturer buys aluminum from a metals producer for \$100 and adds value to it by producing airplane parts, which are then sold for \$300. GDP or value added would total \$300 (as opposed to \$400 economic output). This is because value added subtracts the sale of the purchased aluminum (intermediate input) of \$100 from the total sales price of \$400, resulting in value added of \$300.*
- **Employment income** is the total amount of wages and salaries paid to staff and employees.
- **Employment** is the number of additional jobs created. Employment is commonly measured in terms of full-time equivalents (FTEs).¹²
- **Government Tax Revenue** is the total amount of tax revenues generated for federal, provincial, and local governments.¹³

Economic impacts may be estimated at the direct, indirect, and induced levels.

- **Direct** impacts are changes that occur in “front-end” businesses that would initially receive operating revenue and incur expenditures.
- **Indirect** impacts arise from changes in activity for suppliers of the “front-end” businesses.
- **Induced** impacts arise from spending on goods and services resulting from increases to the payroll of the directly and indirectly affected businesses.

In this study the estimates of the economic impacts were developed using an input-output modelling approach based on economic impact multipliers developed by Statistics Canada. Input-output modelling

¹² One FTE is the equivalent of one person working full time for a year. One FTE is the same as one “person-year” of employment.

¹³ Please note that government revenues are estimated using Statistics Canada input-output multipliers. The government tax revenues include taxes on products, taxes on production, personal income taxes, and corporate income taxes. Government tax policies can change frequently and may result in considerable changes to the amount of tax revenues generated.

is a widely used method, which facilitates comparisons between reported results for different projects, businesses, or industries.

4.2 Key Features and Limitations of Economic Impact Analysis

While an economic impact analysis provides important insight it is important to be mindful of some of its key features and limitations:

- Economic impact analysis provides estimates, not precise calculations. To borrow a concept from statistical sampling, the results of an economic impact analysis can be thought of as having an associated “margin of imprecision.”¹⁴ There are two main factors that introduce imprecision in the results. First, Statistics Canada’s economic impact multipliers are based on industry-wide data. As a result, the multipliers represent average activities across industries rather than the activities of a specific organization or project. Second, Statistics Canada’s economic impact multipliers reflect the structure of the economy in the particular year that the economic data were collected.¹⁵ If substantial changes occur in the economy, economic impact multipliers from earlier years may not reflect the current structure of the economy.
- Economic impact analysis does not address all aspects of economic contribution. While economic impact analysis provides useful information regarding the effects of an industry, business, or project, it does not encompass all aspects of economic contribution. For example, economic impact analysis does not address such things as the benefits resulting from the reinvigoration of communities or from improvements in service delivery. Consequently, when assessing the overall economic contribution of an industry, business, or project, it may be appropriate to complement the results of an economic impact analysis with other types of measures.

¹⁴ A statistical sample has an associated “margin of error” that can be calculated using statistical theory. The use of the term “margin of imprecision” in this report is intended to reflect the fact that the results of an economic impact analysis come with some level of uncertainty in the results. However, unlike statistical sample, the uncertainty in an economic impact analysis cannot be calculated from mathematical theory.

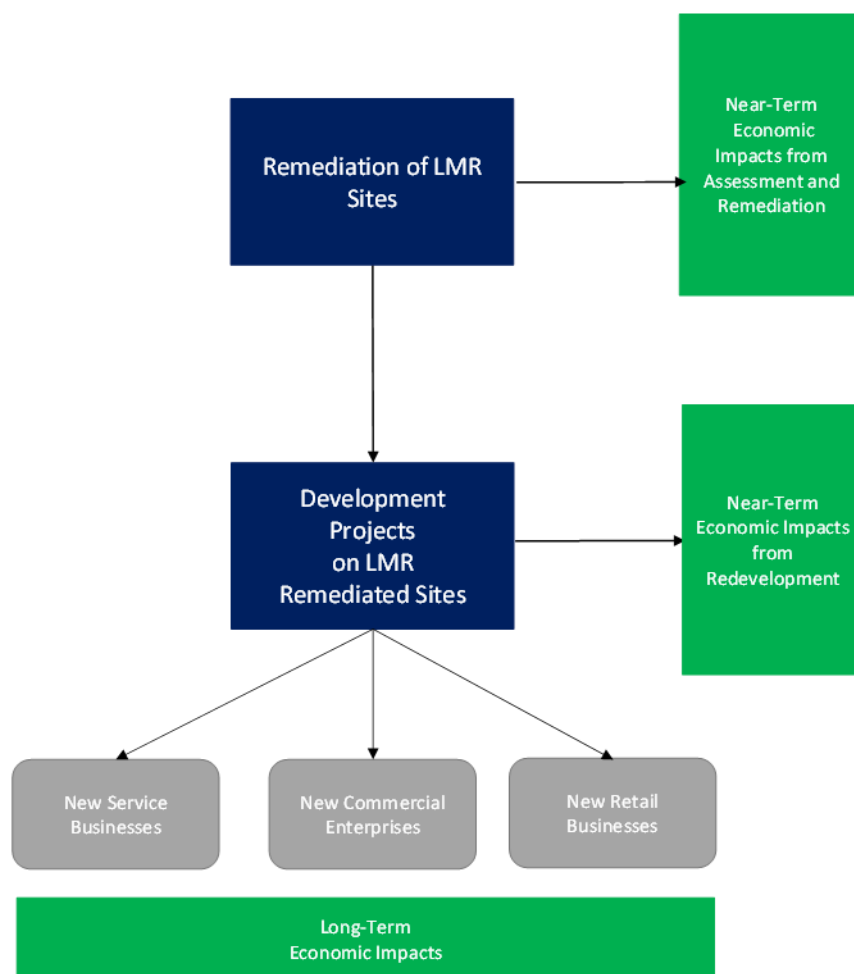
¹⁵ Due to reporting lags Statistics Canada’s economic impact multipliers normally reflect the structure of economy as it was around four years before the date of the economic impact analysis. In this study we have used Statistics Canada multipliers for 2017. These were the most recently published multipliers at the time of the study.

4.3 Categories of Economic Impacts

The economic impacts from remediated LMR sites can be placed into three categories:

- Near-term economic impacts created during the assessment and remediation process. These are economic impacts that result from site assessment and remediation.
- Near-term economic impacts created from redevelopment of the remediated LMR site. These are economic impacts that result from construction and other forms of redevelopment on the site.
- Long-term economic impacts created from new businesses that locate to the remediated LMR site. These are economic impacts that result from ongoing commercial, retail, and service activities on the site.¹⁶

The following figure illustrates the types of economic impacts created from remediated LMR sites.



¹⁶ Please note that in this study long-term impacts are considered to include only those impacts arising from business operations. Long-term impacts arising from the spending of occupants of residential units are not included.

4.4 Approach for Estimating Near-Term Impacts Created During Assessment and Remediation

Near-term economic impacts created during assessment and remediation were studied previously in a 2012 report prepared for CSAP by TyPlan Consulting.¹⁷ To allow for consistency, and to facilitate comparisons with the earlier study, we have followed a similar approach to that used by TyPlan in this report.

The TyPlan approach involved developing estimates of average spending for LMR site assessment and remediation and then using an economic impact model to project the economic impacts arising from that spending. In brief, the process followed by TyPlan was:

- The steps involved in site assessment were identified. The steps consisted of preliminary site investigation – stage 1, preliminary site investigation - stage 2, detailed site investigation, remediation planning or risk assessment, and other services.
- For each step, an average spending estimate was developed using information provided by CSAP members.
- Based on additional information provided by CSAP members, TyPlan projected that all sites would require preliminary site investigation – stage 1, 28 percent would require preliminary site investigation – stage 2, 17 percent would require detailed site investigation, 13 percent would require remediation planning or risk assessment, and 28 percent would require other services.
- Using the estimated costs and percentages of sites requiring each step, TyPlan calculated that the average cost for LMR site review and assessment was approximately \$75,000.
- Based on additional information provided by CSAP members and its own research, TyPlan then estimated the costs of remediation as being three times the cost assessment. This resulted in an estimated average cost of \$225,000 for remediation, and a combined average cost for both assessment and remediation of \$300,000.

Table 1 summarizes the TyPlan cost estimates.

¹⁷ BC Contaminated Sites Sector – Economic Benefit Analysis Economic Benefit of the Contaminated Site Assessment and Review Sector in British Columbia. TyPlan Consulting, 2012.

Table 1: LMR Site Cost Estimates (TyPlan, 2012)

Step	Average Cost	Proportion of Sites Requiring Step	Weighted Average Cost
Preliminary Site Investigation – Stage 1	\$5,847	100%	\$5,847
Preliminary Site Investigation – Stage 2	\$27,594	28%	\$7,714
Detailed Site Investigation	\$48,531	17%	\$8,250
Remediation Planning	\$375,990	13%	\$48,879
Other Costs ¹⁸	\$14,485	28%	\$4,056
<i>Average Cost for Site Assessment</i>			<i>\$74,745 (rounded to \$75,000)</i>
<i>Average Cost for Remediation</i>			<i>\$225,000</i>
Total Average Cost for Assessment and Remediation			\$300,000

TyPlan's reported its estimates for the average economic impacts from assessment and remediation to consist of total output of \$439,167 per site, total employment of 3.02 FTEs per site, and total taxes (all levels of government) of \$31,667 per site. (Please refer Section 5 to see how these estimates have been updated to reflect 2021 costs.)

4.5 Approach for Estimating Near-Term Impacts Created From Redevelopment

The near-term economic impacts that arise from redevelopment have not been previously studied in a systematic manner. Consequently, a new approach was developed for this study that involved the creation of detailed case studies of typical types of redevelopment projects on LMR sites. The approach consisted of the following steps:

- A list of LMR sites that involved APs, and which received a CoC in 2016 or 2017 was provided by CSAP. A review of those sites identified roughly 15 sites on which redevelopment occurred and for which some information on development characteristics was publicly available.
- The candidate sites were then examined closely to determine the extent of the available information and to assess the degree to which they might be considered illustrative of a class or category of development. At the conclusion of this step a set of five sites were selected for case study development.
- For each of the case studies, the redevelopment characteristics were based as closely as possible on the publicly available information. Where characteristics were not available approximations were developed using other sources.

¹⁸ Includes laboratory costs, risk assessment, implementation of plan costs, preparation of CoC applications and confirmation of remediation.

- Building costs for the case studies were not included in the publicly available information. Consequently, building costs were estimated using cost-per-square-foot figures provided in the Altus Group Canadian Cost Guide (2021).¹⁹
- In addition to building costs, redevelopment costs were defined to include soft costs (e.g., architects, engineers, marketing, and insurance), interior buildout costs (e.g., flooring, lighting fixtures, and cabinets), and site infrastructure costs (e.g., excavation, earthwork, and utilities). Those costs were based on the building costs using research published by the NAIOP Research Foundation.²⁰ As summarized in Table 2, soft costs, interior buildout, and site infrastructure costs account for roughly 36.0 percent of total redevelopment costs.

Table 2. Redevelopment Costs by Phase

Redevelopment Phase	Example Costs	Percent of Total Costs
Building Costs	Base building costs	64.0%
Soft Costs	Architectural, engineering, and insurance	13.7%
Interior Buildout	Flooring, lighting fixtures, and cabinets	12.8%
Site Infrastructure Costs	Excavation, earthwork, and utilities	9.5%
Total		100.0%

- The economic impacts from each phase were then estimated using an input-output model based on Statistics Canada's within province multipliers for BC for 2017.²¹

4.6 Approach for Estimating Long-Term Impacts Created From Redevelopment

The long-term economic impacts created by businesses that locate to the redeveloped site have also not been previously studied. Consequently, a new approach was developed for these impacts. The approach consisted of the following steps:

- For each of the case studies, information on the number and square footage of commercial and retail space was obtained.
- Types of businesses that may typically be found in the corresponding commercial and retail space were identified.
- Reported space requirements for identified businesses were matched with the available square footage for the commercial and retail spaces.

¹⁹ The guide provides estimates of construction costs per square foot. The costs assume that a level, open site exists with no restrictions from adjoining properties. It is assumed that stable soil conditions prevail. Average-quality finishes to both exterior and interior are also assumed. For more information on the Altus Group Canadian Cost Guide, please see www.altusgroup.com.

²⁰ NAIOP Research Foundation and the Conference Board of Canada, Economic Impacts of Commercial Real Estate in Canada, 2018.

²¹ The 2017 multipliers were the most recent ones available at the time of the study. Because the within BC multipliers have been used the impacts reported in this report reflect only the impacts generated in BC. Redevelopments also generate impacts outside of BC through supply chains and goods and services purchased from out-of-province suppliers. However, those impacts have not been included in this study.

- Annual revenues for the identified businesses were approximated using financial performance data for small businesses as reported by Industry, Science, and Economic Development Canada.²² For one business (a new car dealership) revenues were approximated using data from economic impact studies published by the New Car Dealers Association of BC.²³
- The annual economic impacts for each business were estimated using an input-output model based on Statistics Canada's within province multipliers for 2017.

²² Financial Performance Data, <https://www.ic.gc.ca/eic/site/pp-pp.nsf/eng/Home>.

²³ www.newcardealers.ca

5 NEAR-TERM ECONOMIC IMPACTS CREATED FROM ASSESSMENT AND REMEDIATION

5.1 Costs of Assessment and Remediation

Using information provided by CSAP members and a review of additional sources, we have updated the TyPlan estimates for average costs to 2021. Using the 2021 estimates for each step together with the TyPlan's estimates for proportions²⁴, resulted in a revised average cost estimate of \$130,000.

Using TyPlan's estimate that the costs of remediation are roughly three times the cost for assessment resulted in an estimated average cost for remediation of an LMR site of \$390,000, and a combined average cost for assessment and remediation of \$520,000.

Table 3 summarizes the updated cost estimates.

Table 3. LMR Site Assessment and Remediation Cost Estimate (2021)

Step	Average Cost	Proportion of Sites Requiring Step	Weighted Average Cost
Preliminary Site Investigation – Stage 1	\$6,500	100%	\$6,500
Preliminary Site Investigation – Stage 2	\$50,000	28%	\$14,000
Detailed Site Investigation	\$155,000	17%	\$26,350
Remediation Planning	\$472,590	13%	\$61,437
Other Costs ²⁵	\$167,192	13%	\$21,735
<i>Average Cost for Site Assessment</i>			<i>\$130,022 (rounded to \$130,000)</i>
<i>Average Cost for Remediation</i>			<i>\$390,000</i>
Total Average Cost for Assessment and Remediation			\$520,000

5.2 Near-Term Economic Impacts Created From Assessment and Remediation

The estimate economic impacts arising from assessment and remediation costs of \$520,000 are:

- Total Output of \$0.835 million.
- Total GDP of \$0.540 million.
- Total Employment of 4.5 FTEs.
- Total Tax Revenues of \$0.116 million.

²⁴ Based on information provided by CSAP members, the percentage for other costs has been aligned to be the same as that for remediation planning.

²⁵ Includes laboratory costs, risk assessment, implementation of plan costs, preparation of CoC applications and confirmation of remediation.

The economic impact estimates are summarized in Table 4.

Table 4. Economic Impacts of Assessment and Remediation

Economic Impact	Output	GDP	Employment (FTEs)	Federal Tax	Provincial Tax	Municipal Tax
Direct	\$520,000	\$347,880	3.0	\$38,103	\$21,400	\$639
Indirect	\$163,800	\$95,160	0.8	\$10,531	\$7,512	\$1,822
Induced	\$151,320	\$97,240	0.7	\$15,450	\$17,174	\$3,739
Total	\$835,120	\$540,280	4.5	\$64,084	\$46,086	\$6,200

6 NEAR-TERM ECONOMIC IMPACTS CREATED FROM REDEVELOPMENT

6.1 Case Studies

The following set of case studies represent categories of redevelopment that commonly occur on remediated LMR sites. The economic impacts created from these case studies are representative of the economic impacts that occur through redevelopment of remediated LMR sites.

The case studies are:

1. A large residential development.
2. A mid-size residential development with retail space.
3. A small, mixed-use (residential/retail) development.
4. A seniors' residence with retail space.
5. A commercial development.

Case Study 1. Large residential development

This case study is typical of a development that occurs frequently in Vancouver and surrounding communities. After remediation, a 33-story residential building is planned to be built, consisting of 127 market strata units. There are no retail or commercial businesses located in the development. Table 5 summarizes the key features of this case study.

Table 5. Key Features of Case Study 1

Case Study 1. Large Residential Development	
Description	33-storey residential building, consisting of 127 market strata units
Residential Space	184,000 sq ft
Retail Space	None
Parking	27,000 sq ft
Other Features	\$31 million in developer contributions to local government, consisting of Community Amenity Contributions, Development Cost Levies, and other contributions
Total Costs, Including Building Costs, Soft Costs, Interior Buildout Costs, and Site Infrastructure Costs	\$113.0 million (\$72.2 million in construction hard costs)

The estimated near-term economic impacts arising from redevelopment for this case study are summarized in Table 6, and include:

- Total Output of \$189.5 million.
- Total GDP of \$98.4 million.
- Total Employment of 846.4 FTEs.
- Total Tax Revenues of \$60.2 million.

Table 6. Near-Term Economic Impacts for Case Study 1

Economic Impact	Output	GDP	Employment (FTEs)	Federal Tax	Provincial Tax	Municipal Tax
Direct	\$112,819,320	\$54,912,033	461.7	\$7,077,886	\$6,282,832	\$33,966,267
Indirect	\$46,966,171	\$24,384,693	232.8	\$3,082,151	\$2,036,435	\$397,345
Induced	\$29,670,381	\$19,066,860	151.9	\$3,198,186	\$3,414,168	\$728,929
Total	\$189,455,871	\$98,363,586	846.4	\$13,358,223	\$11,733,435	\$35,092,541

Case Study 2. A mid-size residential development with retail space

This case study is typical of a development that occurs frequently in both urban and suburban locations. After remediation of the site, a six-story wood frame building with 49 market strata units and one retail outlet is planned to be built. The following Table 7 summarizes the key features of this case study.

Table 7. Key Features of Case Study 2

Case Study 2. Mid-Size Residential Development with Retail Space	
Description	6-storey wood framed residential building, consisting of 49 market strata units
Residential Space	32,000 sq ft
Retail Space	1,000 sq ft Occupied by a general merchandise store
Parking	3,000 sq ft
Total Costs, Including Building Costs, Soft Costs, Interior Buildout Costs, and Site Infrastructure Costs	\$15.6 million (\$10.0 in construction hard costs)

The estimated near-term economic impacts arising from redevelopment for this case study are summarized in the Table 8, and include:

- Total Output of \$26.2 million.
- Total GDP of \$13.6 million.
- Total Employment of 117.2 FTEs.
- Total Tax Revenues of \$4.0 million.

Table 8. Near-Term Economic Impacts for Case Study 2

Economic Impact	Output	GDP	Employment (FTEs)	Federal Tax	Provincial Tax	Municipal Tax
Direct	\$15,567,633	\$7,543,960	63.8	\$972,590	\$863,906	\$340,339
Indirect	\$6,514,372	\$3,383,225	32.3	\$427,617	\$282,351	\$54,976
Induced	\$4,122,474	\$2,649,019	21.1	\$444,358	\$474,363	\$101,292
Total	\$26,204,479	\$13,576,204	117.2	\$1,844,564	\$1,620,620	\$496,606

Case Study 3. A small, mixed-use (residential/retail) development

This case study is typical of a development that occurs frequently in both urban and suburban locations. After remediation, a two-story mixed-used development, containing three commercial units and four residential dwelling units is planned to be built. The Table 9 summarizes the key features of this case study.

Table 9. Key Features of Case Study 3

Case Study 3. Small Mixed-Use Development	
Description	2-storey wood framed, mixed use development, containing 3 commercial units and 4 residential units.
Residential Space	3,800 sq ft
Retail Space	4,400 sq ft Assumed to be occupied by a café and two general merchandise stores
Parking	5,500 sq ft
Total Costs, Including Building Costs, Soft Costs, Interior Buildout Costs, and Site Infrastructure Costs	\$4.0 million (\$2.6 million in construction hard costs)

The estimated near-term economic impacts arising from redevelopment for this case study are summarized in Table 10, and include:

- Total Output of \$6.5 million.
- Total GDP of \$3.6 million.
- Total Employment of 29.4 FTEs.
- Total Tax Revenues of \$1.0 million.

Table 10. Near-Term Economic Impacts for Case Study 3

Economic Impact	Output	GDP	Employment (FTEs)	Federal Tax	Provincial Tax	Municipal Tax
Direct	\$4,021,204	\$2,144,633	16.7	\$271,443	\$235,968	\$92,848
Indirect	\$1,479,030	\$788,907	7.4	\$99,078	\$65,298	\$12,728
Induced	\$1,027,372	\$659,861	5.3	\$110,572	\$117,910	\$25,006
Total	\$6,527,606	\$3,593,402	29.4	\$481,094	\$419,175	\$130,582

Case Study 4. A seniors' residence with retail space

This case study is typical of a development that occurs in both urban and suburban locations. After remediation, a two-story mixed-used development, containing three commercial units and four residential dwelling units is planned to be built. Table 11 summarizes the key features of this case study.

Table 11. Key Features of Case Study 4

Case Study 4. Seniors' Residence with Retail Space	
Description	9-storey residential building, consisting of 132 senior living units
Residential Space	89,100 sq ft
Retail Space	4,600 sq ft Assumed to be occupied by a two- physician medical practice, a coffee stand, and two general merchandise stores
Parking	27,000 sq ft
Total Costs, Including Building Costs, Soft Costs, Interior Buildout Costs, and Site Infrastructure Costs	\$53.4 million (\$34.2 million in construction hard costs)

The estimated near-term economic impacts arising from redevelopment for this case study are summarized in Table 12, and include:

- Total Output of \$88.6 million.
- Total GDP of \$46.8 million.
- Total Employment of 395.2 FTEs.
- Total Tax Revenues of \$13.6 million.

Table 12. Near-Term Economic Impacts for Case Study 4

Economic Impact	Output	GDP	Employment (FTEs)	Federal Tax	Provincial Tax	Municipal Tax
Direct	\$53,405,898	\$26,744,819	218.4	\$3,432,453	\$3,029,355	\$1,180,351
Indirect	\$21,458,475	\$11,189,158	106.5	\$1,412,688	\$934,362	\$183,170
Induced	\$13,747,674	\$8,834,992	70.3	\$1,481,468	\$1,581,197	\$337,030
Total	\$88,612,047	\$46,768,969	395.2	\$6,326,609	\$5,544,915	\$1,700,550

Case Study 5. A commercial development

This case study is typical of a commercial development. After remediation, a two-story new car dealership is assumed. The Table 13 summarizes the key features of this case study.

Table 13. Key Features of Case Study 5

Case Study 5. Commercial Development	
Description	2-storey Commercial Development
Residential Space	None
Retail Space	46,000 sq ft assumed to be a new car dealership
Parking	64,600 sq ft of surface parking
Total Costs, Including Building Costs, Soft Costs, Interior Buildout Costs, and Site Infrastructure Costs	\$19.9 million (\$12.7 million in construction hard costs)

The estimated near-term economic impacts arising from redevelopment for this case study are summarized in Table 14, and include:

- Total Output of \$33.1 million.
- Total GDP of \$18.1 million.
- Total Employment of 154.2 FTEs.
- Total Tax Revenues of \$5.2 million.

Table 14. Near-Term Economic Impacts for Case Study 5

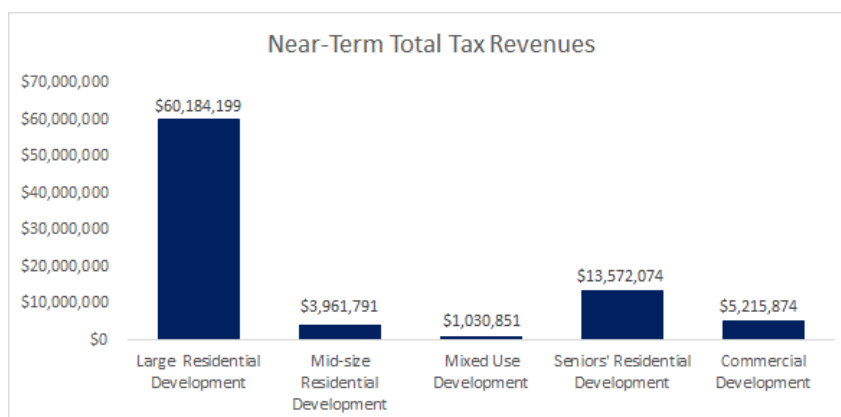
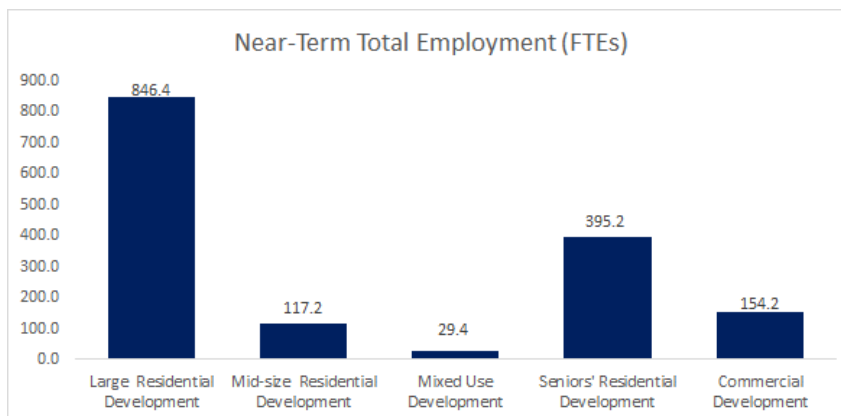
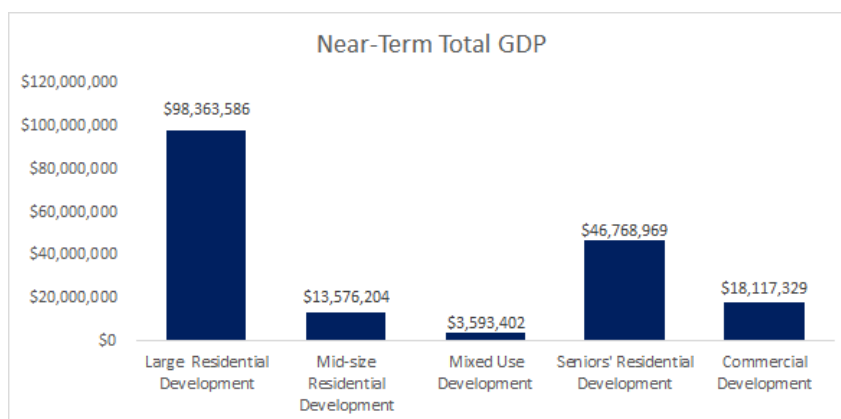
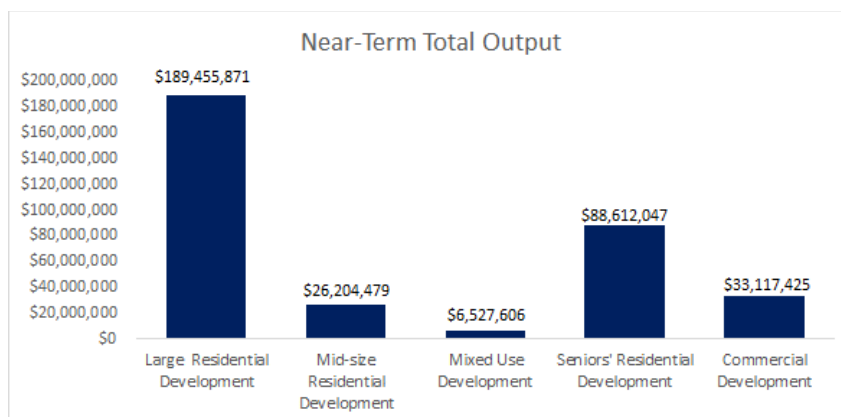
Economic Impact	Output	GDP	Employment (FTEs)	Federal Tax	Provincial Tax	Municipal Tax
Direct	\$19,863,451	\$10,341,723	86.4	\$1,297,700	\$1,125,826	\$475,251
Indirect	\$7,544,756	\$4,114,153	38.5	\$514,483	\$333,841	\$62,043
Induced	\$5,709,217	\$3,661,453	29.3	\$613,868	\$654,182	\$138,681
Total	\$33,117,425	\$18,117,329	154.2	\$2,426,051	\$2,113,849	\$675,974

6.2 Summary of Case Study Near-Term Economic Impacts

As the case studies demonstrate, redevelopments on remediated LMR sites produce substantial near-term economic impacts. The magnitude of the impacts depends on the type of development. For the cases studies, the ranges of near-term economic impacts are:

- Total output of \$6.5 million to \$189.5 million.
- Total GDP of \$3.6 million to \$98.4 million.
- Total employment of 29.4 FTEs to 846.4 FTEs.
- Total government tax revenues of \$1.0 million to \$60.2 million.

The following figures display the estimated near-term total output, GDP, employment, and government tax revenues created by each of the five case studies.



7 LONG-TERM ECONOMIC IMPACTS FROM REMEDIATION

7.1 Case Studies

Long-term economic impacts are due to new businesses that locate to the redeveloped site.²⁶ The long-term impacts are expressed on an annual basis and apply to each year of post-redevelopment business operation.

Case Study 1. A large residential development

Case Study 1 is assumed to consist entirely of residential units. As a result, there is no ongoing business activity.

Case Study 2. A mid-size residential development with retail space.

After remediation of the site, the ongoing businesses are planned to consist of one retail shop. Using financial performance data for small businesses reported by Industry, Science, and Economic Development Canada, we have modelled the retail shop as being a general merchandise store with annual revenues of \$274,000. Table 15 summarizes the key features of the ongoing businesses for this case study.

Table 15. Ongoing Businesses for Case Study 2

Summary of Business Activity	
Retail Space	1,000 sq ft
Businesses	One general merchandise store
Business Annual Revenues	\$274,000

The estimated long-term economic impacts arising from redevelopment for this case study are summarized in Table 16 and include:

- Annual Total Output of \$0.5 million.
- Annual Total GDP of \$0.3 million.
- Annual Total Employment of 3.4 FTEs.
- Annual Total Tax Revenues of \$0.1 million.

Table 16. Annual Long-Term Economic Impacts for Case Study 3

Economic Impact	Output	GDP	Employment (FTEs)	Federal Tax	Provincial Tax	Municipal Tax
Direct	\$274,000	\$178,648	2.5	\$18,651	\$13,263	\$4,610
Indirect	\$98,092	\$56,718	0.4	\$6,283	\$5,097	\$1,755
Induced	\$101,654	\$65,486	0.5	\$10,295	\$11,375	\$2,463
Total	\$473,746	\$300,852	3.4	\$35,229	\$29,735	\$8,827

²⁶ Residents of developments also create economic impacts through their personal spending. However, those impacts are not included in the long-term impacts examined in this report.

Case Study 3. A small, mixed-use (residential/retail) development

After remediation of the site, the ongoing businesses are planned to consist of a café and two general merchandise stores. Using financial performance data for small businesses reported by Industry, Science, and Economic Development Canada we have modelled the café and two general merchandise stores as having total annual revenues of \$1,533,400. Table 17 summarizes the key features of the ongoing businesses for this case study.

Table 17. Ongoing Businesses for Case Study 3

Summary of Business Activity	
Retail Space	4,400 sq ft
Businesses	Assumed to be occupied by a café and two general merchandise stores
Business Annual Revenues	\$1,533,400

The estimated long-term economic impacts arising from redevelopment for this case study are summarized in Table 18, and include:

- Annual Total Output of \$2.7 million.
- Annual Total GDP of \$1.5 million.
- Annual Total Employment of 22.4 FTEs.
- Annual Total Tax Revenues of \$0.4 million.

Table 18. Annual Long-Term Economic Impacts for Case Study 3

Economic Impact	Output	GDP	Employment (FTEs)	Federal Tax	Provincial Tax	Municipal Tax
Direct	\$1,533,400	\$773,355	17.0	\$84,603	\$57,044	\$12,401
Indirect	\$625,959	\$342,534	2.9	\$38,150	\$31,004	\$10,632
Induced	\$534,646	\$343,759	2.5	\$54,129	\$59,780	\$12,841
Total	\$2,694,005	\$1,459,647	22.4	\$176,882	\$147,828	\$35,874

Case Study 4. A seniors' residence with retail space

After remediation of the site, the ongoing businesses are planned to consist of a two-physician medical practice, three general merchandise stores, and a coffee stand. Using financial performance data for small businesses reported by Industry, Science, and Economic Development Canada we have modelled the businesses as having total annual revenues of \$1,639,200. The Table 19 summarizes the key features of the ongoing businesses for this case study.

Table 19. Ongoing Businesses for Case Study 4

Summary of Business Activity	
Retail Space	4,600 sq ft
Businesses	Assumed to be occupied by a two- physician medical practice, and three general merchandise stores, and a coffee stand
Business Annual Revenues	\$1,639,200

The estimated long-term economic impacts arising from redevelopment for this case study are summarized in Table 20, and include:

- Annual Total Output of \$2.7 million.
- Annual Total GDP of \$1.8 million.
- Annual Total Employment of 15.1 FTEs.
- Annual Total Tax Revenues of \$0.4 million.

Table 20. Annual Long-Term Economic Impacts for Case Study 4

Economic Impact	Output	GDP	Employment (FTEs)	Federal Tax	Provincial Tax	Municipal Tax
Direct	\$1,639,200	\$1,128,414	10.4	\$124,666	\$83,843	\$16,334
Indirect	\$514,103	\$301,723	2.3	\$33,467	\$27,816	\$10,017
Induced	\$514,982	\$331,296	2.4	\$52,065	\$57,364	\$12,289
Total	\$2,668,285	\$1,761,433	15.1	\$210,198	\$169,023	\$38,640

Case Study 5. A commercial development

The ongoing business at this site is planned to consist of a new car dealership. Using financial performance data for small businesses reported by Industry, Science, and Economic Development Canada together with information published in economic impact studies for the New Car Dealers Association of BC, we have modelled the business as having total annual revenues of \$15,892,895. The Table 21 summarizes the key features of the ongoing businesses for this case study.

Table 21. Ongoing Businesses for Case Study 5

Summary of Business Activity	
Retail Space	46,000 sq ft assumed to be a new car dealership
Businesses	New Car Dealership
Business Annual Revenues	\$15,892,895

The estimated long-term economic impacts arising from redevelopment for this case study are summarized in Table 22, and include:

- Annual Total Output of \$28.4 million.
- Annual Total GDP of \$17.7 million.
- Annual Total Employment of 180.0 FTEs.
- Annual Total Tax Revenues of \$4.4 million.

Table 22. Annual Long-Term Economic Impacts for Case Study 5

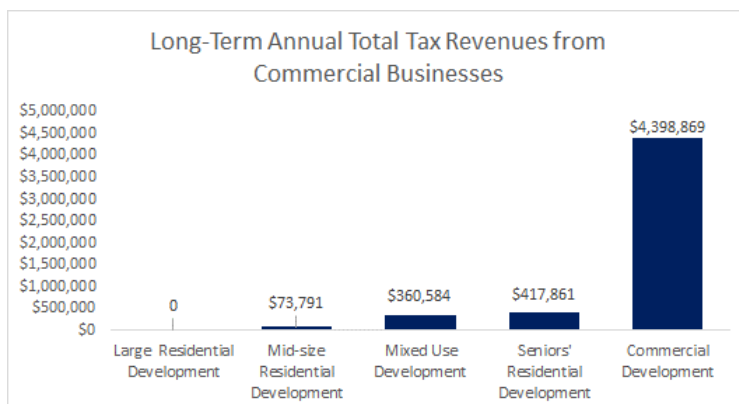
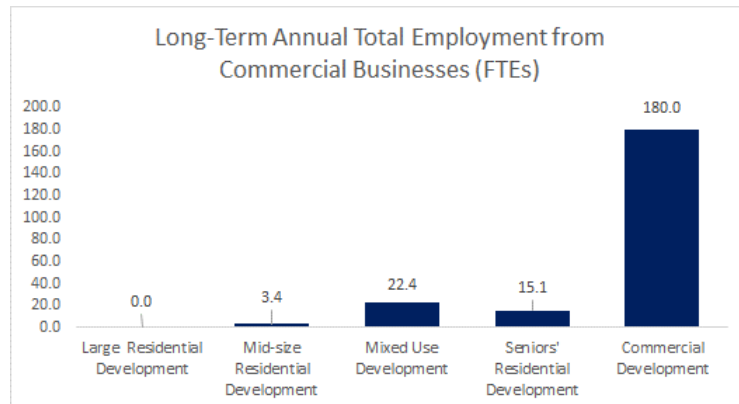
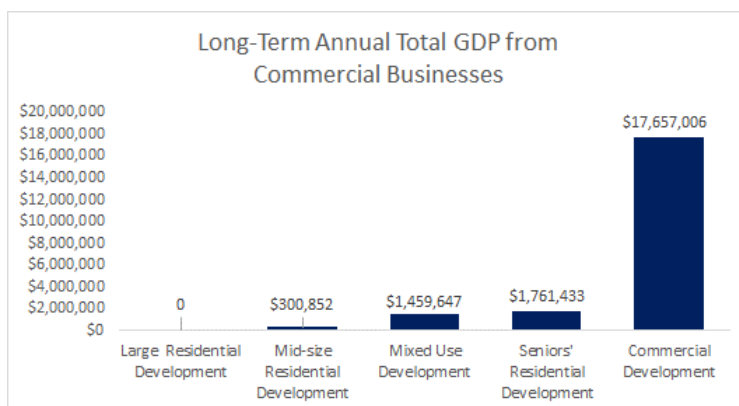
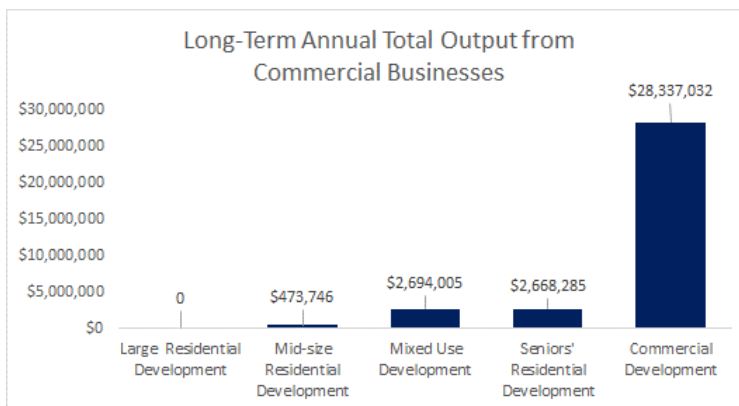
Economic Impact	Output	GDP	Employment (FTEs)	Federal Tax	Provincial Tax	Municipal Tax
Direct	\$15,892,895	\$10,060,202	111.7	\$1,187,940	\$667,977	\$111,389
Indirect	\$5,610,192	\$3,194,472	31.4	\$385,345	\$292,749	\$92,584
Induced	\$6,833,945	\$4,402,332	36.8	\$722,821	\$775,983	\$162,078
Total	\$28,337,032	\$17,657,006	180.0	\$2,296,107	\$1,736,710	\$366,052

7.2 Summary of Case Study Long-Term Economic Impacts

As the case studies illustrate, businesses that locate on remediated LMR sites produce ongoing, long-term economic impacts. The magnitude of the impacts depends on the size and type of business. For the four case studies that contain retail and commercial spaces, the ranges of long-term economic impacts are:

- Annual total output of \$0.5 million to \$28.3 million.
- Annual total GDP of \$0.3 million to \$17.7 million.
- Annual total employment of 3.4 FTEs to 180.0 FTEs.
- Annual total government tax revenues of \$0.1 million to \$4.4 million.

The following figures display the long-term annual total economic impacts for the case studies.



8 ESTIMATED AVERAGE IMPACTS OF REMEDIATED LMR SITES

8.1 Average Near-Term Impacts by Region From Redevelopment

At present, redevelopments that occur on remediated LMR sites are not tracked in a standardized way. As a result, the average near-term economic impacts created from redevelopment cannot be calculated precisely. However, estimates can be made by weighting the results of the five case studies by the proportion of redevelopments that each is believed to represent.

Table 23 summarizes the estimated distribution for the proportion of redevelopments in each region (Vancouver, Metro Vancouver,²⁷ Vancouver Island, Southern Interior, and Northern Interior) that are represented by each of the case studies.²⁸

Table 23. Percent of Redevelopment by Category for Each Region

Region	Large Residential Development	Mid-size Residential Development	Mixed-Use Development	Seniors Residence	Commercial Development	Total
Vancouver	30%	40%	10%	5%	15%	100%
Metro Vancouver	20%	40%	20%	5%	15%	100%
Vancouver Island	0%	40%	40%	5%	15%	100%
Southern Interior	0%	30%	50%	5%	15%	100%
Northern Interior	0%	20%	60%	5%	15%	100%

Using the proportions from Table 23, together with the estimates of economic impacts for the case studies, produces in the following estimates for average near-term total impacts from redevelopment on a remediated LMR site for each region.²⁹

Table 24. Estimated Regional Average Near-Term Total Impacts Per LMR Site from Redevelopment

Region	Average Total Output	Average Total GDP	Average Total Employment	Average Total Government Revenues
Vancouver	\$76,032,302	\$39,622,506	340.6	\$21,003,168
Metro Vancouver	\$57,739,475	\$30,145,488	258.9	\$15,087,833
Vancouver Island	\$21,153,822	\$11,191,451	95.6	\$3,257,163
Southern Interior	\$19,186,135	\$10,193,171	86.8	\$2,964,069
Northern Interior	\$17,218,447	\$9,194,890	78.0	\$2,670,975

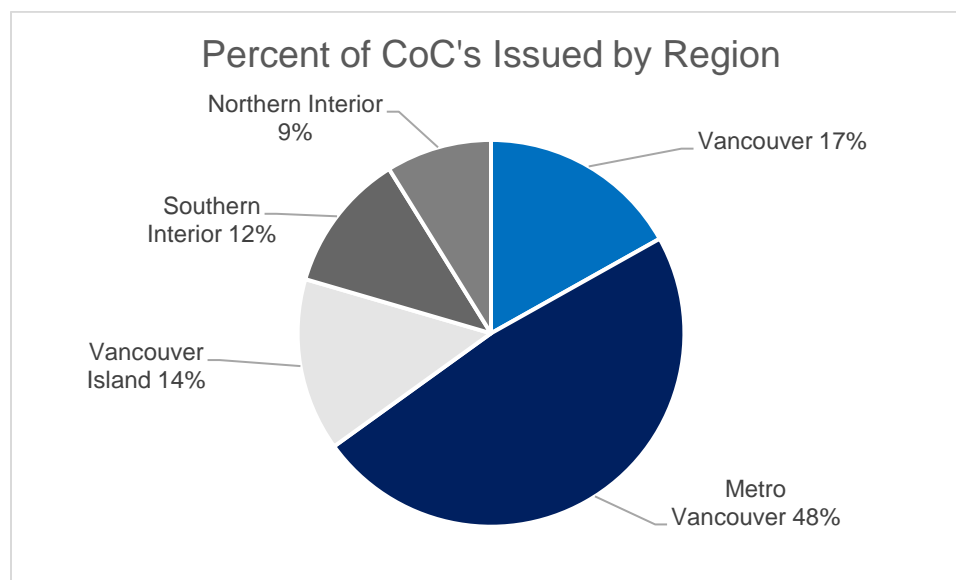
²⁷ Excludes the City of Vancouver.

²⁸ The proportions are approximations and are based on a review of available information and discussions with members of CSAP. Changes in proportions will change the average impacts calculated in this section.

²⁹ Please note this table summarizes only total economic impacts (i.e., the sum of direct, indirect, and induced impacts). Average direct, indirect, and induced impacts can also be calculated for each region.

8.2 Province-Wide Average Near-Term Impacts From Redevelopment

The regional averages can be used to produce province-wide averages by weighting the regional averages by the percentage of remediated LMR sites that involved APs in each region.³⁰ As displayed in the following figure, approximately 17% of CoCs that involve APs are issued in Vancouver, 48 percent in other Metro Vancouver communities, 14 percent in Vancouver Island, 12 percent in the Southern Interior, and 9 percent in the Northern Interior.³¹



Using those percentages, the estimated BC average near-term economic impacts created from redevelopment on a remediated LMR site are:

- Average total output of \$47.5 million per site.
- Average total GDP of \$24.8 million per site.
- Average total employment of 213.1 FTEs per site.
- Average total government revenues of \$11.9 million per site.

The estimated average near-term economic impacts created from redevelopment on a remediated LMR site are summarized in Table 25.

Table 25. Estimated BC Average Near-term Economic Impacts Per LMR Site Created From Redevelopment

Economic Impact	Output	GDP	Employment (FTEs)	Federal Tax	Provincial Tax	Municipal Tax
Direct	\$28,334,273	\$13,936,718	116.7	\$1,791,509	\$1,587,648	\$5,260,211
Indirect	\$11,621,189	\$6,067,410	57.8	\$766,300	\$504,998	\$98,033
Induced	\$7,509,739	\$4,824,730	38.5	\$809,469	\$863,707	\$184,190
Total	\$47,465,201	\$24,828,858	213.1	\$3,367,279	\$2,956,353	\$5,542,433

³⁰ The percentage of remediated LMR sites that involved APs in each region is used as an estimate of the percentage of all remediated sites in each region.

³¹ Based on a review of CoCs issued in 2016 and 2017 to LMR sites that involved APs.

8.3 Average Long-Term Impacts by Region From Redevelopment

Similar to near-term economic impacts from redevelopment, an estimate of the annual average long-term economic impacts can be made by weighting the results of the case studies by the proportion of redevelopments that each is believed to represent. Using the proportions from Table 23, together with the estimates of economic impacts for the case studies, produces the following estimates for annual average long-term total impacts from redevelopment on a remediated LMR site for each region.³²

Table 26. Estimated Regional Annual Average Long-Term Total Impacts Per LMR Site from Redevelopment

Region	Annual Average Total Output	Annual Average Total GDP	Annual Average Total Employment	Annual Average Total Government Revenues
Vancouver	\$4,884,279	\$3,028,015	31.8	\$752,140
Metro Vancouver	\$5,195,090	\$3,199,067	34.5	\$794,039
Vancouver Island	\$5,816,713	\$3,541,170	39.8	\$877,839
Southern Interior	\$6,080,150	\$3,682,136	42.2	\$912,360
Northern Interior	\$6,343,587	\$3,823,103	44.5	\$946,880

8.4 Province-Wide Average Long-Term Impacts From Redevelopment

Province-wide average long-term impacts can be obtained by weighting the regional averages by the percentage of remediated LMR sites in each region. Using that approach, the estimated average annual long-term economic impacts created from new businesses on a remediated LMR site are:

- Average annual total output of \$5.4 million per site.
- Average total GDP of \$3.3 million per site.
- Average total employment of 36.6 FTEs per site.
- Average total government revenues of \$0.8 million per site.

The estimated average long-term economic impacts created from redevelopment on a remediated LMR site are summarized in Table 27.

Table 27. Estimated BC Average Annual Long-term Economic Impacts Per LMR Site Created From Redevelopment

Economic Impact	Output	GDP	Employment (FTEs)	Federal Tax	Provincial Tax	Municipal Tax
Direct	\$3,064,248	\$1,888,686	24.0	\$219,219	\$127,602	\$23,076
Indirect	\$1,105,727	\$626,479	5.9	\$74,146	\$57,247	\$18,531
Induced	\$1,267,116	\$815,906	6.6	\$132,946	\$143,480	\$30,124
Total	\$5,437,090	\$3,331,072	36.6	\$426,311	\$328,329	\$71,731

³² Please note this table summarizes only total economic impacts (i.e., the sum of direct, indirect, and induced impacts). Average direct, indirect, and induced impacts can also be calculated for each region.

8.5 Summary of Economic Impacts

Table 28 summarizes the average total estimated near-term and long-term economic impacts from the remediation process, redevelopment, and location of new businesses on a LMR site.

Table 28. Summary of Average Economic Impacts Per Remediated LMR Site

	Average Total Output	Average Total GDP	Average Total Employment	Average Total Government Revenues
Assessment and Remediation	\$835,120	\$540,280	4.5	\$116,370
Redevelopment	\$47,465,201	\$24,828,858	213.1	\$11,866,066
Total Near-Term Impacts	\$48,300,321	\$25,369,138	217.6	\$11,982,436
Annual Long-Term Impacts	\$5,437,090	\$3,331,072	36.6	\$826,372

9 ECONOMIC IMPACTS FROM INCREASED NUMBER OF REMEDIATED LMR SITES

As summarized in Table 29, over the past three years an average of roughly 100 CoCs per year have been issued for LMR sites that have involved the participation of APs. The following table summarizes the number by year.

Table 29. Number of CoCs Issued to LMR Sites that Involved APs

Year	Number of CoCs Issued for LMR Sites that Involved APs
2011	54
2012	70
2013	110
2014	107
2015	114
2016	167
2017	294
2018	83
2019	136
2020	85
Three Year Average (2018-2020)	101

Table 30 summarizes the economic impacts that could be expected from the redevelopment of an additional 50 remediated LMR sites a year, bringing the annual average of CoCs issues to LMR sites that involve the participation of APs to approximately 150. The impacts include an additional:

- Near-term total output of \$2,415.0 million.
- Near-term total GDP of \$1,268.5 million.
- Near-term total employment of 10,879 FTEs.
- Near-term total government revenues of \$599.1 million.
- Long-term annual total output of \$271.9 million.
- Long-term annual total GDP of \$166.1 million.
- Long-term annual total employment of 1,830 FTEs.
- Long-term annual total government revenues of \$41.3 million.

Table 30. Economic Impacts From an Increase of 50 Remediated LMR Sites

	Total Output	Total GDP	Total Employment	Total Government Revenues
Average Total Near-Term Impacts per Remediated LMR Site	\$48,300,321	\$25,369,138	217.6	\$11,982,436
Total Near-Term Impacts from Redevelopment on 50 Additional Sites	\$2,415,016,048	\$1,268,456,878	10,879	\$599,121,787
Average Annual Long-Term Impacts per Remediated LMR	\$5,437,090	\$3,331,072	36.6	\$826,372
Total Annual Long-Term Impacts from Redevelopment on 50 Additional Sites	\$271,854,511	\$166,553,600	1,830	\$41,318,593

APPENDIX A – GLOSSARY OF TERMS

Economic Terms	
Term	Definition
Output	Output is the total gross value of goods and services produced by a given company or industry measured by the price paid to the producer. This is the broadest measure of economic activity. Output measures the value of all sales of goods and services, including all final purchase and intermediate inputs, which results in the double counting of intermediate purchases. <i>Example: A manufacturer buys aluminum from a metals producer for \$100 and adds value to it by producing airplane parts, which are then sold for \$300. Economic output would total \$400 which is the value of all sales in the chain of activity. The value of the aluminum is therefore counted twice, once as an intermediate good for the manufacturer, and again in the value of the parts.</i>
Gross Domestic Product (GDP)	Gross Domestic Product (GDP), or value-added, refers to the additional value of a good or service over the cost of inputs used to produce it from the previous stage of production. Thus, GDP is equal to the unduplicated value of goods and services produced. GDP isolates only the additional value of goods and services produced and is defined as economic output, less intermediate inputs. <i>Example: A manufacturer buys aluminum from a metals producer for \$100 and adds value to it by producing airplane parts, which are then sold for \$300. GDP or value added would total \$300 (as opposed to \$400 economic output). This is because value added subtracts the sale of the purchased aluminum (intermediate input) of \$100 from the total sales price of \$400, resulting in value added of \$300.</i>
Employment Income	Employment income is the total amount of wages and salaries paid to employees.
Employment	Employment is measured in terms of full-time equivalents (FTEs). One FTE is the equivalent of one person working full-time for a full year. One FTE is also the same as one “person-year” of employment. For example, one person working full time for a year equates to one FTE. Two people each working full time for half a year also equate to one FTE.
Government Tax Revenue	Government tax revenue is the total amount of tax revenue generated for various levels of government, including municipal, provincial, and federal taxes.
Direct Impacts	Direct impacts are changes that occur in “front-end” businesses that would initially receive expenditures and operating revenue as a direct consequence of the operations and activities of an industry, organization, or project. <i>Example: A company spends money on hiring and employing staff. Those staff members would be considered the direct employment created by the project.</i>

Economic Terms	
Term	Definition
Indirect Impacts	Indirect impacts are changes that occur at suppliers to the “front-end” businesses. <i>Example: The company spends money purchasing office equipment, which in turn supports employment at an office equipment supplier. The employment created at the supplier would be considered indirect employment.</i>
Induced Impacts	Induced impacts are due to shifts in spending on goods and services as a consequence of the payroll of the directly and indirectly affected businesses. <i>Example: Company staff and employees with suppliers earn money through working for or supplying goods to the company. The staff and employees then make consumer purchases that create jobs within the general economy. The economic impacts created by staff and supplier employees would be considered induced impacts.</i>
Building Costs	Includes hard costs of construction.
Site and Infrastructure Costs	Includes such costs as earthwork, excavation, utilities, and other general infrastructure costs.
Interior Buildout Costs	Includes such costs as flooring, lighting fixtures and cabinet.
Soft Costs	Includes such costs as architectural, engineering, legal, marketing and insurance costs.

Contaminated Sites Assessment and Remediation Terms	
Term	Definition
Contaminated site	A site that is affected by substances that occur at concentrations above background or local levels and which are likely to pose an immediate or long-term risk to human health and/or the environment. It is not necessary for the boundaries of the contaminated site to correspond to the legal ownership boundaries.
Approved Professionals	Approved Professionals (AP) are qualified professionals who have been appointed to the ministry's Roster of Approved Professionals. APs are registered professional agrologists, biologists, chemists, engineers, and geoscientists who are members of CSAP.

Contaminated Sites Assessment and Remediation Terms	
Term	Definition
Risk-based Standards Approved Professional	<p>An Approved Professional who has passed an examination sponsored by the Contaminated Sites Approved Professionals Society of British Columbia for applicants to qualify as “risk assessment specialists” and whose qualifications and experience:</p> <ul style="list-style-type: none"> (a) represent an application of the knowledge of contaminant sources, fate, exposure, and effects on biota (including humans). (b) were gained in an environment where the individual had primary responsibility for the technical and scientific aspects of the human health and/or ecological risk assessment. (c) show evidence that the accomplishment required a synthesis capability that only those who fully appreciate the topics of their discipline would have; and (d) show that appropriate regulatory requirements and guidelines for risk assessment work and the application of risk-based standards were met.
Numerical Standards Approved Professional	<p>An Approved Professional who has passed an examination sponsored by the Contaminated Sites Approved Professionals Society of British Columbia for applicants to qualify as “standards assessment specialists” and whose qualifications and experience:</p> <ul style="list-style-type: none"> (a) represent an application of the knowledge of contaminant sources, fate, and transport. (b) were gained in an environment where the individual had primary responsibility for the technical and scientific aspects of site assessment and/or remediation. (c) show that appropriate regulatory requirements and guidelines for site investigations, management and remediation work were met; and (d) span all stages of contaminated sites investigation and remediation.
Approval in Principle	<p>An Approval in Principle (AiP) can be issued by the Director when a remediation plan has been reviewed and then approved. When applying for an AiP the applicant must also include copies of any site investigation and assessment reports prepared for the site. Both numerical and risk-based standards can be used under AiPs.</p>
Certificate of Compliance (CoC)	<p>A certificate of compliance is an instrument issued by the Ministry of Environment which certifies that a contaminated property has been satisfactorily remediated to meet the applicable standards set by the <i>Environmental Management Act</i> (“EMA”) and the <i>Contaminated Sites Regulation</i> (“Regulation”).</p>

APPENDIX B – STEPS INVOLVED WITH REMEDIATION OF LMR SITES

The following is a summary of the steps involved with remediation of LMR sites in BC.

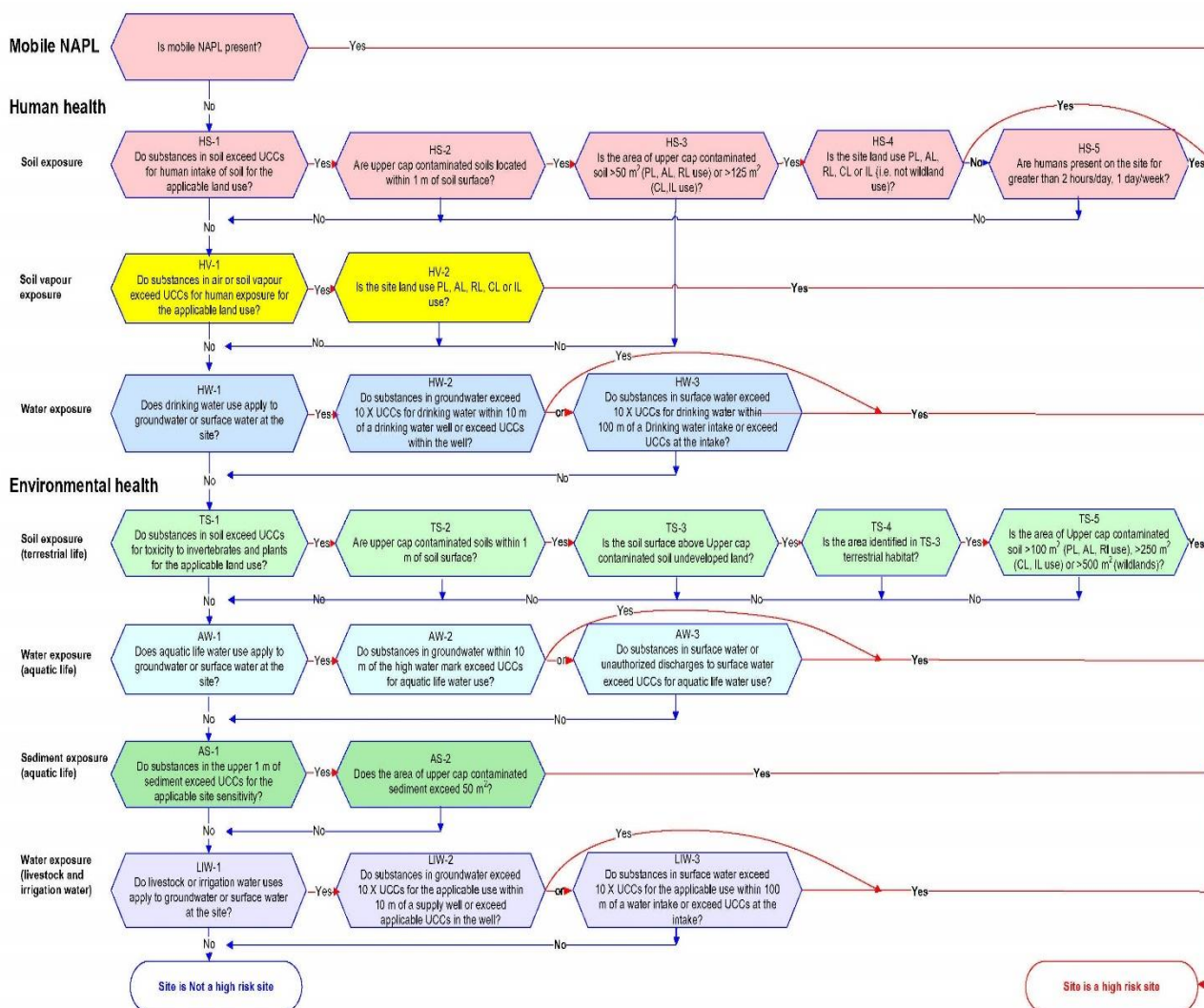
Steps Involved with Remediation. In brief, the steps involved with remediation of low to moderate risk contaminated sites in BC are:³³

1. Stage 1 Preliminary Site Investigation (PSI). This includes historical research, interviews, and a site visit to establish activities and areas that may pose an environmental concern.
2. Stage 2 PSI. This involves sampling of soil, groundwater, vapor, surface water, and sediment as available at the site, and analyzing the samples for concentrations of environmental contaminants at an accredited laboratory. The analysis results are compared with regulated standards for each environmental media (soil, water, etc.) according to the land use and water uses pertaining to the site. If concentrations of the analyzed substances exceed the regulated standards, the site is considered contaminated and potentially subject to mandated investigation and remediation requirements.
3. Detailed Site Investigation. If a site is contaminated, the next step is to conduct a Detailed Site Investigation (DSI). This involves collecting and analyzing more samples to delineate the contamination both in horizontal extent and vertical depth. A DSI can often involve several rounds of environmental investigation.
4. Remediation Planning or Risk Assessment. After delineating the extent of contamination, a remediation plan can be prepared to arrest or remove the contamination, risk assessment to evaluate site-specific risk-based standards for a site or apply one or more treatment methods in situ that will reduce the contaminant concentrations or break down the contamination into less harmful substances.
5. Implementation of a Remediation Plan. Implementation of the remediation plan or conducting the risk assessment constitutes the next step
6. Confirmation of Remediation. After remediating the site, confirmatory environmental sampling is required to show that the contamination has been removed or mitigated.
7. Application for a Certificate of Compliance.

³³ Materials in this section have been provided by CSAP members.

APPENDIX C – SITE RISK CLASSIFICATION³⁴

The Ministry has established a detailed set of procedures for classifying sites based on an evaluation of risk to human health and the environment. A complete description of these requirements is found on the Ministry's website. The following flowchart outlines the Ministry's site evaluation process is presented in the following figure.



³⁴ The material in this section is from the BC Ministry of Environment and Climate Change Strategy, Protocol 12 for Contaminated Sites, Site Risk Classification, Reclassification and Reporting, Version 3.0, Effective date: February 1, 2021.

APPENDIX D – COCS ISSUED FOR SITES INVOLVING APS

The following table summarizes the number and location of LMR sites that involved APs, and which were issued Certificates of Compliance (COCs).

Year	Number of CoCs	Municipalities
2011	54	Abbotsford (1), Burnaby (5), Cultus Lake (1), Fort Nelson (1), Kamloops (1), Langley (5), Maple Ridge (2), Marysville (1), New Westminster (2), Richmond (11), Salmon Arm (1), Squamish (2), Surrey (3), Vancouver (14), Victoria (2), Whistler (2)
2012	70	Abbotsford (1), Burnaby (3), Coquitlam (4), Dawson Creek (3), Fort Nelson (4), Fort St. John (1), Golden (1), Jordan River (1), Kamloops (1), Kelowna (1), Kimberley (1), Langford (1), Langley (1), New Westminster (1), North Saanich (1), North Vancouver (1), Okanagan Falls (2), Oyama (1), Penticton (1), Port Alberni (1), Port McNeill (1), Revelstoke (1), Richmond (2), Saanich (1), Salmon Arm (1), Surrey (2), Vancouver (29), View Royal (1)
2013	110	Abbotsford (4), Burnaby (14), Campbell River (2), Chetwynd (1), Coquitlam (5), Cranbrook (1), Creston (1), Delta (3), Fort Nelson (1), Golden (1), Hope (1), Kamloops (2), Kelowna (3), Langley (1), Lillooet (1), Maple Ridge (1), Nelson (1), New Westminster (1), Nootka District (5), North Vancouver (9), Quesnel (1), Revelstoke (1), Richmond (1), Saanich (5), South Slokan (2), Surrey (6), Terrace (4), Trail (1), Tsawwassen (1), Vancouver (18), Victoria (6), White Rock (2), Williams Lake (4)
2014	107	100 Mile House (2), Abbotsford (1), Black Creek (2), Burnaby (6), Burns Lake (3), Chetwynd (1), Chilliwack (2), Cobble Hill (2), Delta (4), Fort St. John (1), Fort Nelson (3), Gabriola Island (1), Gibson (2), Honeymoon Bay (1), Hope (1), Houston (2), Kamloops (7), Kitimat (1), New Westminster (1), North Vancouver (2), Osoyoos (1), Port Coquitlam (3), Prince George (1), Quesnel (1), Revelstoke (3), Richmond (3), Rock Creek (2), Royston (3), Smithers (2), Squamish (2), Surrey (7), Vancouver (29), Vernon (1), Victoria (3), West Kelowna (1)
2015	114	Abbotsford (1), Aldergrove (1), Burnaby (6), Cache Creek (1), Coquitlam (3), Courtenay (1), Delta (4), Duncan (1), Gibson (6), Golden (1), Hope (1), Kelowna (2), Lake Country (1), Langley (1), Lillooet (2), Nanaimo (2), Nelson (1), New Westminster (3), North Vancouver (1), Penticton (3), Port Alberni (1), Port Moody (5), Prince George (2), Richmond (1), Rosedale (2), Shawnigan Lake (1), Smithers (1), Sparwood (1), Squamish (4), Surrey (14), Terrace (3), Trail (1), Vancouver (29), Vernon (1), Victoria (3), West Vancouver (3)
2016	167	100 Mile House (8), Abbotsford (2), Burnaby (10), Chilliwack (6), Coquitlam (1), Delta (5), Duncan (1), Fort Nelson (3), Golden (1), Hope (3), Kelowna (1), Keremeos (1), Langley (9), Lumby (1), Mission (2), Nanaimo (13), New Westminster (9), North Vancouver (2), Pemberton (1), Penticton (1), Port Coquitlam (1), Prince George (2), Princeton (5), Quesnel (4), Richmond (1),

		Squamish (5), Surrey (9), Tsawwassen (1), Vancouver (37), Vernon (5), Victoria (6), Wells (1)
2017	294	100 Mile House (1), Abbotsford (7), Ashcroft (1), Burnaby (24), Campbell River (5), Cassidy (1), Castlegar (1), Central Saanich (1), Chetwynd (2), Chilliwack (2), Colwood (3), Coquitlam (9), Courtenay (1), Creston (2), Dawson Creek (2), Delta (8), Duncan (2), Elko (1), Fort Fort St. John (2), Fort Nelson (2), Hope (2), Houston (2), Kamloops (10), Kelowna (5), Kimberly (1), Langford (5), Langley (2), Manning Park (1), Maple Ridge (3), Nanaimo (4), New Westminster (9), North Saanich (1), North Vancouver (3), Port Coquitlam (8), Port Moody (4), Prince George (3), Prince Rupert (4), Princeton (4), Richmond (19), Saanich (6), Salt Spring Island (4), Sidney (1), Squamish (2), Stewart (3), Surrey (13), Terrace (9), Trail (2), Tsawwassen (1), Vancouver (31), Vernon (1), Victoria (13), Wells (12), West Vancouver (1), White Rock (2), Williams Lake (27)
2018	83	Abbotsford (1), Burnaby (12), Chilliwack (2), Coquitlam (3), Delta (1), Fort St. John (2), Kamloops (2), Langley (1), Maple Ridge (2), Mission (1), Nanaimo (1), New Westminster (7), North Vancouver (3), Port Coquitlam (1), Port Moody (1), Prince George (1), Richmond (9), Surrey (4), Tumbler Ridge (1), Vancouver (26), Victoria (1), View Royal (1)
2019	136	150 Mile House (1), Abbotsford (1), Burnaby (6), Burns Lake (2), Campbell River (3), Chilliwack (1), Coquitlam (3), Delta (3), Enderby (1), Fort George (1), Jaffray (4), Kamloops (5), Kitimat (1), Nanaimo (2), New Westminster (1), North Cowichan (2), North Vancouver (4), Pitt Meadows (4), Port Alberni (1), Port Coquitlam (7), Quesnel (1), Revelstoke (6), Richmond (14), Saanichton (2), Squamish (2), Surrey (2), Vancouver (40), Vernon (2), Victoria (9), West Vancouver (1), Whistler (2), Windermere (2)
2020	85	Abbotsford (1), Burnaby (5), Cache Creek (3), Campbell River (2), Castlegar (1), Chilliwack (3), Comox (1), Coquitlam (2), Creston (1), Delta (4), Esquimalt (1), Fort St. John (1), Kelowna (4), Ladysmith (1), Langford (1), Merritt (1), Nakusp (6), Nanaimo (3), New Westminster (1), North Cowichan (1), North Vancouver (1), Port Coquitlam (1), Port Renfrew (1), Revelstoke (1), Richmond (2), Saanich (3), Sidney (2), Squamish (1), Strathcona (2), Terrace (2), Tsawwassen (1), Vancouver (20), Vanderhoof (3), Vernon, West Vancouver (1), White Rock (1)

APPENDIX E – NUMBER OF APS BY YEAR

The following table summarizes the number of APs by year.

Number of APs by Year	
Year	Number of APs
2011	88
2012	97
2013	101
2014	105
2015	107
2016	110
2017	115
2018	116
2019	116
2020	108
Three Year Average (2018-2020)	113

APPENDIX F – ABOUT MANSFIELD CONSULTING INC.

Ed Mansfield is the founder and president of Mansfield Consulting Inc. (www.mansfieldconsulting.ca). Ed has more than 30 years of experience in providing consulting services to public and private companies, professional associations, industry organizations, and government agencies.

Among the many sectors in which Ed has worked are, agriculture and agri-food, education, energy, film and television, forestry, government policy, health care, major events, mining, property development, technology, and tourism.

Ed has worked with clients from across Canada and the United States and has provided professional insight and advice to business and industry leaders. He has assisted with the development of public policy and has worked with senior leadership at all levels of government.

Prior to founding Mansfield Consulting Inc. Ed led economics and research practices at four major accounting and business consulting firms. Ed has Ph.D. and M.S. degrees in Applied Mathematics from the University of Washington, and a B.Sc. in Mathematics and Statistics from the University of BC.

For more information on Ed and Mansfield Consulting Inc., please see our website at: www.mansfieldconsulting.ca