



**SUPPLEMENTARY PHASE II ENVIRONMENTAL
SITE ASSESSMENT**

**For
610 Front Street
New Westminster, British Columbia**

Prepared for:

**The Corporation of the City of New Westminster
511 Royal Avenue
New Westminster, BC
V3L 1H9**

**TROW Reference No: 081-01441
April 2009**

Prepared by:

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**TROW Reference No: 081- 01441
April 2009**



EXECUTIVE SUMMARY

The Corporation of the City of New Westminster (City of New Westminster) retained Trow Associates Inc (Trow) to conduct a Supplementary Phase II Environmental Site Assessment (ESA) of the land lot of the property located at 610 Front Street (the Site), New Westminster, British Columbia. Previously Stage 1 Preliminary Site Investigation (PSI) and Phase II Environmental Site Assessment (ESA) studies of the Site had been conducted by Trow on behalf of Colliers International Real Estate Management Services (Colliers).

The Stage 1 PSI and Phase II ESA studies indicated two areas of groundwater contamination and one area with both groundwater and soil contamination. Additionally in the central portion of the site, chlorinated solvents were found at elevated concentrations.

In January 2009, Trow conducted a supplementary assessment of the Site and drilled ten boreholes, eight of which were completed as groundwater monitoring wells. Select soil samples were recovered and analyzed for total metals. Water samples were recovered from seven of the eight groundwater monitoring wells and from four previously installed wells and selectively analysed for polycyclic aromatic hydrocarbons (PAH) and/or volatile organic compounds (VOC).

A review of the soil and groundwater chemistry for the Site to date indicated the following

- The soil quality beneath the site exceeds BC CSR Residential and Commercial standards for total metals in two locations (“hot spots”). Local hydrocarbon contamination may be expected in the proximity of any identified USTs. Other than these locations the soil quality meets the BC CSR Residential soil standards.
- Groundwater beneath the site in the central portion and the east end of the site is contaminated. PAH concentrations exceeded the BC CSR AW standards in some of the wells across the Site, and chlorinated solvents have been identified in at least three groundwater wells.
- Detectable concentrations of volatile or semi-volatile substances were found in soil and groundwater through out the Site indicating that a soil vapour investigation of the Site is required (2009 regulatory requirement).

TABLE OF CONTENTS

1.0 INTRODUCTION..... 1

 1.1 OBJECTIVES AND SCOPE OF WORK..... 1

2.0 BACKGROUND..... 3

 2.1 SITE INFORMATION 3

 2.1.1 Site Description 3

 2.1.2 Location and Legal Description 4

 2.1.3 Site History..... 4

 2.1.4 Topography and Surficial Geology 4

 2.1.5 Hydrogeology..... 5

 2.2 PREVIOUS INVESTIGATIONS 5

 2.2.1 Stage 1 Preliminary Site Investigation 6

 2.2.2 Phase II Environmental Site Assessment 7

3.0 SUPPLEMENTARY PHASE II ESA PROGRAM - 2009 9

 3.1 HEALTH AND SAFETY 9

 3.2 SERVICES CLEARANCE..... 9

 3.3 Drilling Program 9

 3.3.1 Boreholes..... 10

 3.3.2 Groundwater Monitoring Wells 10

 3.4 SOIL SAMPLING PROGRAM 10

 3.5 GROUNDWATER SAMPLING PROGRAM 11

 3.6 SITE ELEVATION 12

 3.7 QUALITY ASSURANCE AND QUALITY CONTROL PROGRAM 13

4.0 REGULATORY CONTEXT (LAND LOT ONLY)..... 14

 4.1 REGULATORY STANDARDS 14

 4.1.1 Soil Standards..... 14

 4.1.2 Groundwater Standards 14

5.0 2009 SITE ASSESSMENT RESULTS 15

 5.1 SITE PHYSICAL CONDITIONS 15

 5.2 ANALYTICAL RESULTS 15

 5.2.1 SOIL ANALYTICAL RESULTS 15

 5.2.2 GROUNDWATER ANALYTICAL RESULTS..... 15

 5.3 QUALITY ASSURANCE AND QUALITY CONTROL EVALUATION..... 16

6.0	FINDINGS	18
6.1	SUMMARY OF 2009 SUPPLEMENTARY STUDY	18
6.2	DICUSSIONS	18
7.0	CONCLUSIONS	20
8.0	REFERENCES	21
9.0	LIMITATIONS AND CLOSURE	22

LIST OF TABLES

Table 1:	Location and Legal Description
Table 2:	Generalized Soil Profile
Table 3:	Areas of Environmental Concern (APECs) Identified in the Stage 1 PSI
Table 4:	Borehole Drilling Program
Table 5:	Soil Sampling and Analyses Program
Table 6:	Groundwater Sampling and Analyses Program
Table S1:	Analytical Results for Metals in Soil
Table W1:	Analytical Results for PAH in Water
Table W2:	Analytical Results for VOC and VPH in Water

LIST OF FIGURES (attached)

Figure 1:	Site Location Plan
Figure 2:	Historical Land Use & Areas of Potential Environmental Concern
Figure 3:	Borehole Testpit and Monitoring Well Locations
Figure 4:	Section A-A'
Figure 5:	Section B-B'
Figure 6:	Section C-C'
Figure 7:	Section D-D'
Figure 8:	Section E-E'
Figure 9:	Supplementary Phase II ESA Analytical Results - Soil
Figure 10:	Supplementary Phase II ESA Analytical Results – Groundwater
Figure 11:	Estimated Areas of Environmental Concern (2009)

LIST OF APPENDICES (attached)

- Appendix A:** Site Photographs
Appendix B: Borehole Logs
Appendix C: Laboratory Certificates
Appendix D: Interpretation and Use of Study & Report

1.0 INTRODUCTION

Trow Associates Inc (Trow) was retained by The Corporation of the City of New Westminster (The City of New Westminster) to conduct a Supplementary Phase II Environmental Site Assessment (ESA) of the soil and groundwater conditions at 610 Front Street (The Site), in the City of New Westminster, British Columbia. The Site, located on the north banks of the Fraser River at an approximate latitude of 49° 16 '8" N and longitude of 123° 6' 4" W. The property comprises a water lot and a land lot divided by a sheet pile bulkhead, which is infilled with sand.

Previously, in 2005, Trow conducted a Stage 1 Preliminary Site Investigation (PSI) and a Phase II Environmental Site Investigation (ESA) of the Site for Collier International Real Estate Management Services (Colliers). Consent was received from Colliers to use the relevant information in this report. This Supplementary Phase II ESA is limited to the land lot of the Site. Concurrent to the study, Triton Environmental Services conducted a sediment sampling investigation of the water lot of the Site, the findings of which are presented under separate cover.

1.1 OBJECTIVES AND SCOPE OF WORK

The objectives and scope of work of the Supplementary Phase II ESA were based on the results and recommendations presented in the 2005 report entitled "Phase II Environmental Site Assessment for 610 Front Street, New Westminster, British Columbia" (Trow, 2005).

The objectives included:

- An intrusive environmental investigation comprising strategically located boreholes and groundwater monitoring wells and collection of soil and groundwater samples for laboratory analyses; and
- Interpretation of soil and groundwater quality results to delineate the vertical and lateral limits of the potential contaminants-of-concern indentified during the Phase II ESA;

The scope of work for the Supplementary Phase II ESA was discussed with the City of New Westminster and focussed on the following tasks:

Field Investigation

- Completion of subsurface clearances (to identify buried services) across the property in preparation for subsurface investigation;

- Clearance from CN Railway to conduct the subsurface intrusive investigation on the portion of the Site adjacent to CN Railway's main tracks;
- Drilling of eight boreholes, all to be completed as groundwater monitoring wells including one groundwater well to the depth of the confining layer beneath the site to investigate the potential existence of a DNAPL (dense non-aqueous phase liquid) plume beneath the site;
- Collection of soil samples from select boreholes at known depths to delineate soil contamination; and
- Purging and sampling of groundwater monitoring wells (including some installed in 2005), followed by water level measurement, interface free phase product detection and select sampling for groundwater contamination.

Analytical Program

- Submission of select soil and groundwater samples to the project laboratory Caro Analytical Services (Caro)

Reporting

- The preparation of this report to document the findings of the supplementary investigation. The format of the report would be consistent with that required by the Ministry of Environment (MoE).

General Assessment Standards

This Supplementary Phase II ESA was completed in general conformance with:

- Environmental Management Act (EMA) BC MoE;
- Contaminated Site Regulation (CSR), BC MoE;
- Checklist for Reviewing a Preliminary Site Investigation BC MoE ; and
- British Columbia Field Sampling Manual – BC MoE

Note: At the time of publication of the British Columbia Field Sampling Manual, the MoE was known as the Ministry of Water, Land and Air Protection.

2.0 BACKGROUND

Trow personnel initially visited the Site on January 11, 2005, as part of the Stage 1 PSI assessment. The site reconnaissance was limited to visual inspection of the site and specifically excluded intrusive sampling and analytical testing. There were no observational limitations or obstacles to the completion of the reconnaissance other than some collapsed areas of the dock. No water wells or surface water drinking water bodies were observed on the subject site or on nearby properties. Location and site plans illustrating the subject site and nearby properties are shown on Figure 1 of this report.

2.1 SITE INFORMATION

2.1.1 Site Description

The total area of the Site is approximately 3.8 hectares of which the land lot is approximately 1 hectare. The remaining water lot part of the site consists of a wharf supported on timber piles driven into the Fraser River bed. The general characteristics of the Site have been illustrated on Figure 1.

The land portion is mostly covered with asphalt, with a few sunken areas toward the central portion. There is sparse vegetation in areas where there is no asphalt cover. Discarded wastes such as plastic bottles, car parts etc are strewn across the land lot. In several areas of the wharf, the treated timber deck shows signs of deterioration. The timber piles in one section toward the southwest appear to have been cut below their original height. It also appears that the cut timber and the floorboard in this section have been salvaged and disposed of. Another section of the wharf to the northwest has collapsed. The photographs 3 and 4, Appendix A, show the mentioned sections of the wharf. A summary of the surrounding land use is provided below:

North

Canadian National (CN) railway tracks run immediately north of the Site. North of the rail tracks is Front Street, which runs parallel to the Fraser River. On the north side of Front Street there are numerous commercial businesses

West

West of the Site is a parking lot that starts at approximately 6th Street. The parking lot continues to 10th Street and is associated with the Westminster Quay Public Market which is located approximately 250 m west of the Site.

South

Immediately to the south of the Site is the Fraser River

East

East of the Site the wharf ends. Further east of the Site boundary the north bank of the river is occupied by a number of small tugboat contractors

2.1.2 Location and Legal Description

Table 1 provides the Site's location and legal description

Table 1: Location and Legal Description	
Civic Address:	610 Front Street, New Westminster
Latitude	49° 16 '8" N
Longitude	123° 6' 4" W
Parcel Identifier:	015-186-474
Legal Description:	Parcel A, District Lot 3979 and 3982, Group 1, New Westminster District Plan Reference No. 83324
Zoning	Residential

2.1.3 Site History

Based on the historical title searches, the city directory searches, fire insurance plans, and aerial photography interpretation of the site and surrounding land, it appears that the Site has been vacant since 1990.

The historical land use activities that occurred at the Site are

- Coal storage warehouses
- Industrial equipment operations
- Industrial machine shops
- Marine works
- Foundries or metal scrap melting
- Coal fired power generation
- Marine and automobile fuelling

2.1.4 Topography and Surficial Geology

Based on the *BCGS Map #92 G/2 of New Westminster*¹ and observations made during the site visit, the site is located on a flood plain of the Fraser River. The local topography is relatively flat from the Fraser River north to Front Street, whereupon the land then slopes steeply up towards Columbia Street.

Information regarding the surficial geology at the Site and in its vicinity was collected from *Surficial Geology Map # 1486A – Vancouver*². The map indicates that the soils at the Site comprise Vashion Drift and Capilano Sediments characterized as glacial drift including: lodgement and minor flow till, lenses and interbeds of substratified glaciofluvial sand to gravel, and lenses and interbeds of glaciolacustrine laminated stony silt.

¹ *BCGS Map 92 G/2 – New Westminster*, 1989, Canada Centre for Mapping, Department of Energy, Mines and Resources

² *Surficial Geology Map 1486A – Vancouver*, 1976, Geologic Survey of Canada, Department of Energy, Mines and Resources

Subsurface soils at the site include a surficial layer of loose alluvial and fill soils overlying dense soils. Groundwater levels within the site are controlled by the water levels in the Fraser River and storm runoff from high ground areas to the north. A generalized soil profile (inferred from 2005 investigative geotechnical data) is itemized on Table 2:

TABLE 2 : Generalized Soil Profile		
Soil Unit	Thickness (m)	Description
Unit 1	3 to 13	Surficial layer of loose FILL covering the entire site north and south of the existing bulkhead and including loose sand and gravel, silt, wood waste, occasional boulders, concrete, bricks - Loose to medium dense.
Unit 2	6 to 9	Grey silty SAND and GRAVEL, gravelly silty SAND, SAND, occasional cobbles and boulders - Dense.
Unit 3	> 8 m to the bottom of the deepest test hole	Grey SILT, some clay extending to the depth of investigation - Very stiff to hard.

Cross-sections were developed for the Site based on the subsurface soil encountered during the 2005 and 2009 studies. Figure 3 represents the locations of the cross-sections and Figures 4 to 8 illustrate the general soil profile.

2.1.5 Hydrogeology

The Fraser River which flows towards the southwest along the south-eastern property boundary is the closest surface freshwater body. Storm water flow at the Site is from northwest to southeast, draining through the wharf timbers onto the intertidal foreshore of the bulkhead.

Based on the surficial geology and local topography, the groundwater at the Site flows in a southerly direction and discharges into the Fraser River. The Site will be influenced primarily by groundwater originating at properties to the north, and to a lesser degree by groundwater originating on properties directly to the east and west of the Site.

2.2 PREVIOUS INVESTIGATIONS

Numerous previous geotechnical and limited environmental investigations have been conducted at the Site between 1990 and 2005. The relevant previous investigations to this study are titled “Final Report – Stage 1 Preliminary Site Investigation for 610 Front Street, New Westminster, British Columbia” (Trow, February 2005) and “Phase II Environmental Site Assessment for 610 Front Street, New Westminster, British Columbia” (Trow, April 2005). Summaries of those studies are presented in the following sections.

2.2.1 Stage 1 Preliminary Site Investigation

The Stage 1 Preliminary Site Investigation (PSI) reviewed information, about the Site and surrounding properties, gathered from government records, previous environmental and geotechnical investigations, city directories, fire insurance plans, historical aerial photographs, and from site reconnaissance visits.

Several areas of potential environmental concern were identified and the table below summarizes the land use activities, their location with respect to the Site, the potential contaminants of concern, medium of concern and the rationale for contamination at the Site.

TABLE 3				
Land Use Activities and Potential Contaminants of Concern				
Identified in the Stage 1 PSI				
Land Use Schedule 2 Activity	Location*	PCOCs	Medium	Rationale
Coal Storage Warehouse / G3- bulk commodity storage or shipping (i.e. coal)	Onsite	PAH, Metals, EPH	Soil, Sediment & Groundwater	Potential for coal to impact either the soil, sediment and/or groundwater
Industrial Equipment Operation	Onsite	BETX, VPH, VOC, EPH, PAH, Metals	Soil, Sediment & Groundwater	Potential for metals, fuel or solvent contamination due to machinery use
Industrial Machine Shop	Onsite	BETX, VPH, VOC, EPH, PAH, Metals	Soil, Sediment & Groundwater	Potential for metals, fuel or solvent contamination due to the general activities involved with industrial machine shops
Marine Works / G7 Truck, rail or marine bulk freight handling	Onsite	BETX, VPH, VOC, EPH, PAH, Metals	Soil, Sediment & Groundwater	General activities associated with the movement of large amounts of freight and fuel
Metal melting and molding / C1 – Foundries or scrap metal smelting	Offsite	Metals, EPH, VOC, PAH	Groundwater	Potential for metals, fuel or solvent contamination due to the general activities involved with foundries
Marine Fuelling Station / F5 – Petroleum product dispensing facilities including services stations and cardlots	Offsite	VPH, BTEX, MTBE, EPH, PAH, Metals, VOC, LNAPL	Sediment & Groundwater	Potential for migration of contaminants onto Site due to leaky USTs, fuel spills or poor housekeeping practices

TABLE 3 Land Use Activities and Potential Contaminants of Concern Identified in the Stage 1 PSI				
Land Use Schedule 2 Activity	Location*	PCOCs	Medium	Rationale
Dry cleaning facilities and dry cleaning chemical storage	Offsite	VOC & DNAPL	Groundwater	Potential for migration of contaminants due to leaky USTs or poor house keeping
Bulk Fuel Storage	Onsite	VPH, BTEX, EPH, PAH, VOC, MTBE, Metals & LNAPL	Soil, Sediment & Groundwater	Potential for migration of contaminants onto Site due to leaky USTs, fuel spills or poor housekeeping practices
Fill material obtained from unknown origins	Onsite	VPH, BTEX, EPH, PAH, VOC, MTBE & Metals	Soil, Sediment & Groundwater	The status of the fill material onsite has not been adequately investigated

Key:

BTEX – Benzene, Toluene, Ethyl benzene, and Xylene
 DNAPL – Dense Non Aqueous Phase Liquid
 EPH – Extractable Petroleum Hydrocarbons
 MTBE- Methyl Tertiary Butyl Ether
 LNAPL- Light Non Aqueous Phase Liquid
 PAH – Polycyclic Aromatic Hydrocarbons
 VPH – Volatile Petroleum Hydrocarbons
 VOC – Volatile Organic Compounds
 UST – Underground Storage Tanks

Figure 2 illustrates the twenty two APEC (six onsite and sixteen offsite) that were identified by the Stage 1 PSI study.

2.2.2 Phase II Environmental Site Assessment

Trow conducted a Phase II ESA based on the findings and recommendations of the Stage 1 PSI, however the offsite APEC were not investigated. The field study involved the excavation of nineteen test pits, drilling of ten boreholes, and installation of nine groundwater monitoring wells at strategic locations on the Site.

A total of 13 sediment samples, 23 soil samples and 13 groundwater samples were submitted to Maxxam Analytics, Burnaby, B.C., and 6 groundwater samples were sent to Norwest Labs, Surrey, B.C., for detailed chemical analyses.

The laboratory results indicated

- Two areas of environmental concern (AECs), each at the east and west end of the land lot with PAH contamination in the groundwater;
- An AEC, toward the central portion of the Site, with PAH and VOC contamination in the groundwater;
- One AEC, toward the western half of the Site, north of the collapsed wharf, with heavy metal contamination in the soil and VOC and PAH contamination in the groundwater;
- Anomalous zinc and lead concentrations, were found in soil in the central portion and toward the west of the Site respectively.
- Groundwater in the central portion of the Site contained elevated concentrations of chlorinated hydrocarbons (tetrachloroethene, trichloroethene –TCE, cis-1,2-dichloroethene, and vinyl chloride).

Not all chlorinated solvents are regulated by the BC CSR but some or all may be deemed deleterious substances under the Fisheries Act considering the Site's proximity to the Fraser River.

A rusty, empty, 2,000-litre underground storage tank (UST) with no secondary containment and an intact 20,000-litre UST containing an unknown liquid with no discernable odour were discovered. Trow concluded that there may be other unknown USTs at the Site.

3.0 SUPPLEMENTARY PHASE II ESA PROGRAM - 2009

The Supplementary Phase II ESA was designed to assess the vertical and lateral extents of the impacted environmental media beneath the Site and determine the environmental quality, four years after the initial investigation. The field investigation involved drilling of additional boreholes and installation of additional groundwater monitoring wells at select locations on the Site. The following sections discuss the methodology that was employed during the supplementary work.

3.1 HEALTH AND SAFETY

Consistent with the Health and Safety Policies of Trow Associates Inc., all work completed at the Site was carried out in accordance with a site-specific health and safety plan. This plan, as a minimum, complied with provincial requirements established by the Workers' Compensation Board of British Columbia (WorkSafeBC).

3.2 SERVICES CLEARANCE

Prior to the commencement of the subsurface investigation a BC One Call was placed to identify the owners of underground utilities on and in the vicinity of the Site. One Call Locators Canada Limited, of Surrey, B.C., a qualified utility locating service, was contracted to identify and mark the locations of any underground telephone cables, cable television, natural gas, hydro cables, sewers and water mains on the Site. On the day of the line location, Trow personnel were present at the Site and marked the locations of the intended boreholes. One Call Locators swept the areas and cleared the drilling plan.

CN Railway was notified about the intended subsurface investigation and the necessary clearances were obtained.

3.3 Drilling Program

All drilling and monitoring well installation activities were completed at the Site between January 14 and January 16, 2009. Borehole and monitoring well locations from the 2005 and 2009 studies are illustrated on Figure 3.

Beck Drilling and Environmental Services of Richmond, BC, mobilized a track-mounted drill rig on January 14, 2009 and a truck-mounted drill rig on January 15 and 16, 2009. Appendix A, presents photographs taken during the drilling program.

Subsurface soil and groundwater conditions encountered during the borehole drilling and monitoring well installation activities were logged, and are presented in Appendix B. To prevent the potential for cross-

contamination between samples and boreholes, the auger flights were pressure washed between drilling locations.

3.3.1 Boreholes

Ten boreholes – MW11, BH12, MW12, MW13, BH14, MW14, MW15, MW16, MW17 and MW18 were advanced at the Site, to a maximum depth of 13.1 metres (MW15). MW17 was drilled with a track-mounted drill rig and all other boreholes were drilled using a truck-mounted drill rig. MW15 was drilled with a hollow stem auger and all other boreholes were drilled with a solid stem auger.

Borehole locations were chosen in order to conduct step-out sampling generally recommended in *Technical Guidance on Contaminated Sites – Site Characterization and Confirmation Testing (April 1997)*. The intent of the step out sampling was to determine the outer boundaries of the contamination found during the Phase II ESA. The table below summarizes the rationale used in selecting the locations of step-out boreholes advanced during the Supplementary Phase II ESA.

Table 4: Borehole Drilling Program	
Borehole	Rationale
MW11	10.5 m step-out from MW04 (advanced during the Phase II ESA)
BH12	15 m step-out from MW04 (advanced during the Phase II ESA)
MW12	19.5 m step-out from MW04 (advanced during the Phase II ESA)
MW13	7.5 m step-out from MW10 (advanced during the Phase II ESA)
BH14	15 m step-out from TP13 (dug during the Phase II ESA)
MW14	45 m step-out from MW10 and 60 m step-out from MW08 (advanced during the Phase II ESA)
MW15	7.5 m step out from MW08 (advanced during the Phase II ESA)
MW16	22.5 m step-out from MW08 (advanced during the Phase II ESA)
MW17	15 m step-out from MW01(advanced during the Phase II ESA)
MW18	10.5 m step-out from MW01 (advanced during the Phase II ESA)

3.3.2 Groundwater Monitoring Wells

Eight of the ten boreholes drilled at the Site were completed as groundwater monitoring wells. Each monitoring well was completed with 50-mm diameter, schedule 40, flush threaded, pre-washed and bagged PVC pipe and PVC slot #10 screens of varying lengths. The screened sections were packed with silica sand. Monitoring well logs, presented in Appendix B, provide details of each monitoring well.

3.4 SOIL SAMPLING PROGRAM

To delineate and verify the findings of the Phase II ESA, soil samples were recovered from BH11, BH12, BH14 and BH16 and submitted to Caro for totals metals analyses. The locations of the test pits and

boreholes are illustrated on Figure 3. The table below describes the locations and depths at which the soil samples were collected.

Table 5: Soil Sampling and Analyses Program		
Sample ID	Borehole	Depth
BH11-S1	BH11	0.4 m
BH12-S1	BH12	0.4 m
BH14-S1	BH14	2.0 m
BH16-S1	BH16	2.0 m
BH16-S2	BH16	4.0 m
BH16-S3	BH16	4.0 m

The excess drill cuttings were stored in labelled drums placed onsite. At the end of the drilling program, the lids of the drums were fastened and sealed.

3.5 GROUNDWATER SAMPLING PROGRAM

The groundwater monitoring program involved the following tasks

- Measuring the water level in each well using a water level indicator and recording the measurement (January 26, 2009);
- Field screening for LNAPL and DNAPL in select wells using an interface probe;
- Development of the monitoring wells by purging of at least three well volumes, following recommended industry practices; and
- Following stabilization for one day, recovering samples from each well for laboratory analyses.

Wells were purged and sampled with a peristaltic pump (low flow) and dedicated tubing was used in each well to avoid cross contamination. Purged water was disposed of into drums placed onsite and once all the wells were purged, the lids of the drums were fastened and labelled.

Table 6 presents a summary of the chemical analyses conducted for the groundwater samples recovered from the Site.

Table 6: Groundwater Sampling and Analyses Program	
Sample Location	Chemical Analysis
MW01	PAH
MW04	PAH
MW08	PAH
MW10	BTEX, VOC,VPH
MW11	PAH
MW12	PAH
MW13	VOC,VPH,PAH
MW14	PAH
MW15	VOC,VPH,PAH
MW16	PAH
MW17	PAH

Key:

BTEX- benzene, toluene, ethylbenzene, xylenes

PAH- polycyclic aromatic hydrocarbons

VOC- volatile organic compounds (including chlorinated hydrocarbons)

VPH- volatile petroleum hydrocarbons

MW15 was specifically drilled to the depth of the confining gravelly silt layer beneath the site to investigate the existence of a DNAPL plume. A groundwater sample (MW15-B) was recovered from the bottom of the monitoring well by drawing the suction line of the peristaltic pump to the bottom of the well. The first 200 ml (calculated based on the diameter and length of the tubing to bottom) was collected and disposed of before the sample was collected.

The water samples for VOC and VPH analyses were collected in laboratory-supplied 40 ml vials with preservative (NaHSO₄) in them and samples for PAH analyses were collected in laboratory- supplied 1-liter amber jars. The samples were labelled and stored in a cooler filled with ice and delivered to Caro following standard chain-of-custody procedure.

3.6 SITE ELEVATION

The Site is generally flat and all elevations were referenced to the ground surface. The groundwater levels encountered during this study varied from 1.78 m to 3.66 m below ground surface (measured on January 26, 2009).

3.7 QUALITY ASSURANCE AND QUALITY CONTROL PROGRAM

A quality assurance (QA) and quality control (QC) program is a system of documented checks that validate the reliability of the data collected regarding any given site. Well-documented procedures regarding sample collection, transportation, and storage are the primary aspects of a field QA/QC program. The reasoning behind this system is that, throughout a sampling program, small deviations from the ideal protocols can occur. The primary function of a QA/QC program is to report any deviations from protocol; thus, providing a measure of confidence for the data being used to form conclusions regarding possible environmental impacts.

The field QA/QC program for this investigation consisted of:

- Following field protocols designed to reduce the incidents of cross-contamination of samples during the field investigation (e.g. chemical resistant gloves replaced between samples, dedicated and disposable sampling equipment, etc);
- Thorough documentation of all aspects of the sampling program (e.g. field notes and chain of custody forms) noting any deviations that could potentially cause sampling bias (e.g. broken bottles or no filtration);
- Collection and analysis of field duplicate samples; and
- Submission of samples under chain-of-custody to a laboratory that is both certified and accredited by the Canadian Association of Environmental Analytical Laboratories (CAEAL).

Caro also provides additional QA/QC by following internal procedures where samples are replicated, analyzed and their results compared.

4.0 REGULATORY CONTEXT (LAND LOT ONLY)

4.1 REGULATORY STANDARDS

The Site is located on privately-owned land and is under the principal jurisdiction of the Province of British Columbia, which regulates environmental quality through the Environmental Management Act and its subsidiary, the Contaminated Sites Regulation (CSR). The regulatory standards discussed in the following sections are applicable to the land lot of the Site.

4.1.1 Soil Standards

Site zoning determines the land use standards applied to soil conditions at a site. The online zoning map accessed from the City of New Westminster Zoning Bylaw webpage showed the Site zoned as “Apartment (High Rise)” (residential). To include the possibility that the Site may be developed for commercial uses in the future, the analytical results for soil samples collected during this investigation were compared to residential land use standards (RL) and commercial land use standards (CL) tabulated in Schedule 4 – Generic Numeric Soil Standards (Columns IV & VI), Schedule 5 – Matrix Numerical Standards (Columns IV & VI) of the CSR and Schedule 10 – Generic Numerical Soil Standards (Columns III & IV). For parameters outlined in Schedule 5, the applicable standards for the subject site were determined by the following site-specific factors:

- Intake of contaminated soil;
- Toxicity to soil invertebrates and plants; and
- Groundwater flow to surface water used by marine aquatic life.

Where more than one standard is applicable, the analytical result has been compared to the most stringent applicable standard.

4.1.2 Groundwater Standards

Analytical results of groundwater samples recovered from the Site were compared to freshwater aquatic life standards tabulated in BC CSR Schedule 6 – Generic Numerical Water Standards (Column II).

5.0 2009 SITE ASSESSMENT RESULTS

The 2009 site assessment study was compared to the finding of the 2005 study. The findings are presented in the following sections.

5.1 SITE PHYSICAL CONDITIONS

The surface conditions of the Site remain unchanged since the 2005 study. The subsurface conditions at the Site encountered during the drilling program were consistent with the 2005 findings (Table 2). The 2009 drilling program included drilling to the depth of the confining, gravelly silt layer, which was encountered at 11.27 m below ground surface. The groundwater elevations found during the 2009 study varied from 2.52 m and 4.77 m below ground surface and the 2005 study found groundwater elevations to vary from 1.78 m to 3.66 m below ground surface.

5.2 ANALYTICAL RESULTS

Appendix C presents the laboratory certificates of the 2009 soil and groundwater analyses and the results are discussed further.

5.2.1 SOIL ANALYTICAL RESULTS

Six soil samples including one blind duplicate sample were recovered and submitted to Caro for total metals analyses. The results presented on Table S1 and show that none of the analyzed samples contained concentrations of total metals in excess BC CSR RL and/or CL standards. The soil analytical results have been summarized on Figure 9.

The contaminants-of-concern in soil, for this study, were cadmium, tin, zinc and lead. The concentration for cadmium and tin ranged from below detection limit to 0.5 mg/kg and 0.7 mg/kg respectively. The zinc concentration ranged from 22.5 mg/kg to 250 mg/kg. For lead the concentration ranged from 2 mg/kg to 26.4 mg/kg.

5.2.2 GROUNDWATER ANALYTICAL RESULTS

Ten groundwater samples recovered from the Site were submitted for analyses of PAH concentrations and the results are presented in Table W1. Five groundwater samples, including one duplicate sample were recovered and submitted for analyzes of VPH and VOC concentrations and the results are presented in Table W2. Groundwater analytical results have been summarized on Figure 10.

A review of the groundwater analyses indicated the following:

- PAH concentrations in the samples recovered from MW04, MW08, MW11, MW13, and MW15 did not exceed the respective detection limits;

- Groundwater samples recovered from MW01 and MW14 contained concentrations of some PAH including acenaphthene, anthracene, benzo(a)anthracene, benzo(b)flouranthene, benzo(k) flouranthene, benzo(g,h,i)perylene, chrysene, fluoranthene, flourene, indeno(1,2,3-cd)pyrene, and phenanthrene. The sample recovered from had concentrations of benzo(a)anthracene, benzo(b)flouranthene, benzo(a)pyrene, benzo(b)flouranthene, chrysene, fluoranthene, phenanthrene and pyrene above the laboratory detection limits.
- The concentration of pyrene and benzo(a) pyrene in samples recovered from MW01 and MW14 exceeded BC CSR AW standards
- The sample recovered from MW16 had concentrations of benzo(a)pyrene and flouranthene above the laboratory detection limits.
- Concentrations of VPH and VOC were below their respective laboratory detection limits in samples recovered from MW10 and MW13.
- Of the three water samples recovered from MW15, two samples contained concentrations of trans-1,2-dicholorothene ranging from 1.1 mg/L to 2.7 mg/L.. The three samples contained concentrations of cis-1,2-dicholoroethene ranging from 3.5mg/L to 9.4 mg/L, tetracholoroethene ranging from 1.4 mg/L to 3.5 mg/L, and trichloroethene ranging from 4.8 mg/L to 12.2 mg/L. All other VOC and VPH concentrations in the three samples were below their laboratory detections limits.
- The concentrations of VPH and VOC in the analyzed samples did not exceed BC CSR AW standards.

5.3 QUALITY ASSURANCE AND QUALITY CONTROL EVALUATION

Trow personnel not involved in the initial data entry verified all data recording, documentation and handling. Data entry errors were identified and corrected.

The relative percentage difference (RPD) for a duplicate sample and its primary sample was calculated using the formula

$$RPD = \frac{C_p - C_d}{((C_p + C_d)/2)} \times 100$$

Where C_p = concentration of the primary sample;

C_d = concentration of the duplicate sample;

For RPD calculations the absolute value of $C_p - C_d$ is used

One soil sample BH16-S1 and its corresponding blind duplicate sample BH16-S2 were analyzed for total metals concentrations. The calculated relative percentage differences (RPD) values ranged from 0-15%. These RPD values are within the acceptable range (0-20%) according to the *British Columbia Field Sampling Manual (MoE, 2003)*.

One groundwater sample recovered from MW15 and its corresponding field duplicate sample MW15 Dup were analyzed for concentrations of VOC and VPH. The concentration of VOC and VPH compounds in both samples were below the corresponding analytical method detection limits except for cis-1,2-dichloroethene, trans-1,2-dichloroethene, tetrachloroethene and trichloroethene. The calculated RPD values for cis-1, 2- dichloroethene, tetrachloroethene and trichloroethene analyses ranged from 3.2 to 9%, which are within the acceptable range.

The detection limit for the trans-1,2- dichloroethene the analysis is 1 ug/L and the concentration of trans-1,2- dichloroethene in the primary and duplicate samples are 2.7 ug/L and 1.1 ug/L respectively. The concentrations of trans-1,2- dichloroethene in the two samples are less than five times the method detection limit. The *British Columbia Field Sampling Manual (MoE, 2003)* states that for concentrations below five times the method detection limit, the difference between the two duplicate values shall not exceed twice the detection limit. The difference (1.6 mg/L) between the two samples is less than twice the method detection limit (2 mg/L) and is within the acceptable range.

Review of laboratory quality control data provided with the certificates of analysis indicated that all laboratory blank, spike, certified reference material and duplicate sample data were within specified laboratory defined performance limits.

During this investigation, no samples were invalidated and thus, the data completeness for the study was 100%. The quality control data indicates that the field-sampling program meets the required performance requirements.

6.0 FINDINGS

Trow completed the 2009 study to investigate the Site conditions and compare the findings to the 2005 study.

6.1 SUMMARY OF 2009 SUPPLEMENTARY STUDY

In January 2009, Trow drilled an additional ten boreholes in select locations of the Site and completed eight as groundwater monitoring wells. Soil samples were collected at strategic locations during drilling and submitted for laboratory analyses to delineate total metals contamination in the soil. Following the installation of the groundwater monitoring wells, Trow recovered groundwater samples from seven recently installed wells and from four previously installed wells (2005 study) and submitted them for laboratory analyses. A summary of the findings is presented below:

- None of the soil samples contained concentrations of total metals in excess of the applicable BC CSR standards.
- Two groundwater monitoring wells contained concentrations of benzo(a)pyrene (a polycyclic aromatic hydrocarbon) in excess of the BC CSR freshwater aquatic life standards.
- Detectable concentrations of volatile or semi volatile substances were found in groundwater recovered from five groundwater monitoring wells. These substances included trichloroethene (TCE) and tetrachloroethene (PCE) in one of the groundwater monitoring wells.

6.2 DISCUSSIONS

The 2009 study confirms the findings of 2005 study that the site is “moderately contaminated” particularly in terms of groundwater quality. PAH and VOC appear to be the contaminants-of-concern.

The comparison of concentrations of volatile organic compounds (VOC) and Polycyclic Aromatic Hydrocarbons (PAH) in wells sampled during the 2005 study and the supplementary 2009 study indicated in the order of approximately 100 x lower concentrations in the latter phase of the work. In 2005 the samples were recovered using wattera foot valves from the bottom of the wells and this method induces turbidity in the samples. In 2009, samples were recovered from varying depths using a peristaltic pump (low flow) and samples appeared unaffected by induced turbidity. The difference in 2005 and 2009 water quality data is thus attributable to sampling variance and is open to some interpretation.

It may be noted that at the time of the 2005 Phase II ESA, soil, sediment and groundwater were the only media considered for potential contamination. Since then the Ministry of Environment (MoE) requires soil

vapour investigations conducted at sites where concentrations of volatile or semi volatile compounds in soil and/or groundwater exceed laboratory detection limits as is the case with the Site.

7.0 CONCLUSIONS

Based on the information gathered about the Site from the 2005 Phase II ESA and the 2009 Supplementary ESA, Trow makes the following conclusions

- The soil quality beneath the site exceeds BC CSR Residential and Commercial standards for total metals in two locations (“hot spots”) as shown in Figure 11. Local hydrocarbon contamination may be expected in the proximity of any identified USTs. Other than these locations the soil quality would appear to meet the BC CSR Residential soil standards.
- Groundwater beneath the site in the central portion and the east end of the site is contaminated. The estimated areas of groundwater contamination have been illustrated on Figure 11. PAH concentrations exceeded the BC CR AW standards in some of the wells across the Site, and chlorinated solvents have been identified in at least three groundwater wells. The concentration of the chlorinated solvents varied per sampling event, which may be attributed to the difference in sampling methodology.
- Detectable concentrations of volatile or semi-volatile substances were found in soil and groundwater through out the Site indicating that a soil vapour investigation of the site involving sampling in a minimum of three locations is required.

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9.0 LIMITATIONS AND CLOSURE

This report was prepared for the exclusive use of the Corporation of the City of New Westminster. The interpretation and use of the study and report are as attached in Appendix D.

Trow trusts that this report meets your needs, to your satisfaction. If you have any questions or comments regarding this report, please contact the undersigned.

Yours truly,

TROW ASSOCIATES INC.

Reviewer

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SIGNED & SEALED.**

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SIGNED & SEALED.**

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APPENDIX A
SITE PHOTOGRAPHS



Photograph 1: A view of the Site, facing east



Photograph 2: Another view of the Site, facing east



Photograph 3: A section of the wharf toward the southeast of the Site



Photograph 4: The collapsed section of wharf toward the northwest of the Site



Photograph 5: Showing drilling in progress on the Site (hollow stem auger with a truck mounted drill rig)



Photograph 6: Showing a groundwater monitoring well being purged prior to sampling

APPENDIX B
BOREHOLE LOGS

