SLR

8 July 2011

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Project No.: 201.88420.00001

Dear Mr. Baumann:

RE: REVIEW OF GOLDER HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT COMPLETED FOR 300 BLOCK LOW LEVEL ROAD, NORTH VANCOUVER, BC

SLR Consulting Canada Ltd. (SLR) was retained by the Vancouver Fraser Port Authority (VFPA) to conduct a review of the Human Health and Ecological Risk Assessment (HHERA) completed by Golder Associates Ltd. (Golder) (Golder, 2010) for its property located at 300 Block Low Level Road (LLR) in North Vancouver, BC (the site). The objectives of this review are to determine whether the HHERA is technically adequate, whether the results and conclusions remain valid considering recent regulatory updates and additional data collected from the site and adjacent areas (located at 375, 350 and 1001 LLR), and whether changes to intended future land use at the site change the outcome. The location of the site and the three adjacent properties are presented on Figure 1.

The site is on the north shore of Burrard Inlet, south of the intersection of East Esplanade and Low Level Road in North Vancouver, BC. The site is bounded to the west and to the north by the Pier 94 access road, bounded to the south by the CN railway tracks and the Pier 94 access road, and bounded to the east by a vacant lot. The Canadian National Railway (CN) railway tracks and Low Level Road are located north of the Pier 94 access road. At the time the HHERA was performed, the site was leased and used to park trucks and as a storage area. The site is on Crown lands administered by the VFPA, and is zoned for industrial land use.

The HHERA was performed assuming that site use will remain industrial, will be entirely paved, and has the potential to have buildings constructed. It is SLR's understanding that VFPA intends to move the existing railway tracks currently located north of the Pier 94 Access Road onto the site. This work will involve the removal of the existing concrete slab, installation of track drainage (at an approximate depth of 1m below existing grade), and the installation of subsurface and top ballast and tracks. The following sections present a summary of the HHERA performed by Golder (2010), comments generated during SLR's review, as well as a discussion of the validity of the HHERA in relation to intended future land use. Recent analytical data collected by SLR from areas adjacent to the site that will be used for the railway track realignment is also considered and compared to the chemistry data utilized by Golder (2010) to conduct the HHERA.

1.0 REVIEW OF HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT

The HHERA was conducted to evaluate the potential for contamination identified at the site to pose a risk to human health and the environment. Data considered in the HHERA included soil data collected between 2006 to 2009, soil vapour data collected in 2009 and groundwater data collected at and downgradient of the site between 1992 and 2009.

The investigations conducted by Golder included a Phase II Environmental Site Assessment (Golder, 2006) and the Supplementary Phase II Environmental Site Assessment (Golder, 2009). A supplementary field investigation was conducted to fill identified data gaps prior to conducting the HHERA. This work was conducted in 2009 and included an assessment of the site hydrogeology and a soil vapour assessment. The results of the hydrogeological assessment indicated that the groundwater plumes were at steady state, and thus contaminant concentrations were not expected to increase in the future. In addition, reductions in contaminant concentrations associated with groundwater mixing in the downgradient rip-rap zone were estimated to be in the order of 80-99%. The Soil Vapour Assessment (SVA) included the collection of samples from two AEC's, where volatile contaminants were identified. The results indicated that predicted outdoor air concentrations were less than the *Contaminated Sites Regulation* (CSR) Schedule 9 Generic Numerical Vapour Standards for Industrial land use (ILv) for both AECs; the predicted indoor air concentrations of volatile petroleum hydrocarbons (VPHv) and/or benzene within both AECs exceeded the CSR ILv standards. Delineation of vapours in excess of the ILv standards was recommended for both AECs.

Following the completion of the supplementary field investigation in 2009, eight areas of environmental concern (AECs) were confirmed/identified. It was noted that although gross delineation of the contamination had been achieved, contaminant delineation had not been conducted to BC Ministry of Environment guidelines. The eight AECs carried forward for evaluation in the HHERA included:

- AEC 1: Shallow metals contamination inferred to be present across the entire site.
- AEC 2: Deeper soil and groundwater contamination below the southwest quandrant of the site; contaminants include cadmium, nickel, zinc, lead and polycyclic aromatic hydrocarbons (PAH).
- AEC 3: PCP contamination in soil and groundwater at the southeastern property boundary.
- AEC 4: Hydrocarbon contamination in soil, groundwater and vapour (for indoor air only) near the southwest property boundary.
- AEC 5: Localized zone of cadmium groundwater contamination next to the northeast property boundary.
- AEC 6: Localized zone of hydrocarbon contamination in soil, groundwater and vapour (for indoor air only) near the central portion of the site.
- AEC 7: Two localized zones (shallow and deep) of hydrocarbon contamination in soil on the east side of the site.
- AEC 8: Localized zone of shallow soil contamination on the southeast corner of the site; contaminants include light and heavy extractable petroleum hydrocarbons (LEPH and HEPH), antimony, arsenic, copper, lead and zinc.

It should be noted that since completion of HHERA the localized shallow soil contamination at AECs 7 and 8 was removed (Golder, 2011a).

As noted above, delineation of vapours in excess of the ILv, and potential further delineation of contaminant hot spots within the site boundaries, has not been completed. On this basis, it is necessary in some cases to assume receptor exposure to worst-case contaminant concentrations; further definition of the extent of the contamination could indicate that this conservative approach is unnecessary. In addition, if future development plans include the construction of building(s), delineation of vapour concentrations resulting in predicted indoor air concentrations in excess of the ILv standards is prudent. If the vapour contamination is widespread, consideration of removing the volatile contaminant source and/or including a vapour mitigation system in the building design will be required.

The HHERA comprised an Upland Risk Assessment and an Aquatic Risk Assessment; both components are reviewed below.

1.1 Upland Risk Assessment

Problem Formulation

For the most part the Problem Formulation has identified the appropriate chemicals of potential concern (COPCs), receptors of concern and complete exposure pathways.

Three scenarios were evaluated as part of the HHRA: the current industrial scenario, the construction scenario and the future industrial scenario. The three scenarios evaluated were based on the following assumptions:

- Current Scenario: site is used for industrial purposes; entire site is paved, with the exception of the eastern corner of the site, which is covered in compact gravel; and, there are no buildings at the site.
- Construction Scenario: construction activities, including excavation and redevelopment, will take place.
- Future Scenario: site will continue to be used for industrial purposes; entire site will be paved; and, buildings will be present.

Receptors of concern identified for each of the three scenarios evaluated included:

- Current Scenario: on-site industrial worker; the potential for off-site workers to be exposed via inhalation of dust and/or volatiles was noted, but it was determined that on-site workers would first be evaluated.
- Construction Scenario: construction workers.
- Future Scenario: on-site industrial worker.

Complete and significant exposure pathways identified for the receptors of concern included direct soil pathways (ingestion, dermal contact, inhalation of dust) for the current industrial worker (surficial soils (upper 1.5 m) on the unpaved portion of the site) and the construction worker (full depth soils across the site), the inhalation of volatiles in outdoor air for the current and future industrial worker and the construction worker, and the inhalation of indoor air for the future industrial worker.

Consistent with the results of the investigations conducted, COPCs identified for the protection of human health include:

- Soil: surface soils (upper 1.5 m) – antimony, arsenic, cadmium, copper, lead, silver, zinc; and full depth soils - antimony, arsenic, cadmium, copper, lead, nickel, silver, tin, zinc, PAHs.
- Soil vapour: benzene, VPHv, CCME CWS PHC Fractions F1 and F2 (identified as COPCs in indoor air only as predicted outdoor air concentrations meet CSR ILv).
- Groundwater: not evaluated for human health based on a lack of complete and significant exposure pathways.

Terrestrial ecological receptors of concern identified were limited to soil invertebrates and plants. Given the industrial nature of the site and surrounding area, SLR agrees with this conclusion. Complete exposure pathways for soil invertebrates include ingestion of soil and trans-dermal uptake and for plants, root uptake.

The following issues identified in the Problem Formulation require further consideration:

- The BC MOE and Health Canada have recommended that groundwater be considered a protected resource, and that future use of groundwater as drinking water be assumed where groundwater quality permits such use. Given the proximity of the site to the Burrard Inlet, it is possible that total dissolved solid levels exceed those that would permit drinking water use; however, this should be evaluated.
- No complete and significant groundwater exposure pathways were identified. Although it was acknowledged that the construction worker receptor has the potential to come into contact with groundwater, it was argued that exposures would be minimized through de-watering and the use of personal protective equipment. Although SLR agrees with this rationale, it is noted that no formal endorsement of this assumption has been made by the BC MOE or Health Canada. SLR's experience also indicates that these agencies have suggested quantification of exposures and associated risks for complete exposure pathways should be conducted, even if deemed insignificant.
- CCME IL screening criteria for ethylbenzene, toluene, xylene and styrene are incorrect. These values should be based on the protection of human health (coarse soil) and be revised as 0.082 mg/kg for ethylbenzene, 0.37 mg/kg for toluene, 11 mg/kg for xylene and 7.6 mg/kg for styrene. Although these guidelines are lower than those currently used, the use of lower values will have no impact on the COPC selection because these compounds were either not detected or detected at concentrations lower than the CCME IL guidelines for the protection of human health.
- Vapour data site was compared to the CSR ILv standards. It is noted that Health Canada has published Air Screening Concentrations for the Protection of Human Health (ASC_{HH}). Because the site is under federal jurisdiction, it is recommended that the vapour data also be compared to these ASC_{HH}.
- COPCs identified in vapour were limited to contaminants measured in excess of the CSR ILv standards (benzene and VPHv for indoor air). For volatile chemicals identified as COPCs in soil, the potential for additivity of exposures via the direct soil pathways and the vapour inhalation pathway should be considered. Volatiles identified as COPCs in soil are limited to naphthalene; on the basis of differing mechanisms of toxicity for the ingestion and inhalation pathways, exposures to naphthalene via the two pathways would not be summed. As such, the conclusions of the risk assessment would not change, however, the above should be discussed within the HHERA.

- A trench worker receptor was not considered in the HHERA; evaluation of this receptor is required by the BC MOE. Although the site is federal lands, evaluation of this receptor is recommended given that utilities are located within the site. The inhalation of volatiles pathway is of specific concern for a trench worker. When a trench (e.g. utility trench) is deeper than it is wide, limited attenuation of vapours within the trench occurs. Although professional judgement should be used, an attenuation factor of 0.1 has been recommended to assess the trench scenario. A review of the vapour data site indicates the use of a 0.1 attenuation factor would result in several volatile contaminants being in excess of the CSR ILv and/or ASC_{HH} (xylenes, decane, hexane, F1 and F2 fractions and naphthalene).

Exposure Assessment

The exposure assessment for the HHRA has been completed according to BC MOE and Health Canada policy. Receptor characteristics and mathematical formulae specified in Health Canada guidance appear to have been adequately used to estimate exposures from the COPCs, with the minor exceptions noted below.

Although the exposure assessment is well presented and follows a straightforward approach, the following issues have been identified

- Receptor characteristics for the industrial worker and the construction worker receptor are indicated to be from the Health Canada Federal Contaminated Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA) (Health Canada, 2007). This version of the document is in Draft, and a newer version of the document (May 2009), also in Draft, is available. The most recent version of the Draft document should be used.
- Unlike the 2007 version of the PQRA guidance, the 2009 version includes receptor characteristics for a construction worker receptor. The 2009 PQRA guidance recommends an outdoor exposure time of 10 hours a day for a construction worker; Golder (2010) used an exposure time of 8 hours. In addition, an inhalation rate of 1.3-1.4 m^3/hr is recommended, versus the daily inhalation rate of 15.8 m^3/day used by Golder (2010) in the HHRA. Health Canada (2009) recommended values for select other receptor characteristics differ from those used by Golder (2010); however, the Golder values are more conservative than the Health Canada default values, and will result in overestimation of exposures and associated risks for the construction workers.
- Similarly to the construction worker receptor, the Health Canada (2009) PQRA guidance recommends an exposure time of 10 hours a day for industrial lands, versus the 8 hours a day used by Golder (2010). The Health Canada (2009) recommended inhalation rate for an adult is 16.6 m^3/day versus the 15.8 m^3/day used by Golder (2010) for the industrial worker. Differences in other receptor characteristics used by Golder (2010) are more conservative than the Health Canada (2009) recommended values, and thus will result in conservative and health protective exposure and risk estimates.
- The maximum soil vapour concentrations of benzene and VPHv site have been used. SLR agrees with this approach given that the vapour contamination has not been delineated. It is recommended that the results of the HHRA be re-evaluated following the delineation of the vapour contamination to ensure that higher concentrations are not encountered and that the assessment remains protective of human health.

The above summarized differences in receptor characteristics, specifically those for exposure time and inhalation rate, are of particular relevance in the estimation of exposures via the inhalation of volatiles pathway.

Toxicity Assessment

The Toxicity Assessment indicates that toxicity reference values (TRVs) for the COPCs were preferentially selected from Health Canada. The TRVs are presented in Table K1 in Appendix A of Golder, 2010.

Several discrepancies were noted in this Table. The Tolerable Daily Intake/Oral Reference Dose (TDI/RfD_o) for zinc should be revised to 0.6 mg/kg-day based on adult exposure (HC, 2009) and the dermal slope factor (SF) for arsenic (referenced as being equivalent to the oral SF) should be 1.8 $(mg/kg\text{-}day)^{-1}$. Although Health Canada (2009) is referenced as the source of the dermal soil relative absorption factors (RAFs), the values listed for several COPCs are incorrect; the table should be revised to include the Health Canada (2009) dermal soil RAFs for all PAHs (0.148), cadmium (0.01), copper (0.06), nickel (0.01), and zinc (0.1).

Risk Characterization

The risk characterization for human health is well presented and follows Health Canada Guidance (2009). Non-carcinogenic risks slightly above acceptable Health Canada levels were identified for construction workers from exposure to cadmium (HQ = 0.25) and lead (HQ = 0.45) and future industrial workers from exposure to VPHv in indoor air (HQ = 0.72). Addressing the issues identified by SLR in the problem formulation, exposure assessment and toxicity assessment may change the outcome of the risk assessment performed by Golder (2010). On this basis, it is recommended that the risk assessment be revised to address SLR's comments as well as incorporate new data available for the site and reflect change in the future land use scenario.

The risk characterization for terrestrial ecological receptors of concern (plants and soil invertebrates) included the calculation of exceedance factors for each of the COPCs; the exceedance factors ranged from 0.4 for antimony to 9.5 for copper. Based on the exceedance factors, Golder (2010) concluded that there was low potential for risk to plants and soil invertebrates. In addition, under the future scenario where it was assumed that the entire site would be paved or covered with buildings, it will not support invertebrate or plant populations and the potential for exposure of terrestrial ecological receptors to site contaminants will be eliminated. SLR agrees with Golder's (2010) approach and conclusions.

Assessment of Soil Contamination at BH06-13 and MW06-16

The HHERA was conducted under the assumption that shallow soil contamination around BH06-13 and MW06-16 within AEC 7 and AEC 8, respectively, in the eastern portion of the site will be excavated due to detections of VPH (280 mg/kg), LEPH (2,400 mg/kg) and HEPH (8,600 mg/kg) in top 0.3 m of soil in concentrations exceeding applicable CSR and CCME standards and guidelines. Risk assessment of these areas was performed separately and included in Golder, 2010. The results of risk assessment for contamination at BH06-13 and MW06-16 for current and future adult worker scenarios indicated acceptable risks at both locations in the current scenario, but unacceptable risk at both locations associated with the inhalation of indoor air for adult workers under future land use scenario. Because remediation of the contamination will be minimally invasive, and based on the potential for future buildings to be constructed at the site, SLR agrees with the Golder's (2010) recommendation to remediate these areas.

1.2 Aquatic Risk Assessment

The potential impact of groundwater contaminants detected upon discharge to Burrard Inlet was evaluated as part of the Aquatic ERA. Bivalve (*Mytilus galloprovincialis*) and giant kelp (*Macrocystis pyrifera*) were selected as aquatic ecological receptors of concern. Metals (aluminum, cadmium, iron, nickel and zinc) LEPH, PAH (acridine, anthracene, benzo[a]anthracene, benzo[a]pyrene, fluoranthene, naphthalene, phenanthrene and pyrene) and PCPs were selected as COPCs based on the comparison of maximum detected concentrations of constituents in on-site groundwater wells sampled from 1996 to 2007 to the lower of the available BC Aquatic life standards (CSR AW) or 10 times the CCME Aquatic Life guidelines. Following the installation of off-site groundwater wells (MW09, MW09-7, MW09-6, MW09-5, MW09-09 and SC-MW97-01), only cadmium, iron, anthracene, fluoranthene, phenanthrene and pyrene were detected in concentrations exceeding the 10x's the CCME Aquatic Life guidelines or the CSR AW standards in at least one downgradient well.

In May 2010, the Federal Interim Groundwater Quality Guidelines (FIGQG) (Meridian, 2010) were published and endorsed for use at federally regulated contaminated sites. The FIGQG are for the most part equivalent to the CCME Aquatic Life guidelines and are therefore more stringent than the 10x's the CCME Aquatic Life guidelines used by Golder (2010) in the COPC screening. Use of the FIGQG would therefore result in the identification of additional COPCs for the protection of aquatic life.

Although screening the groundwater data using the FIGQG would result in retaining additional COPCs, the results of the Aquatic Risk Assessment would not change. In their assessment Golder (2010) used a 10x's attenuation factor to account for tidal influences on groundwater chemistry prior to discharge. SLR agrees with this approach, and thus it would be appropriate to assume 10x's attenuation in the estimation of exposure point concentrations for aquatic receptors.

The magnitude by which the COPC concentrations in downgradient wells exceeded the Aquatic Life guidelines/standards was low. In addition, further dilution of the COPC concentrations upon groundwater discharge to Burrard Inlet would occur. Accordingly, the potential for adverse effects to aquatic receptors from exposure to groundwater COPCs upon discharge to surface water were considered to be low. SLR agrees with the conclusions of the Aquatic Risk Assessment and also agrees with the recommendations for on-going groundwater monitoring of these downgradient monitoring wells.

2.0 RISK MANAGEMENT RECOMMENDATIONS FROM GOLDER (2010) HHERA

Based on the results of HHERA site, Golder recommended as a risk management option to perform hot spot removal identified as near surface hydrocarbon contamination at BH06-13 (AEC 7) and MW06-16 (AEC 8) and to conduct groundwater monitoring of downgradient wells to assure that concentrations of COPCs do not increase with time. In addition, vapour delineation and monitoring at AECs 4 and 6 was recommended to verify the results of the HHRA. SLR agrees with the risk management recommendations.

3.0 RELEVANCE OF GOLDER'S HHERA IN RELATION TO ANTICIPATED FUTURE LAND USE

3.1 Future Land Use Proposed at the Site

As discussed in the introduction, VFPA intends to move the existing railway tracks currently located north of Pier 94 Access Road onto the site. This work will involve removal of the existing concrete slab, installation of track drainage at an approximate depth of 1m below existing grade, and the installation of subsurface and top ballast and tracks. The railway tracks will also be placed on three VFPA properties located to the north and east of the site at 375, 350 and 1001 Low level Road. As a consequence of the proposed activities, portions of the currently existing pavement at the site will be removed and replaced with rail tracks and rail ballast. SLR has also assumed that buildings will be constructed at the site.

3.2 Extent of Contamination at Adjacent Properties

SLR (2011) conducted a soil and groundwater investigation at 375, 350 and 1001 Low Level Road during February and March of 2011 to determine whether these properties were impacted by contamination relating to historical in-filling and industrial activities.

SLR advanced six soil borings at the 375 Low Level Road, four borings at the 350 Low Level Road property, and four borings at the 1001 Low Level Road property. In addition, four, three and two monitoring wells were installed at the 375 Low Level Road property, 350 Low Level Road property and the 1001 Low Level Road property, respectively. Soil and groundwater samples were analyzed for metals (dissolved metals in groundwater), PAHs, PHC, BTEX, NTBE, VPH, CCME CWS PHC F1-F4, VOCs, chlorinated and non-chlorinated phenols, and pesticides (in groundwater only).

Concentrations of metals, PAHs, PHCs and BTEX in soil at these three properties were lower than the lowest CCME Environmental Quality Guidelines for the protection human and environmental health for IL Land Use. With the exception of metals, all other parameters were detected at a very low frequency. Detected concentrations of all parameters analyzed in soil at these three properties were lower than those detected at the site as part of the investigations performed by Golder (2006, 2009).

Aluminum, arsenic, chromium, cadmium, copper, iron, lead, selenium, silver and zinc were detected in groundwater samples at concentrations exceeding the lowest FIGQG for IL land use. Arsenic, chromium, lead and silver were detected at concentrations exceeding standards at only one monitoring well (MW11-5), which is located at 375 Low Level Road, and iron was detected at concentrations exceeding applicable standards at two monitoring wells (MW11-7 and MW11-8) installed at 350 Low Level Road. In contrast, only two metals (cadmium and selenium) were detected at concentrations exceeding the lowest the IL FIGQG at 350 Low Level Road.

Concentrations of hydrocarbon constituents in groundwater beneath these three properties were low, with limited exceedances of the IL FIGQG or CSR standards. Only naphthalene, pyrene and CCME PHC F2 were detected in groundwater at 350 Low Level Road, and only anthracene was detected in groundwater at 1001 LLR property at concentrations exceeding the lowest IL FIGQG.

It should be noted that soil vapour data was not collected by SLR (2011) at any of these properties due to low detections of PHCs in soil and groundwater.

In general, with the exception of selenium in groundwater, concentrations of COPCs detected in soil and groundwater at 375, 350 and 1001 Low Level Road are lower than those measured at the site by Golder. On this basis, the Golder HHERA (2010) conducted for the site is considered to be protective of these off-site properties under the same assumptions and scenarios evaluated.

3.3 Re-evaluation of Golder's HHERA in Context of Future Land Use Assumptions

3.3.1 Human Health Risk Assessment

As discussed in previous sections, exposure scenarios evaluated by Golder under future land use scenarios include the construction worker scenario and the industrial worker scenario. The construction worker scenario assumed that construction workers could potentially be exposed to soil COPCs identified in all soil data collected throughout the entire site at various depths, with the exception of two areas that were intend for excavation (BH06-13 and MW06-16), via incidental ingestion of soil, dermal contact with soil and inhalation of fugitive dust**.** The groundwater pathway was not considered a significant exposure pathway because of the practice of dewatering construction areas, and use of protective clothing. Outdoor air inhalation was also considered an insignificant exposure pathway because no volatile compounds were identified as COPCs in outdoor air. Quantification of risk was performed using 95% UCLM concentrations or 90% percentile concentrations (i.e., assuming site-wide exposure) as exposure point concentrations and Health Canada (HC, 2009a) default exposure parameters. These assumptions are conservative and likely result in an overestimation of risks to construction workers.

As discussed in the previous section, slightly elevated risk, predominantly driven by incidental ingestion and dermal contact with soil, was derived for construction workers from exposure to cadmium (HI = 0.25) and lead (HI = 0.45). Cadmium was detected in soil at concentrations ranging from 0.2 mg/kg to 1840 mg/kg. The highest concentration was detected in a field duplicate of a soil sample (BH06-06) collected from AEC 2 at a depth interval of 4.0 to 4.4 m. The detected concentration of cadmium in the sample was 140 mg/kg, indicating a large discrepancy between the sample and its duplicate. The next highest concentration of cadmium of 66.1 mg/kg, which was detected in sample BH-06-14 collected from AEC 7 at a depth of 0.3-0.6 mbgs. It should be noted that excavation of soil for tract realignment will only be performed to a depth of 1 m; therefore, construction workers are not likely to have direct contact with soil containing the highest detected concentrations of cadmium. Concentrations of cadmium in soil samples collected from the three properties adjacent to the site (at 375, 350 and 1001 Low Level Road) were very low and ranged from 0.1 mg/kg to 3.8 mg/kg, indicating that hot spots are contained within AEC 2 and AEC 7.

Lead was detected in soil samples collected at the site in concentrations ranging from 2 mg/kg to 22,500 mg/kg. The highest and the second highest detection of lead (4,990 mg/kg) were detected at the same locations as cadmium, indicating that these two metals are co-located. As in the case of cadmium, concentrations of lead at properties located at 337, 350 and 1001 Low Level Road were lower (ranged from 2.04 mg/kg to 497 mg/kg) than those detected at the site within AEC 2 and AEC 7. Concentrations of cadmium and lead at the site are expected to be lower than those used in the HHERA because of hot spot removal from AEC 7 performed by

Golder following completion of the HHERA. However, it is SLR understanding that subsurface soil contamination within AEC 2 has not been excavated.

The slightly elevated non-cancer risk estimated for the construction worker from exposure to cadmium and lead in soil site is localized to two areas with the highest concentrations at depths lower than the expected depth of excavation to be performed for track realignment. Considering the conservative assumptions used in the derivation of risk estimates for construction workers from exposure to soil, the limited area of contamination (lead and cadmium contamination is restricted to two hot spots), the presence of the highest contamination occurring at a depth not intended to be reached during excavation, as well as use of protective clothing and the implementation of best working practices, exposure of construction workers during tack realignment either at the site or the properties located at 337, 350 and 1001 Low Level Road are not expected to result in adverse health effects. The risk estimates derived by Golder as part of the HHRA for the construction worker represent the worst case scenario.

The future industrial scenarios evaluated assumed that the site will be paved and buildings may also be constructed. The only significant exposure pathway considered by Golder (2010) under this exposure scenario was the inhalation of indoor air, which resulted in an unacceptable risk from potential exposure to modeled concentrations of benzene (ILCR= 1E-04) and VPHv/CCME F1-F2 (HQ = 0.72) from soil vapour. The highest concentrations of benzene (374 mg/m^3) and VPHv/CCME F1-F2 (42,100 mg/m^3) were detected in a September 2009 in a soil vapour probe (VP09-02) located within AEC 4. Benzene was also detected at high concentration (617 mg/m^3) in a soil vapour probe (VP-09-06) advanced within AEC-06. Based on the potential for buildings to be constructed in the future, the exposure assumptions and pathways evaluated by Golder are valid and appropriate for the intended future site use (i.e., railway tracks realignment and potential presence of buildings). The outdoor air inhalation pathway was considered to be insignificant because predicted concentrations in outdoor air are less than CSR Schedule 11 IL standards.

Since completion of HHERA (Golder, 2010), additional soil vapour data was collected (Golder, 2011b) to provide additional delineation at AECs 4 and 6 and the evaluation of seasonal variability in soil vapour quality. The vapour monitoring program consisted of the installation of seven new step-out vapour probes followed by vapour monitoring at all existing and new probe locations. Vapour sampling was performed during the wet (February 2010) season and again in August 2010 at two locations. Predicted indoor and outdoor air concentrations were estimated using the vapour attenuation factors (VAFs) provided in Technical Guidance 4 (BC, 2009, 2010) and were less than the CSR ILv at all locations. Overall, the results of vapour monitoring indicated that the vapour contamination in AEC 4 has been delineated and is localized to MW07-45 and VP09-02. The contaminant concentrations measured in VP09-02 equate to unacceptable health risks associated with the inhalation of indoor air, but is not a concern under current conditions where no buildings are present. At AEC 6, concentrations measured in step-out vapour probes were fairly consistent between the wet (February) and dry (August) seasons, and concentrations measured in 2010 and considerably lower than those measured in February 2009. Overall, the results of the 2009 and 2011 soil vapour sampling program indicate that inhalation of outdoor air is not a concern; however, indoor air inhalation may present potential health risks if buildings are constructed atop AEC 4 or 6.

As discussed in previous sections of this letter, the trench worker scenario, and in particular the inhalation of volatiles in a trench, was not evaluated in the HHERA (Golder, 2010). If new utilities to be installed, existing utilities require maintenance or a trench is advanced for other reasons, this scenario should be evaluated prior to that work being undertaken.

In the HHERA the groundwater pathway was not quantified because currently groundwater site is not used as a source of potable water and exposure to construction workers is assumed negligible due to the practice of dewatering and the use of protective clothing during excavation. SLR concurs that this assumption is valid for the intended future land use. However, if any assumptions regarding groundwater use change in the future, the groundwater pathway should be re-evaluated.

3.3.2 Terrestrial Ecological Risk Assessment

The proposed future use of the site does not affect conclusions of the Terrestrial ERA performed by Golder (2010).

3.3.3 Aquatic Risk Assessment

Since completing the Aquatic Risk Assessment, Golder collected an additional two rounds of groundwater data from ten monitoring wells (MW09-01 through MW09-09 and SC-MW97-01) downgradient of the site. All ten groundwater wells along Pier 94 Access Road and the railyard were sampled during the wet season (January) and only select wells along Pier 94 access road that exceeded regulatory standards/criteria were sampled during the dry season (August 2010). Concentrations of six metals (cadmium, copper, lead, zinc iron and silver) and five PAHs (benzo(a)pyrene, anthracene, phenanthrene, pyrene and fluoranthene) exceeded 10 x the CCME Aquatic Life guidelines in at least one monitoring well. MW09-01 contained the highest concentrations of cadmium (60.1 ug/L), copper (131 ug/L), lead (87 ug/L), zinc (4,870 ug/L), anthracene (2.03), phenanthrene (13.1 ug/L), pyrene (1.33 ug/L) and fluoranthene (1.99 ug/L). Iron (12,200 ug/L) and silver (1.4 ug/L) were detected at the highest concentrations in MW-03 and MW-09, respectively, and benzo(a)pyrene was detected at the highest concentration of 0.197 ug/L in MW09-07.

The results of the August 2010 sampling event indicated that only cadmium (1.12 ug/L) in MW-09-6, iron (10,600 ug/L) in MW09-09, and four PAHs [fluoranthene (1.77 ug/L), anthracene (1.92 ug/L), phenanthrene (12.5 ug/L) and pyrene (1.21 ug/L)] in SC-MW97-01, exceeded the 10 x the CCME Aquatic Life guidelines. The concentrations measured in the samples collected in August 2010 were lower than those measured in January 2010.

Overall, the concentrations of metals and PAHs detected in downgradient wells, with the exception of iron detected in MW09-09 and several PAHs [benzo(a)anthracene, benzo(a)pyrene, fluoranthene and pyrene] detected in MW 09-07, were similar or lower than the September 2009 monitoring data detected in same wells. Golder (2011) concluded that following discharge to Burrard Inlet, the elevated iron and PAH concentrations measured in groundwater would not be expected to have an adverse effect on aquatic life.

The introduction of the rail corridor on the northern portion of the Site is not likely to have a significant influence on the groundwater chemistry at the Site. The installation of the rail corridor will include the removal of the existing concrete slab, installation of track drainage at an approximate depth of 1m below existing grade, and the installation of subsurface and top ballast and tracks. Although this construction includes the introduction of a more permeable surface, as well as increased surface water/precipitation infiltration, this would be seen to effectively dilute contaminant concentrations in groundwater in the area. It is noted that that in the event of spills and/or other events that result in the contamination of the area surrounding the rail corridor, contaminants would be more likely to infiltrate through these more permeable materials; however, given that this is an unknown, it has not been further evaluated here.

In summary, the conclusions of the Golder Aquatic Risk Assessment remain valid under the proposed future land use.

4.0 CONCLUSIONS OF HHERA REVIEW

The general methods used in the HHRA and ERA (Golder, 2010) are based on Health Canada guidance and methods. Overall, we concur that contamination at the site likely poses acceptable or low risk to people and the environment under the current use; however, the issues indicated in the problem formulation, exposure assessment and toxicity assessment should be addressed before making final risk-based conclusions. Independently no single issue is expected to change the outcome of the risk assessment, however, collectively the issues may results in an altered outcome. In addition, as presented in Golder, 2010, and summarized above, risks in excess of acceptable levels have been identified under the future exposure scenarios for the industrial worker (for inhalation of indoor air inside buildings, if constructed at the site), and for the construction worker.

As discussed, based on the lower contaminant concentrations measured at the adjacent properties 375, 350 and 1001 Low Level Road, the risk assessment conducted by Golder is considered protective of these properties under the same assumptions and scenarios evaluated.

5.0 STATEMENT OF LIMITATIONS

This report has been prepared and the work referred to in this report has been undertaken by SLR for Vancouver Fraser Port Authority. It is intended for the sole and exclusive use of VFPA and its authorized agents for the purpose(s) set out in this report. Any use of, reliance on or decision made based on this report by any person other than VFPA for any purpose, or by VFPA for a purpose other than the purpose(s) set out in this report, is the sole responsibility of such other person or VFPA. VFPA and SLR make no representation or warranty to any other person with regard to this report and the work referred to in this report and they accept no duty of care to any other person or any liability or responsibility whatsoever for any losses, expenses, damages, fines, penalties or other harm that may be suffered or incurred by any other person as a result of the use of, reliance on, any decision made or any action taken based on this report or the work referred to in this report.

The investigation undertaken by SLR with respect to this report and any conclusions or recommendations made in this report reflect SLR's judgment based on the site conditions observed at the time of the site inspection on the date(s) set out in this report, on information available at the time of preparation of this report, on the interpretation of data collected from the field investigation, and on the results of laboratory analyses, which were limited to the quantification in select samples of those substances specifically identified in the report. This report has been prepared for specific application to this site and it is based, in part upon visual observation of the site, subsurface investigation at discrete locations and depths, and specific analysis of specific chemical parameters and materials during a specific time interval, all as described in this report. Unless otherwise stated, the findings cannot be extended to previous or future site conditions, portions of the site which were unavailable for direct investigation, subsurface locations which were not investigated directly, or chemical parameters, materials or analysis which were not addressed. Substances other than those addressed by the investigation described in this report may exist within the site; substances addressed by the investigation may exist in areas of the site not investigated and concentrations of substances addressed which are different than those reported may exist in areas other than the locations from which samples were taken. SLR expresses no warranty with respect to the accuracy of the laboratory analyses, methodologies used, or presentation of analytical results by the laboratory. Actual concentrations of the substances identified in the samples submitted may vary according to the extraction and testing procedures used.

As the evaluation and conclusions reported herein do not preclude the existence of other chemical compounds and/or that variations of conditions within the site may be possible, this report should be used for informational purposes only and should absolutely not be construed as a comprehensive hydrogeological or chemical characterization of the site. If site conditions change or if any additional information becomes available at a future date, modifications to the findings, conclusions and recommendations in this report may be necessary.

Nothing in this report is intended to constitute or provide a legal opinion. SLR makes no representation as to the requirements of or compliance with environmental laws, rules, regulations or policies established by federal, provincial or local government bodies. Revisions to the regulatory standards referred to in this report may be expected over time. As a result, modifications to the findings, conclusions and recommendations in this report may be necessary.

Other than by VFPA and as set out herein, copying or distribution of this report or use of or reliance on the information contained herein, in whole or in part, is not permitted without the express written permission of SLR.

We trust the information presented meets your needs. Should you have any questions or require additional information, please contact the undersigned at your convenience.

Yours sincerely,
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