Remediation Plan for North West Smelting and Refining

Final Report

July 2017 – 17-5694

July 28, 2017

1558 Willson Place
Winnipeg, Manitoba
Canada
R3T 0Y4
Telephone
204.453.2301
Fax
204.452.4412

Manitoba Sustainable Development
1007 Century Street
Winnipeg, MB R3H 0W4

Attention: Warren Rospad
Contaminated Sites Program Specialist | Environment Officer

Remediation Plan for North West Smelting and Refining, 2185 Logan Avenue, Winnipeg, MB

Dear Mr. Rospad,

Please find enclosed one (1) digital copy of the above-mentioned report. If you have any questions or concerns, please contact the undersigned at 204-453-2301 ext. 4077.

Sincerely,

DILLON CONSULTING LIMITED

Heather Fisher, P.Eng.
Associate

HLF:jef

Our File: 17-5694

Table of Contents

Figures

Tables

Appendices

References

Executive Summary

Dillon Consulting Limited (Dillon) was retained by North West Smelting and Refinery Ltd. (NWSR) to prepare a Remediation Plan (RP) for the NWSR site located at 2185 Logan Avenue in Winnipeg, MB. NWSR received a Director's Order dated June 13, 2017 from Manitoba Sustainable Development (MSD) to develop a remediation plan for the site within 30 days after the date of the order.

This RP was developed to address environmental concerns associated with the residual impacts at the NWSR site. This document provides the basis for the development of a technical design and subsequent tender package for the implementation of the remediation.

This RP is based on assessment activities completed by Dillon in 2014, which include the results of the previous investigations, and current land use of the area. Remediation options were evaluated in a Remedial Options Analysis Report (Dillon, 2015) for each area of environmental concern identified at the site. The remedial options were critically evaluated to discuss potential risks, advantages, and disadvantages. Based on a number of factors, outlined below, recommendations were made for the preferred remediation approach. The selected remediation approach was approved by the management team responsible for implementing the cleanup of the site.

The table below provides a summary of the environmental issues identified at the site and the proposed RP for each:

AEC	Volume of metals impacted soil exceeding CCME SQG Tier II Criteria m^3	Remedial Approach	Comments
1 - North End of Site	10,500	Consolidate and compact material, consolidate non-compactable waste in a specified area, place granular compacted cap and coloured geotextile and conduct a risk assessment to verify risk acceptability for groundwater. Complete a drainage management plan to direct surface water.	Any material that is disposed off-site must be tested for leachable metals (lead), and if found exceeding criteria in Man. Reg. 195/2015, the material must be transported, and disposed of as hazardous waste. Future land use restricted to parking and/or staging area.

DILLON CONSULTING

AEC	Volume of metals impacted soil exceeding CCME SQG Tier II Criteria m^3	Remedial Approach	Comments
2 - South Portion of Site	3,240 (on-site) 200 (off-site) 3,440 (total)	Impacted soil is excavated and relocated to AEC 1 prior to capping; resulting in an increase to the ground surface elevation in AEC 1 by approx. 1.5 m. Off-site impacts to west of site are excavated to a depth of 0.5 m, and backfilled with clean fill.	Provides unrestricted industrial site use of AEC 2; Long-term maintenance and monitoring requirements transferred to AEC 1. Any material that is disposed off-site must be tested for leachable metals (lead), and if found exceeding criteria in Man. Reg. 195/2015, the material must be transported, and disposed of as hazardous waste. Future land use restricted to parking and/or staging area.

In addition to the above soil remediation activities, there are foundations and pieces of molten metal currently remaining on-site. Details regarding these issues are as follows:

- Foundations - Limited or no metal-impacted soil is expected below the foundations. The foundations will remain on-site. A borehole program will be conducted to analyze soils for metals beneath the foundations to ensure that they meet the selected soil criteria.
- Molten Metal - Two large pieces of molten metal covered with refractory brick were identified on-site. This material does not meet the standard requirements (via a TCLP test) for acceptance at a landfill that is not licensed to accept hazardous waste. General Scrap in Winnipeg has indicated that they can accept these pieces for recycling. If MSD approves, the metal pieces can be recycled at General Scrap. The selected contractor would be responsible for transport of the metal to the recycling facility, General Scrap.

Note that any material that is disposed of off-site must be tested for leachable metals (lead), and if found exceeding criteria in Man. Reg. 195/2015, the material must be transported, and disposed of as hazardous waste. Hazardous classified soils will be disposed of off-site, as necessary, at a disposal facility such as Miller Environmental Corporation.

There is also the option to screen the debris currently located in the north end of the site (AEC 1) to remove the larger debris and battery casings to be disposed of off-site. By screening this debris out, there would be more space in the north end for impacted soil from the southern portion of the site.

Additionally, AEC 1 needs a surface drainage plan to ensure that surface water is directed away from the cap. The land drainage will be designed to meet City of Winnipeg requirements. A City permit will likely need to be issued to tie into the land drainage sewer located on Ryan Street.

1.0 Introduction

Dillon Consulting Limited (Dillon) was retained by North West Smelting and Refinery Ltd. (NWSR) to prepare a Remediation Plan (RP) for the NWSR site located at 2185 Logan Avenue in Winnipeg, MB. NWSR received a Director's Order dated June 13, 2017 from Manitoba Sustainable Development (MSD) to develop a remediation plan for the site within 30 days after the date of the order . The Director's Order is attached as Appendix A.

1.1 Site Description

The site is located at 2185 Logan Avenue in a northwest industrial area of Winnipeg (Appendix B Figure 1) in Omand's Creek Industrial Park. Historically, the property was used to house a smelting facility and subsequently, a battery recycling operation. The battery recycling operation was housed on the south end of the property in a complex of buildings, formerly used as a refinery. Storage areas filled with metal and plastic battery case debris were identified (IDE, 1993) to the north of the buildings. The northern portion of the property is grass covered and was previously covered with a clay cap overlying refinery and battery recycling debris. In October of 2012, the buildings were demolished by Western Specialty Contracting Ltd., with oversight by Dillon.

Additional site details are summarized in Table 1. A site plan showing the legal lot plan is attached as Figure 1.

Table 1: Site Description

Civic Address	2185 Logan Avenue
Legal Description	Lots 15 – 36, Plan 1431; Lots 37-39, 43, and 47 Plan 24342 in NE 14-11-2E
Registered Owner	North West Smelting and Refining Ltd.
Land Zoning	Manufacturing - General (M2)
Property Size/Area	1.8 ha (4.5 acres)
Facilities	Vacant with gravel, historical landfill (north portion of site), building foundations (south portion of site)
Structures	Building foundations (approx. 3359 m^2 (36,155 ft^2)); no vertical structures

1.2 Background

1.2.1 Historical Environmental Site Investigations

Previous environmental site investigations and their findings are summarized in Figure 3 of Appendix B (attached) and below in Table 1. Further details are provided in Appendix B.

Table 2: Summary of Historical Environmental Site Investigations

Year	Investigating Party	Type of Investigation	Investigations	Findings
1991	I.D. Systems (IDS) Ltd.	On-Site Investigation into Lead Contamination	- 8 shallow test holes; - 9 piezometers; - 66 soil samples.	- Lead impacts in soil exceeded Tier I and Tier II Criteria; - Lead impacts variable with depth; - Vertical delineation to 5.2 m; - Vertical delineation not achieved; - Shallow groundwater flow to the northwest.
1993	I.D. Engineering Canada, Inc.	Off-Site Environmental Site Assessment	- Boreholes; - Monitoring wells.	- Dissolved lead in water concentrations below applicable criteria to the east of site property.; - Off-site soil to the west exceeded Tier I Criteria.
2005	KGS Group	Off-Site Phase II ESA	- Test pits; - Surficial Soil Samples.	- Lead in soil concentrations exceeded; - Off-site soil to the west exceeded Tier I Criteria; - Depth of impacts at less than 1 m below grade.
2009	Dillon Consulting	Off-Site Environmental Site Assessment	- Boreholes	- Off-site limited impacts associated with Polycyclic Aromatic Hydrocarbons to the east of the property.
2013	M.P. Wiebe Environmental Engineering	Off-Site Phase II ESA	- Boreholes	- Off-site impacts above Tier I Criteria confined to upper fill layer; - No Off-site impacts above Tier II Criteria to the west of the property.
2014	Dillon Consulting	On-Site and Off-Site Environmental Site Investigation	- Test Pits; - Boreholes; - Monitoring wells; - Surface Soil Samples.	- North end average cap thickness found to be approx. 0.45 m; - North end approx. waste volume is 10,500m^3 covered by a fill volume of approx. 3,100m^3; - Off-site impacts to west of site are surface impacts restricted to upper 0.3 m of soil and do not exceed the Tier II criteria for lead; - Lead and cadmium in groundwater observed in each stratigraphic unit with greatest concentrations found in deeper stratigraphies along eastern site boundary.
2014	Dillon Consulting	Demolition Report	- None	- Demolition completed May 30, 2014; - Concrete building foundations remain on-site; - Two large pieces of molten metal remain on-site.

DILLON CONSULTING

2.0 Objectives

This RP was developed to identify remedial approaches to address environmental concerns associated with the residual impacts at the NWSR site. This document provides the basis for the development of a technical design and subsequent tender package for the implementation of the remediation.

This RP is based on assessment activities completed by Dillon in 2014, which include the results of the previous investigations and current land use of the area. Remediation options were evaluated in a Remedial Options Analysis Report (Dillon, 2015) for each area of environmental concern identified at the site. The remedial options were critically evaluated to discuss potential risks, advantages, and disadvantages. Based on a number of factors, outlined below, recommendations were made for the preferred remediation approach. The selected remediation approach was approved by the management team responsible for implementing the cleanup of the site.

This RP was designed to meet the following clean-up objectives in accordance with applicable regulatory criteria (see Section 5):

1. Restore the southern portion of the site so that no unacceptable risks are present;
2. Prevent the migration of contaminants;
3. Address physical hazards for safety and the protection of human health; and,
4. Implement a cost-effective remediation solution.

3.0 Biophysical Environment

3.1 Physiographic Description

The subject property is located near the corner of Logan Avenue and Ryan Street. Dixon Bayco Limited (task lighting manufacturer) and Cadorath Uniflyte Company Limited (metal plating) occupy the properties on the southern side of Logan Avenue. Several companies (trucking, lumber storage) rent the spaced owned by 2925924 Manitoba Ltd. that bounds the property to the west. A metal recycling facility, Chisick Metal Ltd. bounds the property to the southeast side. The northern edge of the subject property is adjacent to Altoba Freight.

A site plan showing the area at the former buildings and on-site buried debris is illustrated in Figure 2 of Appendix B (attached).

The closest surface water body or sensitive ecological habitat is located approximately 3 km south of the site (Assiniboine River). There are two ponds within 1 km from the site: a stormwater retention pond to the northwest and a pond at Woodsworth Park across Highway 90 to the northeast. Neither of these surface water bodies is affected by the site.

3.2 Site Services and Surface Topography

Site and surrounding land use is industrial. The site hosted a former smelter and lead acid battery recycling facility. The site was serviced by municipal supplied potable water and sewer. A historical disposal area containing debris from the acid battery recycling facility is situated in the northern portion of the site property. The southern portion of the site contained the smelter and associated buildings, which were demolished in 2012.

The topographical survey conducted in 2012 showed surface drainage patterns that ran to the edges of the site. The property is graded to a greater elevation towards the center of the Site, promoting runoff patterns to the property edges. There are surface water ditches along the eastern and northern property boundaries, however, surface water was not observed in the drainage ditches during field investigations. Erosion potential is minimal for the southern portion of the site. However, there is greater erosion potential for the northern portion of the site due to steeper slope profiles.

3.3 Site Hydrogeology

3.3.1 Regional Hydrogeology

The general geology of the Winnipeg area consists of glacio-lacustrine deposits including sands, silts and clays of the late Wisconsinan glaciation. Bedrock geology mapping for the area indicates the site is underlain by the Red River formation, which consists of Ordovician dolomitic limestones and dolomite

(Province of Manitoba, 1980). The carbonate bedrock serves as a regional aquifer, with an estimated piezometric groundwater level located at approximately 12 m below ground surface (mbgs) in the area of the site (University of Manitoba Department of Engineering, 1983). This unit serves as a groundwater drinking source obtained through wells for rural communities surrounding Winnipeg.

3.3.2 Local Hydrogeology

The subsurface soil conditions observed during the investigation consisted of surficial sand and gravel fill materials, underlain by layers of silt, clay and glacial till to the maximum depth drilled of 7.4 mbgs. The depth to groundwater measured within the monitoring wells during the May 2013 Dillon groundwater monitoring visit ranged between 0.55 (13-03, Fill layer) and 2.60 (13-10, Till layer) mbgs. Depth to groundwater measured during the June 2014 visit ranged between 0.35 (13-13, Fill layer) and 2.49 (13-10, Till layer) mbgs. Shallow groundwater flow direction (fill and clay wells only) was observed to be primarily towards the northeast.

Greater hydraulic conductivity was seen in the upper layers in the following order:

- MW 13-13 (fill/silty clay, 3.02 x10-4 cm/s);
- MW 13-11 (silty clay, 5.14 x10-6 cm/s); and,
- MW 13-10 (tight till, 1.7 x 10-7 cm/s).

The local shallow groundwater flow direction below the site may vary from the regional context and be influenced by industrial groundwater extraction, surface drainage ditches, underground structures and utilities which may be present in the vicinity of the site. Such features are typically backfilled with coarse grain materials which may provide a more permeable conduit for groundwater flow when compared to the lower permeability of the native soils.

3.3.3 Soil, Fill, and Waste

The northern portion of the property consists of grass growing in stony topsoil overlying the 0.5 m of clayey fill with stones, which overlies 1 m of fill consisting of foundry debris, plastic battery case debris and clayey soils. This fill overlays the original black organics and clayey till. Undisturbed till was encountered at a depth of 2 - 3 m.

The southern portion of the property consists of 1 m of gravel road fill, overlying approximately 2 m of grey clay, overlying the till, which extends to the bottom of the test holes.

4.0 Areas of Environmental Concern (AEC)

AEC refers to areas on, in, or under a property where one or more contaminants are present, as determined through previous environmental site assessments. Dillon conducted a Remedial Options Analysis in 2015, attached as Appendix C, which evaluated the remedial options for each area of environmental concern identified at the site and discussed the potential risks, advantages, and disadvantages. The following three (3) AECs were identified and are summarized below.

4.1 AEC 1 – North End Historical Debris Disposal Area

A historical debris disposal area at the northern portion of the property contains foundry debris associated with battery breaking/recycling activities mixed with clayey soil. Grass grows on top of the soil cap that covers the disposal area. Contaminants of concern identified at the north end disposal area are related to the battery and foundry debris. These include:

- Metals (lead, cadmium, copper, zinc); and,
- The estimated volume of bulk metal impacts in fill, waste, and underlying soil that exceeds Tier II CCME soil quality guidelines (SQG) (ingestion of soil pathway, protection of human health) is approximately 10,500 m^3, based on average depth of impacts to 1.5 mbgs, and an approximate area of impacts of 7,000 m^2. Volumes were estimated using known concentrations and a calculated soil-cut volume.

4.2 AEC 2 – Surface Soil Impacts – Southern Portion of Site

Surface soil impacts are associated with previous site activities as a foundry for metal smelting and refining. Impacts have been identified in the surrounding fill and underlying layers. Contaminants of concern identified at the southern portion of the site include:

- Metals (lead, cadmium, copper, zinc), and,
- The estimated volume of impacted soil that exceeds Tier II CCME SQG (ingestion of soil pathway, protection of human health) is approximately 3,240 m^3, based on average depth of impacts to 1.5 mbgs, and an aerial extent of 2,160 m^2. Volumes were estimated using known concentrations and a calculated soil-cut volume.

4.3 AEC 3 – Site-Wide Groundwater

Groundwater impacts associated with leachable metals have been observed at the site in surrounding monitoring wells. Contaminants of concern identified in groundwater include:

- Metals (lead, cadmium).

DILLON CONSULTING

5.0 Selection of Remediation Criteria

The remediation criteria consider both the north end historical debris disposal area and the south end surface soil impacts. The remediation criteria were selected as described below.

5.1 Soil

Based on present and future proposed site land use and potential receptors to the site, Dillon selected the Canadian Council of Ministers of the Environment (CCME) Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health (2008) for industrial land use for remediation of the soil on the south end of the site.

The CCME Tier I criteria considers direct contact between ecological and human receptors and the impacted soils. These values can be overly conservative and are not applicable to industrial sites where there are no identified human and/or ecological receptors. Values that are protection of human health (soil ingestion pathway) are appropriate for the current and proposed future industrial land use. The CCME Tier II exposure pathway for soil ingestion is protective of human health and is appropriate to be used as the remedial objective criteria for soil on the south end of the site. For lead, the Tier II value is 8,200 mg/kg, for cadmium, the Tier II value is 2,090 mg/kg.

5.2 Groundwater

Groundwater impacts have been identified throughout the site. However, based on the observed concentrations and known exposure pathways, they do not appear to pose ecological or human health risks, as no nearby receptors have been identified. Dillon is carrying out a risk assessment to further evaluate the exposure pathways and confirm whether the assessment of "no risk to ecological and/or human receptors" is appropriate.

5.3 Physical Debris

Physical debris at the site includes both non-hazardous and hazardous materials. Debris across the site must be collected and segregated into hazardous and non-hazardous waste streams. Non-hazardous and hazardous materials shall be disposed of off-site in accordance with applicable guidelines and regulations. For waste classification and disposal evaluation, Dillon selected Man. Reg. 195/2015, the Dangerous Goods Handling and Transportation Act Criteria. Hazardous materials are further discussed in Section 6.2.

5.4 Buildings and Infrastructure

Remaining building foundations on-site will remain in place.

6.0 Remediation Plan

6.1 Remedial Objectives

It is Dillon's understanding that the remedial objective for the site is to have the environmental impacts (i.e., lead in soil, fill, waste, and groundwater, and to a lesser extent other metals) managed in a manner that allows for the redevelopment of the site for industrial purposes consistent with the current zoning and surrounding land uses. The management of environmental impacts generally considers three processes: human health and ecological risk assessment, environmental risk management measures, and remediation.

Effective and efficient environmental management options for a site generally include components from each of the above noted processes. Attached as Appendix C, is the Remedial Option Analysis report that Dillon prepared in 2015. The selected remedial options are summarized in the following sections.

6.2 Site Issues

The following sections present a summary of the contaminant and waste disposal issues, as well as the planned remedial methods. Specific issues that need to be addressed at the NWSR site include:

- Disposal of metal-impacted soils (both on-site and off-site);
- Foundations currently on-site;
- Two lead containing metal pieces currently on-site; and,
- Collection and disposal of hazardous soils (leachable lead in soil).

The following sections summarize the remediation plan for the site.

6.2.1 Metal-Impacted Soils

Table 2 summarizes the location and volume of metal-impacted soils identified at the NWSR site and remedial approaches recommended to address these contaminated soils.

DILLON CONSULTING

Table 3: Summary of Metal-Impacted Soil

AEC	Volume of metals impacted soil exceeding CCME SQG Tier II Criteria m^3	Remedial Approach	Comments
1 - North End of Site	10,500	Consolidate and compact material, consolidate non-compactable waste in a specified area, place granular compacted cap and coloured geotextile and conduct a risk assessment to verify risk acceptability for groundwater. Complete a drainage management plan to direct surface water.	Any material that is disposed off-site must be tested for leachable metals (lead), and if found exceeding criteria in Man. Reg. 195/2015, the material must be transported, and disposed of as hazardous waste. Future land use restricted to parking and/or staging area.
2 - South Portion of Site	3,240 (on-site) 200 (off-site) 3,440 (total)	Impacted soil is excavated and relocated to AEC 1 prior to capping; resulting in an increase to the ground surface elevation in AEC 1 by approx. 1.5 m. Off-site impacts to west of site are excavated to a depth of 0.5 m, and backfilled with clean fill.	Provides unrestricted industrial site use of AEC 2; Long-term maintenance and monitoring requirements transferred to AEC1. Any material that is disposed off-site must be tested for leachable metals (lead), and if found exceeding criteria in Man. Reg. 195/2015, the material must be transported, and disposed of as hazardous waste. Future land use restricted to parking and/or staging area.

Metal-impacted groundwater is present throughout the site (AEC 3). Site management options presented above for AECs 1 and 2 will contribute positively to management of the impacted groundwater. However, at present there is no identified need to remediate the groundwater impacts.

Remediation of the AECs presented in Table 3 above, are discussed in further detail in the following sections.

6.2.1.1 AEC **1** – North End of Site - Historical Debris Disposal Area

The remediation plan for the north end of the site includes the construction of a compacted granular cap. The granular cap allows for the impacts in AEC 1 to be managed in place. The cap blocks surface receptors from exposure to the underlying impacts, but does not provide for the further protection of groundwater.

A compacted granular cap would be conceptually designed as follows. The north area of the site would be re-graded removing local depressions and surface irregularities. The surface would be prepared by placing a lightweight indicator or coloured geotextile to delineate non-impacted cap material from the underlying impacted material, and 0.5 m of granular material would be placed and compacted at surface (e.g., 0.25 m of Granular B overlain by 0.25 m of Granular A). This compacted granular cap will provide a staging area for the outdoor storage of materials or equipment.

There is the option to screen the debris currently located in the north end of the site to remove the larger debris and battery casings to be disposed of off-site. By screening this debris out, there would be more space in the north end for impacted soil from the southern portion of the site.

Since the impacts are left in place, a risk assessment will be conducted to evaluate risk acceptability. Additionally, AEC 1 needs a surface drainage plan to ensure that surface water is directed away from the cap. The land drainage will be designed to meet City of Winnipeg requirements. A City permit will likely need to be issued to tie into the land drainage sewer located on Ryan Street. This area may require long-term monitoring and maintenance requirements.

6.2.1.2 AEC 2 – South Portion of Site – Surface Soil Impacts

The remediation plan for the south portion of the site is to excavate and relocate the metal-impacted material exceeding Tier II criteria from AEC 2 to the north end of the site, AEC 1. The excavated material from AEC 2 would be spread across the AEC 1 prior to the placement of the selected capping option. Approximately 3,240 m^3 of material (exceeding Tier II criteria) requires relocation to AEC 1. This would result in the increase of the ground surface in the northern portion of the site by approximately 1.5 m. The areas of AEC 2 excavated to remove impacted fill would be backfilled with imported, non-impacted fill.

By removing the impacted material from AEC 2 this allows for the efficient redevelopment of this area, and increases the value of this area similar to excavation and disposal options but at a reduced cost.

In the case that not all the soil from AEC 2 can be placed in AEC 1, the soil will be disposed of off-site at a suitable disposal facility such as Miller Environmental Corporation pending waste classification as non-hazardous material.

Off-Site Impacts

West of the Site

Dillon reviewed previous reports for the neighbouring property adjacent to the western border of the site located at 2201 Logan Avenue. Historical sampling locations and off-site investigations are summarized in Figure 4 in Appendix B. Impacts were found at 2201 Logan Avenue at a depth of less than 1 m. The total estimate volume of lead impacted soil exceeding Tier II SQG Criteria is 200 m^3, based on an estimated area of impacts of 675 m^2 and an observed depth of impacts to 0.3 m.

Metal-impacted soil west of the site will be handled similar to the on-site impacts in soil on the southern portion of the site (AEC 1). Soils exceeding Tier II Criteria will be relocated to the northern portion of the site. The off-site area excavated to remove impacted fill would be backfilled with imported, non-impacted fill.

6.2.2 Foundations

Foundations and floor slabs including those constructed on platforms above surrounding grade were left in place on-site following demolition of the site structures. Limited or no metal-impacted soil is expected below the foundations. The foundations will remain on-site. A borehole program will be conducted to analyze soils for metals beneath the foundations to ensure that they meet the selected soil criteria.

6.2.3 Lead-Containing Metal Pieces

Two large pieces of molten metal covered with refractory brick were identified as remaining on-site. This material does not meet the standard requirements (via a TCLP test) for acceptance at a landfill that is not licensed to accept hazardous waste. General Scrap in Winnipeg has indicated that they can accept these pieces for recycling. If MSD approves, the metal pieces can be recycled at General Scrap. The selected contractor would be responsible for transport of the metal to the recycling facility, General Scrap.

6.2.4 Collection and Disposal of Hazardous Soils

Material that is disposed of off-site must be tested for leachable metals (lead), and if found exceeding criteria in Man. Reg. 195/2015, the material must be transported, and disposed of as hazardous waste. Hazardous classified soils will be disposed of off-site, as necessary, at a disposal facility such as Miller Environmental Corporation.

7.0 Remedial Design and Implementation

7.1 Remediation Logistics

Mobilization/demobilization to the site is possible by road.

7.2 Site Grading

The entire site will be graded with clean granular fill to allow for site redevelopment. The north end of the site will be capped and graded in accordance with the surface drainage plan and design.

7.3 Health and Safety

The contractor shall have a site-specific Health and Safety Plan (HASP) in place and understood by all involved workers prior to work starting on-site. The contractor shall have a spill contingency plan in place to deal with any unforeseen and accidental releases of contaminants. The HASP will consider dust mitigation measures and proper personal protective equipment.

7.4 Remedial Design

Technical specifications that address the remediation objectives, guidance documents, regulations, and remedial approaches as described in this report will be prepared. Design packages that included technical specifications, detailed drawings, will be prepared at the 90% and tender ready design stages and will be based on the contents of this remediation plan. The specifications will identify and address requirements for site access and management, environmental protection, demolition, waste handling, health and safety, earthwork, erosion and sediment control, quality control, and site restoration.

7.5 Schedule

Assuming the project is tendered in summer 2017, the following is a proposed schedule for the remediation of this site:

- Bidders site meeting and contract tender – August 2017;
- Contract award – End of August 2017;
- Mobilization – September 5, 2017; and,
- Demobilization – November 2017.

8.0 Construction and Long-Term Monitoring

The purpose of the remediation project and long-term monitoring is to confirm compliance of the remedial activities with the specified remediation objectives.

8.1 Construction Monitoring During Remediation Activities

Remediation activities will be monitored to verify that they are being conducted in accordance with the RP and specifications. Construction monitoring will verify that the constructed components comply with the technical specification and design drawings, post-excavation confirmation samples demonstrate and document that the remediation objectives are achieved, and that the overall quality of the project meets the contract requirements. Construction monitoring will document the quantity of work and verify quantities for payment.

The following section outlines the work tasks that need to be performed.

Remediation of Impacted Soils

During soil remediation activities, the following tasks will be conducted:

- Dillon will perform construction observation services during the consolidation of waste in AEC 1 and during cap construction and grading;
- Dillon will perform post-excavation confirmation sampling and analysis, which include appropriate floor and sidewall samples for metal analysis;
- Dillon will collect and verify waste manifests for impacted material that is transported off-site to a licenced disposal facility, if any;
- Dillon will provide photo documentation of remediated areas including pre-construction and post construction/site closure activities;
- Dillon will verify the quantities of backfill hauled to site; and,
- Dillon will verify that compaction testing is performed for backfill material and the material placed in the northern end of the site.

Upon reception of laboratory analytical reports, Dillon will prepare a closure report including data summary tables, figures, and photographs demonstrating the completion of the remedial work proposed herein. A copy of the closure report will be submitted to MSD for review.

Disposal of Non-Hazardous Waste

Dillon will be on-site to complete the following:

- Document clean-up of debris areas and hauling to the north end of the site; and,
- Photo documentation and reporting of above activities.

Hazardous Materials Testing and Abatement

The remedial design package will require that the remedial contractor carries out hazardous materials and abatement in accordance with the specification, which will include the following:

- Verification of shipments (e.g., lead-containing metal pieces and soils exceeding Man. Reg. 195/2015) including waste manifests and quantities of materials transported off-site.

8.2 Post Remediation Long-Term Monitoring

Long-term monitoring of any newly engineered caps should be undertaken and include visual inspections. The visual inspections will look for any settling, ponding, erosion or frost action that may have occurred. If there are signs of instability at these locations such that buried material becomes exposed or otherwise affects the constructed cap's effectiveness, then cap system maintenance may be required. Visual monitoring should be conducted seasonally for a period of 10 years. A full review of data should be completed in the third year to assess whether further monitoring is warranted.

9.0 Limitations

This report was prepared exclusively for the purposes, project and site location(s) outlined in the report. The report is based on information provided to, or obtained by Dillon as indicated in the report, and applies solely to site conditions existing at the time of the site investigation(s). Dillon's report represents a reasonable review of available information within an agreed work scope, schedule and budget. It is therefore possible that currently unrecognized contamination or potentially hazardous materials may exist at the site(s), and that the levels of contamination or hazardous materials may vary across the site(s). Further review and updating of the report may be required as local and site conditions, and the regulatory and planning frameworks, change over time.

This report was prepared by Dillon for the sole benefit of our Client (North West Smelting and Refinery). The material in the report reflects Dillon's judgment in light of the information available to Dillon at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties. Dillon accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Respectfully submitted,

DILLON CONSULTING LIMITED

Heather Fisher, P.Eng.
Associate

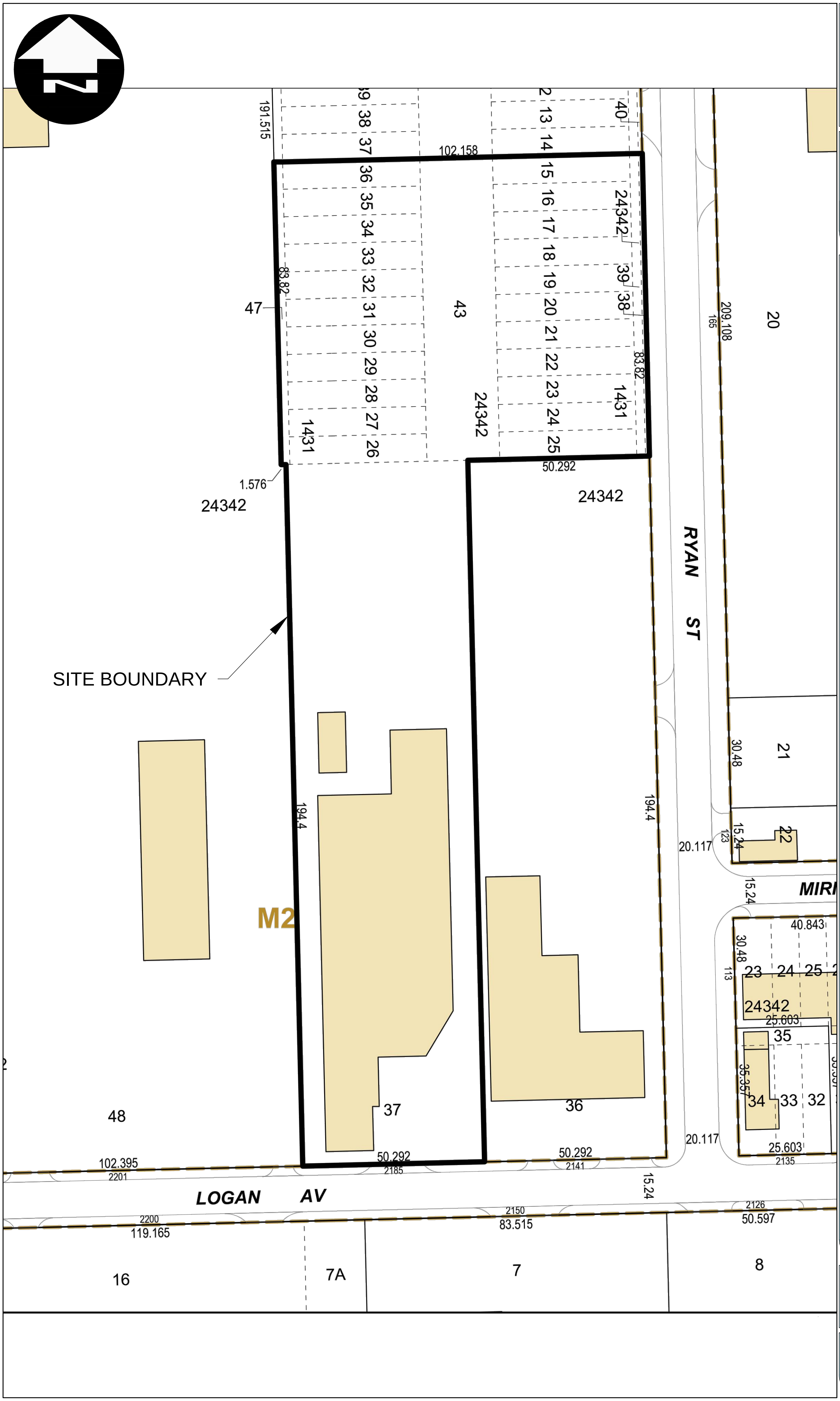
Douglas Bell, M.Sc., P.Geo., FGC
Partner

HLF:jef

PROVINCE OF MANITOBA
H. L. FISHER
Member
22945
July 28 '17
REGISTERED PROFESSIONAL ENGINEER

APEGM
Certificate of Authorization
Dillon Consulting Limited (MB)
No. 1789 Date: July 28, '17.

Figure



Project Name:

NORTHWEST SMELTING AND REFINING LTD.

ADDRESS:

2185 LOGAN AVENUE

Title:

LEGAL LOT PLAN

Data Source:

CITY OF WINNIPEG
PLANNING, PROPERTY AND DEVELOPMENT DEPT.
LAND INFORMATION SERVICES
NOVEMBER 2010

Project Number:
17-5694

Date:
JULY 2017

Presented by:

DILLON CONSULTING

SCALE: 1:1500

FIGURE 1

Appendix A

Director's Order

THE CONTAMINATED SITES REMEDIATION ACT
LOI CONCERNANT L'ASSAINISSEMENT DES LIEUX CONTAMINÉS

Manitoba
Sustainable Development
Développement durable

ORDER/ORDRE

Order No./N° de l'ordre D1-2017-008

Issue Date/Date de l'ordre June 6, 2017

In accordance with The Contaminated Sites Remediation Act (C.C.S.M. c. 205)/
Conformément à la Loi concernant l'assainissement des lieux contaminés (C.P.L.M. c. 205)

THIS ORDER IS ISSUED TO:/CET ORDRE EST DONNÉ À:

Northwest Smelting and Refining, 2185 Logan Avenue, Winnipeg, Manitoba

WHEREAS I, as Director, have designated the site located at 2185 Logan Avenue, Winnipeg, Manitoba (the Site) as an impacted site pursuant to section 7.1(1) of The Contaminated Sites Remediation Act C.C.S.M. C. c205 ("the Act") and that Northwest Smelting and Refining has been notified of the designation pursuant to section 7.1 (3) of the Act ;

AND WHEREAS an environmental site investigation of the Site dated May 2015 has been filed with Manitoba Sustainable Development;

AND WHEREAS under section 9(1) of the Act, I, the Director, have determined that Northwest Smelting and Refining is responsible for the contamination at the site;

AND WHEREAS under section 15(1) of the Act, I, the Director, have determined that an order shall be issued to Northwest Smelting and Refining for the Site;

I THEREFORE ORDER Northwest Smelting and Refining to:

1. Retain the services of a qualified environmental professional acceptable to the Director, to develop a Remediation Plan (RP) for the site and submit the RP within 30 days after the date of this Order.

In accordance with section 32 of the Act, if any of the requirements of this Order are not complied with by Northwest Smelting and Refining within the time specified in the Order, in my capacity as Director, I may do or direct another person to do any or all things required by the Order, without relieving any obligation of Northwest Smelting and Refining hereunder.

Section 53(1) (c) of the Act states that a person who contravenes or fails to comply with a decision or order of the director is guilty of an offence. The penalties prescribed by the Act are noted below:

Upon conviction, the penalties for individuals are:

(a) for a first offence to a fine of not more than $50,000 or imprisonment for a term of not more than six months, or both; and

(b) for each subsequent offence, to a fine of not more than $100,000 or imprisonment for a term of not more than one year, or both.

Upon conviction, the penalties for corporations are:

(a) for a first offence, to a fine of not more than $500,000.; and

(b) for each subsequent offence, to a fine of not more than $1,000,000.

Tracey Braun
DIRECTOR
Director, Manitoba Sustainable Development

June 6, 2017
Date

Received by

Date

Witnessed by Environment Officer

Date

Appendix B

Report – Environmental Site Investigation, Dillon 2015 without Laboratory Reports

DILLON CONSULTING

DILLON CONSULTING

Environmental Summary and Analysis

Northwest Smelting and Refining Ltd, Winnipeg, Manitoba

2015 January Final Report – 10-3834 R.1
(May, 2015)

(In reply, please refer to)
Our File: 10-3834

May 6, 2015

Northwest Smelting and Refining Ltd.
c/o/ Thompson Dorfman Sweatman LLP
Canwest Place, 2201-201 Portage Avenue
Winnipeg, Manitoba R3B 3L3

Attention: Ms. Sheryl Rosenberg

RE: Environmental Summary and Analysis
Northwest Smelting and Refining, Winnipeg, Manitoba

Dear Ms. Rosenberg:

Please find enclosed one (1) digital copy of the above mentioned report.

This report contains a review of potential remediation methods for the various environmental issues identified at the Site.

If you have any questions or comments, please feel free to contact Douglas Bell, M.Sc., P.Geo., or Indra Kalinovich, Ph.D., C.Chem., E.I.T., at 204-453-2301.

Yours sincerely,

DILLON CONSULTING LIMITED

Douglas Bell, M.Sc., P.Geo., FGC
Partner

IKK :knp

Encl.
Summary Tables
Figures

O:\PROJECTS\FINAL\103834\Reports\Final\Environmental Summary and Analysis\Environmental Summary and Analysis_FINAL_2015.02.02.docx

DILLON CONSULTING

Dillon Consulting Limited

1558 Willson Place
Winnipeg, MANITOBA
R3T 0Y4
Tel: 204.453.2301
Fax: 204.452.4412

www.dillon.ca

Executive Summary

Dillon Consulting Limited (Dillon) was contracted by Thompson Dorfman Sweatman (TDS) on behalf of their client Northwest Smelting and Refining Ltd. (NWSR) to conduct an Environmental Site Investigation on the NWSR property located at 2185 Logan Avenue (the Site). The purpose of the assessment was to conduct exploratory investigations to assess horizontal and vertical impacts at the subject property.

Previous in-depth investigations have been conducted at the site by IDS (1991 and 1993) and at adjoining properties to evaluate off-site impacts related to 2185 Logan Avenue (IDE, 1993). Results from two previous investigations from an adjacent property to the west of 2185 Logan Avenue were made available. Review of these investigations indicated that horizontal and vertical impacts for lead in soil were likely associated with previous on-site activities at 2185 Logan Avenue. Areas of Potential Environmental Concern (APECs) were identified as:

- APEC 1 - Historical dump at north end of Site.
- APEC 2 - Metal-impacted surficial soils at the southern end of the Site.
- APEC 3 - Metal impacts in groundwater.

Off-site migration related to APECs 1 and 3 were also identified as a potential environmental concern.

Dillon was on-site in 2012 to evaluate the extent of buried waste and assess site impacts prior to building demolition activities. Test pit and borehole investigations conducted by Dillon in July/November 2012 revealed a preliminary subsurface stratigraphy with both lateral and vertical delineation of impacts. Buried waste composition at the northern portion of the Site was found to be relatively homogeneous in composition. Given the observed average thickness of waste of 1.1 m (ranging in depth from 0.3 to 1.8 m below the soil cap), the approximate volume of waste material buried in the northern portion of the Site is 10,500 m^3. The buried waste is overlain by approximately 3,100 m^3 of fill material, taken from the Site. The soil cover appeared to be non-engineered and remained intact, with a minimum observed thickness of 0.10 m, and an average observed thickness of 0.45 m.

Upon Site building demolition in 2012, a waste inventory showed the presence of additional potential contaminants of concern. Over 200 kg of suspected polychlorinated biphenyl waste was inventoried and removed from the Site. In 2013, Dillon conducted a shallow borehole investigation spanning the Site to evaluate horizontal delineation of lead in soil. Building footprint and selected samples were analysed for the detection of potential contaminants (such as polychlorinated biphenyls and mercury) identified during the waste inventory and building demolition. Site impacts were found to be limited to metals in soil and groundwater.

Lead concentrations in soil were found to exceed federal soil quality guidelines (600 mg/kg) to depths greater than 2 m. No Tier II criteria exceedances were noted in 2012/2013 for lead concentrations in soil. Tier II criteria exceedances (soil ingestion exposure pathway) were observed at depths of 2.8 mbgs at TP-01-02 for arsenic in soil (31.9 mg/kg). Lead concentrations in soil decreased by three orders of magnitude from the surface to a depth greater than 2 mbgs (metres below ground surface) for the same sample locations. These results indicate that although downward vertical migration of lead has occurred, mobility appears to be reduced by interactions with the soil substrate. The greatest observed impacts are associated with the northern section of the Site (APEC 1).

Monitoring wells were installed within discrete stratigraphic layers on site to assess site groundwater flow, and potential impacts to groundwater. Lead and cadmium in groundwater were observed in each stratigraphic unit (fill, clay/silt, till). The greatest impacts in groundwater were found at the greatest depths, along the eastern boundary of the Site property. Shallow groundwater flow direction, based on observed water levels, was observed to flow in a north-easterly direction, with an overall horizontal hydraulic gradient of 0.004 in 2013 and 0.006 in 2014. A downwards vertical hydraulic gradient was observed in 2014 in all stratigraphies and nested monitoring well locations. Historically, off-site impacts in groundwater have not been observed to the east of the Site property.

Contaminants of concern (lead, cadmium) have been identified at the Site in soils and groundwater. A second groundwater monitoring event was conducted in June 2014 to confirm observed impacts following the initial sampling event and were used to evaluate risk exposure pathways. Elevated concentrations of lead in deep groundwater may be attributable to nearby buried waste in APEC 1 and downwards vertical hydraulic gradients.

Table of Contents

Appendices

Figures

Tables

1.0 INTRODUCTION

Dillon Consulting Limited (Dillon) was retained by Thompson Dorfman Sweatman (TDS) on behalf of Northwest Smelting and Refining Ltd. (NWSR) to conduct a site investigation, and ultimately develop a site management plan for the property located at 2185 Logan Avenue in Winnipeg, Manitoba. The objective of the investigation was to identify and evaluate the presence/absence of petroleum hydrocarbon, lead and polychlorinated biphenyl impacts on the property as a basis for the development of future site management and remedial planning.

1.1 Site Description

The Site is located at 2185 Logan Avenue in a northwest industrial area of Winnipeg (Figure 1) in Omand's Creek Industrial Park. Historically, the property was used to house a smelting facility and subsequently, a battery recycling operation. The battery recycling operation was housed on the south end of the property in a complex of buildings, formerly used as a refinery. Storage areas filled with metal and plastic battery case debris were identified (IDE, 1993) to the north of the buildings. The northern portion of the property is grass covered and was previously covered with a clay cap overlying refinery and battery recycling debris. In October of 2012, the buildings were demolished by Western Specialty Contracting Ltd., with oversight by Dillon. The results of the demolition work are not presented in this report.

During demolition activities, site access was restricted by paneled chain-linked fencing, with a gate at Logan Avenue.

1.2 Background

1.2.1 Investigation into Lead Contamination, I.D. Systems (IDS) Ltd., 1991

On January 21, 1991 Manitoba Environment issued an order (Order# 0457) to NWSR to perform an investigation to determine the degree and extent of lead contamination in the soil, the leachability of the lead in the soil, and if the groundwater has been contaminated with lead.

An initial Environmental Site Assessment was conducted in 1991 by IDS for NWSR. In total, nine (9) piezometers and eight (8) shallow test holes were installed on the property and a total of sixty-six (66) soil samples were analyzed for total lead and leachate (concentration in extract) concentrations. Lead concentrations in soil varied from 197,000 to 30 µg/g. Results from lead leachability in soil tests showed leachate concentrations that varied from 166 mg/L to < 0.04 mg/L. Vertical delineation was conducted to a depth of 5.2 m, across nine (9) intervals. Test holes were found to be impacted with lead contamination, and the lead concentration varied with depth. With increasing depth, lead impacts were more localized to the northern half of the property. Vertical delineation was not completed, as it was anticipated that the contamination had not migrated below the undisturbed overburden (IDS, 1991).

Groundwater sample analyses from the nine (9) piezometers that were found to contain dissolved lead concentrations in excess of the Guidelines for Canadian Drinking Water Quality (0.01 mg/L), and ranged from 0.055 to 3.0 mg/L. Shallow groundwater was encountered in seven (7) of the seventeen (17) test holes. Groundwater table elevations indicated that the shallow groundwater tended to flow towards the northwest corner of the property. Other low areas on-site include ditches containing cattails at the northwestern corner of the property.

1.2.2 Off-Site Environmental Site Assessment, I.D. Engineering Canada, Inc. (IDE), 1993

An off-site subsurface investigation at NWSR was conducted by IDE in 1993 for NWSR. Six (6) boreholes were advanced on neighbouring properties to the east and west and completed as monitoring wells. Soil samples from one (1) and three (3) metre depths were taken from each borehole, and a two (2) metre borehole sample was taken borehole BH202 and submitted to a laboratory for analyses. One (1) off-site soil sample exceeded the criteria cited by Manitoba Environment of 1,000 µg/g total lead and 5 mg/L lead leachate at 165 Ryan Street. Dissolved lead in groundwater concentrations were reported to be below or within the Guidelines for Freshwater Aquatic Life of 0.001 to 0.007 mg/L, and the Guidelines for Canadian Drinking Water Quality of 0.01 mg/L.

Observed groundwater elevations indicated that the direction of shallow groundwater flowed towards the west/southwest, differing from the previous investigation in 1991. The report concluded that the dissolved lead concentrations in the off-site groundwater samples confirmed that that presence of lead in the on-site soils had minimal impact on the groundwater regime.

1.2.3 Phase II Environmental Site Assessment, 2201 Logan Avenue, KGS Group, 2005

An off-site environmental assessment was conducted at a property to the west of NWSR for Pa D'or Holdings. A total of seven (7) testpits were excavated along the east boundary of the subject site, with two (2) soil samples collected from each. An additional ten (10) surface soil samples were collected throughout the property. Laboratory results from the samples analyzed indicated that lead in soil concentrations were above the Canadian Council of Ministers of the Environment (CCME) Tier I criteria for industrial land use (600 mg/kg) along shared boundary with NWSR. One other exceedance occurred in a surface sample taken from the central area of the Site. Lead impacts noted at the subject site during the investigation were in surficial soils at depths of less than 1 m below grade.

1.2.4 180 and 123/125 Ryan Street and 2095 Logan Avenue Subsurface Investigation, Dillon Consulting Limited, 2009

A subsurface investigation program was conducted in 2009 to assess closure following excavation of polycyclic aromatic hydrocarbon (PAH) impacted soils. The objective of the investigation was to assess both surface and subsurface impacts related to the storage of petroleum hydrocarbons. Based on analytical results and field observations, no further investigation or actions were recommended for the subject properties. Potential metal impacts in soil and/or groundwater were not investigated as part of these investigations.

1.2.5 Phase II Environmental Site Assessment, 2201 Logan Avenue, M.P. Wiebe Environmental Engineering, 2013

An off-site environmental assessment at a property to the west of NWSR was commissioned by 2925924 Manitoba Ltd. Two (2) boreholes were drilled on the western boundary of the subject site, with two (2) soil samples taken from each borehole. Laboratory results from the samples analyzed, indicated that lead in soil concentrations were above the selected criteria of 600 mg/kg for environmental contact on industrial sites. The results complied with the soil quality guidelines of 8,200 mg/kg for human health ingestion on industrial sites. Impacts in soil were found to be shallow, and confined to the upper fill layer.

A summary of the previous site investigation activities is shown in Figure 3.

1.2.6 Objectives

The main objectives of this Environmental Summary Report were to:

- Summarize historical and recent data collected for the Site, to provide a more comprehensive understanding of subsurface physical conditions and the distribution of impacts at the site (e.g., Conceptual Site Model).
- Using the Conceptual Site Model, identify data gaps requiring further investigation.
- Using the Conceptual Site Model as the base, screen the potentially applicable remediation and risk management options for the protection of the environment and human health.

1.2.7 Biophysical Environment

The subject property is located near the corner of Logan Avenue and Ryan Street. The northeastern portion of the property is bounded by Ryan Street, and the southern portion of the property is bounded by Logan Avenue. Bayco Industries Ltd. (task lighting manufacturer) and Cadorath Plating (metal) occupy the properties on the southern side of Logan Avenue. Several companies (trucking, lumber storage) rent the spaced owned by 2925924 Manitoba Ltd. that bounds the property to the west; the property has recently been sold. A metal recycling facility, Chisick Metal Ltd bounds the property to the southeast side. The northern edge of the subject property is adjacent to Prendiville Industries Ltd., located at 165/180 Ryan Street. A site plan showing the area at the former buildings and on-site buried debris is illustrated in Figure 2.

The closest surface water body or sensitive ecological habitat is located approximately 3.0 km south of the Site (Assiniboine River). There are two ponds within 1 km from the site: a stormwater retention pond to the northwest and a pond at Woodsworth Park across Highway 90 to the northeast.

1.3 Land Use and Surface Topography

Site and surrounding land use is industrial. The Site hosted a former Smelter and Lead Acid Battery Recycling Facility. The Site was serviced by municipally supplied potable water and sewers. A historic landfill containing debris from the acid battery recycling facility is situated in the northern portion of the Site property. The southern portion of the Site contained the Smelter and associated buildings, which were demolished in 2012.

The topographical survey conducted in 2012 showed surface drainage patterns that ran to the edges of the Site. The property is graded to a greater elevation towards the center of the Site, promoting run-off patterns to the property edges. There are surface water ditches along the western and northern property boundaries; however, surface water was not observed in the drainage ditches during field investigations. Erosion potential is minimal for the southern portion of the Site. However, there is greater erosional potential for the northern portion of the Site due to steeper slope profiles.

The Site is bounded by the following properties:

- The northeastern portion of the property is bounded by Ryan Street.
- The southern portion of the property is bounded by Logan Avenue. Both Bayco Industries Ltd. (task lighting manufacturer) and Cadorath Plating (metal) occupy the properties on the southern side of Logan Avenue. Production wells installed for industrial use were identified at 2150 Logan Avenue (Cadorath Plating).

- The western portion of the property is bounded by several companies (trucking, lumber storage) who rent the spaced owned by 2925924 Manitoba Ltd. at 2201 Logan Avenue. (Note: this property has recently been sold).
- The southeastern portion of the property is bounded by a metal recycling facility, Chisick Metal Ltd 2141 Logan Avenue.
- The northern edge of the subject property is adjacent to Prendiville Industries Ltd., located at 165/180 Ryan Street.

1.4 Site Hydrogeology

1.4.1 Regional Hydrogeology

To describe the regional physiography and expected hydrogeologic conditions beneath the property, the following documents were reviewed:

- Province of Manitoba, Groundwater Availability Maps, Bedrock Geology and Drift Thickness maps, 1980.
- Render, F.W. Geohydrology of the Metropolitan Winnipeg area as related to groundwater supply and construction. Canadian Geotechnical Journal, Vol. 7, No. 3, 1970.

The general geology of the Winnipeg area consists of glaciolacustrine deposits including sands, silts and clays of the late Wisconsian glaciation (Province of Manitoba, Groundwater Availability Maps, Surface Deposits map, 1980). Bedrock geology mapping for the area indicates the Site is underlain by the Red River formation, which consists of Ordovician dolomitic limestones and dolomite (Province of Manitoba, Groundwater Availability Maps, Bedrock Geology map, 1980). The carbonate bedrock serves as a regional aquifer, with an estimated piezometric groundwater level located at approximately 12 metres below ground surface (mbgs) in the area of the Site (University of Manitoba Department of Engineering, 1983). This unit serves as a groundwater drinking source obtained through wells for rural communities surrounding Winnipeg.

1.4.2 Local Hydrogeology

The subsurface soil conditions observed during the investigation consisted of surficial sand and gravel fill materials, underlain by layers of silt, clay and glacial till to the maximum depth drilled of 7.4 m below ground.

The depth to groundwater measured within the monitoring wells during the May 2013 Dillon groundwater monitoring visit ranged between 0.55 (13-03, Fill layer) and 2.60 (13-10, Till layer) mbgs. Shallow groundwater flow direction (fill and clay wells only) was observed to be primarily towards the northeast. Depth to groundwater measured during the June 2014 visit ranged between 0.35 (13-13, Fill layer) and 2.49 (13-10, Till layer) mbgs.

Greater hydraulic conductivity was seen in the upper layers in the following order:

- MW 13-13 (fill/silty clay, 3.02 x10^{-4} cm/s).
- MW 13-11 (silty clay, 5.14 x10^{-6} cm/s).
- MW 13-10 (tight till, 1.7 x 10^{-7} cm/s).

The local shallow groundwater flow direction below the Site may vary from the Regional context and be influenced by industrial groundwater extraction, surface drainage ditches, underground structures and utilities which may be present in the vicinity of the Site. Such features are typically backfilled with coarse grain materials which may provide a more permeable conduit for groundwater flow when compared to the lower permeability of the native soils.

1.5 Soil, Fill and Waste

The northern portion of the property consists of grass growing in stony topsoil overlying the 0.5 m of clayey fill with stones, which overlies 1 m of fill consisting of foundry debris, plastic battery case debris and clayey soils. This fill overlays the original black organics and clayey till. Undisturbed till was encountered at a depth of 2-3 m.

The southern portion of the property consists of 1 m of gravel road fill, overlying approximately 2 m of grey clay, overlying the till, which extends to the bottom of the test holes.

1.6 Areas of Potential Environmental Concern (APEC)

APEC refers to means the area on, in or under a property where one (1) or more contaminants are potentially present, as determined through previous environmental site assessments, including:

- Identification of past or present uses on, in or under the phase one (1) property.
- Identification of potentially contaminating activity.

1.6.1 APEC 1 – North End Historical Landfill

A historical landfill at the northern portion of the property contains foundry debris associated with battery breaking/recycling activities mixed with clayey soil. Grass grows on top of the soil cap that covers the landfill. Contaminants of Concern identified at the North End Historical Landfill are related to the battery and foundry debris within the historic landfill. These include:

- Metals (lead, cadmium, copper, zinc).

1.6.2 APEC 2 – Surficial Impacts – Southern Portion of Site

Surficial impacts are associated with previous site activities as a foundry for metal smelting and refinery. Impacts have been identified in the surrounding fill and underlying layers. Contaminants of concern identified at the southern portion of the Site include:

- Metals (lead, cadmium, copper, zinc).

1.6.3 APEC 3 – Site-Wide Groundwater

Groundwater impacts associated with leachable metals have been observed at the site in surrounding monitoring wells (IDE, 1991). Contaminants of concern identified in groundwater include:

- Metals (lead, cadmium).

DILLON CONSULTING

1.7 Environmental Standards and Criteria

As NWSR's property and surrounding areas are zoned as industrial, and groundwater is not used as a drinking water supply, pathways protective of potable and agricultural water uses are eliminated.

The closest surface water body or sensitive ecological habitat is located less than 1 km to the northwest of the Site (pond at Woodsworth Park). The Assiniboine River lies approximately 3 km to the south. Applicable criteria for soil and groundwater were selected based on land use, groundwater use and proximity to nearby receptors and are discussed in the following sections.

1.7.1 Soil

For the assessment of benzene, toluene, ethylbenzene, and xylenes (BTEX) concentrations in the soil samples, the 2004 CCME Canadian Environmental Quality Guidelines for Environmental Health, Industrial Land Use, Fine-Grained Subsoil, Environmental Health check values. Assessment criteria from the 2008 CCME Canada-Wide Standards for Petroleum Hydrocarbons (PHC) in Soil, Industrial Land Use, Fine-Grained Subsoil, Management Limit were also applied to the Site for the four (4) hydrocarbon fractions (F1 - F4).

For PHC fractions F1 – F4, Dillon selected values from the Canada-Wide Standard for PHC in Soil Technical Supplement dates January 2008. Tier I levels for PHCs for fine-grained soils, industrial land use, terrestrial ecological pathway were applied. The selected assessment criteria are summarized as follows:

Parameter	Criteria (mg/kg)
F1 (C6-C10)	320
F2 (>C10-C16)	260
F3 (>C16-C34)	2,500
F4 (>C34)	6,600

For BTEX, Dillon selected the CCME Canadian Soil Quality Guidelines for the Protection of Environmental Health (2004), surface soil, industrial land use, fine-grained soil, environmental health guidelines/check values were applied. Soil quality guidelines for the protection of human health assumed direct soil contact. For benzene specifically, the lower human health criteria for indoor air quality (slab on grade) was used (2004), based on an incremental lifetime cancer risk of 1 in 100,000 (10^{-5}). The selected assessment criteria for BTEX are as follows:

Parameter	Criteria (mg/kg)
Benzene	2.8
Toluene	330
Ethylbenzene	430
Xylenes	230

For PAHs, Dillon selected the CCME Canadian Soil Quality Guidelines and other Polycyclic Aromatic Hydrocarbons (2010) Criteria, industrial land use and fine grained soil, environmental health. Soil quality guidelines for the protection of human health assumed direct soil contact, based on an incremental lifetime cancer risk of 1 in 100,000 (10^{-5}). The selected assessment criteria for PAHs in soil are as follows:

Parameter	Criteria (mg/kg)
Anthracene	32
Benzo(a)anthracene	10
Benzo(a)pyrene	72
Benzo(b&j)fluoranthene	10
Benzo(b)fluoranthene	10
Benzo(b+j+k)fluoranthene	10
Benzo(k)fluoranthene	10
Dibenzo(a,h)anthracene	10
Fluoranthene	180
Indeno(1,2,3-cd)pyrene	10
Naphthalene	22
Phenanthrene	50
Pyrene	100
B(a)P Total Potency Equivalent	5.3
IACR (CCME)	<1.8

Based on present and future proposed Site land use and potential receptors to the Site, Dillon selected the CCME Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health (2008), industrial land use and fine grained soil. The selected assessment criteria for metals in soil are as follows:

Parameter	Criteria (mg/kg)
Antimony (Sb)	40[1]
Arsenic (As)	12[1,2]
Barium (Ba)	2,000
Cadmium (Cd)	22[1], 2,090[2]
Chromium (Cr)	87
Copper (Cu)	91
Lead (Pb)	600[1], 8,200[2]
Nickel (Ni)	50
Selenium (Se)	2.9
Thallium (Tl)	1
Tin (Sn)	300
Uranium (U)	300
Vanadium (V)	130
Zinc (Zn)	360

The values provided above (denoted by [1])are the generic guidelines provided by CCME as Tier I criteria. These values are conservative, using the lowest, recommended value that protects both environmental and human health. Where provided by CCME, pathway-specific Tier II criteria (denoted by [2]) may be applied. The off-site migration check value is typically recommended by the CCME for industrial land as a more applicable, conservative value than eco-soil contact. The off-site migration check was developed to address the possibility of subsequent movement from a commercial or industrial property to a more sensitive adjacent property (CCME, 2006). Given the surrounding industrial land uses (metal recycling facility, lumber yard, plating facility, etc.) and known soil migration patterns, protection of human health by the soil ingestion exposure pathway is considered more appropriate to the Site's present and proposed future land use (compared to eco-soil contact and the off-site migration check). Both Tier I and Tier II values are provided for comparison.

1.7.2 Groundwater

Assessment guidelines for groundwater and surface water depend on the potential uses of the water. Canadian Council of Ministers of the Environment document (CCME, 1999), and more recently, Manitoba Conservation and Water Stewardship (MC, 2000) have developed guidelines for several end use categories for both groundwater and surface waters, although Manitoba Conservation and Water Stewardship has no guidelines for assessing non-potable groundwater outside of agricultural use. Manitoba has accepted the applicability of Environment Canada's *Federal Interim Groundwater Quality Guidelines* for Commercial and Industrial Land Uses, Table 3: Non-Potable Ground Water Condition, Fine Grain Soils, May 2012, as acceptable Tier I Criteria.

It is noted that the FIGQG for metals are generally based on the surface water guidelines (i.e., for protection of freshwater aquatic life) with no allowance for attenuation processes. These values are considered to be overly conservative and not necessarily indicative of potential risks to aquatic receptors. The use of criteria established by Ontario Ministry of Environment, *Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act*, Table 3: Full Depth Generic Site Conditions in a Non-Potable Ground Water Condition, All Types of Property Use, April 2011 is acceptable in Manitoba as Tier II Criteria.

Tier I Criteria (indicated by [1]) considers direct contact between ecological and human receptors and the impacted groundwater (FIGQ, 2012). These values can be overly conservative and are not applicable to industrial sites where there are no identified human and/or ecological receptors. In these cases, the less-conservative Tier II values (MOE, 2011) are used for data comparisons (indicated by [2]). Selected groundwater criteria are presented in Table 1-1:

PHCs		PAHs		Metals	
Parameter	Criteria (mg/L)	Parameter	Criteria (mg/L)	Parameter	Criteria (mg/L)
F1 (C6-C10)	9.9 [1]	Anthracene	0.0024 [2]	Aluminum (Al)	-
F2 (>C10-	3.1 [1]	Benzo(a)anthracene	0.0047 [2]	Antimony (Sb)	20 [2]
F3 (>C16-	0.5 [2]	Benzo(a)pyrene	0.00081 [2]	Arsenic (As)	1.9 [2]
F4 (>C34)	0.5 [2]	Benzo(b&j)fluoranthene	0.00075 [2]	Barium (Ba)	29 [2]
Benzene	19 [1]	Benzo(b)fluoranthene	0.00075 [2]	Beryllium (Be)	0.067 [2]
Toluene	240 [1]	Benzo(b+j+k)fluorant	0.00075 [2]	Boron (Bo)	45 [2]
Ethylbenzene	150 [1]	Benzo(k)fluoranthene	0.0004 [2]	Cadmium (Cd)	0.0027 [2]

PHCs		PAHs		Metals	
Parameter	Criteria (mg/L)	Parameter	Criteria (mg/L)	Parameter	Criteria (mg/L)
Xylenes	74 [1]	Dibenzo(a,h)anthracene	0.00052 [2]	Chromium (Cr)	0.81[2]
		Fluoranthene	0.13 [2]	Copper (Cu)	0.087 [2]
		Indeno(1,2,3-cd)pyrene	0.0002 [2]	Iron (Fe)	-
		Naphthalene	6.4 [2]	Lead (Pb)	0.025 [2]
		Phenanthrene	0.58 [2]	Mercury (Hg)	0.0028 [2]
		Pyrene	0.068 [2]	Molybdenum	9.2 [2]
				Nickel (Ni)	0.49 [2]
				Selenium (Se)	0.063 [2]
				Silver (Ag)	0.0015 [2]
				Thallium (Tl)	0.51 [2]
				Uranium (U)	0.42 [2]
				Vanadium (V)	0.25 [2]
				Zinc (Zn)	1.1 [2]

TABLE 1-1: CRITERIA FOR NON-POTABLE INDUSTRIAL LAND USE GROUNDWATER

1.7.3 Waste Classification

For waste classification and disposal evaluation, Dillon selected the Man. Reg. 282/87 the Dangerous Goods Handling and Transportation Act Criteria. The selected assessment criteria for leachable metals in soil are as follows:

Parameter	Criteria (mg/L)
Arsenic (As)	5
Barium (Ba)	100
Boron (Bo)	500
Cadmium (Cd)	0.5
Chromium (Cr)	5.0
Lead (Pb)	5.0
Selenium (Se)	1.0
Silver (Ag)	5.0
Uranium (U)	2.0

2.0 SITE INVESTIGATIONS

Surface and subsurface soil investigations were conducted on July 12, 2012, November 16, 2012 and May 13-17, 2013. On-site supervision was conducted by Mr. Cam Brown, P.Eng. and Ms. Nanci Beaupre, C.E.T., of Dillon. Maple Leaf Drilling completed the boring and monitoring well installations. Prior to drilling, Dillon coordinated public underground utility clearances (i.e., telephone, hydro, gas, sewer and water) within the areas of investigation. Drilling services were conducted using a track-mounted Acker MP8 drill rig.

An off-site subsurface investigation was conducted on September 6, 2013. Letters of notification were delivered to the affected properties prior to off-site drill work. Permission by the off-site property owners was received prior to off-site drill work. Off-site shallow boreholes were drilled to a depth of 1.5 m and were overseen by Ms. Nanci Beaupre, from Dillon.

A second groundwater monitoring event was conducted on June 17, 2014.

The methodology used for the field investigation was based upon the suggested methods described in *Subsurface Assessment Handbook for Contaminated Sites, CCME, March 1994* (CCME, 1994); and, Dillon's standard environmental field procedures. Table 2-1 summarizes the methodologies used in this investigation.

Procedure	Instrument Used	Notes
Drilling	• Track-mounted rig • 1.5 m solid stem augers	• Provided by Paddock Drilling Ltd. (2012) • Provided by Maple Leaf Drilling Ltd. (2013) • Augers withdrawn every 1.5 m for sampling at 0.75 m intervals.
Test Pitting	• Excavator	• Provided by Western Specialty Contracting ULC • Sampling intervals at 0-0.15m.
Monitoring Well Development	• Peristaltic Pump • Bailers	• 24 hours after drilled, purged minimum of three (3) times borehole casing volume. Wells were purged a second time prior to sampling.
Soil sample recovery for headspace test	• Hand tools	• Soil samples removed from auger with sterile nitrile gloves. • Samples trimmed to remove soil in contact with borehole wall or auger flights, placed in re-sealable plastic bags and allowed to reach ambient temperature.
Hydrocarbon vapours in soil (headspace test)	• RKI Eagle (with methane elimination mode on)	• Soil in bags broken up, massaged. • Sample probe inserted in bag, bag resealed around sample probe. • Instrument reading recorded on borehole log.
Soil sample recovery for laboratory analysis	• Hand tools • 125 ml glass jars • Teflon-lined lids	• Trimmed soil sample placed in jar using sterile nitrile gloves, gloves disposed of after one use. • Samples sealed in jar and stored at approximately 4ºC.
Geological description	• Hand tools • Visual and other observations	• Lithology and observations recorded on borehole logs. • Observations confirmed with particle size analysis

TABLE 2-1: SUMMARY OF METHODOLGY – SUBSURFACE INVESTIGATION

DILLON CONSULTING

A topographical site survey was conducted by Dillon on July 6-9 2012 using a Total Station Leicas Data Logger and 40-449 Level. Co-ordinates were tied in on the NAD83 co-ordinate system. 2013 boreholes and monitoring well vertical survey and GPS locations were tied in with the 2012 topographical site survey. Figure 3 details the topographical contours and slopes.

2.1 Test-Pitting to Evaluate Soil Cap and Debris Waste

A test pitting investigation was conducted at the northern portion of the property to evaluate soil cap thickness and integrity, and debris waste thickness, as shown on Figure 3. A total of nineteen (19) test pits (approximately 2 x 5 m) were advanced on the property to a depth of 1.4 - 2.9 m. Test pit stratigraphy was logged and is shown in Appendix A.

2.2 Borehole Investigation and Monitoring Well Installations

A total of fifteen (15) boreholes were advanced on the property using solid stem methods. Boreholes were drilled to a depth of 1.1 – 7.3 m and were overseen by Mr. Cameron Brown and Ms. Nanci Beaupre, from Dillon. Seven (7) of the borehole locations were completed as monitoring wells (Figure 3), with three (3) of the locations as nested monitoring wells. Nested monitoring wells were installed with 0.6 m screen length in the shallow fill layer and 1.5 m screen lengths in the underlying middle clay and deep fill layers. Soils collected from the auger flights were screened for hydrocarbon vapour concentrations using a RKI Eagle prior to submission to the laboratory. All boreholes were backfilled with auger cuttings and bentonite.

2.3 Groundwater Monitoring

Sampling of groundwater was conducted on July 31 and August 1, 2013, and again on June 17, 2014 by Ms. Nanci Beaupre of Dillon. Groundwater was purged prior to sampling. Field measurements were recorded to evaluate purge water stability. Sampling was conducted using a low-flow peristaltic pump and a multimeter to measure field parameters (temperature, dissolved oxygen, conductivity, and pH). An in-line filter (0.45 µm) was used for inorganics and dissolved metals sample collection. Ground water samples were taken from each well and submitted for laboratory analysis of dissolved metals, major ions, turbidity, dissolved oxygen, conductivity and pH.

2.4 Summary

Soil and groundwater samples were submitted for analysis to ALS Laboratories in Winnipeg, Manitoba. Sample locations and sample types are summarized below.

2.4.1 Soil Samples

Select soil samples were submitted for analysis to ALS Laboratories in Winnipeg, Manitoba, based on screening results and visual and olfactory observations. A total of fifty-two (52) samples were submitted for metals, leachate, BTEX, PAH, PCBs and PHC fractions F1 – F4 analyses. The samples were stored on ice in coolers during shipment to the laboratory. Table 2-2 summarizes Soil Sample Numbers, Sample Depths and Laboratory Analyses.

Soil Sample	Sample Date	Sample Depth (m)	Analysis					
			Metals	Leachate	PCBs	PAH	BTEX	PHC (F1-F4)
12-01-01	7/12/2012	0-0.15	X					
12-02-02	7/12/2012	0.61-0.76	X					
12-02-06	12-02-02 FD	0.61-0.76	X					
12-02-03	7/12/2012	1.37-1.52	X					
12-03-01	7/12/2012	0-0.15	X					
12-04-01	7/12/2012	0-0.15	X					
12-04-03	7/12/2012	1.37-1.52	X					
12-05-02	7/12/2012	0.61-0.76	X				X	X
12-05-05	7/12/2012	2.9-3.0	X					
TP-01-02	11/13/2012	2.8	X					
TP-04-03	11/13/2012	1.8	X					
TP-05-03	11/13/2012	2.3	X					
TP-07-03	11/13/2012	2.4	X					
TP-08-02	11/13/2012	1.3		X				
TP-08-03	11/13/2012	2.8				X		
TP-09-03	11/13/2012	2.8				X		
TP-10-02	11/13/2012	1.1		X				
TP-10-03	11/13/2012	2.8	X					
TP-11-03	11/13/2012	2.4				X		
TP-13-02	11/13/2012	2.3	X					
TP-15-02	11/14/2012	1.5		X				
TP-15-03	11/14/2012	2.4	X					
TP-16-03	11/14/2012	2.6	X					
TP-18-03	11/14/2012	2.5	X					
TP-18-04	TP-18-03 FD	2.5	X					
TP-21-03	11/14/2012	1.8	X					
13-01-5.2	13/05/2013	3.5-4.2	X	X				
13-02-1.8	13/05/2013	1.5-2.0	X	X				
13-03-1.1	13/05/2013	0.8-1.3	X	X				
13-04-1.1	13/05/2013	0.8-1.3	X	X				
13-05-1.5	13/05/2013	0.8-1.3	X	X				
13-06-7.3	13/05/2013	0.5-1.0	X	X				
13-07-2.4	13/05/2013	0.5-1.0	X	X				
13-08-1.5	13/05/2013	0.5-1.0	X	X				
13-09-1.1	13/05/2013	0.5-1.0	X	X				
13-10-7.3	13/05/2013	1.2-1.8	X	X				
13-10-7.3 FD	13/05/2013	1.2-1.8	X	X				
13-11-3.7	13/05/2013	0.5-1.0	X	X				

Soil Sample	Sample Date	Sample Depth (m)	Analysis					
			Metals	Leachate	PCBs	PAH	BTEX	PHC (F1-F4)
13-12-1.1	13/05/2013	0.5-1.0	X	X				
13-13-2.0	14/05/2013	0.5-1.0	X		X		X	X
13-14-1.8	14/05/2013	0.5-1.0	X		X		X	X
13-15-1.8	14/05/2013	0.0-0.5	X		X		X	X
13-16-1.8	14/05/2013	0.5-1.0	X		X		X	X
13-17-1.8	14/05/2013	0.5-1.0	X		X		X	X
13-18-1.8	14/05/2013	0.5-1.0	X		X		X	X
13-19-1.8	14/05/2013	1.2-1.8	X		X		X	X
13-19-1.8 FD	14/05/2013	1.2-1.8	X		X		X	X
13-20-1.8	14/05/2013	1.2-1.8	X		X		X	X
13-21-1.8	14/05/2013	1.2-1.8	X		X		X	X
13-22-0.9	9/6/2013	0.3-0.5	X (lead)					
13-23-0.9	9/6/2013	0.3-0.5	X (lead)					
13-24-0.9	9/6/2013	0.3-0.5	X (lead)					

TABLE 2-2: SOIL SAMPLES SUBMITTED FOR LABORATORY ANALYSES

2.4.2 Groundwater Samples

Groundwater samples were submitted from three (3) nested monitoring well locations, and four (4) perched groundwater monitoring wells, to evaluate the lateral and vertical extent of metal impacts in groundwater.

2.5 Quality Assurance/Quality Control Program

Dillon field personnel followed pre-defined field procedures for quality control so that representative samples were collected and that risk of cross-contamination was alleviated.

Blind field duplicate soil and water samples were submitted for laboratory analysis for quality assurance. Field duplicates are collected to evaluate if the data is reproducible within certain limits and provides the precision of the field quality control program. Reproducibility is quantified by calculating the relative percent difference (RPD) defined by the following equation:

$$\text{Field Duplicate RPD (\%)} = \frac{|(C1-C2)|}{(C1+C2)/2} \times 100$$

Where: RPD = relative percent difference

C1 = ‘parent’ observed values from the field duplicate analysis

C2 = ‘duplicate’ observed values from the field duplicate analysis

In order for a valid Field Duplicate RPD to be calculated, both results must be > 5 x the Method Detection Limit (MDL). If one or both of the analytical results for the matrix duplicates are < 5 x the MDL for an analyte, then it is not possible to calculate a valid Field Duplicate RPD.

3.0 FINDINGS

3.1 Field Observations

Observations made during the drilling program are recorded on the borehole logs provided in Appendix A of this report, including the hydrocarbon vapour screening results and the depth of each sample collected. The location of the boreholes, monitoring wells and test pits are presented in Figure 4 (attached). Surface elevations were observed to be highest in the center, draining outwards to the edges of the property. Ditches surrounded the north and northwestern portions of the property.

3.1.1 Borehole and Testpit Investigations

The subsurface soil conditions observed during the investigation consisted of surficial sand and gravel fill materials, underlain by layers of silt, clay and glacial till to the maximum depth drilled of 7.4 mbgs. The detailed stratigraphy is illustrated in the borehole and test pit logs attached (Appendix A) and in Cross-Section Fence Diagrams (Figures 5-6). Petroleum hydrocarbon vapours were low, from 0 to 40 ppm, in measured soil samples. Detailed vapour screening results are illustrated in the borehole logs attached (Appendix A).

3.1.2 Soil Cap Thickness, Integrity and Debris Waste Thickness

A test-pitting program was conducted on November 13-14, 2012 to investigate the integrity of the soil cap, soil cap thickness and debris thickness at the northern end of the property (APEC 1, Figures 8 and 9). Test pit logs are shown in Appendix A. Average soil cap thickness was found to be 0.45 m, with a maximum of 0.7 m (TP-08) and a minimum of 0.1 m (TP-13). Based on the observed thickness and geometry, the approximate fill volume overlaying the debris waste layer is 3,100 m^3. No observed buried debris had breached the soil cap to the surface.

The debris waste layer was found to be comprised of building materials and battery casing parts, averaging a thickness of 1.09 m, with a maximum of 1.8 m (TP-17) and a minimum of 0.3 m (TP-21).

Based on the observed thickness and geometry, the approximate buried waste volume is 10,500 m^3. The clay layer underlying the debris was observed to be firm and moist.

3.1.3 Site Topography and Drainage Patterns

The topographical survey conducted in 2012 showed surface drainage patterns that ran to the edges of the Site. The property is graded to a greater elevation towards the center of the Site, promoting run-off patterns to the property edges. Drainage patterns and associated percent slopes are shown in Figure 3. The arrows denote drainage direction, and erosion potential (e.g., thin arrow, less erosion potential, thick arrow, more run-off and erosion potential). Erosion potential is minimal for the southern portion of the Site, as evidenced by the low slopes in Figure 3. However, there is greater erosional potential for the northern portion of the Site.

3.2 Soil Analytical Results

3.2.1 Test Pitting Program

Select soil samples were submitted for analysis to ALS Laboratories in Winnipeg, Manitoba, based on screening results and visual and olfactory observations. A total of seventeen (17) samples, including one (1) field duplicate, were submitted for metals, metal leachate or PAH analyses. Sample locations are noted in Figure 4 and the borehole logs, which are appended to this report. Laboratory analytical results for soil samples are summarized in Appendix B, Table B-1, along with the selected assessment criteria. Sample results for PAHs were below laboratory method detection limits. Soil pH was measured to be neutral to slightly alkaline, ranging from 7.74 – 8.87. Full laboratory data sheets are included as Appendix C. Values exceeding the applicable criteria are shown below on Table 3-1.

Sample ID	Sample Depth (m)	Sample Exceedances (mg/kg)					Leachate Exceedance (mg/L)
		Antimony	Arsenic	Lead	Copper	Nickel	
Criteria		40	12[1,2]	600[1], 8,200[2]	91	50	5.0
TP-01-02	2.8	58.6	31.9	5,860	b.c.	50.5	n.a.
TP-04-03	1.8	56.8	25.2	4,780	182	b.c.	n.a.
TP-05-03	2.3	b.c.	b.c.	1,010	b.c.	b.c.	n.a.
TP-08-02	1.3	n.a.	n.a.	n.a.	n.a.	n.a.	120
TP-10-02	1.1	n.a.	n.a.	n.a.	n.a.	n.a.	179
TP-15-02	1.5	n.a.	n.a.	n.a.	n.a.	n.a.	168
TP-15-03	2.4	b.c.	12.8	4,430	b.c.	b.c.	n.a.
TP-16-03	2.6	b.c.	12.3	1,490	b.c.	b.c.	n.a.
TP-18-03	2.5	b.c.	b.c.	b.c.	b.c.	51.6 *	n.a.

[1]Tier I Criteria
[2]Tier II Criteria
*Reported value is the average with field duplicate.
Bold indicates exceedances of Tier II Criteria.
b.c. denotes below criteria
n.a. denotes not analyzed for parameter

TABLE 3-1: SAMPLE ANALYTICAL EXCEEDANCES OF SOIL CRITERIA

Soil samples were taken near the bottom debris-soil interface. Results indicate some vertical impacts associated with lead migration in the debris area. Leachate test results indicate that the form of lead present at Site can be mobilized by decreasing pH. However, lead mobility may be mitigated by the native, slightly alkaline soil pH. Further impacts related to vertical migration were assessed in the 2013 borehole investigation and are discussed in the following section.

3.2.2 2012 Borehole Investigation – APEC 2

Borehole investigations were initiated in 2012, with five (5) boreholes drilled along the southeastern edge of the former building locations (Figure 3). A total of nine (9) samples at varying depths were taken from boreholes and submitted for metals, BTEX, and PHC fractions F1 – F4 analyses. Borehole logs can be found in Appendix A. Soil samples with concentrations of metals that exceed the applicable criteria are shown below on Table 3-2. Full laboratory analyses are summarized in Appendix B.

Sample ID	Sample Depth (m)	Sample Exceedances (mg/kg)							
		Sb	As	Cd	Cu	Pb	Ni	Se	Zn
Criteria		40	12[1,2]	22[1], 2,090[2]	91	600[1], 8,200[2]	50	2.9	360
12-01-01	0-0.15	1,060	368	25.7	4,680	53,400	71.7	9.08	750
12-02-02	0.61-0.76	111*	31.5*	b.c.	94.7*	4,431*	48.9*	b.c.	b.c.
12-02-03	1.37-1.52	b.c.	b.c.	b.c.	b.c.	b.c.	b.c.	b.c.	b.c.
12-03-01	0-0.15	517	226	b.c.	1,000	46,200	76.4	5.18	740
12-04-01	0-0.15	525	132	b.c.	560	33,700	b.c.	3.51	b.c.
12-04-03	1.37-1.52	b.c.	b.c.	b.c.	b.c.	b.c.	50.6	b.c.	b.c.
12-05-02	0.61-0.76	b.c.	b.c.	b.c.	b.c.	b.c.	b.c.	b.c.	b.c.
12-05-05	2.9-3.0	b.c.	b.c.	b.c.	b.c.	b.c.	b.c.	b.c.	b.c.

[1]Tier I Criteria
[2]Tier II Criteria
*Reported value is the average with field duplicate.
Bold indicates exceedances of Tier II Criteria.
b.c. denotes below criteria
n.a. denotes not analyzed for parameter

TABLE 3-2: SAMPLE ANALYTICAL EXCEEDANCES OF SOIL CRITERIA – 2012 BOREHOLE INVESTIGATION

Results indicate that metal impacts are limited to the upper fill layers and are not observed in the underlying clay layers in this region of the property. Downwards vertical migration in soils does not appear to have occurred in this region of the property below the fill layer, consistent with findings by IDS, in 1991.

3.2.3 2013 Borehole Investigation

Based on results from the 2012 test pitting and borehole program (shown in Figure 3), further site investigations were conducted to evaluate potential horizontal and downwards vertical impacts, and potential groundwater impacts. Waste records from building demolition initiated in 2012 by Dillon listed potential PCB and mercury wastes. After the building was demolished, Dillon initiated a shallow borehole investigation to evaluate the extent of impacts on the southern end of the Site in May 2013 (APEC 2). In total, twenty-one (21) boreholes were drilled on the property. Fifteen (15) shallow boreholes were drilled to a maximum depth of 1.5 m to evaluate the extent of impacts across the fill layer of the Site (APEC 2). Borehole logs can be found in Appendix A. Soil sample exceedances are shown below on Table 3-3. Full laboratory analyses are summarized in Appendix B.

Sample ID	Sample Depth (m)	Sample Exceedances (mg/kg)										
		Sb	As	Cd	Cr	Cu	Pb	Ni	Se	Th	Sn	Zn
Criteria		40	12[1,2]	22[1], 2,090[2]	87	91	600[1], 8,200[2]	50	2.9	1	300	360
13-03-1.1	1.1	636	280	b.c.	b.c.	667	17,300	52.7	b.c.	b.c.	304	395
13-04-1.1	1.1	97.5	75.5	b.c.	b.c.	367	9,250	b.c.	b.c.	b.c.	b.c.	b.c.
13-05-1.5	0.8	552	227	b.c.	b.c.	252	25,700	b.c.	3.00	b.c.	b.c.	b.c.
13-06-7.3	0.8	441	251	33.9	b.c.	1,300	24,200	b.c.	5.20	b.c.	b.c.	b.c.
13-07-2.4	0.8	389	238	43.7	b.c.	307	25,200	b.c.	5.12	b.c.	b.c.	b.c.
13-08-1.5	0.8	1370	653	108	b.c.	391	47,200	b.c.	18.3	1.98	364	b.c.
13-10-7.3	1.2	982*	516*	b.c.	b.c.	695*	33,900*	69.1*	2.95*	1.18*	1,010*	550*
13-11-3.7	0.8	1420	858	b.c.	100	1150	37,200	92.9	3.06	1.33	1160	570
13-12-1.1	0.8	959	523	b.c.	b.c.	730	27,600	74.7	b.c.	1.06	930	770
13-13-2.0	0.8	b.c.	22.1	b.c.	b.c.	158	1,640	b.c.	b.c.	b.c.	b.c.	b.c.
13-15-1.8	0.01	186	64.2	b.c.	b.c.	b.c.	9,310	b.c.	5.79	b.c.	b.c.	b.c.
13-16-1.5	0.8	1,720	1,200	30.6	b.c.	200	30,300	54.8	2.93	b.c.	b.c.	b.c.
13-17-1.8	0.8	205	64.4	b.c.	b.c.	1,390	14,200	72.7	3.56	b.c.	1,000	2,100
13-18-1.8	0.8	50	80.9	b.c.	b.c.	b.c.	5,110	b.c.	b.c.	b.c.	b.c.	b.c.

[1]Tier I Criteria
[2]Tier II Criteria
*Reported value is the average with field duplicate.
Bold indicates exceedances of Tier II Criteria.
b.c. denotes below criteria
n.a. denotes not analyzed for parameter

TABLE 3-3: SAMPLE ANALYTICAL EXCEEDANCES OF SOIL CRITERIA – 2013 BOREHOLE INVESTIGATION

Sample data sets were combined from 1991 to 2013 to evaluate the horizontal and vertical limits of lead in soil. Lead in soil concentration contours at varying depth intervals are presented in Figures 10-13.

Lead concentrations in soil were found to exceed federal soil quality guidelines (600 mg/kg) to depths greater than 2 m (in both APECs 1 and 2). No lead concentrations in soil were observed to exceed Tier II criteria at depths greater than 3 m. Lead concentrations in soil decrease in orders of magnitude from approximately 100,000 mg/kg at the surface (TH15, TH16, IDS 1991) to approximately 1,600 and 400 mg/kg at a depth greater than 2 mbgs for the same sample locations. These results indicate that although downward vertical migration of lead has occurred, mobility appears to be reduced by interactions with the soil substrate. The volume of soil that exceeds the Tier I Soil Quality Guideline (SQG) (600 mg/kg) on the southern portion of the property is estimated to be approximately 8,000 m^3.

Lead concentrations that exceeded the Tier II guideline for soil were not observed to extend to depths greater than 1.5 m during historical or Dillon's 2012 and 2013 investigations in the southern portion of the property. The volume of impacts that exceed SQG for lead on industrial sites for human health ingestion is much reduced (3,240 m^3), assuming an aerial extent of 2,160 m^2 and an observed depth to impacts of 1.5 mbgs.

3.2.4 TCLP Analyses

Leachate tests were conducted on soil to evaluate lead mobility in soil and waste classification. These tests evaluate leachability under acidic conditions. There appears to be some linear correlation between lead concentrations in soil and leachate, as approximately 74% of the variance in concentrations in soil can be explained by concentrations of leachate (n=13, r2=0.7438, 2013 data). This correlation indicates that for this Site, as lead in soil concentrations increase, leachable lead concentrations also increase. Some lead remains 'unbound' from the soil and is able to be mobilized in an aqueous form with decreasing pH, as evidenced by TCLP analytical results. Samples that contain debris materials are highly heterogeneous in composition and were observed to contain elevated levels of lead. Lead associated with debris materials and not bound up in a soil matrix are likely to be present be in a more leachable form. Leachate concentrations exceeding SQG for both cadmium and lead were observed, and are detailed below on Table 3-4.

Sample ID	Sample Depth (m)	Sample Exceedances (mg/L)	
		Cd	Pb
Criteria		0.5	5
13-03-1.1	1.1	b.c.	43.5
13-04-1.1	1.1	b.c.	25.7
13-05-1.5	0.8	b.c.	101
13-06-7.3	0.8	b.c.	155
13-07-2.4	0.8	b.c.	89.7
13-08-1.5	0.8	1.38	82.7
13-10-7.3	1.2	b.c.	89.3*
13-11-3.7	0.8	b.c.	238
13-12-1.1	0.8	b.c.	104

*Reported value is the average with field duplicate.
b.c. denotes below criteria

TABLE 3-4: SAMPLE ANALYTICAL EXCEEDANCES OF TCLP CRITERIA – 2013 BOREHOLE INVESTIGATION

3.2.5 Off-Site Impacts

West of the Site

Dillon reviewed previous reports for the neighbouring property adjacent to the western border of the Site (2201 Logan Avenue). Historical sampling locations and off-site investigations are summarized in Figure 4. Impacts were found at 2201 Logan Avenue at a depth of less than 1 m. Three (3) samples were found to contain analytical concentrations of lead in soil that exceeded applicable SQG criteria (KGS, 2005). Two (2) of these sample locations were taken from an area adjacent to the Site property (KGS, 2005). A Phase II ESA conducted by Wiebe in 2013 observed that lead impacts were surficial (restricted to the upper 0.30 m of soil), and did not exceed the Tier II SQG of 8,200 mg/kg for lead on industrial sites for human health ingestion. Two (2) samples were observed to exceed SQG for the protection of environmental health (600 mg/kg, soil ecological contact pathway).

Previous ESAs conducted at 2201 Logan Avenue noted lead impacts in surficial soil at depths less than 1 m. The most significant impacts were observed along the east boundary of the site, along the property line shared with Northwest Smelting and Refining property (KGS, 2005). One soil sample in 2005 was observed to have concentrations exceeding the Tier II SQG Criteria (TP2-1, sample depth 0.25 – 0.3 m). More recently, Phase II ESA results at 2201 Logan Avenue (Wiebe, 2013) observed lead concentrations in soil to exceed Tier I SQG Criteria. Soil concentrations were observed to be below Tier II SQG Criteria. The total estimate volume of lead impacted soil exceeding Tier I SQG Criteria is 390 m^3, based on an estimated area of impacts of 1,300 m^2 and an assumed depth of impacts to 0.3 m.

North of the Site

Based on the current site observations, Dillon conducted a shallow drilling program on the neighbouring property adjacent to the northern property line. Samples were observed to contain elevated analytical concentrations of lead in soil; however, concentrations were found to be below the applicable SQG criteria for both environmental and human health.

East of the Site

Off-site investigations were not pursued in the property immediately east of the southern portion of the property (2141 Logan Avenue). Historical investigations have observed surficial lead impacts in soil and shallow ground water in two (2) boreholes (BH202 and BH203) at the 165 Ryan St. property. Lead concentrations in soil were observed to exceed Tier I Criteria (2,530 mg/kg) at BH202 at a depth of 1 m. No exceedances of Tier II Criteria were observed. Dissolved lead in groundwater concentrations were reported to be below or within the Guidelines for Freshwater Aquatic Life of 0.001 to 0.007 mg/L, and the Guidelines for Canadian Drinking Water Quality of 0.01 mg/L. Off-site impacts do not appear to extend east of Ryan Street.

3.3 Groundwater Monitoring

Monitoring wells were completed during the 2013 subsurface investigations. In total, thirteen (13) of these boreholes were completed as monitoring wells, as depicted on Figure 3. Six (6) shallow boreholes were completed as monitoring wells. Three (3) locations were completed as a cluster of monitoring wells, evaluating groundwater flow and potential impacts in the three stratigraphic layers (fill, native silt/clay and till). Monitoring well construction details are presented in Appendix A with borehole log data. Results from groundwater monitoring will be discussed in the following section.

3.3.1 Field Observations

In May 2013 and June 2014, Dillon measured groundwater elevations. Measured groundwater below ground surface were observed to range between 1.35 (13-13, Fill layer) and 3.61 (13-10, Till layer). Water level measurements at metres below ground surface (mbgs) are shown on Table 3-5.

Monitoring Well ID	Screened Stratigraphy	Water Level Measured 2013 (mbgs)	Water Level Measured 2014 (mbgs)
13-01	Till	Dry	1.51
13-02	Clay	Dry	0.70
13-03	Fill	0.55	0.09
13-04	Fill	0.60	0.27
13-05	Fill	Dry	Damaged
13-06	Till	2.07	1.51
13-07	Clay	1.47	1.35
13-08	Fill	1.49	1.37
13-09	Clay	0.47	Dry
13-10	Till	2.60	2.49
13-11	Clay	1.69	1.52
13-12	Fill	Dry	Dry
13-13	Fill	0.59	0.35

TABLE 3-5: WATER LEVELS MEASURED (MBGS) MAY 2013 AND JUNE 2014

Field pH and redox measurements were taken from monitoring well locations where sampling conditions permitted (i.e., ample well water during in-line flow sampling). Due to sampling volume limitations, pH and redox measurements were not taken at all monitoring well sample locations in 2013. Field observations are shown below on Table 3-6. In comparing field measured parameters to laboratory-derived measurements, stability is noted between field and laboratory measurements, with the exception of sample 13-07. Measured pH values were observed to increase in samples between field and laboratory sampling. Increased turbidity in the laboratory was noted for sample 13-07, indicating that precipitate may have formed during sample storage prior to analysis. Some differences between field-measured parameters and laboratory measured parameters are to be expected, associated with temperature and redox changes during storage prior to analysis.

Monitoring Well ID	Screened Stratigraphy	Field pH		Field Oxidation Reduction Potential (mV)		Turbidity (NTU)	Specific Conductance (µS/cm)	Dissolved Oxygen	
		2013	2014	2013	2014	2013	2014	2013	2014
13-01	Till	7.09	7.52	-40.1	-42.1	6.79	14,140	0.00	1.55
13-02	Clay	n.m.	7.37	n.m.	-44.2	n.m.	8,372	n.m.	2.00
13-03	Fill	n.m.	7.11	n.m.	-42.2	n.m.	3,250	n.m.	1.52
13-04	Fill	n.m.	7.36	n.m.	n.m.	n.m.	2,404	n.m.	2.27
13-06	Till	7.05	7.68	-11.8	n.m.	4.70	9,695	0.00	1.56
13-07	Clay	6.94	7.62	-48.0	n.m.	1.89	2,843	0.53	2.14
13-08	Fill	n.m.	7.56	n.m.	n.m.	n.m.	2,997	n.m.	4.65
13-10	Till	6.65	7.07	-7.6	n.m.	3.62	6,205	0.00	1.33
13-11	Clay	n.m.	7.42	n.m.	n.m.	n.m.	3,534	n.m.	2.46
13-13	Fill	n.m.	7.39	n.m.	-66.3	n.m.	1,592	n.m.	4.60

n.m. denotes not measured.

TABLE 3-6: FIELD PARAMETERS MEASURED MAY 2013 AND JUNE 2014.

3.3.2 Hydraulic Conductivity Testing and Groundwater Flow

Field slug tests were conducted in the fill, clay and till layers in 2013. Hydraulic conductivity was calculated using the Bouwer and Rice method. Greater hydraulic conductivity was seen in the upper layers in the following order:

- MW 13-13 (fill/silty clay, 3.02 x10^{-4} cm/s).
- MW 13-11 (silty clay, 5.14 x10^{-6} cm/s).
- MW 13-10 (tight till, 1.7 x 10^{-7} cm/s).

A local vertical survey was conducted for monitoring wells to enable the calculation of horizontal and vertical gradients and evaluate groundwater flow direction. Calculated hydraulic gradients based on observed groundwater elevations and flow direction are summarized on Table 3-7. Most notable are the differences between measured calculated gradients and velocities in the clay unit, between 2013 and 2014, likely attributable to well recovery between installation and monitoring.

The observed shallow groundwater flow direction is depicted in Figure 7. Groundwater in the fill stratigraphy appears to flow outwards from the site, following site topography, although the dominant calculated flow direction is to the northwest, matching the till groundwater flow direction observed in 2014.

Vertical gradients were calculated for the available data from nested monitoring well locations. Greater downwards gradients were observed in nested monitoring well locations 13-01,-02,-03 and in 13-10,-11, ranging from 0.23 to 0.88. The downwards vertical gradient of 0.88 was noted between the fill and clay units at 13-02/13-03. Lesser downwards gradients were observed at nested monitoring well location 13-06,-07,-08, ranging from 0.002 to 0.12.

Screened Stratigraphy	Hydraulic Gradient		Flow Direction		Calculated Average Velocity (x 10^{-8} m/s)	
	2013	2014	2013	2014	2013	2014
Fill	0.002	0.008	NW	NW	2.7	9.0
Clay	0.01	0.0001	NE	NE	6.5	0.09
Till	n.c.	0.01	n.c.	NW	n.c.	18

n.c. denotes not calculated.
NE denotes Northeast
NW denotes Northwest
Porosities used for Calculated Average Velocity (Fill = 0.3, Clay = 0.5, Till = 0.2).

TABLE 3-7: GROUNDWATER FLOW OBSERVATIONS

3.3.3 Analytical Results

Dillon collected groundwater samples on July 31 and August 1, 2013 from seven (7) of the thirteen (13) monitoring wells. The remaining six (6) monitoring wells were too dry for sampling at the time of site visit. Groundwater samples with concentrations exceeding the applicable criteria are shown on Table 3-8. Full laboratory analyses are summarized in Appendix B. Groundwater impacts were observed in each stratigraphic unit at this Site (fill, silt/clay, till). The greatest concentrations of lead in groundwater were observed in the till layer (the deepest stratigraphic layer, adjacent to limestone bedrock). The source and extent of vertical migration is unclear, as impacts were not observed in corresponding soil samples at the same depth. Analytical concentrations of lead in groundwater sampled from nested monitoring wells (13-01 Till, 13-02 Clay; 13-10 Till, 13-11 Clay) indicate that there may be downwards vertical migration from on-Site impacts, or off-site impacts that affect the deep groundwater.

Monitoring Well ID	Screened Stratigraphy	Cadmium (mg/L)		Lead (mg/L)	
		2013	2014	2013	2014
Criteria		0.0027		0.025	
13-01	Till	b.c.	n.d.	0.0755	0.109
13-02	Clay	b.c.	0.005	0.0462	0.317
13-03	Fill	n.a.	0.008	n.a.	0.155
13-04	Fill	n.a.	b.c.	n.a.	0.163
13-05	Fill	n.a.	n.a.	n.a.	n.a.
13-06	Till	0.005 *	0.005 *	0.114 *	0.113 *
13-07	Clay	0.010	0.011	0.445	0.196
13-08	Fill	n.a.	n.a.	n.a.	n.a.
13-09	Clay	n.a.	n.a.	n.a.	n.a.
13-10	Till	0.0041	0.003	0.636	0.650
13-11	Clay	0.0028	0.006	0.435	0.305
13-12	Fill	n.a.	n.a.	n.a.	n.a.
13-13	Fill	b.c.	b.c.	b.c.	0.044

*Reported value is the average with field duplicate.
b.c. denotes below criteria
n.a. denotes not available
n.d. denotes not detected (i.e., below analytical detection limits)

TABLE 3-8: SAMPLE ANALYTICAL EXCEEDANCES OF GROUNDWATER CRITERIA

Based on available field observations and laboratory analytical data, groundwater chemistry was observed to be consistent between 2013 and 2014, as evidenced by similar measured analyte concentrations and specific conductance (overall dissolved analytes). Minor shifts in pH, and concentrations are anticipated between the two (2) sampling periods. Greater concentrations of lead in groundwater were observed at 13-02 during the 2014 monitoring period. The overall groundwater chemistry remains similar between 2013 and 2014 for 13-02. This discrepancy may be attributable to changing groundwater flow conditions in the shallow groundwater (i.e. sampling in 2014 conducted shortly after precipitation event), or potential field filtration sampling issues. All samples submitted for metals were field filtered. The 2014 groundwater monitoring program re-affirmed observed concentrations in 2013 and enabled data collection from previously unavailable monitoring wells.

Groundwater impacts were observed to be greatest at depth in the clay and till in two locations: 13-11/13-12 to the southeast of the northern portion of the Site, and 13-06/13-07, to the northwest of the northern portion of the Site. Both locations are adjacent to the APEC 1, the North End Dump Site.

3.4 QA/QC Data

Duplicate samples were submitted for analysis of PAHs, BTEX, PHC Fractions F1 to F4 and metals. The blind duplicate was prepared in the field by the sampler. The purpose of this sample was to determine if any unintentional contamination occurred from atmospheric effects, equipment or sampler effects.

The results of the RPD calculations for the blind field duplicates are presented on summary tables A-16 to A-20 in Appendix A. RPD analysis of the blind field duplicate samples indicated the laboratory analysis for hydrocarbon, metals and PAH parameters were within the acceptable RPD range (0-30% for soil, 0-25% for water) where valid RPD values were calculable. High variability was seen in soil field duplicates that contained debris material. The variability is attributable to the highly heterogeneous nature of the debris and soil matrix.

Laboratory quality assurance testing such as matrix spike, spike blanks, method blanks and RPD were within acceptable laboratory limits for analyses conducted in soil and surface water samples. Results of laboratory QA/QC analyses are included in the laboratory certificates of analysis in Appendix D. Laboratory quality control results satisfied laboratory acceptance criteria. The laboratory's QA/QC program showed an acceptable (not applicable) relative percent difference. The laboratory's surrogate spike recovery sample results were also within the acceptable range for soil samples analyzed.

4.0 DISCUSSION OF RESULTS

4.1 Metals-Impacted Soils

Lead concentrations in soil were found to exceed federal soil quality guidelines (600 mg/kg) to depths greater than 2 m. Lead concentrations in soil were observed to exceed Tier I criteria at depths greater than 2 mbgs (Dillon 2012 - TP-01-02, 2.8 mbgs, 5,860 mg/kg; IDS 1991 - 1R8, 2.9-3.2 mbgs, 13,100 mg/kg). No Tier II criteria exceedances were noted at depths below 3 m in 2012/2013 for lead concentrations in soil. Tier II criteria exceedances were observed at depths of 2.8 m at TP-01-02 for arsenic (31.9 mg/kg). Tier I criteria exceedances were noted at the same sampling location for both nickel and antimony. In areas containing buried waste, such as in the northern portion of the Site, elevated concentrations of metals in soil are anticipated.

The Tier I guidelines for the protection of human health for arsenic in soil is protective of human health (soil ingestion). This exposure pathway is not relevant at 2.8 mbgs. The ecological soil contact pathway is not the most applicable criteria given site and surrounding land use. The next most applicable soil criteria for the protection of environmental health is the off-site migration check (arsenic, 140 mg/kg), which is greater than the arsenic concentrations observed in soil at 2.8 mbgs. As discussed above in Section 1.7, the off-site migration check criteria was designed to protect sensitive neighbouring properties, which is not the scenario for this site location.

Nickel concentrations in soil were observed to exceed Tier I guidelines. There is no soil ingestion pathway guideline for this metal, nor is there an off-site migration check guideline for the protection of environmental health. The next most applicable guideline is the nutrient and cycling check at 182 mg/kg for nickel in soil. The values observed in soil do not exceed this guideline.

There is no additional criteria for antimony in soil provided by the CCME, however the depth to impacts is 2.8 mbgs, effectively cutting off most applicable exposure pathways.

The volume of soil that exceeds the SQG on the southern portion of the property is approximately 10,000 m^3. Lead concentrations that exceeded the Tier II guideline for soil were not observed to extend to depths greater than 1.5 m during historical or Dillon's 2012 and 2013 investigations in the southern portion of the property. The volume of impacts that exceed SQG for lead on industrial sites for human health ingestion is much reduced (3,240 m^3), assuming an aerial extent of 2,160 m^2 and an observed depth to impacts of 1.5 mbgs.

Despite the high metal concentrations in soil samples, mobility of metals are likely to be attenuated in the native soils. Mobility of lead and cadmium at this Site is reduced by two factors:

- the native soils capacity for cation adsorption.
- the increased pH associated with high carbonate content.

Soluble lead added to soil reacts with clays, phosphates, sulphates, carbonates, hydroxides and organic matter, greatly reducing lead solubility. At pH values greater than six (6), such as found at this Site, lead is adsorbed on clay surfaces or forms carbonates. Competing cations limit sorption of lead to soils and surfaces; however, clays in the Winnipeg region tend to be dominated by montmorillonite-illite (Quigley, 1968) and have a greater ability to adsorb cations, such as lead.

Location	Exceedance of Applicable Guidelines	Total Volume of Soil Exceeding CCME SQG Tier I Criteria m^3	Volume of metals impacted soil exceeding CCME SQG Tier II Criteria m^3	Comments
APEC 1	Metals in Soil	3,100	0	Exceeds Man. Reg. 282/87. If disposed off-site, must be transported and disposed in a hazardous waste facility.
APEC 2	Metals in soil	10,000	3,240	Exceeds Man. Reg. 282/87. If disposed off-site, must be transported and disposed in a hazardous waste facility.

TABLE 4-1: SUMMARY OF IMPACTED SOILS AT NWSR

Leachate tests were conducted on soil to evaluate lead mobility in soil. There appears to be some correlation between lead concentrations in soil and leachate ($n=13$, $r^2=0.7438$, 2013 data). This correlation indicates that for this Site, as lead in soil concentrations increase, leachable lead concentrations also increase. Some lead remains 'unbound' from the soil and is able to be mobilized in an aqueous form with decreasing pH, as evidenced by TCLP analytical results. Samples that contain debris materials are highly heterogeneous in composition and can contain elevated levels of lead. Debris materials would not be bound up in a soil matrix, and would be in a leachable form. Observed analytical exceedances, with the exception of samples 13-03-1.1 and 13-04-1.1, were taken near debris/potentially containing debris. Values shown on Table 4-2 represent maximum soil concentrations observed, with the average value given in parenthesis ().

Parameter	Soil Concentrations		Comparative Criteria	
	Extractable (mg/L)	Total (mg/kg)	Extractable[1] (mg/L)	Total[2] (mg/kg)
Antimony (Sb)	0.65 (<0.50)	1,720 (278)	5.0	40
Arsenic (As)	<0.20	1,200 (146)	100	26[3]
Barium (Ba)	0.77 (<0.50)	1,550 (260)	-	2,000
Beryllium (Be)	<0.50	1.3 (0.7)	500	8
Bismuth (Bi)	n.v.	5.4 (1.0)	0.5	-
Boron (B)	<5.0	157 (38)		
Cadmium (Cd)	1.4 (0.4)	108 (8.3)	-	22; 2,090[4]
Chromium (Cr)	<0.5	100 (31)	-	87
Cobalt (Co)	<0.20	79 (25)	-	300
Copper (Cu)	<0.50	1390 (197)	-	91
Lead (Pb)	238 (119)	47,200 (17,167)	5.0	600; 8,200[4]
Molybdenum (Mo)	<0.050	620 (197)	-	40
Nickel (Ni)	<0.50	93 (25)	1.0	50
Selenium (Se)	<0.20	6,110 (1600)	1.0	2.9
Silver (Ag)	<0.50	45 (5.3)	5.0	40
Thallium (Tl)	<0.10	4,470 (582)	-	3.6[3]
Tin (Sn)	<0.050	1,160 (251)	2.0	300

Uranium (U)	<0.050	2.8 (1.0)	-	300
Vanadium (V)	<0.50	258 (54)	-	130
Zinc (Zn)	51.7 (<0.50)	2,100 (284)	-	360

[1]Manitoba Regulation 282/87, the Dangerous Goods Handling and Transportation Act (C.C.S.M. c. D12)
[2]Canadian Council of the Ministers of the Environment Soil Environmental Quality Guidelines for the Protection of Environmental and Human Health (1999), Industrial Land Use.
[3]Manitoba Conservation and Water Stewardship Guideline: Criteria for Acceptance of Contaminated Soil at Licensed Waste Disposal Grounds (2002). Guideline 2002-02E.
n.v. denotes no value.
Where two values are presented: maximum concentration observed (average concentration observed)
[4]Canadian Council of the Ministers of the Environment Soil Environmental Quality Guidelines for the Protection of Environmental and Human Health (1999), Industrial Land Use, Soil-Ingestion Pathway.

TABLE 4-2: SUMMARY OF SELECTED COMPARATIVE CRITERIA

Soils that are identified as being regulated will be managed following applicable regulations. In cases where co-contamination of soils is present, the most conservative management option that addresses both contaminants should be applied.

4.1.1 APEC 1 – North End Dump

The North End Dump area was sampled extensively by IDE in 1991. Waste mixed with soil samples were submitted separately from soils for laboratory analysis of lead and leachable lead. Based on the observed concentrations in sample results, it can be assumed that the volume of waste debris estimated at 10,500 m^3 exceeds applicable SQG for both environmental and human health. The estimated volume of impacts associated with lead concentrations in soil exceeding applicable criteria are shown below:

Exceedance of Applicable Guidelines	Total volume of soil and waste exceeding CCME SQG Tier I Criteria m^3	Volume of metals impacted soils and waste exceeding CCME SQG Tier II Criteria m^3	Comments
Metals in Soil & Waste	13,600	10,500	Exceeds Man. Reg. 282/87. If disposed off-site, must be transported and disposed in a hazardous waste facility.

TABLE 4-3: SUMMARY OF IMPACTS IN APEC-1

4.1.2 APEC 2 – Surficial Impacts, Southern Portion of Site

The Southern portion of the Site has been sampled extensively. Soil samples were submitted for laboratory analysis of metals and leachable metals. Based on the observed concentrations in sample results, it can be assumed that the volume of soil estimated at 10,000 m^3 (assuming an aerial extent of 10,000 m^2, accounting for foundation flooring with an observed depth to impacts of 1.5 mbgs) exceeds applicable Tier I SQG for the protection of environmental health. Bulk metal impacts above CCME SQG Tier II Criteria (for the protection of human health) are estimated to be 2,500 m^3, assuming an aerial extent of 2,160 m^2 and an observed depth to impacts of 1.5 mbgs. The estimated volume of impacts associated with lead concentrations in soil exceeding applicable criteria are shown below:

Exceedance of Applicable Guidelines	Total volume of soil and waste exceeding CCME SQG Tier I Criteria m^3	Volume of metals impacted soils and waste exceeding CCME SQG Tier II Criteria m^3	Comments
Metals in Soil	10,000	3,240	Exceeds Man. Reg. 282/87. If disposed off-site, must be transported and disposed in a hazardous waste facility.

TABLE 4-4: SUMMARY OF IMPACTS IN APEC-2

4.2 APEC 3 - Groundwater

Discerning between Site impacts in groundwater and the surrounding properties may prove to be difficult as several properties adjacent to and within the immediate vicinity of the Site have current or historic industrial uses that involved metals handling and processing. Elevated concentrations of lead and cadmium were observed in both shallow and deep groundwater throughout the Site, including locations up-gradient from impacted soil (13-13), or observed on-site potential sources.

The greatest impacts were seen at an area that is slightly south of the debris pile. In 2013, greater laboratory-measured turbidity was observed in samples 13-07 and 13-11, potentially contributing to a positive associated with metals in groundwater concentration. Based on the observed concentrations in field-filtered 2014 groundwater samples, it can be concluded that the increased turbidity is associated with the handling times and storage conditions, as the samples were field-filtered and preserved.

Monitoring Well ID	Laboratory pH	Field pH
13-01	7.67	7.09
13-06	8.10	7.05
13-07	7.69	6.94
13-10	7.30	6.65

TABLE 4-5: COMPARISON OF FIELD-MEASURED TO LABORATORY-MEASURED PH (2013 DATA)

As noted previously, the greatest impacts were noted at the northern portion of the Site, adjacent to APEC 1. Proximity to concentrated waste and potential for metals leaching into groundwater may contribute to elevated cadmium and lead concentrations at greater depths. The observed downwards direction of the vertical hydraulic gradient at all stratigraphies at the Site in 2014 support this finding.

The installation/shut down of a pumping well in the nearby vicinity could impact groundwater flow direction. Production wells for industrial use were identified at the following locations (GWDrill, 2013):

- 2150 Logan Avenue, SW Corner of Building, installed 1979; Cadorath Plating.

- 2150 Logan Avenue, SW Corner of Building, installed 1998; Cadorath Plating.
- 1860 King Edward Street, NW Corner of Plant, installed 1992; Perth's Services.

The proximity of 2150 Logan Avenue to the Site indicates that a production well for industrial use at this location could impact interpretations of groundwater flow direction. The well's location could offer an explanation to the 'radial' groundwater flow pattern – pulling water towards the south west of the Site. The presence of an industrial use production well at 2150 Logan Avenue does not appear to impact the lead in groundwater concentration gradient observed at the Site.

Lead concentrations in groundwater do not appear to be correlated with the soil leachate results taken from the screened intervals ($n=7$, $r^2=0.3422$, 2013 data). However, there does appear to be a weak correlation with lead concentrations in soil ($n=7$, $r^2=0.7681$, 2013 data). These results are indicative that in some areas on site, the soil matrix is heterogeneous and contains debris. The debris corresponds with high lead in 'soil' concentrations and contains unbound, readily mobilized lead. The metals antimony, cadmium, calcium, copper, molybdenum, nickel and uranium have weak correlations with lead concentrations in groundwater ($n=8$, $r^2=0.5$ to 0.6), indicating that these may have originated from a similar source.

Lead is the least mobile of the heavy metals (Kabata-Pendias and Pendias, 1992) and accumulates in the surface horizons of soils and is not usually leached (Davies, 1990). Lead is most available under soft, acidic conditions and precipitates as hydroxides, phosphates and carbonates as pH increases. In association with manganese oxides, the solubility of lead decreases as divalent lead (Pb^{2+}) is oxidized to Pb^{4+}. There is limited availability of lead in all soils unless the cation exchange capacity is saturated and lead is present in soluble organic complexes (NRCC, 1978).

Geochemical analyses (using AQUACHEM and PHREEQCi) of the groundwater concentrations indicate active carbonate and dolomite (source rock) weathering, a process that rapidly immobilizes Pb^{2+} from aqueous solutions. However, organics present in solutions and natural waters can mobilize Pb^{2+} from Pb^{2+}-calcite phases.

The geochemical analyses, observed concentrations in soil and groundwater, and observed groundwater flow conditions (downwards vertical gradient) support the hypothesis that the greater concentrations in groundwater at the northern portion of the Site are associated with the buried waste materials in APEC 1.

As noted in Section 3.2.5, off-site impacts in groundwater were not observed to the east of Ryan Street.

4.3 Data Gaps and Recommendations for Future Data Collection

4.3.1 APEC 1 – North End Dump Site

No further data gaps were identified for the North End Dump Site. The waste debris volume, thickness and composition are known. The soil cap integrity, thickness and composition are known. Contaminants of concern have been identified and delineation has been achieved both horizontally and vertically. Further work associated may follow, as recommended by a site-specific risk assessment and/or management program. Based on the results from field investigations in 2013, minimal off-site impacts were observed to the north of this APEC. All off-site results were observed to be below the applicable criteria.

4.3.2 APEC 2 – Surficial Impacts, Southern Portion of Site

No further data gaps were identified for the surficial impacts at the southern end of the Site. Soil stratigraphy has been identified for the area, with the exception of the property to the east of the southern end of the site. Contaminants of concern have been identified and delineation has been achieved both horizontally and vertically. Based on results from field investigations conducted in 2013, off-site impacts were observed to the west of the subject site. Further work may follow, as recommended by a site-specific risk assessment and/or management program.

4.3.3 APEC 3 – Groundwater

At the end of the 2013 groundwater monitoring investigation, data gaps were identified for understanding the site conceptual model with respect to groundwater impacts. Groundwater gradients and flow direction were confirmed in a subsequent groundwater monitoring program (in 2014).

Contaminants of concern have been identified at the Site. A second groundwater monitoring event was conducted to confirm observed impacts following the initial sampling event. Downwards vertical gradients were observed within all measured stratigraphic units. The proximity to buried waste combined with the downwards vertical gradient support the hypothesis that the greater concentrations in groundwater at the northern portion of the Site are associated with the buried waste materials in APEC 1. The stabilization or removal of materials in APEC 1 will likely improve impacts in the deep groundwater.

Further investigations may be required to identify impacts associated in the deep groundwater at the northeastern section of the property. Groundwater samples submitted for isotope analysis may help to differentiate between on-site and off-site impacts.

Human health and ecological receptors were not identified for the Site. Regional groundwater is non-potable and the nearest surface water body or sensitive ecological habitat is located less than 1 km to the northwest of the site (storm water pond at Woodsworth Park). Lead in groundwater concentration exceedances were noted at a significant distance away from any possible fish habitats. Given that there are no observed immediate ecological or human receptors, a site-specific Tier III Criteria or risk management strategy may be more appropriate.

5.0 SUMMARY

Fifteen (15) shallow boreholes were drilled to a maximum depth of 1.5 m to evaluate the extent of impacts across the fill layer of the Site. Lead concentrations in soil were found to exceed federal soil quality guidelines protective of both environmental and human health (600 mg/kg) to depths greater than 2 m.

In the North End, the average soil cap thickness was found to be 0.45 m, with a maximum of 0.7 m (TP-08) and a minimum of 0.1 m (TP-13). Based on the observed thickness and geometry, the approximate fill volume overlaying the debris waste layer is 3,100 m^3. No observed buried debris had breached the soil cap to the surface.

The debris waste layer was found to be comprised of building materials and battery packaging parts, averaging a thickness of 1.1 m, with a maximum of 1.8 m (TP-17) and a minimum of 0.3 m (TP-21). Based on the observed thickness and geometry, the approximate buried waste volume is 10,500 m^3. Firm and moist clay underlie the debris layer.

The property is graded to a greater elevation towards the center of the Site, promoting run-off patterns to the property edges. Erosion potential is minimal for the southern portion of the Site, with greater erosion potential in the northern portion of the Site.

Samples that contain debris materials are highly heterogeneous in composition and likely contain elevated levels of lead. Debris materials would not be bound up in a soil matrix, and the lead would likely be present in a leachable form.

Lead concentrations in soil decrease by three orders of magnitude from the surface to a depth greater than 2 mbgs for the same sample locations. These results indicate that although downward vertical migration of lead is occurring, mobility appears to be reduced by interactions with the soil substrate.

Previous Site investigations on the neighbouring property to the west of the Site found that lead impacts were surficial (restricted to the upper 0.30 m of soil), and did not exceed the SQG of 8,200 mg/kg for lead on industrial sites for human health ingestion. Full delineation of off-site impacts to the east has not been achieved; however, concentrations in soil and groundwater were below criteria for the protection of environmental and human health. Off-site impacts were minimally observed to the north. Soil samples contained elevated analytical concentrations of lead, however, concentrations were found to be below the applicable SQG criteria for both environmental and human health.

The greatest concentrations of lead in groundwater were found in the till layer (stratigraphic layer adjacent to limestone bedrock). Monitoring wells were installed within discrete stratigraphic layers on site, to assess site groundwater flow, and potential impacts to groundwater. Lead and cadmium in groundwater were observed in each stratigraphic unit (fill, clay/silt, till). Greater concentrations of lead and cadmium in groundwater were found in the deeper stratigraphies, along the eastern boundary of the Site property. Shallow groundwater flow direction, based on observed water levels, was observed to flow in a north-easterly direction, with an overall horizontal hydraulic gradient of 0.004 in 2013 and 0.006 in 2014. A downwards vertical hydraulic gradient was observed in 2014 in the three stratigraphies and nested monitoring well locations. Historically, off-site impacts in groundwater have not been observed to the east of the Site property.

Contaminants of concern (lead, cadmium) have been identified at the Site in soils and groundwater. A second groundwater monitoring event was conducted in June 2014 to confirm observed impacts following the initial sampling event and may be used to evaluate risk exposure pathways. Elevated concentrations of lead in deep groundwater may be attributable to nearby buried waste in APEC 1 and downwards vertical hydraulic gradients.

Further investigations may be required to further identify impacts associated in the deep groundwater at the northeastern section of the property. No information is known to the southeast (2141 Logan Avenue). Isotope analysis of analytes in groundwater may help to differentiate between on-site and off-site impacts.

6.0 LIMITATIONS

This report was prepared exclusively for the purposes, project and site location(s) outlined in the report. The report is based on information provided to, or obtained by Dillon as indicated in the report, and applies solely to site conditions existing at the time of the site investigation(s). Dillon's report represents a reasonable review of available information within an agreed work scope, schedule and budget. It is therefore possible that currently unrecognized contamination or potentially hazardous materials may exist at the site(s), and that the levels of contamination or hazardous materials may vary across the site(s). Further review and updating of the report may be required as local and site conditions, and the regulatory and planning frameworks, change over time.

This report was prepared by Dillon for the sole benefit of our Client (Thompson Dorfman Sweatman). The material in the report reflects Dillon's judgment in light of the information available to Dillon at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties. Dillon accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

PROVINCE OF MANITOBA
May 6/15
D. D.
BELL
Member
20503G
REGISTERED PROFESSIONAL GEOSCIENTIST

Respectfully Submitted:

DILLON CONSULTING LIMITED

Indra Kalinovich, Ph.D., C.Chem., E.I.T.

Doug Bell, MSc, P.Geo.,FGC

APEGM
Certificate of Authorization
Dillon Consulting Limited (MB)
No. 1789 Date: May 6, 2015

IKK/knh

7.0 REFERENCES

I.D. Systems Ltd. 1991. Investigations into Lead Contamination at North West Smelting and Refining Ltd., 2185 Logan Avenue, Winnipeg, Manitoba.

I.D. Engineering Canada Inc. 1993. Draft Off-Site Environmental Site Assessment North West Smelting and Refining Ltd. 2185 Logan Avenue, Winnipeg, Manitoba. File 01-145.

Kabata-Pendias, A. and Pendias, H. 1992. Trace Elements in Soils and Plants, 2nd ed., CRC Press Inc., Boca Raton, Florida. 365 pp.

KGS Group. 2005. Phase II Environmental Site Assessment Pa D'Or Manufacturing 2201 Logan Avenue, Winnipeg, Manitoba.

M.P. Wiebe Environmental Engineering. 2013. Phase II Environmental Site Assessment Industrial Property, 2201 Logan Avenue, Winnipeg, Manitoba.

McBride, M. B. 1994. Environmental Chemistry of Soils. Oxford University Press, Inc. New York, New York. pp. 326-339.

NRCC, 1978. Effects of Lead in the Environment - Quantitative Aspects. Associate Committee on Scientific Criteria for Environmental Quality, National Research Council of Canada, Ottawa. NRCC No. 16736. 779 pp.

Province of Manitoba, Groundwater Availability Maps, Bedrock Geology and Drift Thickness maps, 1980.

Province of Manitoba. 2013. GWDrill 2013, Provincial Groundwater Well Data Base.

Quigley, R.M., 1968. Soil Mineralogy, Winnipeg Swelling Clays. Canadian Geotechnical Journal, Vol. 2, No. 2, pp 120-122.

Render, F.W. Geohydrology of the Metropolitan Winnipeg area as related to Groundwater supply and construction.

Canadian Geotechnical Journal, Vol. 7, No. 3, 1970.

University of Manitoba Department of Engineering. 1983. Geological Engineering Report for Urban Development of Winnipeg.

Figures

DILLON CONSULTING

PROJECT North West Smelting and Refining

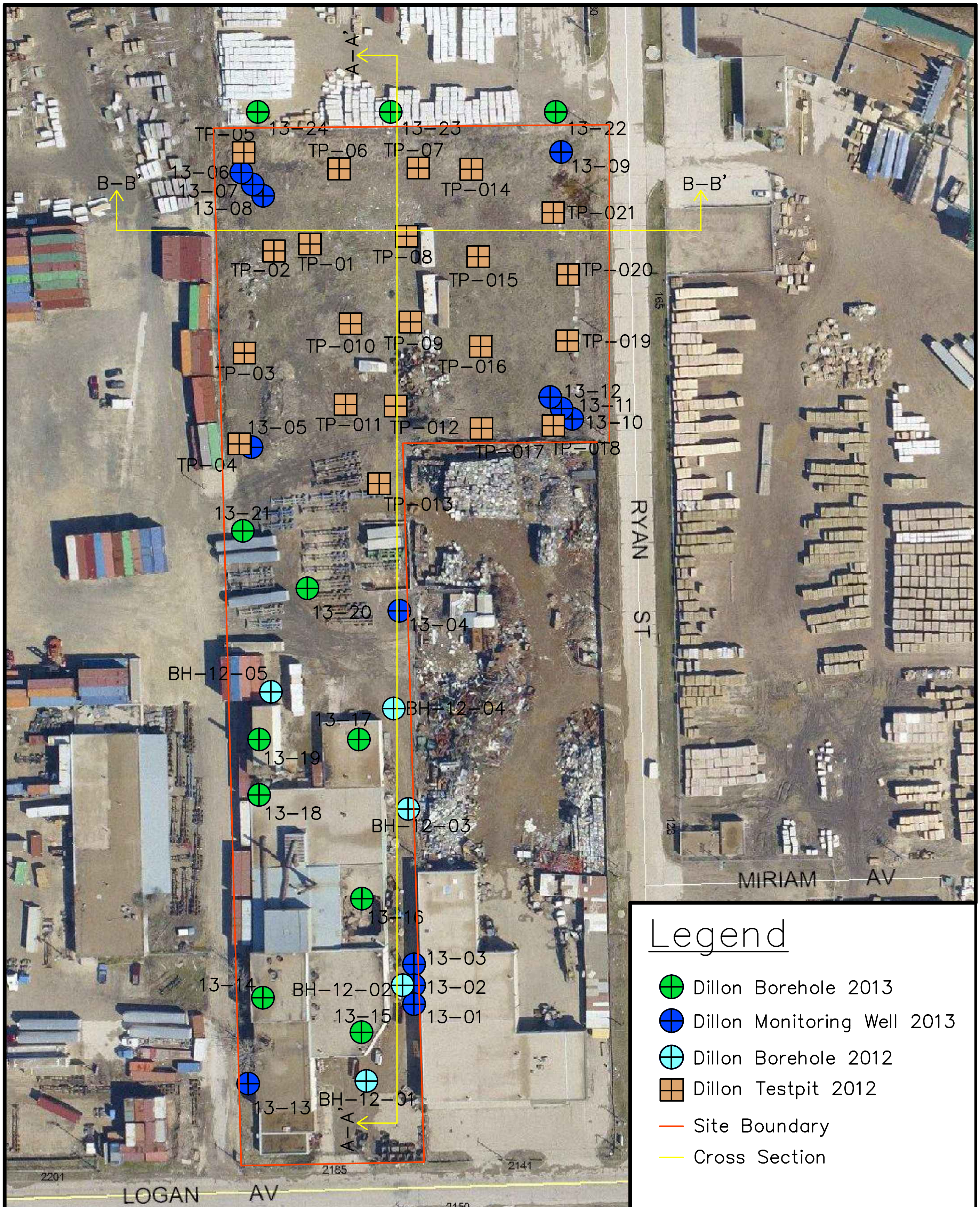
PROJECT NO. 10-3834

TITLE Site Location

FIGURE NO. 1

DATE October 2013

FileName:c:\users\40ik\desktop\nwsr_ik.dwg



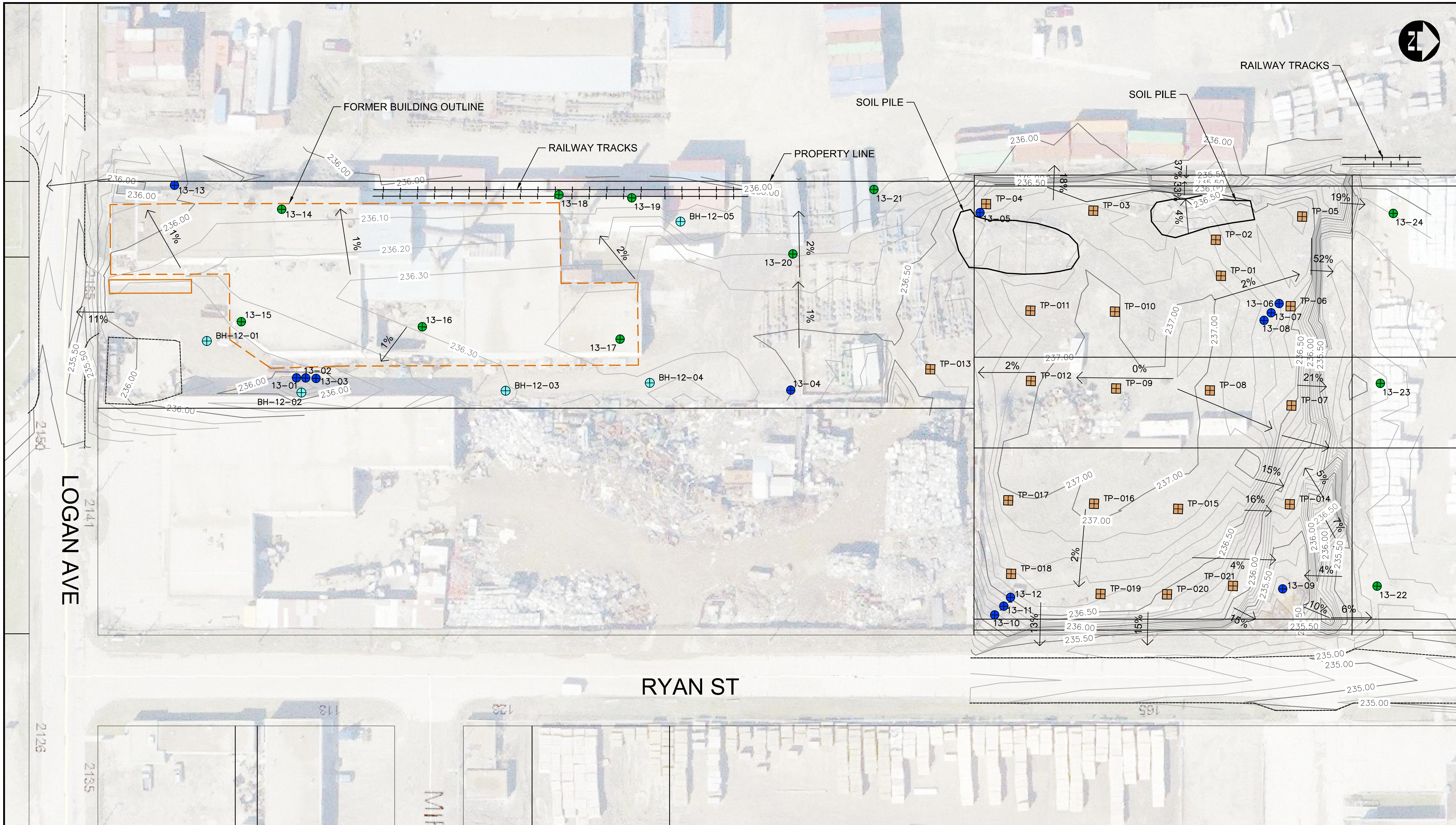
Legend

- Dillon Borehole 2013
- Dillon Monitoring Well 2013
- Dillon Borehole 2012
- Dillon Testpit 2012
- Site Boundary
- Cross Section

DILLON CONSULTING

DATE October 2013	PROJECT North West Smelting and Refining	PROJECT NO. 10-3834
	TITLE Site Plan	FIGURE NO. 2

FileName:c:\users\40ik\desktop\nwsr_ik.dwg



FileName:g:\cad\103834\103834-fig-1.dwg

DILLON CONSULTING

DATE October 2013

LEGEND

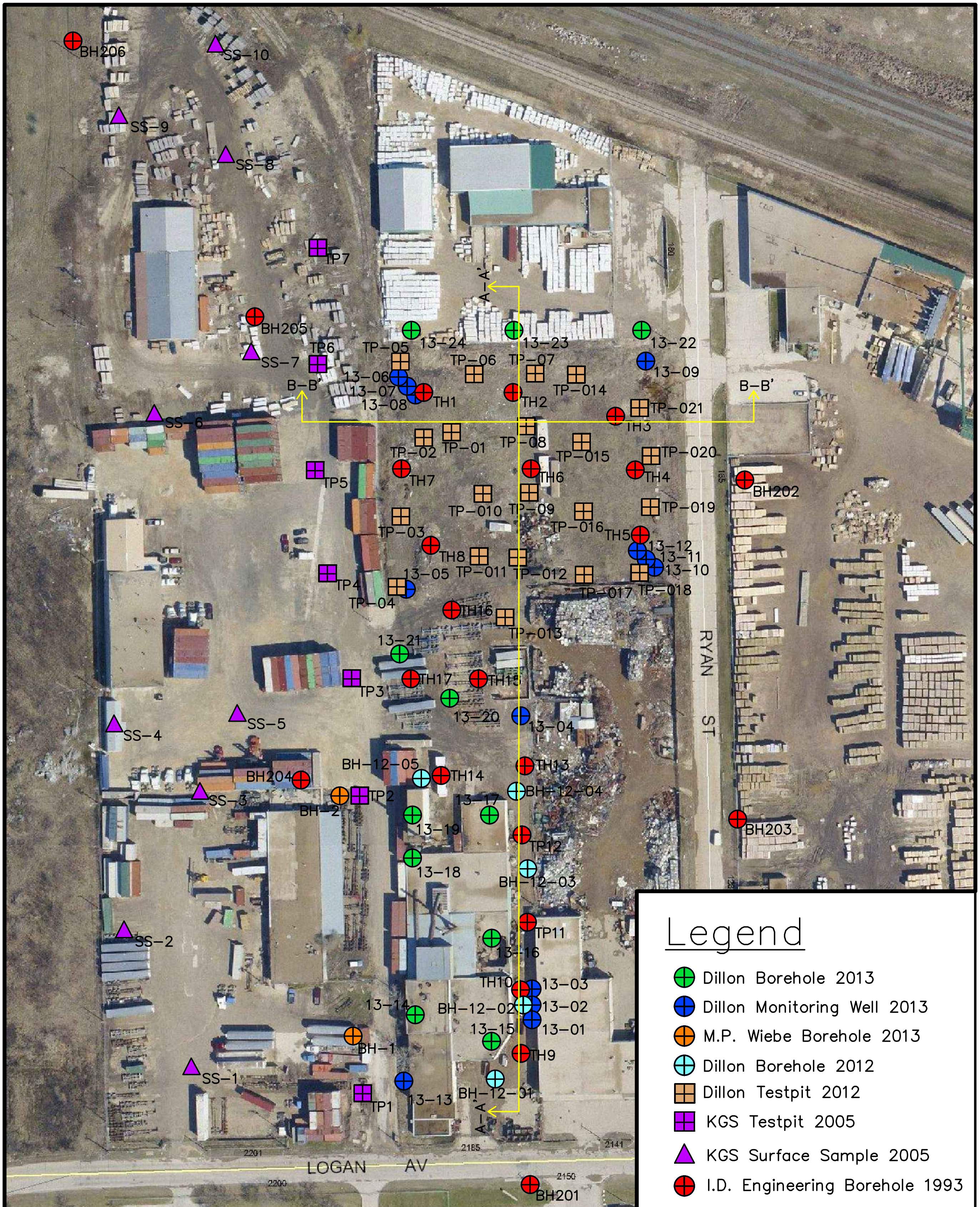
- DILLON TEST PITS 2012
- DILLON BORE HOLES 2012
- DILLON BORE HOLES 2013
- DILLON MONITORING WELLS 2013

PROJECT North West Smelting and Refining

PROJECT NO. 10-3834

TITLE Site Topography

FIGURE NO. 3



DILLON CONSULTING

	PROJECT North West Smelting and Refining	PROJECT NO. 10-3834
DATE October 2013	TITLE Sampling Locations from 1993 to 2013	FIGURE NO. 4

FileName:c:\users\40ik\desktop\nwsr_ik.dwg

Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba

SUBSURFACE DIAGRAM
Stratigraphic Cross-Section A-A'

CLIENT Northwest Smelting & Refinery

PROJECT NUMBER 10-3834

PROJECT NAME 2013 Environmental Site Assessment

PROJECT LOCATION 2185 Logan Ave

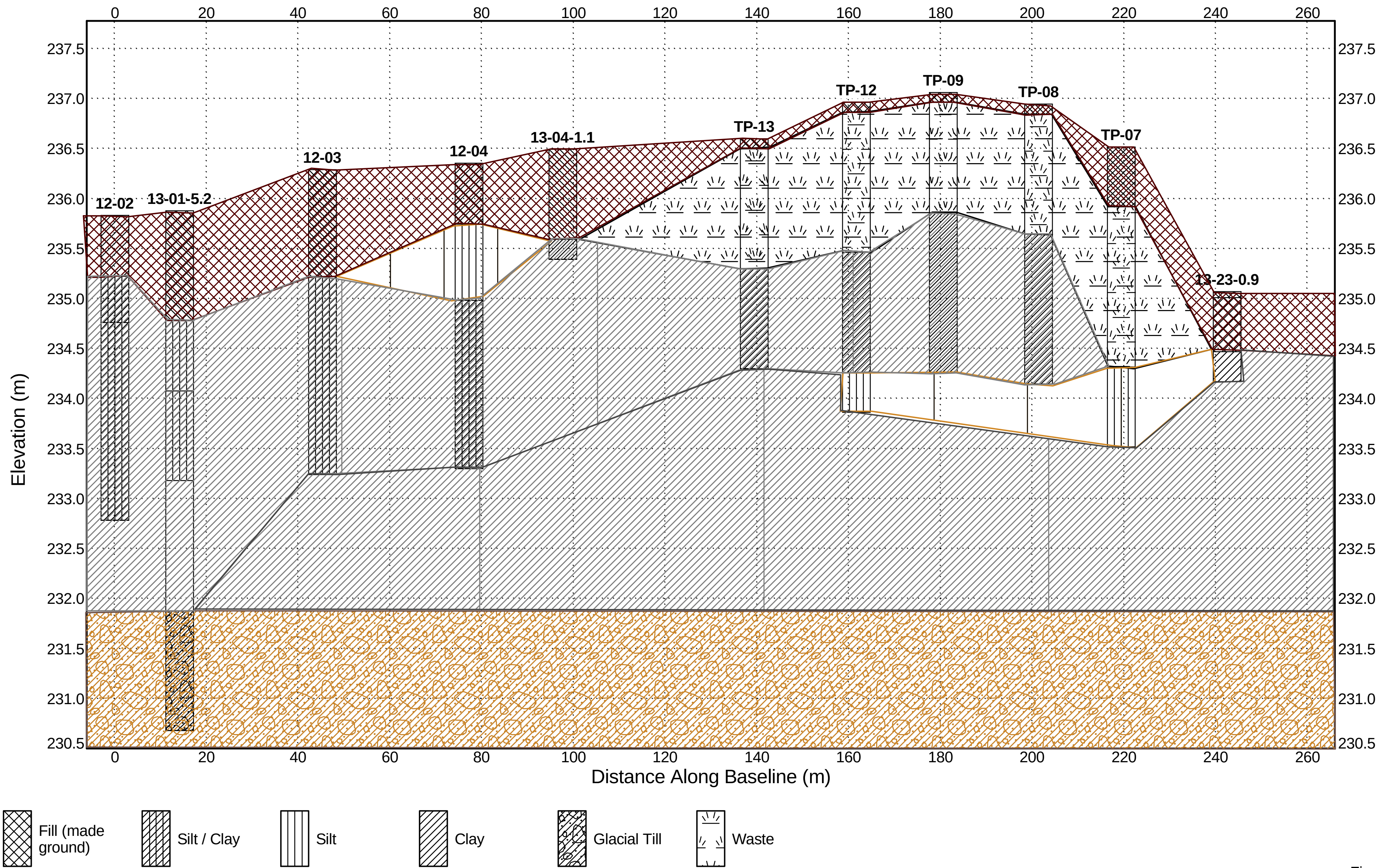


Figure 5

Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba

SUBSURFACE DIAGRAM
Stratigraphic Cross-Section B-B'

CLIENT Northwest Smelting & Refinery
PROJECT NUMBER 10-3834
PROJECT NAME 2013 Environmental Site Assessment
PROJECT LOCATION 2185 Logan Ave

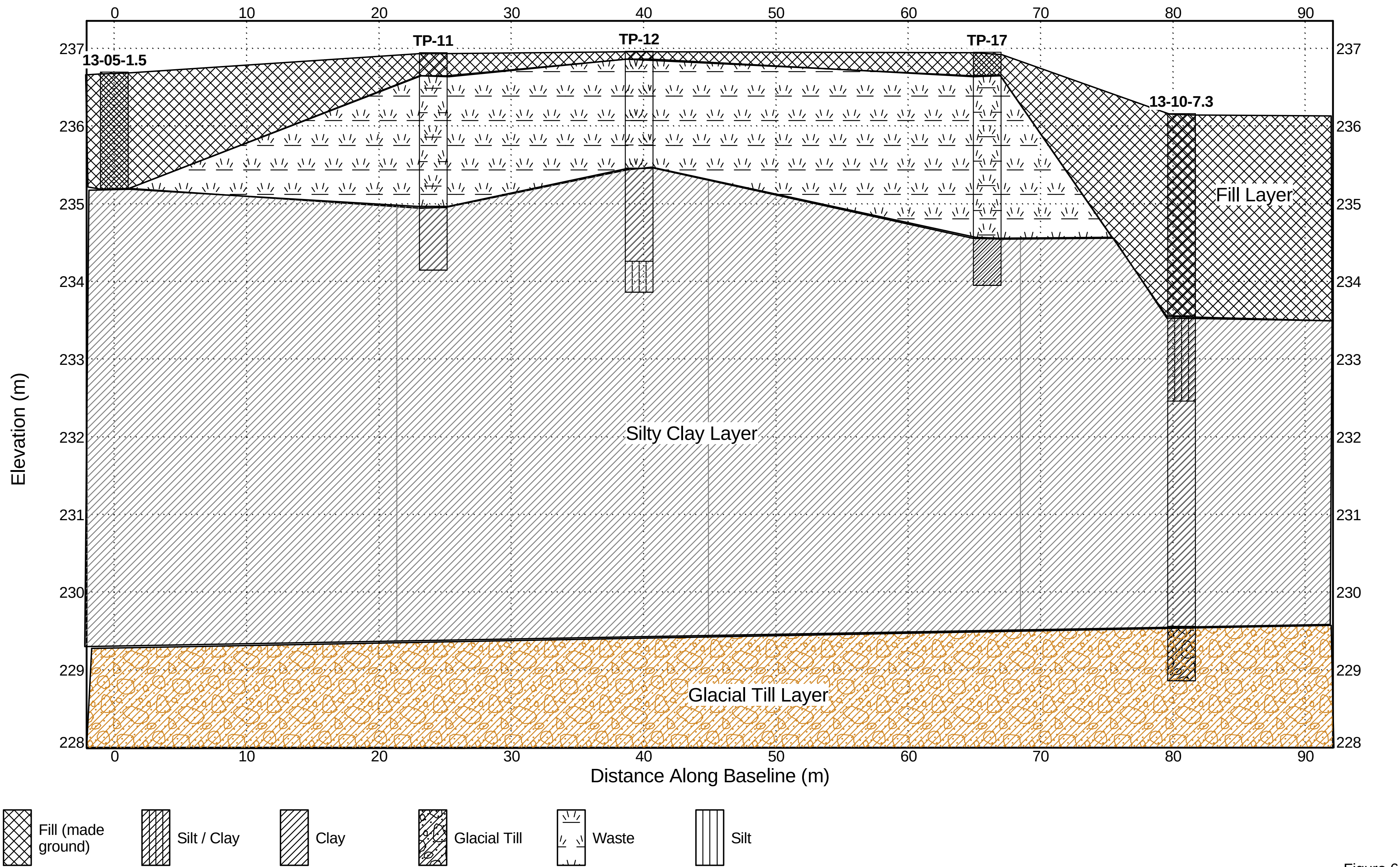


Figure 6

LEGEND

Arrows Indicate Observed Groundwater Flow Direction

✦ Monitoring Well

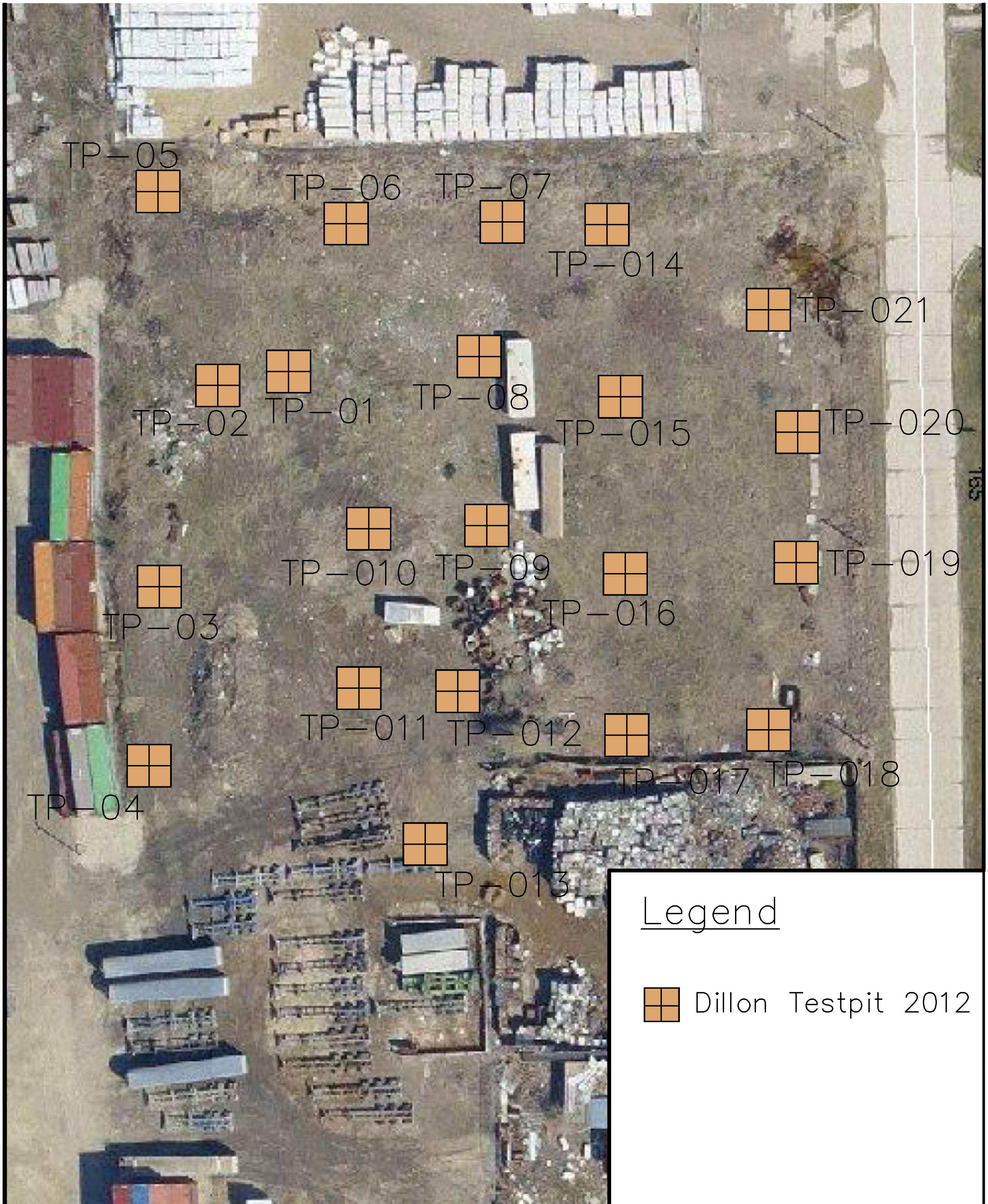
DILLON CONSULTING

OCT 2013

TITLE
Shallow Groundwater Levels and
Indicated Shallow Groundwater Flow Direction, May 2013
2185 Logan Ave, Winnipeg Manitoba

PROJ. NO.
10-3834

FIG. NO.
7



DILLON CONSULTING

PROJECT: North West Smelting and Refining

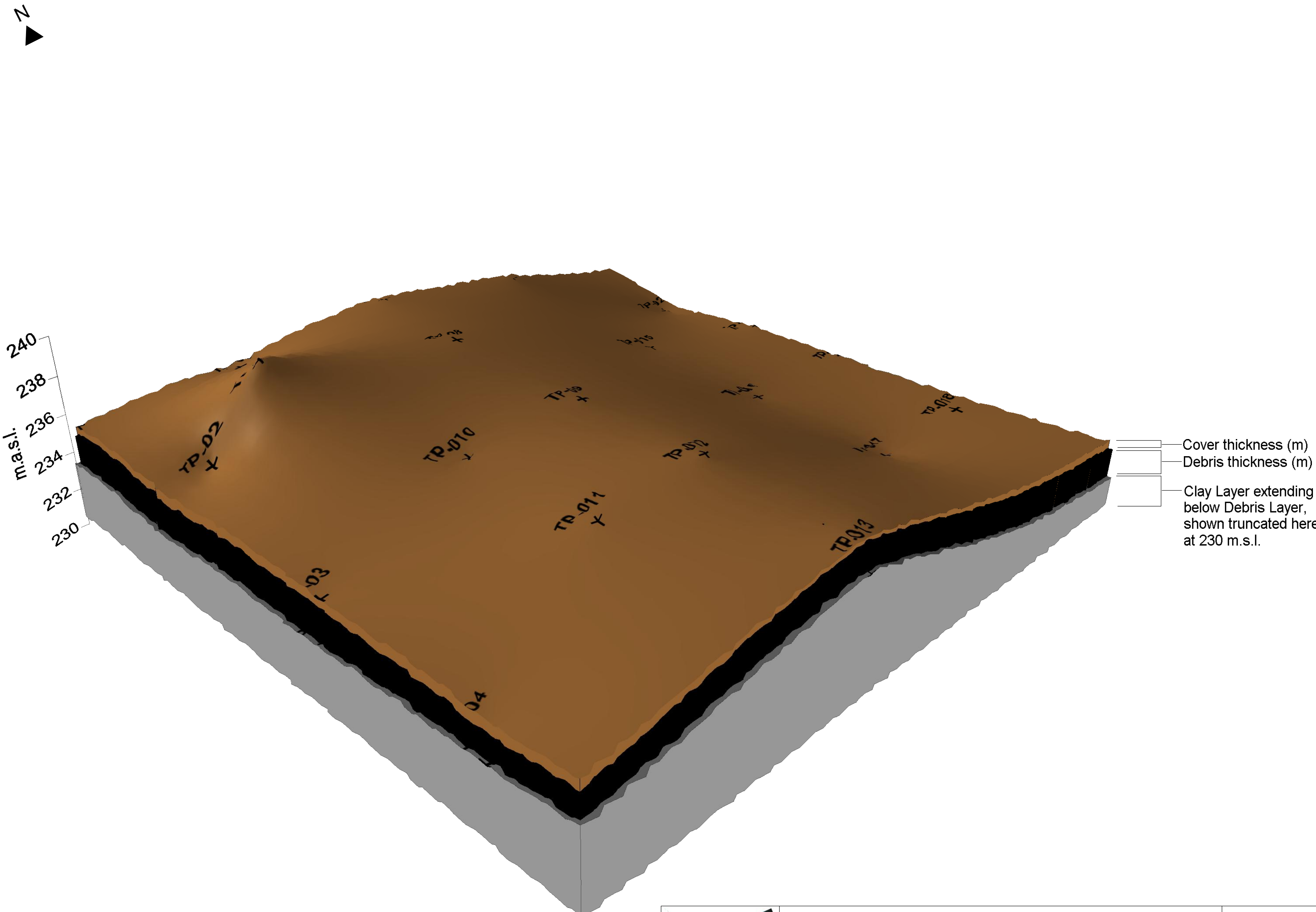
PROJECT NO.: 10-3834

TITLE: APEC #1 (North End) Test Pitting Locations

FIGURE NO.: 8

DATE: October 2013

FileName:c:\users\40ik\desktop\nwsr_ik.dwg



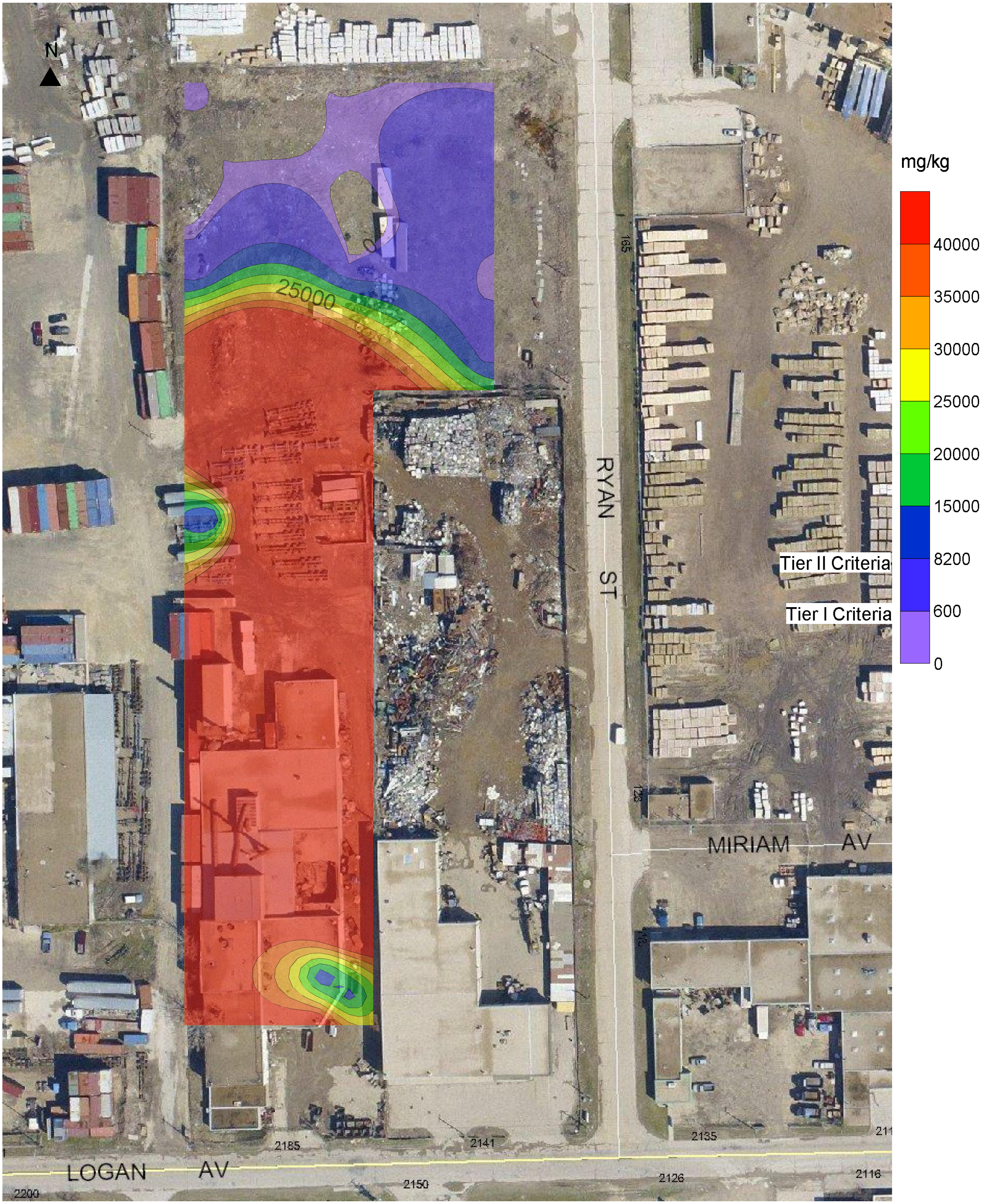
DILLON CONSULTING

OCT 2013

TITLE
Soil Cap and Debris Layer Thickness (m), November 2012
2185 Logan Ave, Winnipeg Manitoba

PROJ. NO.
10-3834

FIG. NO.
9



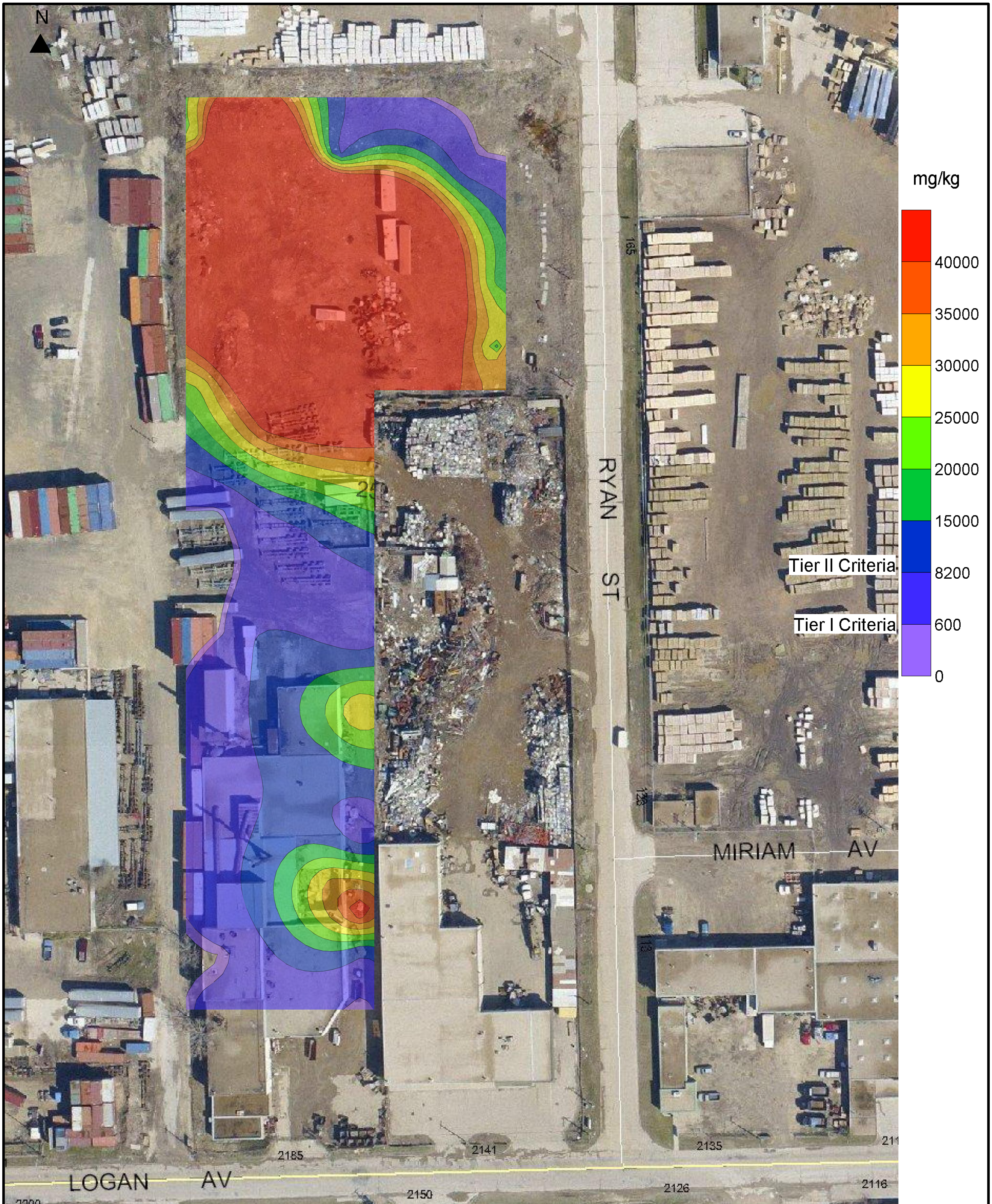
DILLON CONSULTING

AUG 2014

TITLE
Lead Concentration Contours in Soil, 1991-2013.
Soil Depths 0 - 0.5 m
2185 Logan Ave, Winnipeg Manitoba

PROJ. NO.
10-3834

FIG. NO.
10



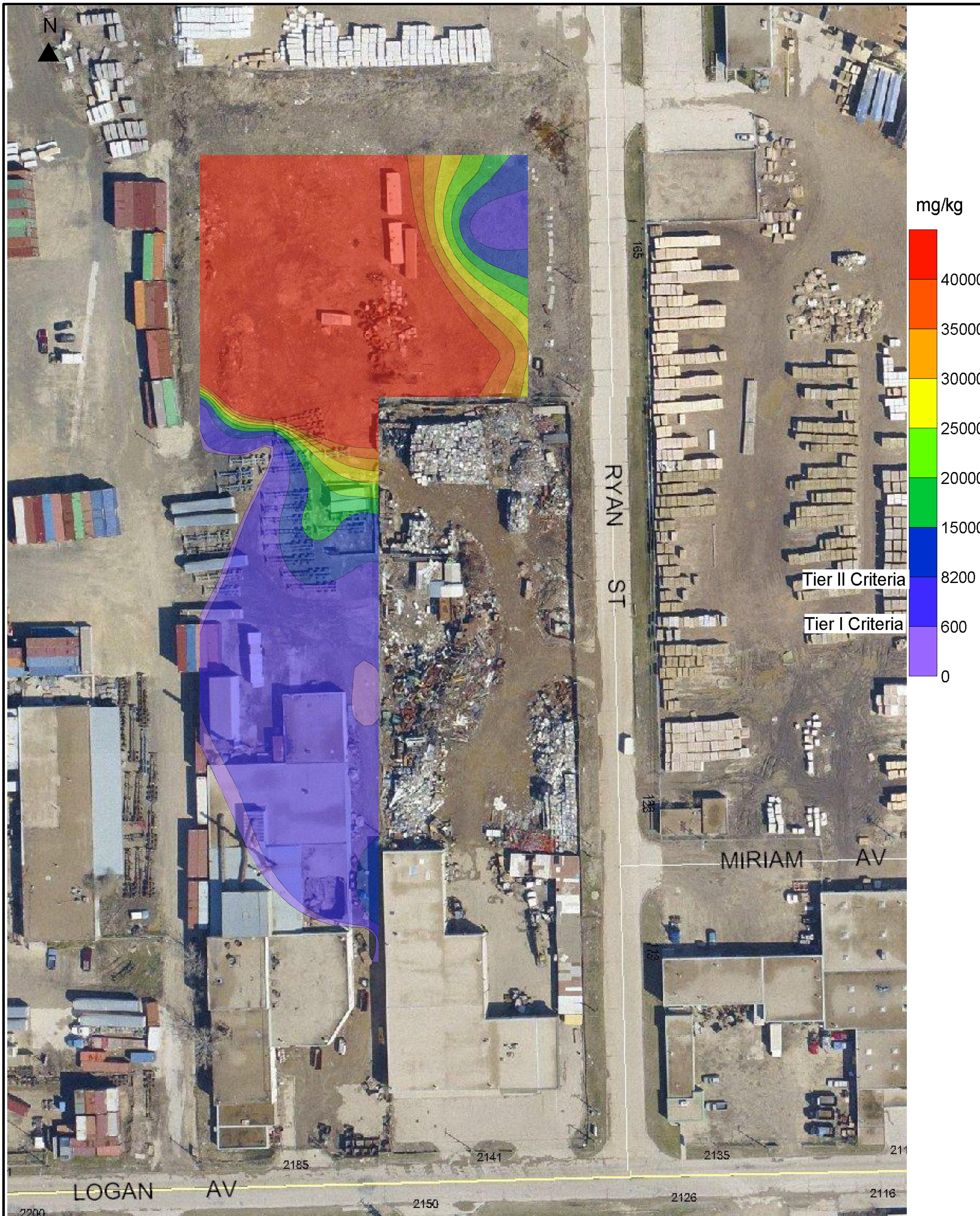
DILLON CONSULTING

AUG 2014

TITLE
Lead Concentration Contours in Soil, 1991-2013.
Soil Depths 0.5 - 1.0 m
2185 Logan Ave, Winnipeg Manitoba

PROJ. NO.
10-3834

FIG. NO.
11



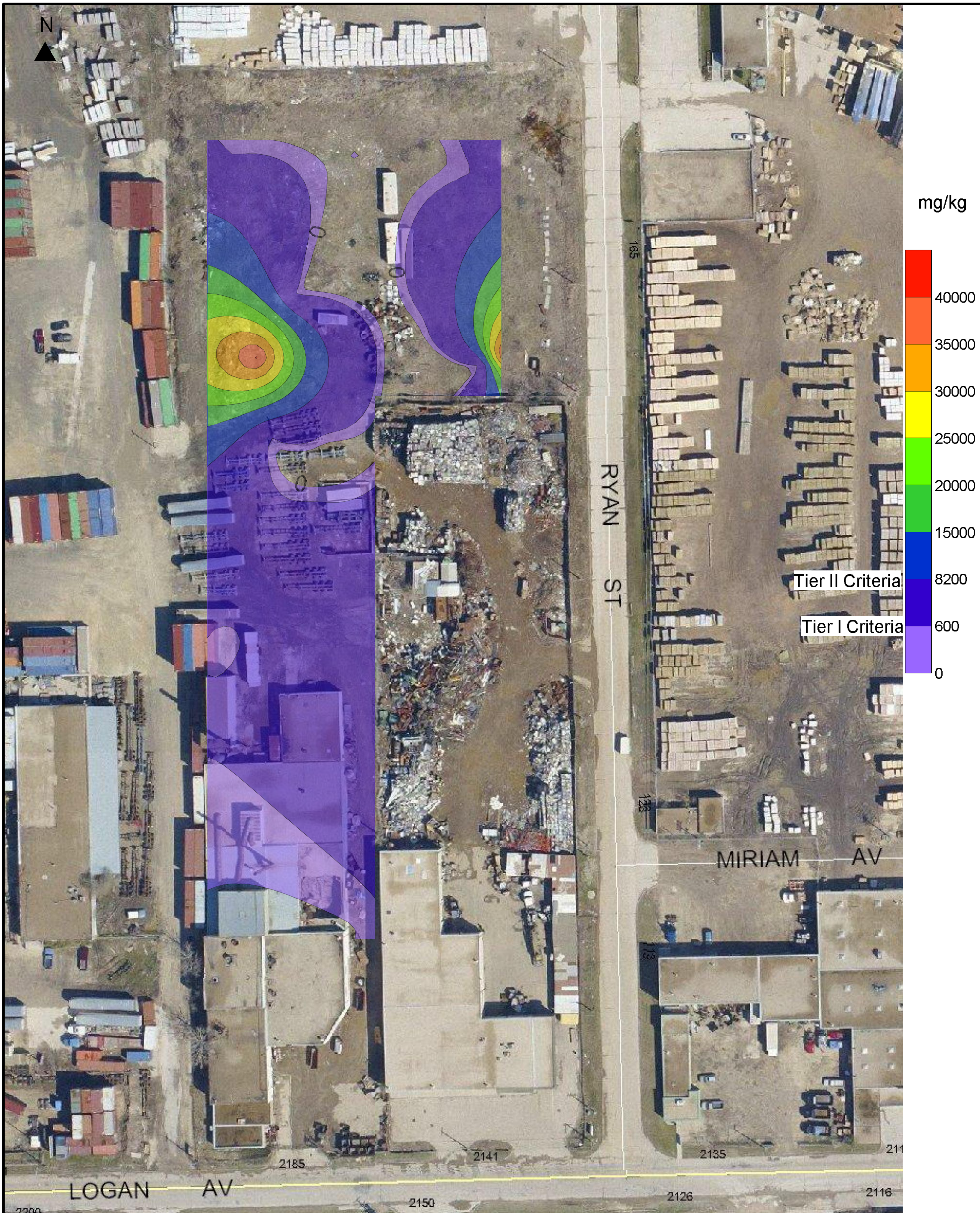
DILLON CONSULTING

AUG 2014

TITLE
Lead Concentration Contours in Soil, 1991-2013.
Soil Depths1.0 - 2.0 m
2185 Logan Ave, Winnipeg Manitoba

PROJ. NO.
10-3834

FIG. NO.
12



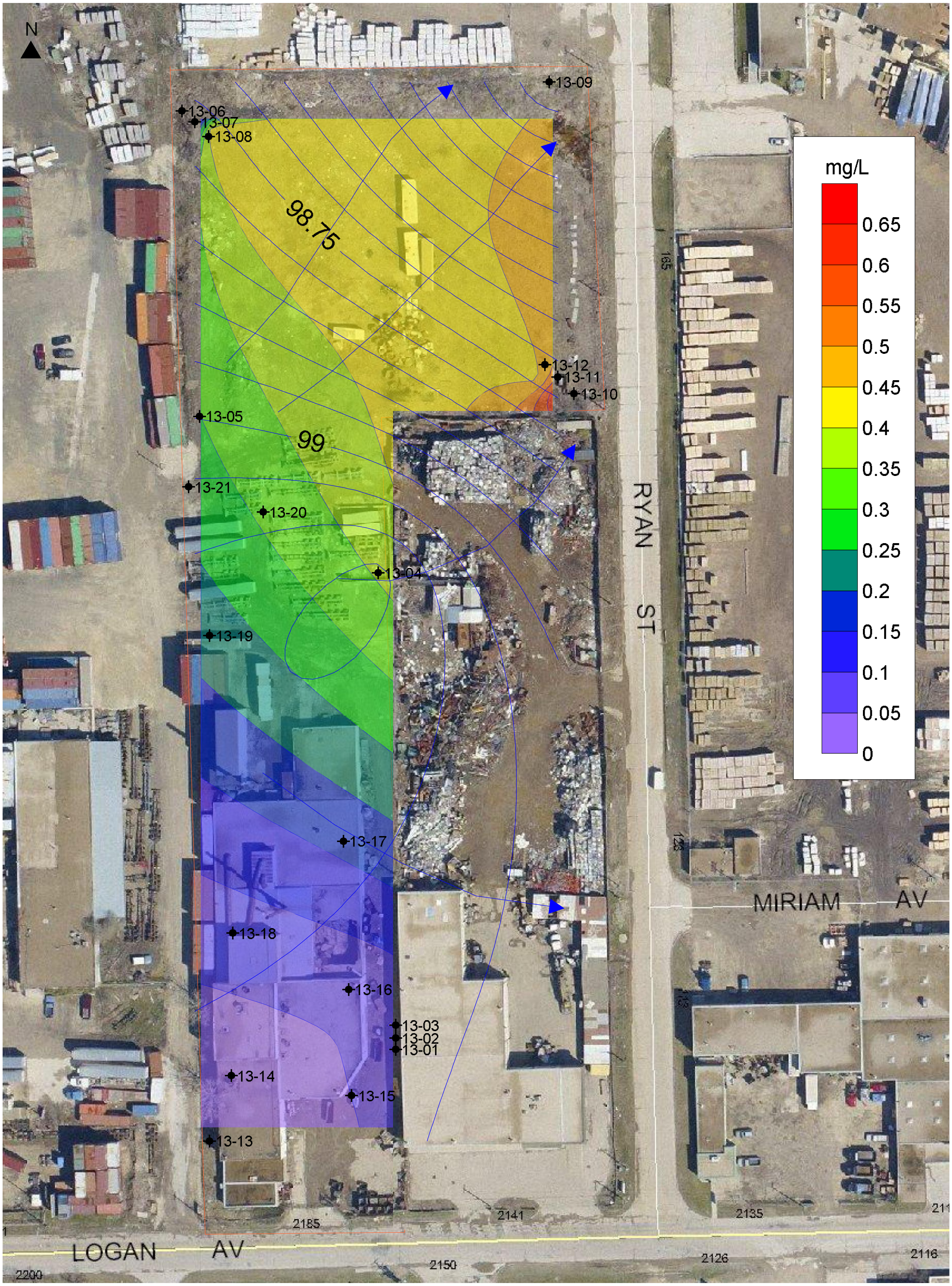
DILLON CONSULTING

AUG 2014

TITLE
Lead Concentration Contours in Soil, 1991-2013.
Soil Depths >2 m
2185 Logan Ave, Winnipeg Manitoba

PROJ. NO.
10-3834

FIG. NO.
13



LEGEND

Arrows Indicate Observed Groundwater Flow Direction

Monitoring Well

DILLON CONSULTING

OCT 2013

TITLE
Concentration Contours of Lead in Groundwater, July-August 2013
2185 Logan Ave, Winnipeg Manitoba

PROJ. NO.
10-3834

FIG. NO.
14

Appendix A

Borehole Logs

Dillon Consulting Ltd.
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Telephone: 204-453-2301

TP-01

Client: North West Smelting & Refining	Project: Environmental Investigation
Project No.: 10-3834-3001	Location: See Siteplan
Drilling Co.: Western	Drilling Method: Excavator
Supervised by: CWB	Date Started: 11/13/12 Date Completed: 11/13/12

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Notes	Sample Method	Sample Number	N Value	Rec %	VOC (ppm or %LEL)	Depth Scale (m)
	Loose, Brown Sand & Gravel Fill	Fill (made ground)								
	Silty, black, organic topsoil	Fill (made ground)	0.3							
0.5	Debris	Waste	0.5							0.5
1.0										1.0
1.5										1.5
					Grab Sample	TP-01-01				
2.0										2.0
2.5	Firm, moist, grey clay	Clay	2.4							2.5
					Grab Sample	TP-01-02				
3.0			3							3.0

DILLON BH 10-3834-3001 - A TO A'.GPJ DILLON TEMPLATE.GDT 4/10/14

LITHOLOGY SYMBOLS: Fill (made ground); Clay; Waste

SAMPLE TYPE: Grab Sample

* Indicates sample submitted for analysis

Dillon Consulting Ltd.
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Telephone: 204-453-2301

TP-02

Client: North West Smelting & Refining
Project No.: 10-3834-3001
Drilling Co.: Western
Supervised by: CWB
Project: Environmental Investigation
Location: See Siteplan
Drilling Method: Excavator
Date Started: 11/13/12
Date Completed: 11/13/12

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Notes	Sample Method	Sample Number	N Value	Rec %	VOC (ppm or %LEL)	Depth Scale (m)
	Clay Topsoil with organics	Fill (made ground)			Grab Sample	TP-02-01				
0.5										0.5
	Debris	Waste	0.6							
1.0										1.0
1.5					Grab Sample	TP-02-03				1.5
2.0										2.0
	Grey Clay	Clay	2.1							
2.5					Grab Sample	TP-02-02				2.5
			2.6							

LITHOLOGY SYMBOLS: Fill (made ground); Waste; Clay

SAMPLE TYPE: Grab Sample

* Indicates sample submitted for analysis

DILLON BH 10-3834-3001 - A TO A'.GPJ DILLON TEMPLATE.GDT 4/10/14

DILLON CONSULTING

Dillon Consulting Ltd.
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Telephone: 204-453-2301

TP-03

Client: North West Smelting & Refining
Project No.: 10-3834-3001
Drilling Co.: Western
Supervised by: CWB

Project: Environmental Investigation
Location: See Siteplan
Drilling Method: Excavator
Date Started: 11/13/12 Date Completed: 11/13/12

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Notes	Sample Method	Sample Number	N Value	Rec %	VOC (ppm or %LEL)	Depth Scale (m)
	Clay Topsoil	Fill			Grab	TP-03-01				
0.5	Debris	Waste	0.5							0.5
1.0										1.0
1.5					Grab	TP-03-02				1.5
2.0	Grey Clay (Layer of black at interface)	Clay	2							2.0
2.5					Grab	TP-03-03				2.5
			2.8							

LITHOLOGY SYMBOLS: Fill (made ground); Waste; Clay

SAMPLE TYPE: Grab Sample

* Indicates sample submitted for analysis

DILLON BH 10-3834-3001 - A TO A'.GPJ DILLON TEMPLATE.GDT 4/10/14

Dillon Consulting Ltd.
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Telephone: 204-453-2301

TP-04

Client: North West Smelting & Refining	Project: Environmental Investigation
Project No.: 10-3834-3001	Location: See Siteplan
Drilling Co.: Western	Drilling Method: Excavator
Supervised by: CWB	Date Started: 11/13/12 Date Completed: 11/13/12

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Notes	Sample Method	Sample Number	N Value	Rec %	VOC (ppm or %LEL)	Depth Scale (m)
	Clay Topsoil	Fill (made ground)			Grab Sample	TP-04-01				
0.5										0.5
	Debris	Waste	0.6							
1.0					Grab Sample	TP-04-02				1.0
1.5										1.5
	Black Clay	Clay	1.6		Grab Sample	TP-04-03				
2.0										2.0
	Grey Clay	Clay	2.2							
2.5										2.5
			2.8							

DILLON BH 10-3834-3001 - A TO A'.GPJ DILLON TEMPLATE.GDT 4/10/14

LITHOLOGY SYMBOLS: Fill (made ground); Clay; Waste

SAMPLE TYPE: Grab Sample

* Indicates sample submitted for analysis

Dillon Consulting Ltd.
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Telephone: 204-453-2301

TP-05

Client: North West Smelting & Refining
Project: Environmental Investigation
Project No.: 10-3834-3001
Location: See Siteplan
Drilling Co.: Western
Drilling Method: Excavator
Supervised by: CWB
Date Started: 11/13/12
Date Completed: 11/13/12

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Notes	Sample Method	Sample Number	N Value	Rec %	VOC (ppm or %LEL)	Depth Scale (m)
	Clay Topsoil	Fill (made ground)			Grab Sample	TP-05-01				
0.5	Debris	Waste	0.3							0.5
1.0										1.0
1.5					Grab Sample	TP-05-02				1.5
2.0	Grey Clay	Clay	1.9							2.0
2.5			2.5		Grab Sample	TP-05-03				2.5

LITHOLOGY SYMBOLS: Fill (made ground); Clay; Waste

SAMPLE TYPE: Grab Sample

* Indicates sample submitted for analysis

Dillon Consulting Ltd.
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Telephone: 204-453-2301

TP-06

Client: North West Smelting & Refining
Project: Environmental Investigation
Project No.: 10-3834-3001
Location: See Siteplan
Drilling Co.: Western
Drilling Method: Excavator
Supervised by: CWB
Date Started: 11/13/12
Date Completed: 11/13/12

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Notes	Sample Method	Sample Number	N Value	Rec %	VOC (ppm or %LEL)	Depth Scale (m)
	Silty Clay Topsoil	Fill (made ground)			Grab Sample	TP-06-01				
0.5	Debris	Waste	0.4							0.5
1.0										1.0
1.5					Grab Sample	TP-06-02				1.5
2.0										2.0
2.5	Grey Clay	Clay	2.4		Grab Sample	TP-06-03				2.5
			2.9							

LITHOLOGY SYMBOLS: Fill (made ground); Clay; Waste

SAMPLE TYPE: Grab Sample

* Indicates sample submitted for analysis

Dillon Consulting Ltd.
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Telephone: 204-453-2301

TP-07

Client: North West Smelting & Refining
Project No.: 10-3834-3001
Drilling Co.: Western
Supervised by: CWB

Project: Environmental Investigation
Location: See Siteplan
Drilling Method: Excavator
Date Started: 11/13/12 Date Completed: 11/13/12

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Notes	Sample Method	Sample Number	N Value	Rec %	VOC (ppm or %LEL)	Depth Scale (m)
	Silty Clay Topsoil	Fill			Grab	TP-07-01				
0.5										0.5
	Debris	Waste	0.6							
1.0										1.0
1.5					Grab	TP-07-01				1.5
2.0										2.0
	Brown Silt (Black at interface)	Silt	2.2							
2.5					Grab	TP-07-01				2.5
3.0			3							3.0

LITHOLOGY SYMBOLS: Fill (made ground); Waste; Silt

SAMPLE TYPE: Grab Sample

* Indicates sample submitted for analysis

Dillon Consulting Ltd.
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Telephone: 204-453-2301

TP-08

Client: North West Smelting & Refining
Project: Environmental Investigation
Project No.: 10-3834-3001
Location: See Siteplan
Drilling Co.: Western
Drilling Method: Excavator
Supervised by: CWB
Date Started: 11/13/12
Date Completed: 11/13/12

Surface Elevation (m): 99.36

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Notes	Sample Method	Sample Number	N Value	Rec %	VOC (ppm or %LEL)	Depth Scale (m)
	Silty Clay Topsoil	Fill (made ground)			Grab Sample	TP-08-01				
0.5										0.5
	Debris	Waste	0.7							
1.0										1.0
					Grab Sample	TP-08-02				
1.5										1.5
2.0										2.0
	Grey Clay	USCS Low Plasticity Clay	2.2							
2.5										2.5
			2.9		Grab Sample	TP-08-03				

LITHOLOGY SYMBOLS: Fill (made ground); Waste; USCS Low Plasticity Clay

SAMPLE TYPE: Grab Sample

* Indicates sample submitted for analysis

Dillon Consulting Ltd.
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Telephone: 204-453-2301

TP-09

Client: North West Smelting & Refining	Project: Environmental Investigation
Project No.: 10-3834-3001	Location: See Siteplan
Drilling Co.: Western	Drilling Method: Excavator
Supervised by: CWB	Date Started: 11/13/12 Date Completed: 11/13/12

Surface Elevation (m): 99.39

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Notes	Sample Method	Sample Number	N Value	Rec %	VOC (ppm or %LEL)	Depth Scale (m)
	Silty Clay Topsoil	Fill (made ground)			Grab Sample	TP-09-01				
0.5										0.5
	Debris	Waste	0.6							
1.0										1.0
1.5					Grab Sample	TP-09-02				1.5
2.0										2.0
			2.3							
2.5										2.5
	Grey Clay		2.9		Grab Sample	TP-09-03				

LITHOLOGY SYMBOLS: Fill (made ground); Waste

SAMPLE TYPE: Grab Sample

* Indicates sample submitted for analysis

Dillon Consulting Ltd.
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Telephone: 204-453-2301

TP-10

Client: North West Smelting & Refining
Project No.: 10-3834-3001
Drilling Co.: Western
Supervised by: CWB
Project: Environmental Investigation
Location: See Siteplan
Drilling Method: Excavator
Date Started: 11/13/12
Date Completed: 11/13/12

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Notes	Sample Method	Sample Number	N Value	Rec %	VOC (ppm or %LEL)	Depth Scale (m)
	Silty Clay Topsoil	Fill (made ground)			Grab	TP-10-01				
0.5										0.5
	Debris	Waste	0.6							
1.0										1.0
					Grab	TP-10-02				
1.5										1.5
2.0										2.0
	Grey Clay	Clay	2.2							
2.5										2.5
					Grab	TP-10-03				
			3							

LITHOLOGY SYMBOLS: Fill (made ground); Waste; Clay

SAMPLE TYPE: Grab Sample

* Indicates sample submitted for analysis

Dillon Consulting Ltd.
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Telephone: 204-453-2301

TP-11

Client: North West Smelting & Refining
Project No.: 10-3834-3001
Drilling Co.: Western
Supervised by: CWB

Project: Environmental Investigation
Location: See Siteplan
Drilling Method: Excavator
Date Started: 11/13/12 Date Completed: 11/13/12

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Notes	Sample Method	Sample Number	N Value	Rec %	VOC (ppm or %LEL)	Depth Scale (m)
	Silty Clay Topsoil	Fill			Grab	TP-11-1-01				
0.5	Debris	Waste	0.3							0.5
1.0										1.0
1.5					Grab	TP-11-02				1.5
2.0	Grey Clay	Clay	2							2.0
					Grab	TP-11-03				
			2.8							

LITHOLOGY SYMBOLS: Fill (made ground); Clay; Waste

SAMPLE TYPE: Grab Sample

* Indicates sample submitted for analysis

DILLON BH 10-3834-3001 - A TO A'.GPJ DILLON TEMPLATE.GDT 4/10/14

Dillon Consulting Ltd.
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Telephone: 204-453-2301

TP-12

Client: North West Smelting & Refining
Project No.: 10-3834-3001
Drilling Co.: Western
Supervised by: CWB
Project: Environmental Investigation
Location: See Siteplan
Drilling Method: Excavator
Date Started: 11/13/12
Date Completed: 11/13/12

Surface Elevation (m): 99.31

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Notes	Sample: Method	Sample: Number	Sample: N Value	Sample: Rec %	Sample: VOC (ppm or %LEL)	Depth Scale (m)
	Silty Clay Topsoil	Fill (made ground)								
	Debris	Waste	0.1		Grab Sample	TP-12-01				
0.5										0.5
1.0										1.0
1.5	Grey Clay	USCS Low Plasticity Clay	1.5		Grab Sample	TP-12-02				1.5
2.0										2.0
2.5										2.5
			2.7		Grab Sample	TP-12-03				

LITHOLOGY SYMBOLS: Fill (made ground); Waste; USCS Low Plasticity Clay

SAMPLE TYPE: Grab Sample

* Indicates sample submitted for analysis

Dillon Consulting Ltd.
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Telephone: 204-453-2301

TP-13

Client: North West Smelting & Refining
Project No.: 10-3834-3001
Drilling Co.: Western
Supervised by: CWB

Project: Environmental Investigation
Location: See Siteplan
Drilling Method: Excavator
Date Started: 11/13/12 Date Completed: 11/13/12

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Notes	Sample Method	Sample Number	N Value	Rec %	VOC (ppm or %LEL)	Depth Scale (m)
	Gravel Fill	Fill (made ground)	0.1							
0.5	Debris	Waste								0.5
					Grab Sample	TP-13-01				
1.0										1.0
	Grey Clay	Clay	1.3							
1.5										1.5
2.0										2.0
			2.3		Grab Sample	TP-13-02				

LITHOLOGY SYMBOLS: Fill (made ground); Waste; Clay

SAMPLE TYPE: Grab Sample

* Indicates sample submitted for analysis

Dillon Consulting Ltd.
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Telephone: 204-453-2301

TP-14

Client: North West Smelting & Refining
Project: Environmental Investigation
Project No.: 10-3834-3001
Location: See Siteplan
Drilling Co.: Western
Drilling Method: Excavator
Supervised by: CWB
Date Started: 11/14/12
Date Completed: 11/14/12

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Notes	Sample Method	Sample Number	N Value	Rec %	VOC (ppm or %LEL)	Depth Scale (m)
	Brown Silty Clay	Silt / Clay			Grab Sample	TP-14-01				
0.5	Black Silty Clay with Organics	Silt / Clay	0.4		Grab Sample	TP-14-02				0.5
1.0										1.0
1.5										1.5
	Brown Silt	Silt	1.7							
2.0			2.1							2.0

LITHOLOGY SYMBOLS: Silt / Clay; Silt

SAMPLE TYPE: Grab Sample

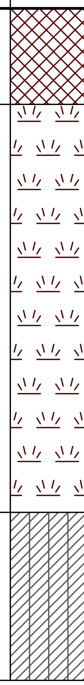
* Indicates sample submitted for analysis

Dillon Consulting Ltd.
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Telephone: 204-453-2301

TP-15

Client: North West Smelting & Refining	Project: Environmental Investigation
Project No.: 10-3834-3001	Location: See Siteplan
Drilling Co.: Western	Drilling Method: Excavator
Supervised by: CWB	Date Started: 11/14/12 Date Completed: 11/14/12

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Notes	Sample: Method	Sample: Number	Sample: N Value	Sample: Rec %	Sample: VOC (ppm or %LEL)	Depth Scale (m)
	Silty Clay Topsoil					TP-15-01				
0.5	Debris		0.4							0.5
1.0										1.0
1.5						TP-15-02				1.5
2.0										2.0
	Grey clay & brown silt		2.1							
2.5						TP-15-03				2.5
			2.8							



LITHOLOGY SYMBOLS: Fill (made ground); Silt / Clay; Waste

SAMPLE TYPE

* Indicates sample submitted for analysis

Dillon Consulting Ltd.
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Telephone: 204-453-2301

TP-16

Client: North West Smelting & Refining	Project: Environmental Investigation
Project No.: 10-3834-3001	Location: See Siteplan
Drilling Co.: Western	Drilling Method: Excavator
Supervised by: CWB	Date Started: 11/14/12 Date Completed: 11/14/12

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Notes	Sample Method	Sample Number	N Value	Rec %	VOC (ppm or %LEL)	Depth Scale (m)
	Silty Clay Topsoil	Fill			Grab	TP-16-01				
0.5	Debris	Waste	0.4							0.5
1.0					Grab	TP-16-02				1.0
1.5										1.5
2.0										2.0
2.5	Grey Clay	Clay	2.3		Grab	TP-16-03				2.5
3.0			3							3.0

LITHOLOGY SYMBOLS: Fill (made ground); Clay; Waste

SAMPLE TYPE: Grab Sample

* Indicates sample submitted for analysis

Dillon Consulting Ltd.
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Telephone: 204-453-2301

TP-17

Client: North West Smelting & Refining
Project: Environmental Investigation
Project No.: 10-3834-3001
Location: See Siteplan
Drilling Co.: Western
Drilling Method: Excavator
Supervised by: CWB
Date Started: 11/14/12
Date Completed: 11/14/12

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Notes	Sample Method	Sample Number	N Value	Rec %	VOC (ppm or %LEL)	Depth Scale (m)
	Silty Clay Topsoil	Fill (made ground)			Grab Sample	TP-17-01				
0.5	Debris	Waste	0.3							0.5
1.0										1.0
1.5										1.5
2.0					Grab Sample	TP-17-02				2.0
2.5	Grey Clay	Clay	2.4							2.5
3.0			3		Grab Sample	TP-17-03				3.0

DILLON BH 10-3834-3001 - A TO A'.GPJ DILLON TEMPLATE.GDT 4/10/14

LITHOLOGY SYMBOLS: Fill (made ground); Clay; Waste

SAMPLE TYPE: Grab Sample

* Indicates sample submitted for analysis

Dillon Consulting Ltd.
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Telephone: 204-453-2301

TP-18

Client: North West Smelting & Refining
Project: Environmental Investigation
Project No.: 10-3834-3001
Location: See Siteplan
Drilling Co.: Western
Drilling Method: Excavator
Supervised by: CWB
Date Started: 11/14/12
Date Completed: 11/14/12

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Notes	Sample Method	Sample Number	N Value	Rec %	VOC (ppm or %LEL)	Depth Scale (m)
	Silty Clay Topsoil	Fill			Grab	TP-18-01				
0.5	Debris	Waste	0.4							0.5
1.0					Grab	TP-18-02				1.0
1.5										1.5
2.0										2.0
	Grey clay & brown silt	Silt / Clay	2.2							
2.5					Grab	TP-18-03				2.5
			2.9							

LITHOLOGY SYMBOLS: Fill (made ground); Waste; Silt / Clay

SAMPLE TYPE: Grab Sample

* Indicates sample submitted for analysis

Dillon Consulting Ltd.
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Telephone: 204-453-2301

TP-19

Client: North West Smelting & Refining
Project No.: 10-3834-3001
Drilling Co.: Western
Supervised by: CWB

Project: Environmental Investigation
Location: See Siteplan
Drilling Method: Excavator
Date Started: 11/14/12 Date Completed: 11/14/12

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Notes	Sample: Method	Number	N Value	Rec %	VOC (ppm or %LEL)	Depth Scale (m)
	Silty Clay Topsoil	Fill (made ground)								
0.5	Debris	Waste	0.4							0.5
1.0					Grab Sample	TP-196-02				1.0
1.5										1.5
2.0										2.0
2.5	Grey clay & brown silt	Silt / Clay	2.2							2.5
			2.9							

LITHOLOGY SYMBOLS: Fill (made ground); Silt / Clay; Waste

SAMPLE TYPE: Grab Sample

* Indicates sample submitted for analysis

Dillon Consulting Ltd.
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Telephone: 204-453-2301

TP-20

Client: North West Smelting & Refining	Project: Environmental Investigation
Project No.: 10-3834-3001	Location: See Siteplan
Drilling Co.: Western	Drilling Method: Excavator
Supervised by: CWB	Date Started: 11/14/12 Date Completed: 11/14/12

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Notes	Sample: Method	Sample: Number	Sample: N Value	Sample: Rec %	Sample: VOC (ppm or %LEL)	Depth Scale (m)
	Silty Clay Topsoil	Fill (made ground)								
0.5	Debris	Waste	0.5							0.5
1.0					Grab Sample	TP20-02				1.0
1.5										1.5
2.0	Black, grey clay & brown silt	Silt / Clay	1.8							2.0
2.5										2.5
3.0			3							3.0

LITHOLOGY SYMBOLS: Fill (made ground); Waste; Silt / Clay

SAMPLE TYPE: Grab Sample

* Indicates sample submitted for analysis

Dillon Consulting Ltd.
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Telephone: 204-453-2301

TP-21

Client: North West Smelting & Refining
Project No.: 10-3834-3001
Drilling Co.: Western
Supervised by: CWB

Project: Environmental Investigation
Location: See Siteplan
Drilling Method: Excavator
Date Started: 11/14/12 Date Completed: 11/14/12

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Notes	Sample Method	Sample Number	N Value	Rec %	VOC (ppm or %LEL)	Depth Scale (m)
	Silty Clay Topsoil	Fill (made ground)								
0.5	Silty Clay & Gravel, fill with concrete & rebar.	Silty Clay and Gravel	0.4							0.5
1.0										1.0
1.5	Brown Silt, black and clayey @ interface.	Silt	1.1		Grab Sample	TP-21-03				1.5
			1.9							

LITHOLOGY SYMBOLS: Fill (made ground); Silty Clay and Gravel; Silt

SAMPLE TYPE: Grab Sample

* Indicates sample submitted for analysis

Dillon Consulting Ltd.
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Telephone: 204-453-2301

12-01

Client: North West Smelting & Refining	Project: Environmental Investigation
Project No.: 10-3834-3001	Location: See Siteplan
Drilling Co.: Paddock Drilling	Drilling Method: Solid Stem Auger
Supervised by: CWB	Date Started: 7/12/12 Date Completed: 7/12/12

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Notes	Sample Method	Sample Number	N Value	Rec %	VOC (ppm or %LEL)	Depth Scale (m)
	SILT/GRAVEL FILL - Brown, loose, dry	Fill			Auger	1		*	0	
0.5										0.5
	SILT - Black, loose, wet	Silt	0.61		Auger	2			0	
1.0										1.0
	SILTY CLAY - Grey, firm, moist Mottled with gypsum inclusions below 8'	Silt / Clay	1.07							
1.5					Auger	3			0	1.5
2.0										2.0
					Auger	4			0	
2.5										2.5
3.0					Auger	5			0	3.0
			3.05							

LITHOLOGY SYMBOLS: Fill (made ground); Silt; Silt / Clay

SAMPLE TYPE: Auger

* Indicates sample submitted for analysis

Dillon Consulting Ltd.
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Telephone: 204-453-2301

12-02

Client: North West Smelting & Refining
Project No.: 10-3834-3001
Drilling Co.: Paddock Drilling
Supervised by: CWB
Project: Environmental Investigation
Location: See Siteplan
Drilling Method: Solid Stem Auger
Date Started: 7/12/12 Date Completed: 7/12/12

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Notes	Sample: Method	Sample: Number	Sample: N Value	Sample: Rec %	Sample: VOC (ppm or %LEL)	Depth Scale (m)
	SILT/GRAVEL FILL - Brown, loose, dry Becomes black with depth	Fill			Auger	1			0	
0.5										0.5
	SILTY CLAY - Black, firm, moist Bricks and debris noted	Silt / Clay	0.61		Auger	2		*	0	
1.0										1.0
	SILTY CLAY - Grey, firm, moist Mottled with gypsum inclusions below 7'	Silt / Clay	1.07							
1.5					Auger	3		*	0	1.5
2.0										2.0
					Auger	4			0	
2.5										2.5
3.0					Auger	5			0	3.0
			3.05							

LITHOLOGY SYMBOLS: Fill (made ground); Silt / Clay

SAMPLE TYPE: Auger

* Indicates sample submitted for analysis

Dillon Consulting Ltd.
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Telephone: 204-453-2301

12-03

Client: North West Smelting & Refining	Project: Environmental Investigation
Project No.: 10-3834-3001	Location: See Siteplan
Drilling Co.: Paddock Drilling	Drilling Method: Solid Stem Auger
Supervised by: CWB	Date Started: 7/12/12 Date Completed: 7/12/12

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Notes	Sample Method	Sample Number	N Value	Rec %	VOC (ppm or %LEL)	Depth Scale (m)
	CLAY FILL - Brown, some gravel, soft, moist Bricks and debris noted Becomes black with depth Wet 0.08m silt seam at 0.91m	Fill			Auger	1		*	0	
0.5										0.5
					Auger	2			5	
1.0										1.0
	SILTY CLAY - Grey, firm, moist Mottled with gypsum inclusions below 8'	Silt / Clay	1.07							
					Auger	3			0	
1.5										1.5
2.0										2.0
					Auger	4			5	
2.5										2.5
3.0					Auger	5			0	3.0
			3.05							

LITHOLOGY SYMBOLS: Fill (made ground); Silt / Clay

SAMPLE TYPE: Auger

* Indicates sample submitted for analysis

DILLON BH 10-3834-3001.GPJ DILLON TEMPLATE.GDT 7/30/12

Dillon Consulting Ltd.
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Telephone: 204-453-2301

12-04

Client: North West Smelting & Refining	Project: Environmental Investigation
Project No.: 10-3834-3001	Location: See Siteplan
Drilling Co.: Paddock Drilling	Drilling Method: Solid Stem Auger
Supervised by: CWB	Date Started: 7/12/12 Date Completed: 7/12/12

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Notes	Sample Method	Sample Number	N Value	Rec %	VOC (ppm or %LEL)	Depth Scale (m)
	SILT/GRAVEL FILL - Brown, loose, dry	Fill			Auger	1		*	0	
0.5										0.5
	SILT - Black, soft, wet	Silt	0.61		Auger	2			0	
1.0										1.0
1.5	SILTY CLAY - Grey, firm, moist Mottled with gypsum inclusions below 8'	Silt / Clay	1.37		Auger	3		*	0	1.5
2.0										2.0
					Auger	4			0	
2.5										2.5
3.0					Auger	5			0	3.0
			3.05							

LITHOLOGY SYMBOLS: Fill (made ground); Silt; Silt / Clay

SAMPLE TYPE: Auger

* Indicates sample submitted for analysis

DILLON BH 10-3834-3001.GPJ DILLON TEMPLATE.GDT 7/30/12

Dillon Consulting Ltd.
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Telephone: 204-453-2301

12-05

Client: North West Smelting & Refining
Project: Environmental Investigation
Project No.: 10-3834-3001
Location: See Siteplan
Drilling Co.: Paddock Drilling
Drilling Method: Solid Stem Auger
Supervised by: CWB
Date Started: 7/12/12
Date Completed: 7/12/12

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Notes	Sample: Method	Sample: Number	Sample: N Value	Sample: Rec %	Sample: VOC (ppm or %LEL)	Depth Scale (m)
	SILT/GRAVEL/CLAY FILL - Brown, firm, moist	Fill			Auger	1			0	
0.5										0.5
	SILT - Black, soft, wet Wood debris and petroleum hydrocarbon odour noted	Silt	0.61		Auger	2		*	0	
1.0										1.0
	SILTY CLAY - Grey, firm, moist Mottled with gypsum inclusions below 6'	Silt / Clay	1.22							
1.5					Auger	3			0	1.5
2.0										2.0
					Auger	4			0	
2.5										2.5
3.0					Auger	5		*	0	3.0
			3.05							

DILLON BH 10-3834-3001.GPJ DILLON TEMPLATE.GDT 7/30/12

LITHOLOGY SYMBOLS: Fill (made ground); Silt; Silt / Clay

SAMPLE TYPE: Auger

* Indicates sample submitted for analysis

Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Tel. 204-453-2301
Fax. 204-452-4412

13-01-5.2

Client: North West Smelting and Refining
Project No.: 10-3834
Drilling Co.: Maple Leaf Drilling
Supervised by: NLB

Project: Environmental Subsurface Investigation
Location: 2185 Logan Avenue
Drilling Method: Solid Stem
Date Started: 5/13/13
Date Completed: 5/13/13

Depth (m)	Stratigraphic Description	Lithology
0.0	Fill, dark brown, medium grain size, loose, some sand and trace gravel, moist	Fill (made ground)
1.1	Silty clay, dark brown and gray, moist	Silty Clay
1.8	Dense	Silty Clay
2.7	Slight fracturing	Clay
4	Light brown, medium grain size, damp, sand with traces of gravel.	Till
5.2		

Well Construction:
Bentonite
Riser PVC pipe from 0.9 m above grade to 4.6 m below grade
Slotted PVC pipe from 4.6 m below grade to 5.2 m
Silica Sand

Approx. Depth (m)	Method	Number	N Value	Rec %	VOC(ppm or %LEL)
0.8					ND
1.5					ND
2.3					ND
3.0					ND
3.8				*	5
4.6					10

LITHOLOGY SYMBOLS: Fill (made ground); Clay; Silty Clay; Till

SAMPLE TYPE

* Indicates sample submitted for analysis

Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Tel. 204-453-2301
Fax. 204-452-4412

13-02-1.8

Client: North West Smelting and Refining
Project No.: 10-3834
Drilling Co.: Maple Leaf Drilling
Supervised by: NLB

Project: Environmental Subsurface Investigation
Location: 2185 Logan Avenue
Drilling Method: Solid Stem
Date Started: 5/13/13 Date Completed: 5/13/13

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Well Construction	Sample: Method	Sample: Number	Sample: N Value	Sample: Rec %	Sample: VOC(ppm or %LEL)	Depth Scale (m)
	Fill, dark brown, medium grain size, some sand, trace gravel, moist	Fill		Bentonite Riser PVC pipe from 0.9 m above ground to 1.2 m below grade					ND	
1.0										1.0
	Silty clay, dark black and gray, moist.	Silty Clay	1.1	Slotted PVC pipe from 1.2 m below grade 1.8 m Silica Sand					ND	
			1.8					*	10	

LITHOLOGY SYMBOLS: Fill (made ground); Silty Clay

SAMPLE TYPE

* Indicates sample submitted for analysis

DILLON CONSULTING

Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Tel. 204-453-2301
Fax. 204-452-4412

13-03-1.1

Client: North West Smelting and Refining
Project No.: 10-3834
Drilling Co.: Maple Leaf Drilling
Supervised by: NLB

Project: Environmental Subsurface Investigation
Location: 2185 Logan Avenue
Drilling Method: Solid Stem
Date Started: 5/13/13 Date Completed: 5/13/13

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Well Construction	Sample: Method	Sample: Number	Sample: N Value	Sample: Rec %	Sample: VOC(ppm or %LEL)	Depth Scale (m)
1.0	Fill, dark brown, medium grain size, some sand, trace gravel, moist, metals appeared in fill	Fill	1.1	Bentonite Riser PVC pipe from 0.9m above grade to 0.5 m below grade Slotted PVC pipe from 0.5 m below grade to 1.1 m Silica sand				*	ND 5	1.0

LITHOLOGY SYMBOLS: Fill (made ground)

SAMPLE TYPE

* Indicates sample submitted for analysis

DILLON MW 10-3834.GPJ DILLON TEMPLATE.GDT 8/13/13

Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Tel. 204-453-2301
Fax. 204-452-4412

13-04-1.1

Client: North West Smelting and Refining
Project: Environmental Subsurface Investigation
Project No.: 10-3834
Location: 2185 Logan Avenue
Drilling Co.: Maple Leaf Drilling
Drilling Method: Solid Stem
Supervised by: NLB
Date Started: 5/13/13
Date Completed: 5/13/13

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Well Construction	Sample: Method	Sample: Number	Sample: N Value	Sample: Rec %	Sample: VOC(ppm or %LEL)	Depth Scale (m)
	Fill, dark brown, medium grain size, moist	Fill		Bentonite Riser PVC pipe from 0.9 m above ground to 0.5 m below grade Slotted PVC pipe from 0.5 m below grade to 1.1 m Silica Sand					35	
1.0	Clay, dark black and gray, some silt, moist	Clay	0.9					*	40	1.0
			1.1							

LITHOLOGY SYMBOLS: Fill (made ground); Clay

SAMPLE TYPE

* Indicates sample submitted for analysis

DILLON MW 10-3834.GPJ DILLON TEMPLATE.GDT 8/13/13

Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Tel. 204-453-2301
Fax. 204-452-4412

13-05-1.5

Client: North West Smelting and Refining	Project: Environmental Subsurface Investigation
Project No.: 10-3834	Location: 2185 Logan Avenue
Drilling Co.: Maple Leaf Drilling	Drilling Method: Solid Stem
Supervised by: NLB	Date Started: 5/13/13 Date Completed: 5/13/13

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Well Construction	Sample: Method	Sample: Number	Sample: N Value	Sample: Rec %	Sample: VOC(ppm or %LEL)	Depth Scale (m)
	Fill, dark brown, medium grain size, some sand, trace gravel, moist	Fill		Bentonite Riser PVC pipe from 0.9 m above ground to 0.9 m below grade				*	10	
1.0				Slotted PVC pipe 0.9 m below grade to 1.5 m Silica sand						1.0
			1.5						ND	

LITHOLOGY SYMBOLS: Fill (made ground)

SAMPLE TYPE

* Indicates sample submitted for analysis

DILLON MW 10-3834.GPJ DILLON TEMPLATE.GDT 8/13/13

DILLON CONSULTING

Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Tel. 204-453-2301
Fax. 204-452-4412

13-06-7.3

Client: North West Smelting and Refining
Project No.: 10-3834
Drilling Co.: Maple Leaf Drilling
Supervised by: NLB

Project: Environmental Subsurface Investigation
Location: 2185 Logan Avenue
Drilling Method: Solid Stem
Date Started: 5/13/13 Date Completed: 5/13/13

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Well Construction	Sample: Method	Sample: Number	Sample: N Value	Sample: Rec %	Sample: VOC(ppm or %LEL)	Depth Scale (m)
	Fill, dark brown, medium grain size, some sand, trace gravel, moist	Fill						*	30	
1.0										1.0
	Silty clay, dark gray, trace sand, moist	Silty Clay	1.5						10	
2.0									15	2.0
3.0				Bentonite					20	3.0
	Olive brown	Till	3.4						ND	
4.0	Some sand, trace gravel	Till	4						ND	4.0
5.0									10	5.0

LITHOLOGY SYMBOLS: Fill (made ground); Till; Silty Clay

SAMPLE TYPE

* Indicates sample submitted for analysis

Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Tel. 204-453-2301
Fax. 204-452-4412

13-06-7.3

Client: North West Smelting and Refining
Project: Environmental Subsurface Investigation
Project No.: 10-3834
Location: 2185 Logan Avenue
Drilling Co.: Maple Leaf Drilling
Drilling Method: Solid Stem
Supervised by: NLB
Date Started: 5/13/13
Date Completed: 5/13/13

Depth Scale (m)	Stratigraphic Description (continued)	Lithology	Depth (m)	Well Construction	Sample: Method	Sample: Number	Sample: N Value	Sample: Rec %	Sample: VOC(ppm or %LEL)	Depth Scale (m)
	Some sand, trace gravel *(Continued)*	Silty Clay		Bentonite Riser PVC pipe from 0.9 m above grade to 6.7 m below grade					20	
7.0	Till, light brown, sandy, trace gravel, soft, moist	Till	6.4	Riser PVC pipe from 0.9 m above grade to 6.7 m below grade Slotted PVC pipe from 6.7 m below grade to 7.3 m Silica Sand					25	7.0
			7.3							

LITHOLOGY SYMBOLS: Fill (made ground); Till; Silty Clay

SAMPLE TYPE

* Indicates sample submitted for analysis

Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Tel. 204-453-2301
Fax. 204-452-4412

13-07-2.4

Client: North West Smelting and Refining
Project No.: 10-3834
Drilling Co.: Maple Leaf Drilling
Supervised by: NLB

Project: Environmental Subsurface Investigation
Location: 2185 Logan Avenue
Drilling Method: Solid Stem
Date Started: 5/13/13
Date Completed: 5/13/13

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Well Construction	Method	Number	N Value	Rec %	VOC(ppm or %LEL)	Depth Scale (m)
	Fill, dark brown, medium grain size, some sand and gravel, moist	Fill		Bentonite Riser PVC pipe from 0.9 m above ground to 1.8 m below grade				*	35	
1.0										1.0
									10	
	Silty clay, dark brown, trace sand, moist	Silty Clay	1.5							
2.0				Slotted PVC pipe from 1.8 m below grade to 2.4 m Silica Sand						2.0
									30	
			2.4							

LITHOLOGY SYMBOLS: Fill (made ground); Silty Clay

SAMPLE TYPE

* Indicates sample submitted for analysis

DILLON CONSULTING

Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Tel. 204-453-2301
Fax. 204-452-4412

13-08-1.5

Client: North West Smelting and Refining
Project: Environmental Subsurface Investigation
Project No.: 10-3834
Location: 2185 Logan Avenue
Drilling Co.: Maple Leaf Drilling
Drilling Method: Solid Stem
Supervised by: NLB
Date Started: 5/13/13
Date Completed: 5/13/13

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Well Construction	Sample: Method	Sample: Number	Sample: N Value	Sample: Rec %	Sample: VOC(ppm or %LEL)	Depth Scale (m)
	Fill, dark brown, medium grain size, some sand, trace gravel, moist	Fill		Bentonite Riser PVC pipe from 0.9 m above grade to 0.9 m below grade				*	20	
1.0				Slotted PVC pipe from 0.9 m below grade to 1.5 m Silica Sand					20	1.0
			1.5							

LITHOLOGY SYMBOLS: Fill (made ground)

SAMPLE TYPE

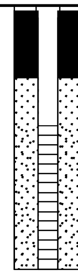
* Indicates sample submitted for analysis

Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Tel. 204-453-2301
Fax. 204-452-4412

13-09-1.1

Client:	North West Smelting and Refining	Project:	Environmental Subsurface Investigation
Project No.:	10-3834	Location:	2185 Logan Avenue
Drilling Co.:	Maple Leaf Drilling	Drilling Method:	Solid Stem
Supervised by:	NLB	Date Started: 5/13/13	Date Completed: 5/13/13

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Well Construction	Sample: Method	Sample: Number	Sample: N Value	Sample: Rec %	Sample: VOC(ppm or %LEL)	Depth Scale (m)
	Fill, dark brown, medium grain size, some sand and gravel, moist	Fill		Bentonite Riser PVC pipe from 0.9 m above grade to 0.5 m below grade						
	Clay, dark brown, trace sand, dense, moist, some fracturing	Clay	0.4	Slotted PVC pipe from 0.5 m below grade to 1.1 m Silica Sand				*	15	
1.0										1.0
			1.5						10	



LITHOLOGY SYMBOLS: Fill (made ground); Clay

SAMPLE TYPE

* Indicates sample submitted for analysis

Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Tel. 204-453-2301
Fax. 204-452-4412

13-10-7.3

Client: North West Smelting and Refining	Project: Environmental Subsurface Investigation
Project No.: 10-3834	Location: 2185 Logan Avenue
Drilling Co.: Maple Leaf Drilling	Drilling Method: Solid Stem
Supervised by: NLB	Date Started: 5/13/13 Date Completed: 5/13/13

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Well Construction	Sample: Method	Sample: Number	Sample: N Value	Sample: Rec %	Sample: VOC(ppm or %LEL)	Depth Scale (m)
0.0	Fill, dark brown, medium grain size, sandy, some gravel, moist	Fill								
									5	
1.0										1.0
								*	10	
2.0										2.0
									ND	
	Silty clay, dark brown, trace sand, moist	Silty Clay	2.6							
3.0				Bentonite					10	3.0
	Clay, olive brown, some sand, trace silt, moist	Clay	3.7						10	
4.0										4.0
									5	
5.0										5.0
									10	

LITHOLOGY SYMBOLS: Fill (made ground), Clay, Silty Clay, Till

SAMPLE TYPE

* Indicates sample submitted for analysis

Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Tel. 204-453-2301
Fax. 204-452-4412

13-10-7.3

Client: North West Smelting and Refining
Project No.: 10-3834
Drilling Co.: Maple Leaf Drilling
Supervised by: NLB

Project: Environmental Subsurface Investigation
Location: 2185 Logan Avenue
Drilling Method: Solid Stem
Date Started: 5/13/13 Date Completed: 5/13/13

Depth Scale (m)	Stratigraphic Description (continued)	Lithology	Depth (m)	Well Construction	Sample: Method	Sample: Number	Sample: N Value	Sample: Rec %	Sample: VOC(ppm or %LEL)	Depth Scale (m)
	Clay, olive brown, some sand, trace silt, moist*(Continued)*			Bentonite Riser PVC pipe from 0.9 m above grade to 6.7 m below grade Riser PVC pipe from 0.9 m above grade to 6.7 m below grade					ND	
7.0	Till, light brown, medium grain size, sandy with some gravel, moist		6.6	Slotted PVC pipe from 6.7 m below grade to 7.3 m Silica Sand					ND	7.0
			7.3							

DILLON MW 10-3834.GPJ DILLON TEMPLATE.GDT 8/13/13

LITHOLOGY SYMBOLS: Fill (made ground); Clay; Silty Clay; Till

SAMPLE TYPE

* Indicates sample submitted for analysis

Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Tel. 204-453-2301
Fax. 204-452-4412

13-11-3.7

Client: North West Smelting and Refining
Project: Environmental Subsurface Investigation
Project No.: 10-3834
Location: 2185 Logan Avenue
Drilling Co.: Maple Leaf Drilling
Drilling Method: Solid Stem
Supervised by: NLB
Date Started: 5/13/13
Date Completed: 5/13/13

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Well Construction	Method	Number	N Value	Rec %	VOC(ppm or %LEL)	Depth Scale (m)
	Fill, dark brown, medium grain size, sandy with some gravel, moist	Fill						*	20	
1.0				Bentonite Riser PVC pipe from 0.9 m above grade to 3.0 m below grade					ND	1.0
2.0									ND	2.0
	Silty clay, dark brown, trace sand, moist	Silty Clay	2.6							
3.0				Slotted PVC pipe from 3.0 m below grade to 3.7 m Silica Sand					ND	3.0
			3.7						5	

LITHOLOGY SYMBOLS: Fill (made ground); Silty Clay

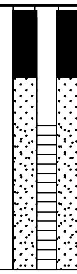
SAMPLE TYPE

* Indicates sample submitted for analysis

Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Tel. 204-453-2301
Fax. 204-452-4412

13-12-1.1

Client: North West Smelting and Refining
Project: Environmental Subsurface Investigation
Project No.: 10-3834
Location: 2185 Logan Avenue
Drilling Co.: Maple Leaf Drilling
Drilling Method: Solid Stem
Supervised by: NLB
Date Started: 5/13/13
Date Completed: 5/13/13

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Well Construction	Sample: Method	Sample: Number	Sample: N Value	Sample: Rec %	Sample: VOC(ppm or %LEL)	Depth Scale (m)
1.0	Fill, dark brown, medium grain size, sandy, trace gravel, moist	Fill	1.1	 Bentonite; Riser PVC pipe from 0.9 m above grade to 0.5 m below grade; Slotted PVC pipe from 0.5 m below grade to 1.1 m; Silica Sand				*	ND, ND	1.0

LITHOLOGY SYMBOLS: Fill (made ground)

SAMPLE TYPE

* Indicates sample submitted for analysis

Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Tel. 204-453-2301
Fax. 204-452-4412

13-13-2.0

Client: North West Smelting and Refining
Project: Environmental Subsurface Investigation
Project No.: 10-3834
Location: 2185 Logan Avenue
Drilling Co.: Maple Leaf Drilling
Drilling Method: Solid Stem
Supervised by: NLB
Date Started: 5/14/13
Date Completed: 5/14/13

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Well Construction	Sample: Method	Sample: Number	Sample: N Value	Sample: Rec %	Sample: VOC(ppm or %LEL)	Depth Scale (m)
	Fill, dark brown, medium grain size, sandy, trace gravel, moist	Fill (made ground)		Bentonite Riser PVC pipe from 0.9 m above grade to 0.5 m below grade				*	ND	
1.0										1.0
	Silty clay, dark brown, trace sand, moist	Silty Clay	1.1	Silica Sand Slotted PVC pipe from 0.5 m below grade to 2.0 m					ND	
2.0			2							2.0

LITHOLOGY SYMBOLS: Fill (made ground); Silty Clay

SAMPLE TYPE

* Indicates sample submitted for analysis

Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Tel. 204-453-2301
Fax. 204-452-4412

13-14-1.8

Client: North West Smelting and Refining
Project No.: 10-3834
Drilling Co.: Maple Leaf Drilling
Supervised by: NLB

Project: Environmental Subsurface Investigation
Location: 2185 Logan Avenue
Drilling Method: Solid Stem
Date Started: 5/14/13 Date Completed: 5/14/13

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Well Construction	Sample: Method	Sample: Number	Sample: N Value	Sample: Rec %	Sample: VOC(ppm or %LEL)	Depth Scale (m)
	Concrete slab 1.2 m above grade to surface		0.01							
	Fill, dark brown, medium grain size, sandy, gravel, moist	Fill						*	15	
1.0	Silty clay, dark brown, trace sand, moist, fracturing	Silty Clay	0.8							1.0
									ND	
			1.8						ND	

LITHOLOGY SYMBOLS: Concrete; Silty Clay; Fill (made ground)

SAMPLE TYPE

* Indicates sample submitted for analysis

Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Tel. 204-453-2301
Fax. 204-452-4412

13-15-1.8

Client: North West Smelting and Refining
Project: Environmental Subsurface Investigation
Project No.: 10-3834
Location: 2185 Logan Avenue
Drilling Co.: Maple Leaf Drilling
Drilling Method: Solid Stem
Supervised by: NLB
Date Started: 5/14/13
Date Completed: 5/14/13

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Well Construction	Method	Number	N Value	Rec %	VOC(ppm or %LEL)	Depth Scale (m)
	Concrete slab 1.2 m above grade to surface		0.01					*	25	
	Fill, dark brown, medium grain size, sandy, trace gravel, moist	Fill								
	Silty clay, dark brown, trace sand, moist	Silty Clay	0.8						5	
1.0										1.0
			1.8						5	

LITHOLOGY SYMBOLS: Concrete; Silty Clay; Fill (made ground)

SAMPLE TYPE

* Indicates sample submitted for analysis

Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Tel. 204-453-2301
Fax. 204-452-4412

13-16-1.8

Client: North West Smelting and Refining
Project No.: 10-3834
Drilling Co.: Maple Leaf Drilling
Supervised by: NLB

Project: Environmental Subsurface Investigation
Location: 2185 Logan Avenue
Drilling Method: Solid Stem
Date Started: 5/14/13
Date Completed: 5/14/13

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Well Construction	Sample: Method	Sample: Number	Sample: N Value	Sample: Rec %	Sample: VOC(ppm or %LEL)	Depth Scale (m)
	Concrete slab 0.5 m above grade to surface	Concrete	0.01							
	Fill, dark brown, medium grain size, some sand, trace gravel, moist	Fill (made ground)								
	Silty clay, dark brown, trace sand, moist	Silty Clay	0.8					*	15	
1.0										1.0
									25	
			1.8						10	

DILLON MW 10-3834.GPJ DILLON TEMPLATE.GDT 8/13/13

LITHOLOGY SYMBOLS: Concrete; Silty Clay; Fill (made ground)

SAMPLE TYPE

* Indicates sample submitted for analysis

Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Tel. 204-453-2301
Fax. 204-452-4412

13-17-1.8

Client: North West Smelting and Refining
Project No.: 10-3834
Drilling Co.: Maple Leaf Drilling
Supervised by: NLB

Project: Environmental Subsurface Investigation
Location: 2185 Logan Avenue
Drilling Method: Solid Stem
Date Started: 5/14/13
Date Completed: 5/14/13

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Well Construction	Sample: Method	Sample: Number	Sample: N Value	Sample: Rec %	Sample: VOC(ppm or %LEL)	Depth Scale (m)
	Concrete slab 0.5 m above grade to surface	Concrete	0.01							
	Fill, dark brown, medium grain size, moist	Fill								
	Silty clay, dark brown, trace sand, moist	Silty Clay	0.8					*	15	
1.0										1.0
									25	
			1.8						10	

LITHOLOGY SYMBOLS: Concrete; Fill (made ground); Silty Clay

SAMPLE TYPE

* Indicates sample submitted for analysis

DILLON MW 10-3834.GPJ DILLON TEMPLATE.GDT 8/13/13

Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Tel. 204-453-2301
Fax. 204-452-4412

13-18-1.8

Client: North West Smelting and Refining
Project: Environmental Subsurface Investigation
Project No.: 10-3834
Location: 2185 Logan Avenue
Drilling Co.: Maple Leaf Drilling
Drilling Method: Solid Stem
Supervised by: NLB
Date Started: 5/14/13
Date Completed: 5/14/13

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Well Construction	Sample: Method	Sample: Number	Sample: N Value	Sample: Rec %	Sample: VOC(ppm or %LEL)	Depth Scale (m)
	Concrete slab 0.5 m above grade to surface		0.01							
	Fill, dark brown, medium grain size, sandy, trace gravel, moist									
	Clay, dark brown, trace silt, dense, moist		0.8					*	35	
1.0										1.0
									30	
			1.8						5	

LITHOLOGY SYMBOLS: Concrete; Clay; Fill (made ground)

SAMPLE TYPE

* Indicates sample submitted for analysis

Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Tel. 204-453-2301
Fax. 204-452-4412

13-19-1.8

Client: North West Smelting and Refining
Project: Environmental Subsurface Investigation
Project No.: 10-3834
Location: 2185 Logan Avenue
Drilling Co.: Maple Leaf Drilling
Drilling Method: Solid Stem
Supervised by: NLB
Date Started: 5/14/13
Date Completed: 5/14/13

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Well Construction	Sample: Method	Sample: Number	Sample: N Value	Sample: Rec %	Sample: VOC(ppm or %LEL)	Depth Scale (m)
	Concrete slab 0.5 m above grade to surface	Concrete	0.01							
	Fill, dark brown, medium grain size, sandy, some gravel, moist	Fill								
	Traces of coal fragments	Fill	0.6						5	
1.0	Silty clay, dark brown, trace sand, moist	Silty Clay	0.9							1.0
								*	50	
			1.8						20	

LITHOLOGY SYMBOLS: Concrete; Silty Clay; Fill (made ground)

SAMPLE TYPE

* Indicates sample submitted for analysis

Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Tel. 204-453-2301
Fax. 204-452-4412

13-20-1.8

Client: North West Smelting and Refining
Project: Environmental Subsurface Investigation
Project No.: 10-3834
Location: 2185 Logan Avenue
Drilling Co.: Maple Leaf Drilling
Drilling Method: Solid Stem
Supervised by: NLB
Date Started: 5/14/13
Date Completed: 5/14/13

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Well Construction	Sample: Method	Sample: Number	Sample: N Value	Sample: Rec %	Sample: VOC(ppm or %LEL)	Depth Scale (m)
	Fill, dark brown, medium grain size, sandy, some gravel, moist	Fill							ND	
1.0										1.0
	Clay, dark brown, trace silt, dense, moist, fracturing	Clay	1.4					*	30	
			1.8						ND	

LITHOLOGY SYMBOLS: Fill (made ground); Clay

SAMPLE TYPE

* Indicates sample submitted for analysis

Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Tel. 204-453-2301
Fax. 204-452-4412

13-21-1.8

Client: North West Smelting and Refining
Project No.: 10-3834
Drilling Co.: Maple Leaf Drilling
Supervised by: NLB

Project: Environmental Subsurface Investigation
Location: 2185 Logan Avenue
Drilling Method: Solid Stem
Date Started: 5/14/13 Date Completed: 5/14/13

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Well Construction	Sample: Method	Number	N Value	Rec %	VOC(ppm or %LEL)	Depth Scale (m)
	Fill, dark brown, medium grain size, sandy, gravel, moist	Fill							ND	
1.0										1.0
	Clay, dark brown, some silt, trace sand, moist	Clay	1.4					*	20	
			1.8						ND	

LITHOLOGY SYMBOLS: Fill (made ground); Clay

SAMPLE TYPE

* Indicates sample submitted for analysis

Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Tel. 204-453-2301
Fax. 204-452-4412

13-22-0.9

Client: North West Smelting and Refining
Project: Environmental Subsurface Investigation
Project No.: 10-3834
Location: 180 Ryan Street
Drilling Co.: Maple Leaf
Drilling Method: Solid Stem
Supervised by: NLB
Date Started: 9/6/13
Date Completed: 9/6/13

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Well Construction	Sample: Method	Sample: Number	Sample: N Value	Sample: Rec %	Sample: VOC(ppm or %LEL)	Depth Scale (m)
	0.06 m of gray asphalt, dry	Asphalt	0.06							
	Fill, light brown, medium grain size, gravel with some sand, moist	Fill	0.5					*	ND	
	Clay, dark brown, trace gravel, moist	Clay	0.9						ND	

LITHOLOGY SYMBOLS: Asphalt; Clay; Fill (made ground)

SAMPLE TYPE

* Indicates sample submitted for analysis

DILLON CONSULTING

Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Tel. 204-453-2301
Fax. 204-452-4412

13-23-0.9

Client: North West Smelting and Refining
Project: Environmental Subsurface Investigation
Project No.: 10-3834
Location: 180 Ryan Street
Drilling Co.: Maple Leaf
Drilling Method: Solid Stem
Supervised by: NLB
Date Started: 9/6/13
Date Completed: 9/6/13

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Well Construction	Sample: Method	Sample: Number	Sample: N Value	Sample: Rec %	Sample: VOC(ppm or %LEL)	Depth Scale (m)
	Fill, light brown, medium grain size, gravel, some sand, dry	Fill	0.06							
	Moist	Fill						*	ND	
	Clay, dark brown, some sand, trace silt, moist	Clay	0.6							
			0.9						ND	

LITHOLOGY SYMBOLS: Fill (made ground); Clay

SAMPLE TYPE

* Indicates sample submitted for analysis

Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba R3T 0Y4
Tel. 204-453-2301
Fax. 204-452-4412

13-24-0.9

Client: North West Smelting and Refining
Project No.: 10-3834
Drilling Co.: Maple Leaf
Supervised by: NLB

Project: Environmental Subsurface Investigation
Location: 180 Ryan Street
Drilling Method: Solid Stem
Date Started: 9/6/13 Date Completed: 9/6/13

Depth Scale (m)	Stratigraphic Description	Lithology	Depth (m)	Well Construction	Sample: Method	Sample: Number	Sample: N Value	Sample: Rec %	Sample: VOC(ppm or %LEL)	Depth Scale (m)
	Fill, light brown, medium grain size, gravel, some sand, moist		0.06							
	Fill, light gray, medium grain size, gravel, some sand, trace silt, moist		0.6					*	ND	
	Clay, dark gray, some silt, trace sand, moist		0.9						ND	

DILLON MW 10-3834.GPJ DILLON TEMPLATE.GDT 9/24/13

LITHOLOGY SYMBOLS: Fill (made ground); Clay

SAMPLE TYPE

* Indicates sample submitted for analysis

Appendix B

Summary Data Tables

Table B-1 - Summary of Soil Analytical Data - Metals

Parameter	Units	Assessment Criteria	Sample ID	13-01-5.2	13-02-1.8	13-03-1.1	13-04-1.1	13-05-1.5	13-06-7.3	13-07-2.4
			Sample Date	13-May-13	13-May-13	13-May-13	13-May-13	13-May-13	13-May-13	13-May-13
			Sample Depth	3.5 - 4.2 m	1.5 - 2.0 m	0.8 - 1.3 m	0.8 - 1.3 m	0.5 - 1.0 m	0.5 - 1.0 m	0.5 - 1.0 m
			RDL							
Metals										
Aluminum (Al)	mg/kg	-	50	10700	25000	21500	17600	10600	14500	10300
Antimony (Sb)	mg/kg	40 [1]	0.10	5.31	2.10	**636**	**97.5**	**552**	**441**	**389**
Arsenic (As)	mg/kg	12 [2]	0.10	6.03	9.18	**280**	**75.5**	**227**	**251**	**238**
Barium (Ba)	mg/kg	2000 [6]	0.50	105	245	367	327	287	235	203
Beryllium (Be)	mg/kg	8 [1]	0.10	0.57	1.10	1.07	0.72	0.59	0.58	0.48
Bismuth (Bi)	mg/kg	-	0.020	0.162	0.303	0.758	0.670	1.24	1.68	1.96
Boron (B)	mg/kg	-	10	15	21	132	36	37	57	30
Cadmium(Cd)	mg/kg	22 [3]	0.020	0.227	0.384	4.53	2.89	10.2	**33.9**	**43.7**
Calcium (Ca)	mg/kg	-	1000	105000	28800	68600	45500	83400	62900	81300
Chromium (Cr)	mg/kg	87 [2]	1.0	24.4	46.0	46.4	46.1	27.9	38.0	39.1
Cobalt (Co)	mg/kg	300 [1]	0.020	6.87	16.0	14.8	11.2	7.04	8.86	7.39
Copper (Cu)	mg/kg	91 [3]	1.0	20.0	35.1	**667**	**367**	**252**	**1300**	**307**
Iron (Fe)	mg/kg	-	25	17900	33600	49000	36900	23100	25500	27600
Lead (Pb)	mg/kg	600 [3]	0.20	148	156	**17300**	**9250**	**25700**	**24200**	**25200**
Magnesium (Mg)	mg/kg	-	10	46800	18400	31900	20400	35600	23700	29300
Manganese (Mn)	mg/kg	-	0.50	287	508	551	687	310	387	350
Molybdenum (Mo)	mg/kg	40 [1]	0.020	2.74	3.32	7.28	3.85	3.46	3.36	4.34
Nickel (Ni)	mg/kg	50 [3]	0.50	20.5	43.1	**52.7**	38.0	31.0	38.9	42.5
Phosphorus (P)	mg/kg	-	100	430	520	900	700	580	660	500
Potassium (K)	mg/kg	-	25	2340	4290	3240	4300	2370	3440	2240
Selenium (Se)	mg/kg	2.9 [5]	0.50	0.76	0.88	1.50	1.45	**3.00**	**5.20**	**5.12**
Silver (Ag)	mg/kg	40 [1]	0.10	0.12	0.18	0.54	0.35	0.43	0.51	0.60
Sodium (Na)	mg/kg	-	10	1690	2930	2960	1120	974	752	586
Strontium (Sr)	mg/kg	-	0.10	69.7	82.3	518	164	154	113	148
Thallium (Tl)	mg/kg	1 [3]	0.10	0.18	0.34	0.40	0.36	0.77	0.83	0.86
Tin (Sn)	mg/kg	300 [1]	5.0	<5.0	<5.0	**304**	133	131	136	112
Titanium (Ti)	mg/kg	-	0.50	159	129	499	201	225	237	239
Uranium (U)	mg/kg	300 [4]	0.020	1.48	2.12	2.79	1.63	1.29	1.36	1.05
Vanadium (V)	mg/kg	130 [2]	0.50	33.1	75.1	53.9	55.7	32.6	45.2	31.8
Zinc (Zn)	mg/kg	360 [3]	10	43	82	**395**	250	180	236	299

NOTES

'-' - no criteria available
1 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 1991), Industrial Land Use.
2 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 1997), Industrial Land Use.
3 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 1999), Industrial Land Use.
4 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 2007), Industrial Land Use.
5 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 2009), Industrial Land Use.
6 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 2013), Industrial Land Use.
20 exceeds criteria
RDL - Reportable Detection Limit
* RDL adjusted, matrix interferences

Table B-1 - Summary of Soil Analytical Data - Metals

Parameter	Units	Assessment Criteria	Sample ID	13-08-1.5	13-09-1.1	13-10-7.3	FD1	13-11-3.7	13-12-1.1	13-13-1.1
			Sample Date	13-May-13	13-May-13	13-May-13	13-May-13	13-May-13	13-May-13	14-May-13
			Sample Depth	0.5 - 1.0 m	0.5 - 1.0 m	1.2 - 1.8 m	1.2 - 1.8 m	0.5 - 1.0 m	0.5 - 1.0 m	0.5 - 1.0 m
			RDL							
Metals										
Aluminum (Al)	mg/kg	-	50	4890	24300	17800	16500	17100	13700	11500
Antimony (Sb)	mg/kg	40 [1]	0.10	1370	1.20	1080	883	1420	959	35.7
Arsenic (As)	mg/kg	12 [2]	0.10	653	8.65	538	493	858	523	22.1
Barium (Ba)	mg/kg	2000 [6]	0.50	95.6	214	355	236	148	211	447
Beryllium (Be)	mg/kg	8 [1]	0.10	0.20	1.14	0.93	0.98	1.14	0.91	0.62
Bismuth (Bi)	mg/kg	-	0.020	5.44	0.306	2.41	3.02	4.32	3.60	0.231
Boron (B)	mg/kg	-	10	27	23	36	37	50	34	37
Cadmium(Cd)	mg/kg	22 [3]	0.020	108	0.254	8.55	11.2	14.9	12.6	1.36
Calcium (Ca)	mg/kg	-	1000	80500	29600	55500	50000	63000	62000	82000
Chromium (Cr)	mg/kg	87 [2]	1.0	17.4	55.5	70.4	69.5	100	78.3	26.7
Cobalt (Co)	mg/kg	300 [1]	0.020	4.61	17.0	17.4	20.1	23.0	20.0	7.18
Copper (Cu)	mg/kg	91 [3]	1.0	391	36.3	639	750	1150	730	158
Iron (Fe)	mg/kg	-	25	16000	35300	72700	79300	102000	86900	17200
Lead (Pb)	mg/kg	600 [3]	0.20	47200	40.6	28400	39400	37200	27600	1640
Magnesium (Mg)	mg/kg	-	10	16500	17300	19500	17100	18800	19100	33700
Manganese (Mn)	mg/kg	-	0.50	225	488	679	648	697	672	338
Molybdenum (Mo)	mg/kg	40 [1]	0.020	2.64	2.14	7.78	7.21	10.2	8.94	1.14
Nickel (Ni)	mg/kg	50 [3]	0.50	43.8	47.8	65.9	72.3	92.9	74.7	25.8
Phosphorus (P)	mg/kg	-	100	310	580	880	1010	1130	940	760
Potassium (K)	mg/kg	-	25	1010	7000	3510	3450	2300	2140	2420
Selenium (Se)	mg/kg	2.9 [5]	0.50	18.3	<0.50	3.47	2.43	3.06	1.72	0.70
Silver (Ag)	mg/kg	40 [1]	0.10	1.42	0.18	0.98	0.89	1.14	1.08	1.04
Sodium (Na)	mg/kg	-	10	310	1990	2610	2010	2910	1890	620
Strontium (Sr)	mg/kg	-	0.10	97.4	74.3	140	107	127	112	197
Thallium (Tl)	mg/kg	1 [3]	0.10	1.98	0.34	0.89	1.03	1.33	1.06	0.18
Tin (Sn)	mg/kg	300 [1]	5.0	364	<5.0	563	860	1160	930	41.5
Titanium (Ti)	mg/kg	-	0.50	211	221	353	336	502	324	240
Uranium (U)	mg/kg	300 [4]	0.020	0.583	1.71	1.82	1.77	1.67	1.41	1.33
Vanadium (V)	mg/kg	130 [2]	0.50	15.4	89.3	58.5	58.9	59.9	52.1	32.2
Zinc (Zn)	mg/kg	360 [3]	10	260	83	620	530	570	770	250

NOTES

'-' - no criteria available
1 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 1991), Industrial Land Use.
2 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 1997), Industrial Land Use.
3 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 1999), Industrial Land Use.
4 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 2007), Industrial Land Use.
5 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 2009), Industrial Land Use.
6 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 2013), Industrial Land Use.
20 exceeds criteria
RDL - Reportable Detection Limit
* RDL adjusted, matrix interferences

Table B-1 - Summary of Soil Analytical Data - Metals

Parameter	Units	Assessment Criteria	Sample ID	13-14-1.8	13-15-1.8	13-16-1.5	13-17-1.8	13-18-1.8	13-19.18	FD 2
			Sample Date	14-May-13	14-May-13	14-May-13	14-May-13	14-May-13	14-May-13	14-May-13
			Sample Depth	0.5 - 1.0 m	0.0 - 0.5 m	0.5 - 1.0 m	0.5 - 1.0 m	0.5 - 1.0 m	1.2 - 1.8 m	1.2 - 1.8 m
			RDL							
Metals										
Aluminum (Al)	mg/kg	-	50	26800	5510	13200	16200	3950	23100	23100
Antimony (Sb)	mg/kg	40 [1]	0.10	1.08	**186**	**1720**	**205**	**50**	0.67	0.59
Arsenic (As)	mg/kg	12 [2]	0.10	8.09	**64.2**	**1200**	**64.4**	**80.9**	8.97	8.86
Barium (Ba)	mg/kg	2000 [6]	0.50	234	130	320	305	66.3	234	231
Beryllium (Be)	mg/kg	8 [1]	0.10	1.24	0.28	0.73	0.73	0.19	1.24	1.32
Bismuth (Bi)	mg/kg	-	0.020	0.292	0.609	2.05	0.537	0.188	0.369	0.367
Boron (B)	mg/kg	-	10	31	24	52	157	23	18	17
Cadmium(Cd)	mg/kg	22 [3]	0.020	0.518	3.67	**30.6**	1.53	21.2	0.305	0.304
Calcium (Ca)	mg/kg	-	1000	44400	95000	65000	54000	121000	27700	31500
Chromium (Cr)	mg/kg	87 [2]	1.0	50.0	18.7	29.7	46.0	9.9	45.0	45.3
Cobalt (Co)	mg/kg	300 [1]	0.020	15.6	4.65	10.3	15	2.87	16.9	17.6
Copper (Cu)	mg/kg	91 [3]	1.0	32.6	58.0	**200**	**1390**	23.2	36.9	35.0
Iron (Fe)	mg/kg	-	25	29700	17400	22900	62900	7700	31500	32300
Lead (Pb)	mg/kg	600 [3]	0.20	61.2	**9310**	**30300**	**14200**	**5110**	28.2	24.9
Magnesium (Mg)	mg/kg	-	10	15800	39900	25500	30800	48800	16000	15500
Manganese (Mn)	mg/kg	-	0.50	444	225	331	575	166	478	512
Molybdenum (Mo)	mg/kg	40 [1]	0.020	0.567	1.43	1.45	4.41	0.342	1.82	1.77
Nickel (Ni)	mg/kg	50 [3]	0.50	43.7	16.8	**54.8**	**72.7**	11.5	**50.4**	48.5
Phosphorus (P)	mg/kg	-	100	570	340	690	750	370	580	590
Potassium (K)	mg/kg	-	25	5150	1280	3300	3260	975	3980	3950
Selenium (Se)	mg/kg	2.9 [5]	0.50	0.95	0.67	**5.79**	**2.93**	**3.56**	0.94	<0.50
Silver (Ag)	mg/kg	40 [1]	0.10	0.18	0.21	0.76	1.05	<0.10	0.17	0.17
Sodium (Na)	mg/kg	-	10	647	529	752	2530	266	1250	1220
Strontium (Sr)	mg/kg	-	0.10	108	78.3	194	190	71.1	77.7	82.3
Thallium (Tl)	mg/kg	1 [3]	0.10	0.35	0.24	0.87	0.51	0.45	0.35	0.35
Tin (Sn)	mg/kg	300 [1]	5.0	<5.0	64.5	147	**1000**	32.2	<5.0	<5.0
Titanium (Ti)	mg/kg	-	0.50	197	197	220	263	207	115	99.8
Uranium (U)	mg/kg	300 [4]	0.020	2.68	0.727	1.47	1.65	0.52	2.53	2.51
Vanadium (V)	mg/kg	130 [2]	0.50	89.5	18.9	42.3	57.9	13.8	71.3	73.1
Zinc (Zn)	mg/kg	360 [3]	10	87	54	223	**2100**	64	88	88

NOTES

'-' - no criteria available
1 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 1991), Industrial Land Use.
2 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 1997), Industrial Land Use.
3 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 1999), Industrial Land Use.
4 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 2007), Industrial Land Use.
5 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 2009), Industrial Land Use.
6 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 2013), Industrial Land Use.
20 exceeds criteria
RDL - Reportable Detection Limit
* RDL adjusted, matrix interferences

Table B-1 - Summary of Soil Analytical Data - Metals

Parameter	Units	Assessment Criteria	Sample ID	13-20-1.8	13-21-1.8	13-22-0.9	13-23-0.9	FD 1	13-24-0.9
			Sample Date	14-May-13	14-May-13	6-Sep-13	6-Sep-13	6-Sep-13	6-Sep-13
			Sample Depth	1.2 - 1.8 m	1.2 - 1.8 m	0.3 - 0.5 m	0.3 - 0.5 m	0.3 - 0.5 m	0.3 - 0.5 m
			RDL						
Metals									
Aluminum (Al)	mg/kg	-	50	30200	27900	-	-	-	-
Antimony (Sb)	mg/kg	40 [1]	0.10	1.88	0.96	-	-	-	-
Arsenic (As)	mg/kg	12 [2]	0.10	8.40	10.7	-	-	-	-
Barium (Ba)	mg/kg	2000 [6]	0.50	170	221	-	-	-	-
Beryllium (Be)	mg/kg	8 [1]	0.10	1.20	1.14	-	-	-	-
Bismuth (Bi)	mg/kg	-	0.020	0.316	0.302	-	-	-	-
Boron (B)	mg/kg	-	10	61	52	-	-	-	-
Cadmium(Cd)	mg/kg	22 [3]	0.020	0.411	0.330	-	-	-	-
Calcium (Ca)	mg/kg	-	1000	15200	36400	-	-	-	-
Chromium (Cr)	mg/kg	87 [2]	1.0	53.9	51.1	-	-	-	-
Cobalt (Co)	mg/kg	300 [1]	0.020	16.7	15.9	-	-	-	-
Copper (Cu)	mg/kg	91 [3]	1.0	35.8	33.6	-	-	-	-
Iron (Fe)	mg/kg	-	25	32100	31800	-	-	-	-
Lead (Pb)	mg/kg	600 [3]	0.20	168	38.2	209	13.9	33.7	412
Magnesium (Mg)	mg/kg	-	10	12200	15100	-	-	-	-
Manganese (Mn)	mg/kg	-	0.50	478	416	-	-	-	-
Molybdenum (Mo)	mg/kg	40 [1]	0.020	0.494	0.627	-	-	-	-
Nickel (Ni)	mg/kg	50 [3]	0.50	46.8	45.4	-	-	-	-
Phosphorus (P)	mg/kg	-	100	550	550	-	-	-	-
Potassium (K)	mg/kg	-	25	6100	5580	-	-	-	-
Selenium (Se)	mg/kg	2.9 [5]	0.50	0.82	<0.50	-	-	-	-
Silver (Ag)	mg/kg	40 [1]	0.10	0.24	0.20	-	-	-	-
Sodium (Na)	mg/kg	-	10	2240	1170	-	-	-	-
Strontium (Sr)	mg/kg	-	0.10	85.7	124	-	-	-	-
Thallium (Tl)	mg/kg	1 [3]	0.10	0.39	0.37	-	-	-	-
Tin (Sn)	mg/kg	300 [1]	5.0	<5.0	<5.0	-	-	-	-
Titanium (Ti)	mg/kg	-	0.50	170	246	-	-	-	-
Uranium (U)	mg/kg	300 [4]	0.020	1.47	2.09	-	-	-	-
Vanadium (V)	mg/kg	130 [2]	0.50	89.2	89.1	-	-	-	-
Zinc (Zn)	mg/kg	360 [3]	10	104	95	-	-	-	-

NOTES

'-' - no criteria available
1 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 1991), Industrial Land Use.
2 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 1997), Industrial Land Use.
3 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 1999), Industrial Land Use.
4 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 2007), Industrial Land Use.
5 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 2009), Industrial Land Use.
6 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 2013), Industrial Land Use.
20 exceeds criteria
RDL - Reportable Detection Limit
* RDL adjusted, matrix interferences

Table B-1 - Summary of Soil Analytical Data - Metals

Parameter	Units	Assessment Criteria	Sample ID	12-01-01	12-02-02	12-02-06	12-02-03	12-03-01	12-04-01	12-04-03
			Sample Date	7/12/2012	7/12/2012	7/12/2012	7/12/2012	7/12/2012	7/12/2012	7/12/2012
			Sample Depth	0 - 0.15 m	0.61 - 0.76 m	12-02-02 FD	1.37 - 1.52 m	0 - 0.15 m	0 - 0.15 m	1.37 - 1.52 m
			MDL							
Metals										
Aluminum (Al)	mg/kg	-	5	7780	17100	16000	<5.0	9030	3410	32300
Antimony (Sb)	mg/kg	40 [1]	0.1	1060 *	1.17	221	<0.10	517	414	2.18
Arsenic (As)	mg/kg	12 [2]	0.1	368	5.11	57.9	<0.10	226	132	10.3
Barium (Ba)	mg/kg	2000 [6]	0.5	261	212	935	<0.50	222	130	199
Beryllium (Be)	mg/kg	8 [1]	0.1	0.23	0.6	0.71	<0.10	0.2	0.14	0.97
Bismuth (Bi)	mg/kg	-	0.02	3.87	0.19	0.389	<0.020	2.92	2.15	0.283
Boron (B)	mg/kg	-	10	45	39	67	<10	57	37	49
Cadmium (Cd)	mg/kg	22 [3]	0.02	25.7	0.341	1.44	<0.020	16.8	8.99	0.372
Calcium (Ca)	mg/kg	-	100	126000 *	76000	89800	<100	158000 *	215000 *	26300
Cesium (Cs)	mg/kg	-	0.02	0.544	1.26	0.783	<0.020	0.449	0.242	1.83
Chromium (Cr)	mg/kg	87 [2]	1	64.9	79.2	25.9	<1.0	57	32.9	52.7
Cobalt (Co)	mg/kg	300 [1]	0.02	7.41	9.08	7.74	<0.020	7.48	3.97	13.2
Copper (Cu)	mg/kg	91 [3]	1	4680 *	35.3	154	<1.0	1000 *	560	43.4
Iron (Fe)	mg/kg	-	25	39300	25700	26700	<25	28100	19000	33300
Lead (Pb)	mg/kg	600 [3]	0.2	53400 *	92.1	8770 *	0.32	46200 *	33700 *	170
Magnesium (Mg)	mg/kg	-	10	50500	26200	29500	<10	62000	103000 *	13200
Manganese (Mn)	mg/kg	-	0.5	461	511	353	<0.50	454	515	524
Molybdenum (Mo)	mg/kg	40 [1]	0.02	6.15	4.69	2.55	<0.020	7.32	17.4	1.1
Nickel (Ni)	mg/kg	50 [3]	0.5	71.7	69.6	28.1	<0.50	76.4	35.3	50.6
Phosphorus (P)	mg/kg	-	100	510	490	720	<100	460	260	650
Potassium (K)	mg/kg	-	25	1400	3670	2400	<25	1260	709	6010
Rubidium (Rb)	mg/kg	-	0.02	8.78	26.1	15.8	<0.020	8.3	3.78	44.8
Selenium (Se)	mg/kg	2.9 [5]	0.5	9.08	0.52	0.99	<0.50	5.18	3.51	0.87
Silver (Ag)	mg/kg	40 [1]	0.1	1.17	0.22	0.47	<0.10	1	0.51	0.59
Sodium (Na)	mg/kg	-	10	800	624	1910	<10	491	538	2410
Strontium (Sr)	mg/kg	-	0.1	85.9	187	552	<0.10	77.6	82.9	127
Tellurium (Te)	mg/kg	-	0.1	0.56	<0.10	<0.10	<0.10	0.31	0.16	<0.10
Thallium (Tl)	mg/kg	1 [3]	0.1	0.97	0.2	0.29	<0.10	0.64	0.62	0.35
Tin (Sn)	mg/kg	300 [1]	5	258	<5.0	95.7	<5.0	147	94.3	<5.0
Titanium (Ti)	mg/kg	-	0.5	185	321	525	<0.50	155	122	244
Tungsten (W)	mg/kg	-	0.05	0.95	0.173	0.409	<0.050	1.77	0.66	0.08
Uranium (U)	mg/kg	300 [4]	0.02	0.699	0.96	2.02	<0.020	0.556	0.521	1.52
Vanadium (V)	mg/kg	130 [2]	0.5	19.5	49.2	36.1	<0.50	17.8	9.75	90.9
Zinc (Zn)	mg/kg	360 [3]	10	750 *	200	170	<10	740 *	163	101
Zirconium (Zr)	mg/kg	-	0.1	2.6	10.7	15.5	<0.10	2.3	3.77	12.3
Other Parameters										
pH (1:2 soil:water)	pH		0.1	-	9.23	8.32	8.48	7.94	-	-

NOTES

'-' - no criteria available
1 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 1991), Industrial Land Use.
2 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 1997), Industrial Land Use.
3 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 1999), Industrial Land Use.
4 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 2007), Industrial Land Use.
5 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 2009), Industrial Land Use.
6 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 2013), Industrial Land Use.
20 exceeds criteria
RDL - Reportable Detection Limit
* RDL adjusted, matrix interferences

Table B-1 - Summary of Soil Analytical Data - Metals

Parameter	Units	Assessment Criteria	Sample ID	12-05-02	12-05-05	TP-01-02	TP-04-03	TP-05-03	TP-07-03	TP-10-03
			Sample Date	7/12/2012	7/12/2012	11/13/2012	11/13/2012	11/13/2012	11/13/2012	11/13/2012
			Sample Depth	0.61 - 0.76 m	2.9 - 3.0 m	2.8 m	1.8 m	2.3 m	2.4 m	2.8 m
			MDL							
Metals										
Aluminum (Al)	mg/kg	-	5	21600	20300	25700 *	7960	21500 *	5970	28300 *
Antimony (Sb)	mg/kg	40 [1]	0.1	33.1	0.36	**58.6**	**56.8**	11.9	0.89	3.07
Arsenic (As)	mg/kg	12 [2]	0.1	7.43	7.64	**31.9**	**25.2**	11.2	2.39	7.63
Barium (Ba)	mg/kg	2000 [6]	0.5	1550	406	345	234	200	52	323
Beryllium (Be)	mg/kg	8 [1]	0.1	0.82	0.93	1.02	0.42	1.04	0.16	1.09
Bismuth (Bi)	mg/kg	-	0.02	0.147	0.259	1.04	0.324	0.331	0.079	0.277
Boron (B)	mg/kg	-	10	138	16	16	40	22	12	16
Cadmium (Cd)	mg/kg	22 [3]	0.02	0.609	0.307	0.818	1.81	0.811	0.137	0.249
Calcium (Ca)	mg/kg	-	100	79900	59300	36400	76900	45000	88100 *	35400
Cesium (Cs)	mg/kg	-	0.02	0.821	1.6	-	-	-	-	-
Chromium (Cr)	mg/kg	87 [2]	1	21.1	38.5	54.9	16.6	48.8	15.8	53
Cobalt (Co)	mg/kg	300 [1]	0.02	7.27	14.1	16.4	5.64	15.4	4.39	17.4
Copper (Cu)	mg/kg	91 [3]	1	54.4	30	78.6	**182**	40.7	11.3	38
Iron (Fe)	mg/kg	-	25	19500	27500	34600	13200	30000	9540	32000
Lead (Pb)	mg/kg	600 [3]	0.2	499	15.9	**5860 ***	**4780 ***	**1010 ***	75	272
Magnesium (Mg)	mg/kg	-	10	23600	24900	17100	24900	16800	52300	14900
Manganese (Mn)	mg/kg	-	0.5	439	620	498	295	494	256	584
Molybdenum (Mo)	mg/kg	40 [1]	0.02	3.15	1.2	1.46	1.07	1.28	0.466	0.684
Nickel (Ni)	mg/kg	50 [3]	0.5	25.2	45.3	**50.5**	19	48.7	14.1	48.8
Phosphorus (P)	mg/kg	-	100	1480	540	570	570	600	410	500
Potassium (K)	mg/kg	-	25	2780	3790	4270	1450	3730	1470	4480
Rubidium (Rb)	mg/kg	-	0.02	15.1	30.3	-	-	-	-	-
Selenium (Se)	mg/kg	2.9 [5]	0.5	0.9	0.63	0.5	0.79	<0.50	<0.50	<0.50
Silver (Ag)	mg/kg	40 [1]	0.1	0.29	0.19	0.22	0.15	0.19	<0.10	0.15
Sodium (Na)	mg/kg	-	10	4470	1190	1930	479	1670	523	1370
Strontium (Sr)	mg/kg	-	0.1	1110	76.7	97.1	151	88.6	42.2	90.3
Tellurium (Te)	mg/kg	-	0.1	<0.10	<0.10	-	-	-	-	-
Thallium (Tl)	mg/kg	1 [3]	0.1	0.14	0.26	0.39	0.2	0.34	0.11	0.34
Tin (Sn)	mg/kg	300 [1]	5	12.6	<5.0	41.1	26.6	<5.0	<5.0	<5.0
Titanium (Ti)	mg/kg	-	0.5	574	93.9	155	202	162	279	144
Tungsten (W)	mg/kg	-	0.05	0.478	<0.050	-	-	-	-	-
Uranium (U)	mg/kg	300 [4]	0.02	3.11	2.21	2.28	0.935	1.97	0.715	1.81
Vanadium (V)	mg/kg	130 [2]	0.5	31.2	59.2	88.1	23.9	73.2	21.6	89.6
Zinc (Zn)	mg/kg	360 [3]	10	106	77	99	170	81	24	85
Zirconium (Zr)	mg/kg	-	0.1	14.9	13.4	-	-	-	-	-
Other Parameters										
pH (1:2 soil:water)	pH		0.1	-	-	8.01	7.74	8.28	8.87	8.34

NOTES

'-' - no criteria available
1 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 1991), Industrial Land Use.
2 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 1997), Industrial Land Use.
3 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 1999), Industrial Land Use.
4 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 2007), Industrial Land Use.
5 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 2009), Industrial Land Use.
6 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 2013), Industrial Land Use.
20 exceeds criteria
RDL - Reportable Detection Limit
* RDL adjusted, matrix interferences

Table B-1 - Summary of Soil Analytical Data - Metals

Parameter	Units	Assessment Criteria	Sample ID	TP-13-02	TP-15-03	TP-16-03	TP-18-03	TP-18-04	TP-21-03
			Sample Date	11/13/2012	11/14/2012	11/14/2012	11/14/2012	11/14/2012	11/14/2012
			Sample Depth	2.3 m	2.4 m	2.6 m	2.5 m	TP-18-04 FD	1.8 m
			MDL						
Metals									
Aluminum (Al)	mg/kg	-	5	25000 *	18600 *	23200 *	28500 *	28000 *	6580
Antimony (Sb)	mg/kg	40 [1]	0.1	21.8	31.7	20.2	1.03	1.68	6.05
Arsenic (As)	mg/kg	12 [2]	0.1	10.3	12.8	12.3	7.6	7.53	3.86
Barium (Ba)	mg/kg	2000 [6]	0.5	349	164	224	249	193	57.4
Beryllium (Be)	mg/kg	8 [1]	0.1	0.98	0.54	0.69	0.91	0.9	0.2
Bismuth (Bi)	mg/kg	-	0.02	0.302	0.337	0.249	0.28	0.27	0.084
Boron (B)	mg/kg	-	10	16	17	18	17	17	13
Cadmium (Cd)	mg/kg	22 [3]	0.02	0.358	0.454	0.542	0.272	0.254	0.239
Calcium (Ca)	mg/kg	-	100	37500	77900	53100	37000	34400	89600 *
Cesium (Cs)	mg/kg	-	0.02	-	-	-	-	-	-
Chromium (Cr)	mg/kg	87 [2]	1	51.3	45.3	47.6	59.2	59.1	16.6
Cobalt (Co)	mg/kg	300 [1]	0.02	16	13.4	11.9	18.8	17.2	4.69
Copper (Cu)	mg/kg	91 [3]	1	43.8	44.1	46.4	36.5	37.5	13.8
Iron (Fe)	mg/kg	-	25	31200	25400	26300	33000	33400	10100
Lead (Pb)	mg/kg	600 [3]	0.2	565	4430 *	1490 *	110	202	188
Magnesium (Mg)	mg/kg	-	10	17000	29000	16200	16400	16200	48400
Manganese (Mn)	mg/kg	-	0.5	500	493	498	556	499	244
Molybdenum (Mo)	mg/kg	40 [1]	0.02	0.789	0.731	0.455	0.61	0.619	0.56
Nickel (Ni)	mg/kg	50 [3]	0.5	46.5	41.7	39	52	51.1	14.8
Phosphorus (P)	mg/kg	-	100	550	620	700	600	600	410
Potassium (K)	mg/kg	-	25	4370	4360	6110	5180	5210	1310
Rubidium (Rb)	mg/kg	-	0.02	-	-	-	-	-	-
Selenium (Se)	mg/kg	2.9 [5]	0.5	<0.50	<0.50	<0.50	0.88	<0.50	0.88
Silver (Ag)	mg/kg	40 [1]	0.1	0.16	0.15	0.13	0.18	0.18	<0.10
Sodium (Na)	mg/kg	-	10	1650	873	1960	1440	1500	353
Strontium (Sr)	mg/kg	-	0.1	97.3	111	107	90.2	83.8	52.8
Tellurium (Te)	mg/kg	-	0.1	-	-	-	-	-	-
Thallium (Tl)	mg/kg	1 [3]	0.1	0.34	0.39	0.31	0.38	0.38	0.12
Tin (Sn)	mg/kg	300 [1]	5	11.3	11.9	11	<5.0	<5.0	<5.0
Titanium (Ti)	mg/kg	-	0.5	182	664	367	310	323	260
Tungsten (W)	mg/kg	-	0.05	-	-	-	-	-	-
Uranium (U)	mg/kg	300 [4]	0.02	2.61	1.42	1.07	1.39	1.37	0.744
Vanadium (V)	mg/kg	130 [2]	0.5	83.9	66.6	78.4	92.6	92.6	24
Zinc (Zn)	mg/kg	360 [3]	10	86	67	85	89	91	27
Zirconium (Zr)	mg/kg	-	0.1	-	-	-	-	-	-
Other Parameters									
pH (1:2 soil:water)	pH		0.1	8.66	8.4	8.73	8.46	8.6	8.66

NOTES

'-' - no criteria available
1 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 1991), Industrial Land Use.
2 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 1997), Industrial Land Use.
3 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 1999), Industrial Land Use.
4 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 2007), Industrial Land Use.
5 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 2009), Industrial Land Use.
6 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 2013), Industrial Land Use.
20 exceeds criteria
RDL - Reportable Detection Limit
* RDL adjusted, matrix interferences

Table B-2 - Summary of Soil Analytical Data - Leachate

Parameter	Units	Assessment Criteria	Sample ID	13-01-5.2	13-02-1.8	13-03-1.1	13-04-1.1	13-05-1.5	13-06-7.3	13-07-2.4
			Sample Date	13-May-13	13-May-13	13-May-13	13-May-13	13-May-13	13-May-13	13-May-13
			Sample Depth	3.5 - 4.2 m	1.5 - 2.0 m	0.8 - 1.3 m	0.8 - 1.3 m	0.5 - 1.0 m	0.5 - 1.0 m	0.5 - 1.0 m
			RDL							
Leachate										
Antimony (Sb)-Dissolved	mg/L	-	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.65	<0.50
Arsenic (As)-Dissolved	mg/L	5	0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Barium (Ba)-Dissolved	mg/L	100	0.50	<0.50	<0.50	<0.50	0.77	<0.50	<0.50	<0.50
Beryllium (Be)-Dissolved	mg/L	-	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Boron (B)-Dissolved	mg/L	500	5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Cadmium (Cd)-Dissolved	mg/L	0.5	0.050	<0.050	<0.050	<0.050	<0.050	0.091	0.427	0.355
Calcium (Ca)-Dissolved	mg/L	-	5.0	779	530	498	361	606	765	953
Chromium (Cr)-Dissolved	mg/L	5	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Cobalt (Co)-Dissolved	mg/L	-	0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Copper (Cu)-Dissolved	mg/L	-	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Iron (Fe)-Dissolved	mg/L	-	5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Lead (Pb)-Dissolved	mg/L	5	0.50	<0.50	<0.50	**43.5**	**25.7**	**101**	**155**	**89.7**
Magnesium (Mg)-Dissolved	mg/L	-	5.0	106	168	123	84.1	50.7	39.7	30.8
Manganese (Mn)-Dissolved	mg/L	-	0.050	2.14	6.07	4.37	9.18	0.059	0.472	1.55
Molybdenum (Mo)-Dissolved	mg/L	-	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel (Ni)-Dissolved	mg/L	-	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Potassium (K)-Dissolved	mg/L	-	5.0	6.1	<5.0	14.8	12.1	11.3	7.7	7.7
Selenium (Se)-Dissolved	mg/L	1	0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Silver (Ag)-Dissolved	mg/L	5	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Strontium (Sr)-Dissolved	mg/L	-	0.010	0.935	1.21	3.35	2.00	1.36	1.22	1.25
Thallium (Tl)-Dissolved	mg/L	-	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Tin (Sn)-Dissolved	mg/L	-	0.050	0.430	0.433	0.430	0.438	0.427	0.429	0.445
Uranium (U)-Dissolved	mg/L	2	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Vanadium (V)-Dissolved	mg/L	-	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Zinc (Zn)-Dissolved	mg/L	-	1.0	<1.0	<1.0	<1.0	<1.0	51.7	<1.0	<1.0
Zirconium (Zr)-Dissolved	mg/L	-	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50

NOTES

'-' - no criteria available
1 - Manitoba Regulation 282/87, Classification Critieria for Products, Substances and Organisms, Table 1 - Leachate Quality Criteria
20 exceeds criteria
RDL - Reportable Detection Limit

Table B-2 - Summary of Soil Analytical Data - Leachate

Parameter	Units	Assessment Criteria	Sample ID	13-08-1.5	13-09-1.1	13-10-7.3	FD1	13-11-3.7	13-12-1.1
			Sample Date	**13-May-13**	**13-May-13**	**13-May-13**	**13-May-13**	**13-May-13**	**13-May-13**
			Sample Depth	**0.5 - 1.0 m**	**0.5 - 1.0 m**	**1.2 - 1.8 m**	**1.2 - 1.8 m**	**0.5 - 1.0 m**	**0.5 - 1.0 m**
			RDL						
Leachate									
Antimony (Sb)-Dissolved	mg/L	-	0.50	0.66	<0.50	<0.50	<0.50	<0.50	<0.50
Arsenic (As)-Dissolved	mg/L	5	0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Barium (Ba)-Dissolved	mg/L	100	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Beryllium (Be)-Dissolved	mg/L	-	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Boron (B)-Dissolved	mg/L	500	5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Cadmium (Cd)-Dissolved	mg/L	0.5	0.050	**1.38**	<0.050	<0.050	0.083	0.073	0.071
Calcium (Ca)-Dissolved	mg/L	-	5.0	1190	279	483	480	505	646
Chromium (Cr)-Dissolved	mg/L	5	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Cobalt (Co)-Dissolved	mg/L	-	0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Copper (Cu)-Dissolved	mg/L	-	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Iron (Fe)-Dissolved	mg/L	-	5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Lead (Pb)-Dissolved	mg/L	5	0.50	**82.7**	<0.50	**55.6**	**126**	**238**	**104**
Magnesium (Mg)-Dissolved	mg/L	-	5.0	25.0	108	54.6	37.7	29.2	39.6
Manganese (Mn)-Dissolved	mg/L	-	0.050	0.186	0.342	0.145	1.22	0.189	1.41
Molybdenum (Mo)-Dissolved	mg/L	-	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel (Ni)-Dissolved	mg/L	-	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Potassium (K)-Dissolved	mg/L	-	5.0	7.1	23.2	9.1	10.3	7.9	10.0
Selenium (Se)-Dissolved	mg/L	1	0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Silver (Ag)-Dissolved	mg/L	5	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Strontium (Sr)-Dissolved	mg/L	-	0.010	0.586	0.715	1.08	1.14	1.01	1.21
Thallium (Tl)-Dissolved	mg/L	-	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Tin (Sn)-Dissolved	mg/L	-	0.050	0.423	0.407	0.412	0.423	0.399	0.443
Uranium (U)-Dissolved	mg/L	2	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Vanadium (V)-Dissolved	mg/L	-	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Zinc (Zn)-Dissolved	mg/L	-	1.0	<1.0	<1.0	<1.0	5.6	2.2	25.6
Zirconium (Zr)-Dissolved	mg/L	-	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50

NOTES

'-' - no criteria available

Manitoba Regulation 282/87, Classification Critieria for Products, Substances and Organisms, Table 1 - Leachate Quality Criteria

20 exceeds criteria

RDL - Reportable Detection Limit

Table B-2 - Summary of Soil Analytical Data - Leachate

Parameter	Units	Assessment Criteria	Sample ID	12-05-02	TP-08-03	TP-09-03	TP-11-03
			Sample Date	7/12/2012	11/13/2012	11/13/2012	11/13/2012
			Sample Depth	0.61 - 0.76 m	2.8 m	2.8 m	2.4 m
			MDL				
Petroleum Hydrocarbons							
Benzene	mg/kg	0.0068 [2]	0.005	<0.0050	-	-	-
Ethyl Benzene	mg/kg	0.018 [2]	0.015	<0.015	-	-	-
Toluene	mg/kg	0.08 [2]	0.05	<0.050	-	-	-
Xylenes	mg/kg	2.4 [2]	0.1	<0.10	-	-	-
F1 (C6-C10)	mg/kg	320 [1]	10	<10	-	-	-
F2 (C10-C16)	mg/kg	260 [1]	10	16	-	-	-
F3 (C16-C34)	mg/kg	2500 [1]	50	95	-	-	-
F4 (C34-C50)	mg/kg	3300 [1]	50	64			
PAHs							
Acenaphthene	mg/kg	-	0.005	-	<0.0050	<0.0050	<0.0050
Acenaphthylene	mg/kg	-	0.005	-	<0.0050	<0.0050	<0.0050
Acridine	mg/kg	-	0.01	-	<0.010	<0.010	<0.010
Anthracene	mg/kg	32 [3]	0.004	-	<0.0040	<0.0040	<0.0040
Benzo(a)anthracene	mg/kg	0.33 [4]	0.01	-	<0.010	<0.010	<0.010
Benzo(a)pyrene	mg/kg	0.16 [4]	0.01	-	<0.010	<0.010	<0.010
Benzo(b&j)fluoranthene	mg/kg	0.33 [4]	0.01	-	<0.010	<0.010	<0.010
Benzo(b)fluoranthene	mg/kg	-	0.01	-	<0.010	<0.010	<0.010
Benzo(b+j+k)fluoranthene	mg/kg	-	0.014	-	<0.014	<0.014	<0.014
Benzo(g,h,i)perylene	mg/kg	6.8 [4]	0.01	-	<0.010	<0.010	<0.010
Benzo(k)fluoranthene	mg/kg	0.034 [4]	0.01	-	<0.010	<0.010	<0.010
Chrysene	mg/kg	2.1 [4]	0.01	-	<0.010	<0.010	<0.010
Dibenzo(a,h)anthracene	mg/kg	0.23 [4]	0.005	-	<0.0050	<0.0050	<0.0050
Fluoranthene	mg/kg	180 [3]	0.01	-	<0.010	<0.010	<0.010
Fluorene	mg/kg	-	0.01	-	<0.010	<0.010	<0.010
Indeno(1,2,3-cd)pyrene	mg/kg	2.7 [4]	0.01	-	<0.010	<0.010	<0.010
1-Methyl Naphthalene	mg/kg	-	0.01	-	<0.010	<0.010	<0.010
2-Methyl Naphthalene	mg/kg	-	0.01	-	<0.010	<0.010	<0.010
Naphthalene	mg/kg	-	0.01	-	<0.010	<0.010	<0.010
Phenanthrene	mg/kg	-	0.01	-	<0.010	<0.010	<0.010
Pyrene	mg/kg	-	0.01	-	<0.010	<0.010	<0.010
Quinoline	mg/kg	-	0.01	-	<0.010	<0.010	<0.010
B(a)P Total Potency Equivalent	mg/kg	0.6 [4,5]	0.02	-	<0.020	<0.020	<0.020
IACR (CCME)	mg/kg	1.0 [4]	0.15	-	<0.15	<0.15	<0.15

NOTES

'-' - no criteria available
1 - Canadian Council of Ministers of the Environment (2008), Canada Wide Standards for Petroleum Hydrocarbons in Soil (Fine-Grained)
2 - Canadian Council of Ministers of the Environment SQGs (2004), Industrial Land Use
3 - Canadian SQGs for Carcinogenic and other Polycyclic Aromatic Hydrocarbons Environmental Health Guidelines/Check Values
4 - Canadian SQGs for Carcinogenic and other Polycyclic Aromatic Hydrocarbons Human Health Guideline/Check Values
5 - Canadian SQGs for Carcinogenic and other Polycyclic Aromatic Hydrocarbons Human Health Guideline/Check Values 10^{-6} B(a) P Total Potency Equivalents
20 exceeds criteria
MDL - Method Detection Limit

Table B-3 - Summary of Soil Analytical Data - Mercury and pH

Parameter	Units	Assessment Criteria	Sample ID	13-01-5.2	13-02-1.8	13-03-1.1	13-04-1.1	13-05-1.5	13-06-7.3	13-07-2.4
			Sample Date	13-May-13	13-May-13	13-May-13	13-May-13	13-May-13	13-May-13	13-May-13
			Sample Depth	3.5 - 4.2 m	1.5 - 2.0 m	0.8 - 1.3 m	0.8 - 1.3 m	0.5 - 1.0 m	0.5 - 1.0 m	0.5 - 1.0 m
			RDL							
Mercury	mg/kg	50	0.050	<0.050	<0.050	0.067	0.174	0.102	0.209	0.194
pH	-	6 to 8	0.10	**8.14**	**8.40**	**8.22**	**8.05**	7.81	7.69	7.64

Parameter	Units	Assessment Criteria	Sample ID	13-08-1.5	13-09-1.1	13-10-7.3	FD1	13-11-3.7	13-12-1.1
			Sample Date	13-May-13	13-May-13	13-May-13	13-May-13	13-May-13	13-May-13
			Sample Depth	0.5 - 1.0 m	0.5 - 1.0 m	1.2 - 1.8 m	1.2 - 1.8 m	0.5 - 1.0 m	0.5 - 1.0 m
			RDL						
Mercury	mg/kg	50	0.050	0.200	<0.050	0.272	0.224	0.196	0.351
pH	-	6 to 8	0.10	7.61	**8.20**	7.73	7.66	7.61	7.60

NOTES

1 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 1991), Industrial Land Use.
2 - Canadian Council of Ministers of the Environment, Canadian Soil Quality Guildelines (update 1999), Industrial Land Use.
20 exceeds criteria

Table B-4 - Summary of Soil Analytical Data - Polycyclic Aromatic Hydrocarbons, Petroleum Hydrocarbons and Polychlorinated Biphenyls

Parameter	Units	Assessment Criteria	Sample ID	13-13-1.1	13-14-1.8	13-15-1.8	13-16-1.5	13-17-1.8	13-18-1.8	13-19.18	FD 2
			Sample Date	14-May-13	14-May-13	14-May-13	14-May-13	14-May-13	14-May-13	14-May-13	14-May-13
			Sample Depth	0.5 - 1.0 m	0.5 - 1.0 m	0.0 - 0.05 m	0.5 - 1.0 m	0.5 - 1.0 m	0.5 - 1.0 m	1.2 - 1.8 m	1.2 - 1.8 m
			RDL								
Petroleum Hydrocarbons											
Benzene	mg/kg	0.28 [2]	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0098	0.0079
Toluene	mg/kg	430 [3]	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Ethyl Benzene	mg/kg	330 [3]	0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015
Total Xylenes	mg/kg	230 [3]	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
F1 (C6-C10)	mg/kg	320	10	<10	<10	<10	<10	<10	<10	<10	<10
F2 (C10-C16)	mg/kg	260	25	<25	86	<25	<25	<25	<25	<25	<25
F3 (C16-C34)	mg/kg	2500	50	65	51	84	371	<50	<50	<50	<50
F4 (C34-C50)	mg/kg	6600	50	60	<50	<50	270	<50	<50	<50	<50
PCBs											
Total Polychlorinated Biphenyls	mg/kg	33	0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30

NOTES

1 - CCME Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health (2004), coarse grained surface soil (Table 1a), commercial land use, Tier II ecological guidelines/check values for eco-soil contact.

2 - CCME Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health (2004), coarse grained surface soil (Table 1a), commercial land use, Tier II ecological guidelines/check values for eco-soil contact.

3 - CCME Canada-Wide Standards for Petroleum Hydrocarbons (PHC) in Soil technical Supplement (January 2008) Tier II, coarse grained surface soil (Table 2), commercial land use, Eco Soil Contact.

20 exceeds criteria

RDL - Reportable Detection Limit

Table B-4 - Summary of Soil Analytical Data - Polycyclic Aromatic Hydrocarbons, Petroleum Hydrocarbons and Polychlorinated Biphenyls

Parameter	Units	Assessment Criteria	Sample ID	13-20-1.8	13-21-1.8	12-05-02	TP-08-03	TP-09-03	TP-11-03
			Sample Date	14-May-13	14-May-13	7/12/2012	11/13/2012	11/13/2012	11/13/2012
			Sample Depth	1.2 - 1.8 m	1.2 - 1.8 m	0.61 - 0.76 m	2.8 m	2.8 m	2.4 m
			MDL						
Petroleum Hydrocarbons									
Benzene	mg/kg	0.0068 [2]	0.005	<0.0050	<0.0050	<0.0050	-	-	-
Ethyl Benzene	mg/kg	0.018 [2]	0.015	<0.050	<0.050	<0.015	-	-	-
Toluene	mg/kg	0.08 [2]	0.05	<0.015	<0.015	<0.050	-	-	-
Xylenes	mg/kg	2.4 [2]	0.1	<0.10	<0.10	<0.10	-	-	-
F1 (C6-C10)	mg/kg	320 [1]	10	<10	<10	<10	-	-	-
F2 (C10-C16)	mg/kg	260 [1]	10	<25	<25	16	-	-	-
F3 (C16-C34)	mg/kg	2500 [1]	50	<50	<50	95	-	-	-
F4 (C34-C50)	mg/kg	3300 [1]	50	<50	<50	64			
PAHs									
Acenaphthene	mg/kg	-	0.005	-	-	-	<0.0050	<0.0050	<0.0050
Acenaphthylene	mg/kg	-	0.005	-	-	-	<0.0050	<0.0050	<0.0050
Acridine	mg/kg	-	0.01	-	-	-	<0.010	<0.010	<0.010
Anthracene	mg/kg	32 [3]	0.004	-	-	-	<0.0040	<0.0040	<0.0040
Benzo(a)anthracene	mg/kg	0.33 [4]	0.01	-	-	-	<0.010	<0.010	<0.010
Benzo(a)pyrene	mg/kg	0.16 [4]	0.01	-	-	-	<0.010	<0.010	<0.010
Benzo(b&j)fluoranthene	mg/kg	0.33 [4]	0.01	-	-	-	<0.010	<0.010	<0.010
Benzo(b)fluoranthene	mg/kg	-	0.01	-	-	-	<0.010	<0.010	<0.010
Benzo(b+j+k)fluoranthene	mg/kg	-	0.014	-	-	-	<0.014	<0.014	<0.014
Benzo(g,h,i)perylene	mg/kg	6.8 [4]	0.01	-	-	-	<0.010	<0.010	<0.010
Benzo(k)fluoranthene	mg/kg	0.034 [4]	0.01	-	-	-	<0.010	<0.010	<0.010
Chrysene	mg/kg	2.1 [4]	0.01	-	-	-	<0.010	<0.010	<0.010
Dibenzo(a,h)anthracene	mg/kg	0.23 [4]	0.005	-	-	-	<0.0050	<0.0050	<0.0050
Fluoranthene	mg/kg	180 [3]	0.01	-	-	-	<0.010	<0.010	<0.010
Fluorene	mg/kg	-	0.01	-	-	-	<0.010	<0.010	<0.010
Indeno(1,2,3-cd)pyrene	mg/kg	2.7 [4]	0.01	-	-	-	<0.010	<0.010	<0.010
1-Methyl Naphthalene	mg/kg	-	0.01	-	-	-	<0.010	<0.010	<0.010
2-Methyl Naphthalene	mg/kg	-	0.01	-	-	-	<0.010	<0.010	<0.010
Naphthalene	mg/kg	-	0.01	-	-	-	<0.010	<0.010	<0.010
Phenanthrene	mg/kg	-	0.01	-	-	-	<0.010	<0.010	<0.010
Pyrene	mg/kg	-	0.01	-	-	-	<0.010	<0.010	<0.010
Quinoline	mg/kg	-	0.01	-	-	-	<0.010	<0.010	<0.010
B(a)P Total Potency Equivalent	mg/kg	0.6 [4,5]	0.02	-	-	-	<0.020	<0.020	<0.020
IACR (CCME)	mg/kg	1.0 [4]	0.15	-	-	-	<0.15	<0.15	<0.15
PCBs									
Total Polychlorinated Biphenyls	mg/kg	33	0.30	<0.30	<0.30	-	-	-	-

'-' - no criteria available
1 - Canadian Council of Ministers of the Environment (2008), Canada Wide Standards for Petroleum Hydrocarbons in Soil (Fine-Grained)
2 - Canadian Council of Ministers of the Environment SQGs (2004), Industrial Land Use
3 - Canadian SQGs for Carcinogenic and other Polycyclic Aromatic Hydrocarbons Environmental Health Guidelines/Check Values
4 - Canadian SQGs for Carcinogenic and other Polycyclic Aromatic Hydrocarbons Human Health Guideline/Check Values
5 - Canadian SQGs for Carcinogenic and other Polycyclic Aromatic Hydrocarbons Human Health Guideline/Check Values 10^{-6} B(a) P Total Potency Equivalents
20 exceeds criteria
RDL - Reportable Detection Limit

Table B-5 - Summary of Soil Analytical Data - Grain Size

Sample Identifier: Borehole ID	Sample Identifier: Depth (mbgs)	Date (dd/mm/yy):	% Sand	% Silt	% Clay	Texture
13-01-5.2	0.8	13/05/13	47.1	50.1	2.8	Clay
	1.5	13/05/13	11.9	9.6	78.5	Clay
	4.6	13/05/13	42.9	38.7	18.4	Loam

Notes:
mbgs - metres below ground surface.

Parameter / Location / Date	Unit	FIGWQ Guidelines	MOE Industrial (Table 3)	13-01 17-Jun-14	13-01 FD1 17-Jun-14	13-01-5.2 1-Aug-13	13-02 17-Jun-14	13-02-1.8 21-Aug-13	13-03 17-Jun-14	13-04 17-Jun-14	13-06-7.3 31-Jul-13	13-06-7.3 FD 31-Jul-13	13-06 17-Jun-14	13-06 FD2 17-Jun-14	13-07-2.4 21-Aug-13	13-07 17-Jun-14
Conductivity	umhos/cm	-	-	>10000	>10000	13100	-	10000	2780	1580	9010	9250	9920	9950	4020	2780
Oxygen, Dissolved	mg/L	-	-	0.10	0.20	0.6	0.40	0.1	2.10	<0.10	0.6	0.3	0.50	0.80	0.1	0.50
pH	-	-	-	8.10	7.90	7.67	-	7.32	7.71	7.86	8.09	8.1	7.72	7.76	7.69	7.90
Turbidity	NTU	-	-	>4000	>4000	2.37	-	157	459	2760	4	3.41	143	178	<4000	510
Alkalinity, Total (as CaCO3)	mg/L	-	-	1970	1990	627	-	1010	92	158	549	550	515	517	602	317
Bicarbonate (HCO3)	mg/L	-	-	2330	2430	765	-	1230	113	193	670	671	628	631	735	386
Carbonate (CO3)	mg/L	-	-	34	<12	<12	-	<12	<12	<12	<12	<12	<12	<12	<12	<12
Chloride	mg/L	-	-	1410	1380	2310	-	83.7	97.9	68.1	1560	1580	1640	1640	58.8	59.8
Hydroxide (OH)	mg/L	-	-	<6.8	<6.8	<6.8	-	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8
Sulphide	mg/L	-	-	8090	7960	0.036	-	<0.020	1730	691	<0.020	<0.020	3910	3880	<0.020	1580
Aluminum (Al)-Dissolved	mg/L	0.1‡	-	*<0.20*	*<0.20*	<0.020	<0.020	<0.020	<0.0020	0.0027	<0.020	<0.020	<0.020	<0.020	<0.020	<0.0020
Antimony (Sb)-Dissolved	mg/L	2	20	0.065	0.068	0.0734	0.191	0.0393	0.172	0.138	0.0297	0.0313	0.0375	0.0359	0.574	0.806
Arsenic (As)-Dissolved	mg/L	0.0005	1.9	*<0.020*	*<0.020*	0.0107	0.0107	0.0269	0.00465	0.0315	0.0067	0.0073	0.0063	0.0064	0.238	0.0280
Barium (Ba)-Dissolved	mg/L	0.5	290	<0.020	<0.020	0.0208	0.0209	0.0309	0.0337	0.0366	0.0176	0.0184	0.0158	0.0173	0.0565	0.0672
Beryllium (Be)-Dissolved	mg/L	0.0053	0.067	*<0.020*	*<0.020*	<0.0010	<0.0020	<0.0010	<0.00020	<0.00020	<0.0010	<0.0010	<0.0020	<0.0020	<0.0010	<0.00020
Bismuth (Bi)-Dissolved	mg/L	-	-	<0.020	<0.020	<0.00050	<0.0020	<0.00050	<0.00020	<0.00020	<0.00050	<0.00050	<0.0020	<0.0020	<0.00050	<0.00020
Boron (B)-Dissolved	mg/L	5	45	<1.0	<1.0	1.37	6.35	6.22	3.51	1.99	1.12	1.11	1.09	0.91	18.2	8.03
Cadmium (Cd)-Dissolved	mg/L	0.000017	0.0027	*<0.0010*	0.0011	0.00131	0.00539	0.00112	0.00760	0.00219	0.00486	0.00529	0.00497	0.00459	0.00963	0.0114
Calcium (Ca)-Dissolved	mg/L	-	-	388	380	524	453	495	487	210	475	461	475	468	454	498
Cesium (Cs)-Dissolved	mg/L	-	-	<0.010	<0.010	<0.00050	<0.0010	<0.00050	<0.00010	<0.00010	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.00010
Chromium (Cr)-Dissolved	mg/L	0.0089	0.81	<0.20	<0.20	0.0021	<0.020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.020	<0.020	<0.0020	<0.0020
Cobalt (Co)-Dissolved	mg/L	-	0.066	<0.020	<0.020	0.00503	0.0128	0.0148	0.00386	0.00172	0.00401	0.00392	0.0035	0.0034	0.00937	0.00108
Copper (Cu)-Dissolved	mg/L	0.004‡	0.087	0.037	0.038	0.015	0.0260	<0.0020	0.0117	0.00434	0.0059	0.006	0.0124	0.0129	0.0121	0.00957
Iron (Fe)-Dissolved	mg/L	0.3	-	<10	<10	<0.10	<1.0	0.79	<0.10	0.15	<0.10	<0.10	<1.0	<1.0	13.5	<0.10
Lead (Pb)-Dissolved	mg/L	0.007‡	0.025	0.109	0.107	0.0755	0.317	0.0462	0.155	0.163	0.113	0.115	0.113	0.112	0.445	0.196
Lithium (Li)-Dissolved	mg/L	-	-	1.05	1.06	0.794	0.351	0.331	0.0791	0.0549	0.547	0.541	0.492	0.476	0.182	0.0972
Magnesium (Mg)-Dissolved	mg/L	-	-	795	810	1070	1100	1020	195	88.2	649	643	653	636	202	141
Manganese (Mn)-Dissolved	mg/L	-	-	0.292	0.292	0.18	4.26	7.04	1.32	0.779	0.276	0.275	0.255	0.252	1.4	0.0810
Molybdenum (Mo)-Dissolved	mg/L	0.073	9.2	0.021	0.021	0.0165	0.0169	0.0195	0.00633	0.00633	0.014	0.014	0.0062	0.0060	0.0215	0.0124
Nickel (Ni)-Dissolved	mg/L	0.15	0.49	<0.10	<0.10	0.0317	0.038	0.0361	0.0154	0.0090	0.018	0.0176	0.015	0.014	0.0308	0.0213
Phosphorus (P)-Dissolved	mg/L	-	-	<3.0	<3.0	<0.50	<0.30	<0.50	<0.030	<0.030	<0.50	<0.50	<0.30	<0.30	<0.50	0.086
Potassium (K)-Dissolved	mg/L	-	-	20.9	21.4	33.5	4.94	7.27	42.2	14.5	14.4	14.5	12.9	12.8	8.49	13.2
Rubidium (Rb)-Dissolved	mg/L	-	-	<0.020	<0.020	0.0112	0.0037	0.00378	0.0168	0.00499	0.00809	0.00829	0.0042	0.0041	0.00329	0.00335
Selenium (Se)-Dissolved	mg/L	0.001	0.063	*<0.10*	*<0.10*	0.0235	*<0.010*	*<0.0050*	0.0068	<0.0010	0.0094	0.0056	*<0.010*	*<0.010*	0.0472	0.0673
Silicon (Si)-Dissolved	mg/L	-	-	<10	10	8.52	5.0	7.56	4.49	4.49	11.8	11.8	10.6	9.8	10.3	11.5
Silver (Ag)-Dissolved	mg/L	0.0001	0.0015	*<0.010*	*<0.010*	*<0.0010*	*<0.0010*	*<0.0010*	<0.00010	<0.00010	*<0.0010*	*<0.0010*	*<0.0010*	*<0.0010*	*<0.0010*	<0.00010
Sodium (Na)-Dissolved	mg/L		-	3180	3250	2470	1040	1370	147	135	1470	1490	1490	1470	480	160
Strontium (Sr)-Dissolved	mg/L		-	5.59	5.42	4.64	5.25	5.21	2.06	1.03	3.97	3.86	3.88	3.77	1.66	1.47
Tellurium (Te)-Dissolved	mg/L	-	-	<0.020	<0.020	<0.0010	<0.0020	<0.0010	<0.00020	<0.00020	<0.0010	<0.0010	<0.0020	<0.0020	<0.0010	<0.00020
Thallium (Tl)-Dissolved	mg/L	0.0008	0.51	*<0.010*	*<0.010*	*<0.0050*	*<0.0010*	*<0.0050*	0.00040	0.00025	*<0.0050*	*<0.0050*	*<0.0010*	*<0.0010*	*<0.0050*	0.00018
Thorium (Th)-Dissolved	mg/L		-	<0.010	<0.010	<0.0010	<0.0010	<0.0010	<0.00010	<0.00010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.00010
Tin (Sn)-Dissolved	mg/L	-	-	<0.020	<0.020	0.102	<0.0020	0.00825	0.00081	<0.00020	0.0631	0.0643	<0.0020	<0.0020	0.00442	0.00095
Titanium (Ti)-Dissolved	mg/L	-	-	<0.050	<0.050	0.135	<0.0050	0.125	<0.00050	<0.00050	0.0706	0.0713	<0.0050	<0.0050	0.0423	<0.00050
Tungsten (W)-Dissolved	mg/L	-	-	<0.010	<0.010	<0.0020	<0.0010	<0.0020	<0.00010	<0.00010	<0.0020	<0.0020	<0.0010	<0.0010	<0.0020	0.00026
Uranium (U)-Dissolved	mg/L	0.015	0.42	0.275	0.270	0.112	0.0920	0.0631	0.00286	0.00169	0.127	0.127	0.102	0.0979	0.0168	0.00694
Vanadium (V)-Dissolved	mg/L	-	0.25	<0.020	<0.020	0.0024	0.0022	<0.0020	<0.00020	<0.00020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.00088
Zinc (Zn)-Dissolved	mg/L	0.01	1.1	*<0.20*	*<0.20*	*<0.020*	0.035	*<0.020*	0.0222	0.0148	*<0.020*	*<0.020*	*<0.020*	*<0.020*	0.07	0.0484
Zirconium (Zr)-Dissolved	mg/L	-	-	<0.040	<0.040	0.0026	0.0062	0.0062	<0.00040	<0.00040	<0.0010	<0.0010	<0.0040	<0.0040	0.0012	<0.00040

NOTES

FIGWQ Federal Interim Groundwater Quality Guidelines for Commercial and Industrial Land Uses, Table 3: Non-Potable Ground Water Condition, Inhalation Pathway, Fine Grain Soils, May 2012

‡ Values from CCME CEQG Water Quality for the Protection of Aquatic Life, water hardness assumed greater than 180 mg/L, pH ≥6.5.

MOE Ontario Ministry of Environment, *Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act*, Table 3: Full Depth Generic Site Conditions in a Non-Potable Ground Water Condition, All Types of Property Use, April 2011

25 Exceeds Ontario MOE Groundwater Standards under Table 3, Industrial Use

25 Exceeds FIGWQ Tier I Criteria

25 Exceeds both Criteria

italics Detection limit exceeds criteria

"-" No guideline; calculated guideline excees solubility limit

"<" less than laboratory detection limit

FD Field Duplicate

RDL Reportable Detection Limit

Parameter / Location	Unit	FIGWQ Guidelines	MOE Industrial (Table 3)	13-10-7.3	13-10	13-11-3.7	13-11	13-13-1.1	13-13	TRIP BLANK	EQUIPMENT BLANK	EQUIPMENT BLANK
Date				1-Aug-13	17-Jun-14	21-Aug-13	17-Jun-14	21-Aug-13	17-Jun-14	21-Aug-13	21-Aug-13	17-Jun-14
Conductivity	umhos/cm	-	-	6400	-	3980	3180	1800	1660	<1.0	<1.0	2.7
Oxygen, Dissolved	mg/L	-	-	0.7	1.30	1	1.20	1.6	2.60	0.1	3.1	5.00
pH	-	-	-	7.3	-	7.54	7.68	7.31	8.31	5.95	6.15	6.35
Turbidity	NTU	-	-	19	-	<4000	530	1180	115	0.25	0.11	1.02
Alkalinity, Total (as CaCO3)	mg/L	-	-	503	-	172	122	334	275	1.3	1.8	2.6
Bicarbonate (HCO3)	mg/L	-	-	614	-	210	148	408	331	2	2.2	3.1
Carbonate (CO3)	mg/L	-	-	<12	-	<12	<12	<12	<12	<0.60	<0.60	<0.60
Chloride	mg/L	-	-	472	-	49.9	37.4	85.1	53.7	N/A	N/A	<0.50
Hydroxide (OH)	mg/L	-	-	<6.8	-	<6.8	<6.8	<6.8	<6.8	<0.34	<0.34	<0.34
Sulphide	mg/L	-	-	0.036	-	<0.020	2060	<0.020	460	<0.20	<0.20	<0.50
Aluminum (Al)-Dissolved	mg/L	0.1‡	-	*<0.020*	0.023	0.065	<0.0020	*<0.020*	0.0214	*<0.020*	*<0.020*	<0.0020
Antimony (Sb)-Dissolved	mg/L	2	20	0.139	0.336	0.118	0.147	0.0487	0.191	<0.0010	<0.0010	<0.00020
Arsenic (As)-Dissolved	mg/L	0.0005	1.9	0.0063	0.0141	0.0218	0.0112	0.0064	0.00251	*<0.0010*	*<0.0010*	<0.00020
Barium (Ba)-Dissolved	mg/L	0.5	290	0.0637	0.0342	0.054	0.0296	0.102	0.0837	<0.00050	<0.00050	<0.00020
Beryllium (Be)-Dissolved	mg/L	0.0053	0.067	<0.0010	<0.0020	<0.0010	<0.00020	<0.0010	<0.00020	<0.0010	<0.0010	<0.00020
Bismuth (Bi)-Dissolved	mg/L	-	-	0.00096	<0.0020	<0.00050	<0.00020	<0.00050	<0.00020	<0.00050	<0.00050	<0.00020
Boron (B)-Dissolved	mg/L	5	45	1.2	0.85	1.58	1.73	1.51	1.09	<0.030	<0.030	<0.010
Cadmium (Cd)-Dissolved	mg/L	0.000017	0.0027	**0.0041**	**0.00339**	**0.0028**	**0.00588**	0.00021	0.000170	<0.00020	<0.00020	<0.000010
Calcium (Ca)-Dissolved	mg/L	-	-	575	498	519	498	165	115	<0.20	<0.20	<0.050
Cesium (Cs)-Dissolved	mg/L	-	-	<0.00050	<0.0010	<0.00050	<0.00010	<0.00050	<0.00010	<0.00050	<0.00050	<0.00010
Chromium (Cr)-Dissolved	mg/L	0.0089	0.81	<0.0020	<0.020	<0.0020	<0.0020	0.0022	<0.0020	<0.0020	<0.0020	<0.0020
Cobalt (Co)-Dissolved	mg/L	-	0.066	0.00516	0.0032	0.00433	0.00705	0.00273	0.00033	<0.00050	<0.00050	<0.00020
Copper (Cu)-Dissolved	mg/L	0.004‡	0.087	0.0189	0.0269	0.0062	0.0142	0.0065	0.0188	<0.0020	<0.0020	<0.00020
Iron (Fe)-Dissolved	mg/L	0.3	-	<0.10	<1.0	0.32	<0.10	1.13	<0.10	<0.10	<0.10	<0.10
Lead (Pb)-Dissolved	mg/L	0.007‡	0.025	0.636	0.650	0.435	0.305	0.0067	0.0438	<0.0010	<0.0010	<0.000090
Lithium (Li)-Dissolved	mg/L	-	-	0.291	0.592	0.119	0.140	0.102	0.0782	<0.010	<0.010	<0.0020
Magnesium (Mg)-Dissolved	mg/L	-	-	449	711	188	157	74.5	54.1	<0.050	<0.050	<0.010
Manganese (Mn)-Dissolved	mg/L	-	-	0.0064	0.0642	0.0508	0.0901	0.496	0.0131	<0.0010	<0.0010	<0.00010
Molybdenum (Mo)-Dissolved	mg/L	0.073	9.2	0.00283	0.0034	0.00179	0.00140	0.0109	0.00368	<0.00050	<0.00050	<0.00010
Nickel (Ni)-Dissolved	mg/L	0.15	0.49	0.0382	0.061	0.038	0.0830	0.0054	0.0070	<0.0020	<0.0020	<0.0010
Phosphorus (P)-Dissolved	mg/L	-	-	<0.50	<0.30	<0.50	<0.030	<0.50	<0.030	<0.50	<0.50	<0.030
Potassium (K)-Dissolved	mg/L	-	-	17	16.1	13.1	13.2	18.4	32.5	<0.10	<0.10	<0.020
Rubidium (Rb)-Dissolved	mg/L	-	-	0.00449	0.0042	0.00275	0.00178	0.00346	0.00329	<0.00050	<0.00050	<0.00020
Selenium (Se)-Dissolved	mg/L	0.001	0.063	0.0095	*<0.010*	*<0.0050*	<0.0010	*<0.0050*	0.0044	*<0.0050*	*<0.0050*	<0.0010
Silicon (Si)-Dissolved	mg/L	-	-	10.5	11.6	7.86	8.37	8.64	7.37	<0.30	<0.30	<0.10
Silver (Ag)-Dissolved	mg/L	0.0001	0.0015	*<0.0010*	*<0.0010*	*<0.0010*	<0.00010	*<0.0010*	<0.00010	*<0.0010*	*<0.0010*	<0.00010
Sodium (Na)-Dissolved	mg/L		-	733	1320	256	222	153	133	<0.050	<0.050	<0.020
Strontium (Sr)-Dissolved	mg/L		-	3.01	2.80	1.94	1.49	1.11	0.675	<0.00050	<0.00050	<0.00010
Tellurium (Te)-Dissolved	mg/L	-	-	<0.0010	<0.0020	<0.0010	<0.00020	<0.0010	<0.00020	<0.0010	<0.0010	<0.00020
Thallium (Tl)-Dissolved	mg/L	0.0008	0.51	*<0.0050*	*<0.0010*	*<0.0050*	0.00017	*<0.0050*	<0.00010	*<0.0050*	*<0.0050*	<0.00010
Thorium (Th)-Dissolved	mg/L		-	<0.0010	<0.0010	<0.0010	<0.00010	<0.0010	<0.00010	<0.0010	<0.0010	<0.00010
Tin (Sn)-Dissolved	mg/L	-	-	0.0939	<0.0020	0.00319	0.00066	0.00679	0.00033	<0.00060	<0.00060	<0.00020
Titanium (Ti)-Dissolved	mg/L	-	-	0.0673	<0.0050	0.041	<0.00050	0.0093	<0.00050	<0.0010	<0.0010	<0.00050
Tungsten (W)-Dissolved	mg/L	-	-	<0.0020	<0.0010	<0.0020	<0.00010	<0.0020	<0.00010	<0.0020	<0.0020	<0.00010
Uranium (U)-Dissolved	mg/L	0.015	0.42	0.0284	0.0736	0.00185	0.00079	0.0081	0.00328	<0.00050	<0.00050	<0.00010
Vanadium (V)-Dissolved	mg/L	-	0.25	<0.0020	<0.0020	<0.0020	<0.00020	<0.0020	0.00042	<0.0020	<0.0020	<0.00020
Zinc (Zn)-Dissolved	mg/L	0.01	1.1	0.064	0.078	0.076	0.0820	*<0.020*	0.0086	*<0.020*	*<0.020*	<0.0020
Zirconium (Zr)-Dissolved	mg/L	-	-	<0.0010	<0.0040	<0.0010	<0.00040	<0.0010	<0.00040	<0.0010	<0.0010	<0.00040

NOTES

FIGWQ Federal Interim Groundwater Quality Guidelines for Commercial and Industrial Land Uses, Table 3: Non-Potable Ground Water Condition, Inhalation Pathway, Fine Grain Soils, May 2012

‡ Values from CCME CEQG Water Quality for the Protection of Aquatic Life, water hardness assumed greater than 180 mg/L, pH ≥6.5.

MOE Ontario Ministry of Environment, *Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act* , Table 3: Full Depth Generic Site Conditions in a Non-Potable Ground Water Condition, All Types of Property Use, April 2011

25 Exceeds Ontario MOE Groundwater Standards under Table 3, Industrial Use

25 Exceeds FIGWQ Tier I Criteria

25 Exceeds both Criteria

italics Detection limit exceeds criteria

"-" No guideline; calculated guideline excees solubility limit

"<" less than laboratory detection limit

FD Field Duplicate

RDL Reportable Detection Limit

Table B-7 Metals and Inorganics in Soil RPD

Parameter	Units	Sample ID	13-10-7.3	FD1	RPD	13-19.18	FD 2	RPD	13-23-0.9	FD 1	RPD	12-02-02	12-02-06	RPD	12-02-02	12-02-06	RPD	TP-18-03	TP-18-04	RPD
		Sample Date	13-May-13	13-May-13		14-May-13	14-May-13		6-Sep-13	6-Sep-13		7/12/2012	7/12/2012		7/12/2012	7/12/2012		11/14/2012	11/14/2012	
		Sample Depth	1.2 - 1.8 m	1.2 - 1.8 m		1.2 - 1.8 m	1.2 - 1.8 m		0.3 - 0.5 m	0.3 - 0.5 m		0.61 - 0.76 m	12-02-02 FD		0.61 - 0.76 m	12-02-02 FD		2.5 m	TP-18-04 FD	
		RDL																		
Metals																				
pH	-	0.1	7.73	7.66	0.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aluminum (Al)	mg/kg	50	17800	16500	8	23100	23100	0.0	-	-	-	10600	14500	31	17100	16000	6.6	28500 *	28000 *	1.8
Antimony (Sb)	mg/kg	0.10	1080	883	20	0.67	0.59	13	-	-	-	552	441	22	1.17	221	198	1.03	1.68	48
Arsenic (As)	mg/kg	0.10	538	493	9	8.97	8.86	1.2	-	-	-	227	251	10	5.11	57.9	168	7.6	7.53	1
Barium (Ba)	mg/kg	0.50	355	236	40	234	231	1.3	-	-	-	287	235	20	212	935	126	249	193	25
Beryllium (Be)	mg/kg	0.10	0.93	0.98	5	1.24	1.32	6	-	-	-	0.59	0.58	1.7	0.6	0.71	17	0.91	0.9	1
Bismuth (Bi)	mg/kg	0.020	2.41	3.02	22	0.369	0.367	0.5	-	-	-	1.24	1.68	30	0.19	0.389	69	0.28	0.27	4
Boron (B)	mg/kg	10	36	37	3	18	17	5.7	-	-	-	37	57	43	39	67	53	17	17	0
Cadmium(Cd)	mg/kg	0.020	8.55	11.2	27	0.305	0.304	0.3	-	-	-	10.2	33.9	107	0.341	1.44	123	0.272	0.254	7
Calcium (Ca)	mg/kg	1000	55500	50000	10	27700	31500	-13	-	-	-	83400	62900	28	76000	89800	17	37000	34400	7
Cesium (Cs)	mg/kg	0.02	-	-	-	-	-	-	-	-	-	-	-	-	1.26	0.783	47	-	-	-
Chromium (Cr)	mg/kg	1.0	70.4	69.5	1	45.0	45.3	1	-	-	-	27.9	38.0	31	79.2	25.9	101	59.2	59.1	0
Cobalt (Co)	mg/kg	0.020	17.4	20.1	14	16.9	17.6	4	-	-	-	7.04	8.86	23	9.08	7.74	15.9	18.8	17.2	9
Copper (Cu)	mg/kg	1.0	639	750	16	36.9	35.0	5	-	-	-	252	1300	135	35.3	154	125	36.5	37.5	3
Iron (Fe)	mg/kg	25	72700	79300	9	31500	32300	3	-	-	-	23100	25500	10	25700	26700	4	33000	33400	1
Lead (Pb)	mg/kg	0.20	28400	39400	32	28.2	24.9	12	13.9	33.7	-83	25700	24200	6.0	92.1	8770 *	196	110	202	59
Magnesium (Mg)	mg/kg	10	19500	17100	13	16000	15500	3	-	-	-	35600	23700	40	26200	29500	12	16400	16200	1
Manganese (Mn)	mg/kg	0.50	679	648	5	478	512	7	-	-	-	310	387	22	511	353	37	556	499	11
Mercury	mg/kg	0.05	0.272	0.224	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Molybdenum (Mo)	mg/kg	0.020	7.78	7.21	8	1.82	1.77	2.8	-	-	-	3.46	3.36	2.9	4.69	2.55	59	0.61	0.619	1
Nickel (Ni)	mg/kg	0.50	65.9	72.3	9	50.4	48.5	3.8	-	-	-	31.0	38.9	23	69.6	28.1	85	52	51.1	2
Phosphorus (P)	mg/kg	100	880	1010	14	580	590	2	-	-	-	580	660	13	490	720	38	600	600	0
Potassium (K)	mg/kg	25	3510	3450	2	3980	3950	0.8	-	-	-	2370	3440	37	3670	2400	42	5180	5210	1
Rubidium (Rb)	mg/kg	0	-	-	-	-	-	-	-	-	-	-	-	-	26.1	15.8	49	-	-	-
Selenium (Se)	mg/kg	0.50	3.47	2.43	35	0.94	<0.50	n.c.	-	-	-	3.00	5.20	54	0.52	0.99	62	0.88	<0.50	n.c.
Silver (Ag)	mg/kg	0.10	0.98	0.89	10	0.17	0.17	0.0	-	-	-	0.43	0.51	17	0.22	0.47	72	0.18	0.18	0
Sodium (Na)	mg/kg	10	2610	2010	26	1250	1220	2.4	-	-	-	974	752	26	624	1910	101	1440	1500	4
Strontium (Sr)	mg/kg	0.10	140	107	27	77.7	82.3	6	-	-	-	154	113	31	187	552	99	90.2	83.8	7
Tellurium (Te)	mg/kg	0.10	-	-	-	-	-	-	-	-	-	-	-	-	<0.10	<0.10	n.c.	-	-	-
Thallium (Tl)	mg/kg	0.10	0.89	1.03	15	0.35	0.35	0.0	-	-	-	0.77	0.83	7	0.2	0.29	37	0.38	0.38	0
Tin (Sn)	mg/kg	5.0	563	860	42	<5.0	<5.0	n.c.	-	-	-	131	136	4	<5.0	95.7	n.c.	<5.0	<5.0	n.c.
Titanium (Ti)	mg/kg	0.50	353	336	5	115	99.8	14	-	-	-	225	237	5	321	525	48	310	323	4
Tungsten (W)	mg/kg	0.050	-	-	-	-	-	-	-	-	-	-	-	-	0.173	0.409	81	-	-	-
Uranium (U)	mg/kg	0.020	1.82	1.77	3	2.53	2.51	0.8	-	-	-	1.29	1.36	5	0.96	2.02	71	1.39	1.37	1
Vanadium (V)	mg/kg	0.50	58.5	58.9	1	71.3	73.1	2	-	-	-	32.6	45.2	32	49.2	36.1	31	92.6	92.6	0
Zinc (Zn)	mg/kg	10	620	530	16	88	88	0.0	-	-	-	180	236	27	200	170	16	89	91	2
Zirconium (Zr)	mg/kg	0.10	-	-	-	-	-	-	-	-	-	-	-	-	10.7	15.5	37	-	-	-

NOTES

"-" Not analyzed
n.c. Not calculable (i.e., values are less than 5x the RDL)
RDL Reportable Detection Limit
RPD Relative Percent Difference

Table B-8 Polycyclic Aromatic Hydrocarbons, Petroleum Hydrocarbons Polychlorinated Biphenyls in Soil RPD

DILLON CONSULTING

Parameter	Units	Sample ID	13-19.18	FD 2	RPD
		Sample Date	14-May-13	14-May-13	
		Sample Depth	1.2 - 1.8 m	1.2 - 1.8 m	
		MDL			
Petroleum Hydrocarbons					
Benzene	mg/kg	0.0050	0.0098	0.0079	21
Toluene	mg/kg	0.050	<0.050	<0.050	n.c.
Ethyl Benzene	mg/kg	0.015	<0.015	<0.015	n.c.
Total Xylenes	mg/kg	0.10	<0.10	<0.10	n.c.
F1 (C6-C10)	mg/kg	10	<10	<10	n.c.
F2 (C10-C16)	mg/kg	25	<25	<25	n.c.
F3 (C16-C34)	mg/kg	50	<50	<50	n.c.
F4 (C34-C50)	mg/kg	50	<50	<50	n.c.
PCBs					
Total Polychlorinated Biphenyls	mg/kg	0.30	<0.30	<0.30	n.c.
PAHs					
Acenaphthene	mg/kg	0.005	-	-	-
Acenaphthylene	mg/kg	0.005	-	-	-
Acridine	mg/kg	0.01	-	-	-
Anthracene	mg/kg	0.004	-	-	-
Benzo(a)anthracene	mg/kg	0.01	-	-	-
Benzo(a)pyrene	mg/kg	0.01	-	-	-
Benzo(b&j)fluoranthene	mg/kg	0.01	-	-	-
Benzo(b)fluoranthene	mg/kg	0.01	-	-	-
Benzo(b+j+k)fluoranthene	mg/kg	0.014	-	-	-
Benzo(g,h,i)perylene	mg/kg	0.01	-	-	-
Benzo(k)fluoranthene	mg/kg	0.01	-	-	-
Chrysene	mg/kg	0.01	-	-	-
Dibenzo(a,h)anthracene	mg/kg	0.005	-	-	-
Fluoranthene	mg/kg	0.01	-	-	-
Fluorene	mg/kg	0.01	-	-	-
Indeno(1,2,3-cd)pyrene	mg/kg	0.01	-	-	-
1-Methyl Naphthalene	mg/kg	0.01	-	-	-
2-Methyl Naphthalene	mg/kg	0.01	-	-	-
Naphthalene	mg/kg	0.01	-	-	-
Phenanthrene	mg/kg	0.01	-	-	-
Pyrene	mg/kg	0.01	-	-	-
Quinoline	mg/kg	0.01	-	-	-
B(a)P Total Potency Equivalent	mg/kg	0.02	-	-	-
IACR (CCME)	mg/kg	0.15	-	-	-

NOTES

"-" Not analyzed
n.c. Not calculable (i.e., values are less than 5x the RDL)
RDL Reportable Detection Limit
RPD Relative Percent Difference

Table B-9 Metals and Inorganics in Groundwater RPD

DILLON CONSULTING

Parameter / Location / Date	Unit	RDL	13-06-7.3	13-06-7.3 FD	RPD
			31-Jul-13	31-Jul-13	
Conductivity	umhos/cm	20	9010	9250	3
Oxygen, Dissolved	mg/L	0.10	0.6	0.3	n.c.
pH	-	0.1	8.09	8.1	0.1
Turbidity	NTU	4000	4	3.41	n.c.
Alkalinity, Total (as CaCO3)	mg/L	20	549	550	0.2
Bicarbonate (HCO3)	mg/L	24	670	671	0.1
Carbonate (CO3)	mg/L	12	<12	<12	n.c.
Chloride	mg/L	5	1560	1580	1
Hydroxide (OH)	mg/L	6.8	<6.8	<6.8	n.c.
Sulphide	mg/L	0.02	<0.020	<0.020	n.c.
Aluminum (Al)-Dissolved	mg/L	0.02	<0.020	<0.020	n.c.
Antimony (Sb)-Dissolved	mg/L	0.001	0.0297	0.0313	5
Arsenic (As)-Dissolved	mg/L	0.001	0.0067	0.0073	9
Barium (Ba)-Dissolved	mg/L	0.0005	0.0176	0.0184	4
Beryllium (Be)-Dissolved	mg/L	0.001	<0.0010	<0.0010	n.c.
Bismuth (Bi)-Dissolved	mg/L	0.001	<0.00050	<0.00050	n.c.
Boron (B)-Dissolved	mg/L	0.03	1.12	1.11	1
Cadmium (Cd)-Dissolved	mg/L	0.0002	**0.00486**	**0.00529**	8
Calcium (Ca)-Dissolved	mg/L	0.20	475	461	3
Cesium (Cs)-Dissolved	mg/L	0.0005	<0.00050	<0.00050	n.c.
Chromium (Cr)-Dissolved	mg/L	0.002	<0.0020	<0.0020	n.c.
Cobalt (Co)-Dissolved	mg/L	0.0005	0.00401	0.00392	2
Copper (Cu)-Dissolved	mg/L	0.002	**0.0059**	**0.006**	2
Iron (Fe)-Dissolved	mg/L	0.1	<0.10	<0.10	n.c.
Lead (Pb)-Dissolved	mg/L	0.001	**0.113**	**0.115**	2
Lithium (Li)-Dissolved	mg/L	0.01	0.547	0.541	1
Magnesium (Mg)-Dissolved	mg/L	0.5	649	643	1
Manganese (Mn)-Dissolved	mg/L	0.001	0.276	0.275	0
Molybdenum (Mo)-Dissolved	mg/L	0.0005	0.014	0.014	0
Nickel (Ni)-Dissolved	mg/L	0.002	0.018	0.0176	2
Phosphorus (P)-Dissolved	mg/L	0.5	<0.50	<0.50	n.c.
Potassium (K)-Dissolved	mg/L	0.1	14.4	14.5	1
Rubidium (Rb)-Dissolved	mg/L	0.0005	0.00809	0.00829	2
Selenium (Se)-Dissolved	mg/L	0.005	0.0094	0.0056	n.c.
Silicon (Si)-Dissolved	mg/L	0.3	11.8	11.8	0
Silver (Ag)-Dissolved	mg/L	0.001	<0.0010	<0.0010	n.c.
Sodium (Na)-Dissolved	mg/L	0.5	1470	1490	1
Strontium (Sr)-Dissolved	mg/L	0.0005	3.97	3.86	3
Tellurium (Te)-Dissolved	mg/L	0.001	<0.0010	<0.0010	n.c.
Thallium (Tl)-Dissolved	mg/L	0.005	<0.0050	<0.0050	n.c.
Thorium (Th)-Dissolved	mg/L	0.001	<0.0010	<0.0010	n.c.
Tin (Sn)-Dissolved	mg/L	0.0006	0.0631	0.0643	2
Titanium (Ti)-Dissolved	mg/L	0.001	0.0706	0.0713	1
Tungsten (W)-Dissolved	mg/L	0.002	<0.0020	<0.0020	n.c.
Uranium (U)-Dissolved	mg/L	0.0005	0.127	0.127	0
Vanadium (V)-Dissolved	mg/L	0.002	<0.0020	<0.0020	n.c.
Zinc (Zn)-Dissolved	mg/L	0.02	<0.020	<0.020	n.c.
Zirconium (Zr)-Dissolved	mg/L	0.001	<0.0010	<0.0010	n.c.

NOTES

"-" No value
n.c. Not calculable (i.e., values are less than 5x the RDL)
RDL Reportable Detection Limit
RPD Relative Percent Difference

Table B-10 Metals and Inorganics in Groundwater RPD

Parameter / Location / Date	Unit	RDL	13-01 17-Jun-14	13-01 FD1 17-Jun-14	RPD
Conductivity	umhos/cm	20	>10000	>10000	n.c.
Oxygen, Dissolved	mg/L	0.1	0.10	0.20	n.c.
pH	-	0.1	8.10	7.90	2
Turbidity	NTU	4000	>4000	>4000	n.c.
Alkalinity, Total (as CaCO3)	mg/L	20	1970	1990	1
Bicarbonate (HCO3)	mg/L	24	2330	2430	4
Carbonate (CO3)	mg/L	12	34	<12	n.c.
Chloride	mg/L	5	1410	1380	2
Hydroxide (OH)	mg/L	6.8	<6.8	<6.8	n.c.
Sulphide	mg/L	0.02	8090	7960	n.c.
Aluminum (Al)-Dissolved	mg/L	0.02	<0.20	<0.20	n.c.
Antimony (Sb)-Dissolved	mg/L	0.001	0.065	0.068	5
Arsenic (As)-Dissolved	mg/L	0.001	<0.020	<0.020	n.c.
Barium (Ba)-Dissolved	mg/L	0.0005	<0.020	<0.020	n.c.
Beryllium (Be)-Dissolved	mg/L	0.001	<0.020	<0.020	n.c.
Bismuth (Bi)-Dissolved	mg/L	0.001	<0.020	<0.020	n.c.
Boron (B)-Dissolved	mg/L	0.03	<1.0	<1.0	n.c.
Cadmium (Cd)-Dissolved	mg/L	0.0002	<0.0010	0.0011	n.c.
Calcium (Ca)-Dissolved	mg/L	0.20	388	380	2
Cesium (Cs)-Dissolved	mg/L	0.0005	<0.010	<0.010	n.c.
Chromium (Cr)-Dissolved	mg/L	0.002	<0.20	<0.20	n.c.
Cobalt (Co)-Dissolved	mg/L	0.0005	<0.020	<0.020	n.c.
Copper (Cu)-Dissolved	mg/L	0.002	0.037	0.038	3
Iron (Fe)-Dissolved	mg/L	0.1	<10	<10	n.c.
Lead (Pb)-Dissolved	mg/L	0.001	0.109	0.107	2
Lithium (Li)-Dissolved	mg/L	0.01	1.05	1.06	1
Magnesium (Mg)-Dissolved	mg/L	0.5	795	810	2
Manganese (Mn)-Dissolved	mg/L	0.001	0.292	0.292	0
Molybdenum (Mo)-Dissolved	mg/L	0.0005	0.021	0.021	0
Nickel (Ni)-Dissolved	mg/L	0.002	<0.10	<0.10	n.c.
Phosphorus (P)-Dissolved	mg/L	0.5	<3.0	<3.0	n.c.
Potassium (K)-Dissolved	mg/L	0.1	20.9	21.4	2
Rubidium (Rb)-Dissolved	mg/L	0.0005	<0.020	<0.020	n.c.
Selenium (Se)-Dissolved	mg/L	0.005	<0.10	<0.10	n.c.
Silicon (Si)-Dissolved	mg/L	0.3	<10	10	n.c.
Silver (Ag)-Dissolved	mg/L	0.001	<0.010	<0.010	n.c.
Sodium (Na)-Dissolved	mg/L	0.5	3180	3250	2
Strontium (Sr)-Dissolved	mg/L	0.0005	5.59	5.42	3
Tellurium (Te)-Dissolved	mg/L	0.001	<0.020	<0.020	n.c.
Thallium (Tl)-Dissolved	mg/L	0.005	<0.010	<0.010	n.c.
Thorium (Th)-Dissolved	mg/L	0.001	<0.010	<0.010	n.c.
Tin (Sn)-Dissolved	mg/L	0.0006	<0.020	<0.020	n.c.
Titanium (Ti)-Dissolved	mg/L	0.001	<0.050	<0.050	n.c.
Tungsten (W)-Dissolved	mg/L	0.002	<0.010	<0.010	n.c.
Uranium (U)-Dissolved	mg/L	0.0005	0.275	0.270	2
Vanadium (V)-Dissolved	mg/L	0.002	<0.020	<0.020	n.c.
Zinc (Zn)-Dissolved	mg/L	0.02	<0.20	<0.20	n.c.
Zirconium (Zr)-Dissolved	mg/L	0.001	<0.040	<0.040	n.c.

NOTES

"-" No value
n.c. Not calculable (i.e., values are less than 5x the RDL)
RDL Reportable Detection Limit
RPD Relative Percent Difference

Table B-11 Metals and Inorganics
in Groundwater RPD

Parameter / Location / Date	Unit	RDL	13-06	13-06 FD2	RPD
			17-Jun-14	17-Jun-14	
Conductivity	umhos/cm	20	9920	9950	n.c.
Oxygen, Dissolved	mg/L	0.10	0.50	0.80	n.c.
pH	-	0.1	7.72	7.76	1
Turbidity	NTU	4000	143	178	n.c.
Alkalinity, Total (as CaCO3)	mg/L	20	515	517	0
Bicarbonate (HCO3)	mg/L	24	628	631	0
Carbonate (CO3)	mg/L	12	<12	<12	n.c.
Chloride	mg/L	5	1640	1640	0
Hydroxide (OH)	mg/L	6.8	<6.8	<6.8	n.c.
Sulphide	mg/L	0.02	3910	3880	n.c.
Aluminum (Al)-Dissolved	mg/L	0.02	<0.020	<0.020	n.c.
Antimony (Sb)-Dissolved	mg/L	0.001	0.0375	0.0359	4
Arsenic (As)-Dissolved	mg/L	0.001	0.0063	0.0064	n.c.
Barium (Ba)-Dissolved	mg/L	0.0005	0.0158	0.0173	n.c.
Beryllium (Be)-Dissolved	mg/L	0.001	<0.0020	<0.0020	n.c.
Bismuth (Bi)-Dissolved	mg/L	0.001	<0.0020	<0.0020	n.c.
Boron (B)-Dissolved	mg/L	0.03	1.09	0.91	n.c.
Cadmium (Cd)-Dissolved	mg/L	0.0002	0.00497	0.00459	n.c.
Calcium (Ca)-Dissolved	mg/L	0.20	475	468	1
Cesium (Cs)-Dissolved	mg/L	0.0005	<0.0010	<0.0010	n.c.
Chromium (Cr)-Dissolved	mg/L	0.002	<0.020	<0.020	n.c.
Cobalt (Co)-Dissolved	mg/L	0.0005	0.0035	0.0034	n.c.
Copper (Cu)-Dissolved	mg/L	0.002	0.0124	0.0129	4
Iron (Fe)-Dissolved	mg/L	0.1	<1.0	<1.0	n.c.
Lead (Pb)-Dissolved	mg/L	0.001	0.113	0.112	1
Lithium (Li)-Dissolved	mg/L	0.01	0.492	0.476	3
Magnesium (Mg)-Dissolved	mg/L	0.5	653	636	3
Manganese (Mn)-Dissolved	mg/L	0.001	0.255	0.252	1
Molybdenum (Mo)-Dissolved	mg/L	0.0005	0.0062	0.0060	3
Nickel (Ni)-Dissolved	mg/L	0.002	0.015	0.014	n.c.
Phosphorus (P)-Dissolved	mg/L	0.5	<0.30	<0.30	n.c.
Potassium (K)-Dissolved	mg/L	0.1	12.9	12.8	1
Rubidium (Rb)-Dissolved	mg/L	0.0005	0.0042	0.0041	n.c.
Selenium (Se)-Dissolved	mg/L	0.005	<0.010	<0.010	n.c.
Silicon (Si)-Dissolved	mg/L	0.3	10.6	9.8	n.c.
Silver (Ag)-Dissolved	mg/L	0.001	<0.0010	<0.0010	n.c.
Sodium (Na)-Dissolved	mg/L	0.5	1490	1470	1
Strontium (Sr)-Dissolved	mg/L	0.0005	3.88	3.77	3
Tellurium (Te)-Dissolved	mg/L	0.001	<0.0020	<0.0020	n.c.
Thallium (Tl)-Dissolved	mg/L	0.005	<0.0010	<0.0010	n.c.
Thorium (Th)-Dissolved	mg/L	0.001	<0.0010	<0.0010	n.c.
Tin (Sn)-Dissolved	mg/L	0.0006	<0.0020	<0.0020	n.c.
Titanium (Ti)-Dissolved	mg/L	0.001	<0.0050	<0.0050	n.c.
Tungsten (W)-Dissolved	mg/L	0.002	<0.0010	<0.0010	n.c.
Uranium (U)-Dissolved	mg/L	0.0005	0.102	0.0979	4
Vanadium (V)-Dissolved	mg/L	0.002	<0.0020	<0.0020	n.c.
Zinc (Zn)-Dissolved	mg/L	0.02	<0.020	<0.020	n.c.
Zirconium (Zr)-Dissolved	mg/L	0.001	<0.0040	<0.0040	n.c.

NOTES

"-" No value
n.c. Not calculable (i.e., values are less than 5x the RDL)
RDL Reportable Detection Limit
RPD Relative Percent Difference

Appendix C

Laboratory Results and COC

Appendix D

Letters Submitted for Off-Site Permission

DILLON
CONSULTING

1558 Willson Place
Winnipeg
Manitoba
Canada
R3T 0Y4
Telephone
(204) 453-2301
Fax
(204) 452-4412

(In reply, please refer to)
Our File: 10-3834

June 13, 2013

Pa D'or Manufacturing Inc.
2201 Logan Avenue
Winnipeg, Manitoba R2R 0J3

Attn: Doreen Demare

Off-Site Soil Investigations at 2185 Logan Avenue

Dear Ms. Demare:

As part of the environmental site work planned for the former Northwest Smelting & Refining property located at 2185 Logan Avenue, Winnipeg Manitoba, Dillon Consulting Limited (Dillon) will be conducting a subsurface investigation program along the borders of the neighbouring properties.

We would appreciate a letter from yourself (the property owner), granting permission to access your property for these activities at your earliest convenience. Manitoba Conservation, through Mr. Warren Rospad, has approved the investigation for potential off-site impacts. Drilling and sampling activity locations will run alongside the property line adjacent to 2185 Logan Ave, as shown in the attached Figure 1. Drilling will be carried out by Maple Leaf Drilling Ltd. (Maple Leaf) in late June/early July.

Representatives from Dillon will notify the occupants prior to arriving, inform the occupants when they first enter upon a property, and when they have completed their work on the property. Mr. Warren Rospad from Manitoba Conservation can address any questions or concerns you might have.

Dillon and Maple Leaf will proceed carefully to ensure minimal disruption and disturbance affects your property and workplace.

Dillon Consulting
Limited

If you have any comments, questions or concerns regarding site activities, please do not hesitate to contact Doug Bell (Dillon) at (204) 453-2301.

Your cooperation and assistance is sincerely appreciated.

Yours sincerely,

DILLON CONSULTING LIMITED

Doug Bell, M.Sc., P.Geo
Project Manager

IKK/aqs

Encl. Figure 1

O:\PROJECTS\FINAL\103834\Letters\Letters\Notification Letter off-site Investigations_DeMare.docx

DILLON CONSULTING	TITLE	DRAWING NO.
SCALE 1:1250	PROPOSED BOREHOLE AND SAMPLING LOCATIONS 2201 LOGAN AVENUE, WINNIPEG MANITOBA	1

Appendix E

Site Photographs

Photo 1: View looking north at 13-01, 13-02 and 13-03

Photo 2: View looking east at 13-01, 13-02 and 13-03

Photo 3: View looking east at 13-04

Photo 4: View looking north at 13-05

DILLON CONSULTING	SITE PHOTOGRAPHS	PROJECT NO. 10-3834
	NWSR Site Investigation	PHOTO NO.
May 2013	2185 Logan Avenue, Winnipeg, Manitoba	1-4

Photo 5: View looking north west at 13-06, 13-07 and 13-08

Photo 6: View looking north east at 13-09

Photo 7: View looking south east at 13-10, 13-11 and 13-12

Photo 8: View looking north at 13-13

DILLON CONSULTING	SITE PHOTOGRAPHS	PROJECT NO. 10-3834
	NWSR Site Investigation	PHOTO NO. 5-8
May 2013	2185 Logan Avenue, Winnipeg, Manitoba	

Photo 9: View looking south at 13-14 and 13-13

Photo 10: View looking north east at 13-15

Photo 11: View looking south west at 13-16

Photo 12: View looking west at 13-17

DILLON CONSULTING	SITE PHOTOGRAPHS	PROJECT NO. 10-3834
	NWSR Site Investigation	PHOTO NO.
May 2013	2185 Logan Avenue, Winnipeg, Manitoba	9-12

Photo 13: View looking north at 13-18 and 13-19

Photo 14: View looking south at 13-20

Photo 15: View looking south west at 13-21

Photo 16: View looking south at 13-22 (offsite)

DILLON CONSULTING	SITE PHOTOGRAPHS	PROJECT NO. 10-3834
	NWSR Site Investigation	PHOTO NO.
May/Sept 2013	2185 Logan Avenue, Winnipeg, Manitoba	13-16

Photo 17: View looking west at 13-23 (offsite)

Photo 18: View looking north at 13-23 (offsite)

Photo 19: View looking west at 13-24 (offsite)

Photo 20: View looking north at 13-24 (offsite)

DILLON CONSULTING	SITE PHOTOGRAPHS	PROJECT NO. 10-3834
	NWSR Site Investigation	PHOTO NO. 17-20
September 2013	2185 Logan Avenue, Winnipeg, Manitoba	

Appendix C

Report – Remedial Options Analysis, Dillon 2015 without Laboratory Reports

DILLON
CONSULTING

Remedial Options Analysis

Northwest Smelting and Refinery Ltd.

August 2015 – 10-3834

(in reply, please refer to)
Our File: 10-3834

DILLON
CONSULTING

August 10, 2015

1558 Willson Place
Winnipeg
Manitoba
Canada
R3T 0Y4
Telephone
(204) 453-2301
Fax
(204) 452-4412

Northwest Smelting and Refining Ltd.
c/o Thompson Dorfman Sweatman LLP
Canwest Place, 2201-201 Portage Avenue
Winnipeg, Manitoba
R3B 3L3

Attention: Ms. Sheryl Rosenberg

RE: Remedial Options Analysis
Northwest Smelting and Refining, Winnipeg, Manitoba

Dear Ms. Rosenberg:

Please find enclosed one (1) digital copy of the above-mentioned report.

This report contains a review of potential remediation methods for the various environmental issues identified at the Site.

If you have any questions or comments, please feel free to contact Douglas Bell, M.Sc., P.Geo., or Indra Kalinovich, Ph.D., C.Chem., E.I.T., at 204-453-2301.

Yours sincerely,

DILLON CONSULTING LIMITED

Douglas Bell, M.Sc., P.Geo., F.G.C.
Partner

IKK: knp

Encl.
Summary Tables
Figures

Table of Contents

TABLES

APPENDICES

Executive Summary

In 2012 and 2013, Dillon conducted environmental investigations at 2185 Logan Avenue, in Winnipeg, MB. A preliminary remedial options analysis was conducted based on the results from the 2012 and 2013 Site Investigations. The specific remedial objectives for the site are:

- Remediate impacts to remove identified risks to both human and environmental health;
- Increase property value and potential land use; and,
- Cost-recovery (minimize remedial costs).

The real estate market in the surrounding industrial park was examined in December 2014, to provide cost considerations and re-sale value of impacted and non-impacted land. Based on market data, the most effective path forward for minimizing liability and cost recovery is based on the scenario of an unimpacted, southern site. It is anticipated that a 'split-titles' approach may be adopted to improve cost recovery ($0.4M for the southern site, $0.2M for the northern site). The site use limitations on the northern portion of the site for staging and yard storage are not (at the present time) a market-driven limitation. Neighbouring properties have expressed a need for more staging and yard storage.

Cost estimates provided above are used to compare the various remedial option scenarios. The cost to implement a remediation program at NWSR includes the following further components:

- Remedial Action Plan (including RA and Drainage Management Plan);
- Design Specifications and Tender Documents;
- Contract Administration and Site Management; and,
- Closure Reporting.

The following table summarizes the recommended environmental management options and costing to carry out the program of work:

TABLE 4: METHODS SUMMARY OF RECOMMENDED REMEDIATION

Environmental Concern	Site Assessment Findings	Recommended Remediation Method
APEC 1 - Historical Dump at North End of Site	Given the observed average thickness of waste of 1.09 m (ranging in depth from 0.3 to 1.8 m below the soil cap), the approximate volume of waste material buried in the northern portion of the Site is 10,500 m^3. The buried waste is overlain by approximately 3,100 m^3 of fill material, taken from the Site. The soil cover appeared to be non-engineered and remained intact, with a minimum thickness of 0.10 m, and an average thickness of 0.45 m.	Re-stabilize and leave in situ. Re-cap and add more cover. ($375,000[1] to $1,035,000[2])

Environmental Concern	Site Assessment Findings	Recommended Remediation Method
APEC 2 - Metal Impacted Soils South End (includes identified off-site impacts to the west of the site)	Lead concentrations in soil were found to exceed federal soil quality guidelines (600 mg/kg) to depths greater than 2 m. Results in soil were not observed to exceed criteria at depths greater than 3 m in APEC 2.	Excavate Material and cap in place in APEC 1. ($246,000 to $942,000[3])
APEC 3 - Impacted Groundwater	Lead and cadmium in groundwater were observed in each stratigraphic unit (fill, clay/silt, till). The greatest impacts in groundwater were found at the greatest depths (till), along the eastern boundary of the Site property. No observed immediate ecological or human receptors.	Risk Management[4]

Notes:
$ denotes $CAD
Includes costing for development of Remedial Action Plan (containing Risk Management/Risk Assessment, Drainage Management Plan), Design Specifications for Tender, Contract Administration, Site Activity Management and Closure Reporting.
[1]Scenario 4 Impermeable Cap under APEC #1
[2]Scenario 3 Granular Cap under APEC #1
[3]50% of material is moved to APEC #1; the remainder is removed for off-site disposal at a licensed facility.
[4]Costs included above.

The combination of options recommended for APEC #1 and #2, allows for the unrestricted redevelopment (e.g., allows for the construction of industrial buildings) of the southern area of the Site, while allow controlled redevelopment of the northern area for outside storage and staging. This is consistent with the adjacent properties land use, and is typical of industrial developments in this area of the City.

The implementation of a low permeability cap versus a compacted granular cap was seen as a best management practice consistent with typical solid waste landfills. In addition to protecting surface receptors, the low permeability cap also improves the protection of groundwater, potentially reducing or removing the need for future groundwater mitigation, however, cap selection for APEC #1 (granular vs. impermeable) may be subject to a future buyer's proposed land use.

It is recommended that these items be carried forward in the development of a detailed remedial action plan for the Site which will critically evaluate the assumption and estimates presented herein, and proceed with further planning and basic design details which are beyond the scope of this document.

1.0 INTRODUCTION

Dillon Consulting Limited (Dillon) was retained by Thompson Dorfman Sweatman (TDS) on behalf of Northwest Smelting and Refinery (NWSR) to conduct a site investigation (attached as **Appendix A**), and ultimately develop a site management plan for the property located at 2185 Logan Avenue in Winnipeg, Manitoba (the Site). This report details the remedial options analysis and recommended site management approach based on the findings from the site investigation.

1.1 Site Description

The Site is located at 2185 Logan Avenue in a northwest industrial area of Winnipeg (**Appendix A Figure 1)** in Omand's Creek Industrial Park. Historically, the property was used to house a smelting facility and subsequently, a battery recycling operation. The battery recycling operation was housed on the south end of the property in a complex of buildings, formerly used as a refinery. Storage areas filled with metal and plastic battery case debris were identified (IDE, 1993) to the north of the buildings. The northern portion of the property is grass covered and was previously covered with a clay cap overlying refinery and battery recycling debris. In October of 2012, the buildings were demolished by Western Specialty Contracting Ltd., with oversight by Dillon.

1.2 Objectives

The main objectives of this Remedial Options Analysis Report were to:

- Summarize historical and recent data collected for the Site, to provide a more comprehensive understanding of subsurface physical conditions and the distribution of impacts at the Site (e.g., Conceptual Site Model);
- Using the Conceptual Site Model, identify data gaps requiring further investigation; and,
- Using the Conceptual Site Model as the base, screen the potentially applicable remediation and risk management options for the protection of the environment and human health.

1.3 Biophysical Environment

The subject property is located near the corner of Logan Avenue and Ryan Street. The northeastern portion of the property is bounded by Ryan Street, and the southern portion of the property is bounded by Logan Avenue. Bayco Industries Limited (task lighting manufacturer) and Cadorath Plating (metal) occupy the properties on the southern side of Logan Avenue. Several companies (trucking, lumber storage) rent the spaced owned by 2925924 Manitoba Ltd. that bounds the property to the west; the property has recently been sold. A metal recycling facility, Chisick Metal Ltd. bounds the property to the southeast side. The northern edge of the subject property is adjacent to Prendiville Industries Limited, located at 165/180 Ryan Street. A site plan showing the area at the former buildings and on-site buried debris is illustrated in **Figure 2** of **Appendix A** (attached).

The closest surface water body or sensitive ecological habitat is located approximately 3 km south of the Site (Assiniboine River). There are two ponds within 1 km from the Site: a stormwater retention pond to the northwest and a pond at Woodsworth Park across Highway 90 to the northeast.

1.4 Land Use and Surface Topography

Site and surrounding land use is industrial. The Site hosted a former Smelter and Lead Acid Battery Recycling Facility. The Site was serviced by municipally supplied potable water and sewers. A historic landfill containing debris from the acid battery recycling facility is situated in the northern portion of the Site property. The southern portion of the Site contained the Smelter and associated buildings, which were demolished in 2012.

The topographical survey conducted in 2012 showed surface drainage patterns that ran to the edges of the Site. The property is graded to a greater elevation towards the center of the Site, promoting run-off patterns to the property edges. There are surface water ditches along the western and northern property boundaries, however, surface water was not observed in the drainage ditches during field investigations. Erosion potential is minimal for the southern portion of the Site. However, there is greater erosional potential for the northern portion of the Site due to steeper slope profiles.

The Site is bounded by the following properties:

- The northeastern portion of the property is bounded by Ryan Street;
- The southern portion of the property is bounded by Logan Avenue. Both Bayco Industries Limited (task lighting manufacturer) and Cadorath Plating (metal) occupy the properties on the southern side of Logan Avenue. Production wells installed for industrial use were identified at 2150 Logan Avenue (Cadorath Plating);
- The western portion of the property is bounded by several companies (trucking, lumber storage) who rent the spaced owned by 2925924 Manitoba Ltd. at 2201 Logan Avenue. (Note: this property has recently been sold);
- The southeastern portion of the property is bounded by a metal recycling facility, Chisick Metal Ltd. 2141 Logan Avenue; and,
- The northern edge of the subject property is adjacent to Prendiville Industries Limited, located at 165/180 Ryan Street.

1.5 Site Hydrogeology

1.5.1 Regional Hydrogeology

To describe the regional physiography and expected hydrogeologic conditions beneath the property, the following documents were reviewed:

- Province of Manitoba, Groundwater Availability Maps, Bedrock Geology and Drift Thickness maps, 1980; and,
- Render, F.W. Geohydrology of the Metropolitan Winnipeg area as related to Groundwater supply and construction. Canadian Geotechnical Journal, Vol. 7, No. 3, 1970.

The general geology of the Winnipeg area consists of glacio-lacustrine deposits including sands, silts and clays of the late Wisconsinan glaciation (Province of Manitoba, Groundwater Availability Maps, Surface Deposits map, 1980). Bedrock geology mapping for the area indicates the Site is underlain by the Red River formation, which consists of Ordovician dolomitic limestones and dolomite (Province of Manitoba, Groundwater Availability Maps, Bedrock Geology map, 1980). The carbonate bedrock serves as a regional aquifer, with an estimated piezometric groundwater level located at approximately 12 metres below ground surface (mbgs) in the area of the Site (University of Manitoba Department of Engineering, 1983). This unit serves as a groundwater drinking source obtained through wells for rural communities surrounding Winnipeg.

1.5.2 Local Hydrogeology

The subsurface soil conditions observed during the investigation consisted of surficial sand and gravel fill materials, underlain by layers of silt, clay and glacial till to the maximum depth drilled of 7.4 mbgs.

The depth to groundwater measured within the monitoring wells during the May 2013 Dillon groundwater monitoring visit ranged between 0.55 (13-03, Fill layer) and 2.60 (13-10, Till layer) mbgs. Shallow groundwater flow direction (fill and clay wells only) was observed to be primarily towards the northeast. Depth to groundwater measured during the June 2014 visit ranged between 0.35 (13-13, Fill layer) and 2.49 (13-10, Till layer) mbgs.

Greater hydraulic conductivity was seen in the upper layers in the following order:

- MW 13-13 (fill/silty clay, 3.02 x10^{-4} cm/s);
- MW 13-11 (silty clay, 5.14 x10^{-6} cm/s); and,
- MW 13-10 (tight till, 1.7 x 10^{-7} cm/s).

The local shallow groundwater flow direction below the Site may vary from the Regional context and be influenced by industrial groundwater extraction, surface drainage ditches, underground structures and utilities which may be present in the vicinity of the Site. Such features are typically backfilled with coarse grain materials which may provide a more permeable conduit for groundwater flow when compared to the lower permeability of the native soils.

1.5.3 Soil, Fill and Waste

The northern portion of the property consists of grass growing in stony topsoil overlying the 0.5 m of clayey fill with stones, which overlies 1 m of fill consisting of foundry debris, plastic battery case debris and clayey soils. This fill overlays the original black organics and clayey till. Undisturbed till was encountered at a depth of 2-3 m.

The southern portion of the property consists of 1 m of gravel road fill, overlying approximately 2 m of grey clay, overlying the till, which extends to the bottom of the test holes.

1.6 Historical Environmental Site Investigations

Previous Environmental Site Investigations and their findings are summarized in **Figure 3** of **Appendix A** (attached) and below in **Table 1.** Further details are provided in **Appendix A.**

TABLE 1: SUMMARY OF HISTORICAL ENVIRONMENTAL SITE INVESTIGATIONS

Year	Investigating Party	Type of Investigation	Investigations	Findings
1991	I.D. Systems (IDS) Ltd.	On-Site Investigation into Lead Contamination	– 8 shallow test holes; – 9 piezometers; – 66 soil samples.	– Lead impacts in soil exceeded Tier I and Tier II Criteria; – Lead impacts variable with depth; – Vertical delineation to 5.2 m. – Vertical delineation not achieved; – Shallow groundwater flow to the Northwest.
1993	I.D. Engineering Canada, Inc.	Off-Site Environmental Site Assessment	– Boreholes; – Monitoring wells.	– Dissolved lead in water concentrations below applicable criteria to the east of Site property. – Off-site soil to the west exceeded Tier I Criteria.
2005	KGS Group	Off-Site Phase II ESA	– Test pits; – Surficial Soil Samples.	– Lead in soil concentrations exceeded – Off-site soil to the west exceeded Tier I Criteria. – Depth of impacts at less than 1 m below grade.
2009	Dillon Consulting	Off-Site Environmental Site Assessment	– Boreholes.	– Off-Site limited impacts associated with Polycyclic Aromatic Hydrocarbons to the east of the property.
2013	M.P. Wiebe Environmental Engineering	Off-Site Phase II ESA	– Boreholes	– Off-site impacts above Tier I Criteria confined to upper fill layer; – No Off-Site impacts above Tier II Criteria to the west of the property.
2014	Dillon Consulting	On-Site and Off-Site Environmental Site Investigation	– Boreholes; – Monitoring wells; – Surficial Soil Samples	

1.7 Areas of Potential Environmental Concern (APEC)

APEC refers to means the area on, in or under a property where one or more contaminants are potentially present, as determined through previous environmental site assessments, including:

- Identification of past or present uses on, in or under the phase one property, and,
- Identification of potentially contaminating activity.

1.7.1 APEC 1 – North End Historical Landfill

A historical landfill at the northern portion of the property contains foundry debris associated with battery breaking/recycling activities mixed with clayey soil. Grass grows on top of the soil cap that covers the landfill. Contaminants of Concern identified at the North End Historical Landfill are related to the battery and foundry debris within the historic landfill. These include:

- Metals (lead, cadmium, copper, zinc).

1.7.2 APEC 2 – Surficial Impacts – Southern Portion of Site

Surficial impacts are associated with previous site activities as a foundry for metal smelting and refinery. Impacts have been identified in the surrounding fill and underlying layers. Contaminants of concern identified at the southern portion of the Site include:

- Metals (lead, cadmium, copper, zinc).

1.7.3 APEC 3 – Site-Wide Groundwater

Groundwater impacts associated with leachable metals have been observed at the site in surrounding monitoring wells (IDE, 1991). Contaminants of concern identified in groundwater include:

- Metals (lead, cadmium).

1.8 Environmental Standards and Criteria

As NWSR's property and surrounding areas are zoned as industrial, and groundwater is not used as a drinking water supply, pathways protective of potable and agricultural water uses are eliminated.

The closest surface water body or sensitive ecological habitat is located less than 1 km to the northwest of the site (pond at Woodsworth Park). The Assiniboine River lies approximately 3 km to the south. Applicable criteria for soil and groundwater were selected based on land use, groundwater use and proximity to nearby receptors and are discussed in the following sections.

1.8.1 Soil

For the assessment of benzene, toluene, ethylbenzene, and xylenes (BTEX) concentrations in the soil samples, the 2004 Canadian Council of Ministers of the Environment (CCME) Canadian Environmental Quality Guidelines for Environmental Health, Industrial Land Use, Fine-Grained Subsoil, Environmental Health check values. Assessment criteria from the 2008 CCME Canada-Wide Standards for Petroleum Hydrocarbons (PHC) in Soil, Industrial Land Use, Fine-Grained Subsoil, Management Limit were also applied to the Site for the four hydrocarbon fractions (F1 - F4).

For PHC fractions F1 – F4, Dillon selected values from the Canada-Wide Standard for PHC in Soil Technical Supplement dates January 2008. Tier I levels for PHCs for fine-grained soils, industrial land use, terrestrial ecological pathway were applied. Based on present and future proposed Site land use and potential receptors to the Site, Dillon selected the CCME Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health (2008), industrial land use and fine grained soil.

Both Tier I and Tier II criteria from CCME were applied. Tier I Criteria (indicated by [1]) considers direct contact between ecological and human receptors and the impacted soils. These values can be overly conservative and are not applicable to industrial sites where there are no identified human and/or ecological receptors. In these cases, the less-conservative Tier II values (denoted by [2]) is are used for data comparisons, and in this instance, are protective of the soil ingestion pathway.

1.8.2 Groundwater

Assessment guidelines for groundwater and surface water depend on the potential uses of the water. CCME document (CCME, 1999), and more recently, Manitoba Conservation and Water Stewardship (MC, 2000) have developed guidelines for several end use categories for both groundwater and surface waters, although Manitoba Conservation and Water Stewardship has no guidelines for assessing non-potable groundwater outside of agricultural use. Manitoba has accepted the applicability of Environment Canada'*s Federal Interim Groundwater Quality Guidelines (FIGQG)* for Commercial and Industrial Land Uses, Table 3: Non-Potable Ground Water Condition, Fine Grain Soils, May 2012, as acceptable Tier I Criteria. It is noted that the FIGQG for metals are generally based on the surface water guidelines (i.e., for protection of freshwater aquatic life) with no allowance for attenuation processes. These values are considered to be overly conservative and not necessarily indicative of potential risks to aquatic receptors. The use of criteria established by Ontario Ministry of Environment, *Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act*, Table 3: Full Depth Generic Site Conditions in a Non-Potable Ground Water Condition, All Types of Property Use, April 2011 is acceptable in Manitoba as Tier II Criteria.

Tier I Criteria (indicated by [1]) considers direct contact between ecological and human receptors and the impacted groundwater (FIGQ, 2012). These values can be overly conservative and are not applicable to industrial sites where there are no identified human and/or ecological receptors. In these cases, the less-conservative Tier II values (MOE, 2011) are used for data comparisons (indicated by [2]).

1.8.3 Waste Classification

For waste classification and disposal evaluation, Dillon selected the Man. Reg. 282/87 the Dangerous Goods Handling and Transportation Act Criteria.

1.9 Data Gaps and Recommendations for Future Data Collection

The following data gaps and recommendations are based on the results from the 2014 ESI Final Report.

1.9.1 APEC 1 – North End Dump Site

No further data gaps were identified for the North End Dump Site. The waste debris volume, thickness and composition are known. The soil cap integrity, thickness and composition are known. Contaminants of concern have been identified and delineation has been achieved both horizontally and vertically. Further work associated may follow, as recommended by a site-specific risk assessment and/or management program. Based on the results from field investigations in 2013, minimal off-site impacts were observed to the north of this APEC. All results were observed to be below the applicable criteria.

1.9.2 APEC 2 – Surficial Impacts, Southern Portion of Site

No further data gaps were identified for the surficial impacts at the southern end of the Site. Soil stratigraphy has been identified for the area, with the exception of the property to the east of the southern end of the Site. Contaminants of concern have been identified and delineation has been achieved both horizontally and vertically. Based on results from field investigations conducted in 2013, off-site impacts were observed to the west of the subject site and are discussed further in the Environmental Site Investigation Report (**Appendix A**). Further work associated may follow, as recommended by a site-specific risk assessment and/or management program.

1.9.3 APEC 3 – Groundwater

At the end of the 2013 groundwater monitoring investigation, data gaps were identified for understanding the site conceptual model with respect to groundwater impacts. Groundwater gradients and flow direction were confirmed in a subsequent groundwater monitoring program (in 2014).

Contaminants of concern have been identified at the Site. A second groundwater monitoring event was conducted to confirm observed impacts following the initial sampling event. Downwards vertical gradients were observed within all measured stratigraphic units. The proximity to buried waste combined with the downwards vertical gradient support the hypothesis that the greater concentrations in groundwater at the northern portion of the Site are associated with the buried waste materials in APEC 1. The stabilization or removal of materials in APEC 1 will likely improve impacts in the deep groundwater.

Human health and ecological receptors were not identified for the site. Regional groundwater is non-potable and the nearest surface water body or sensitive ecological habitat is located less than 1 km to the northwest of the Site (pond at Woodsworth Park). Lead in groundwater concentration exceedances were noted at a significant distance away from any possible fish habitats. Given that there are no observed immediate ecological or human receptors, a site-specific Tier III Criteria or risk management strategy may be more appropriate.

2.0 REMEDIAL OPTIONS SCREENING

To complete the designation process under Manitoba's Contaminated Sites Remediation Act (CSRA), it has been determined that a Human-Health based EQG was exceeded in soil and groundwater samples. The Site is designated as "contaminated" and is listed as #20164 on Manitoba Conservation and Water Stewardship's Contaminated Sites List. As such, a remedial action plan must be submitted to the Director of Manitoba Conservation and Water Stewardship. Upon the completion of remediation activities, a revocation of designation as a contaminated site will be issued to the Land Titles Office, registered owner(s), municipality, and to the site registry. This remedial options analysis moves the process forward to selecting an appropriate approach for site remediation.

2.1 Remedial Objectives

2.1.1 Mitigate Environmental and Human Health Risks

It is Dillon's understanding that the objective for the Site is to have the environmental impacts at the Site (i.e., lead in soil, fill, waste and groundwater and to a lesser extend other metals) managed in a manner that allows for the redevelopment of the Site for industrial purposes consistent with the current zoning and surrounding land uses. The management of environmental impacts generally considers three processes: human health and ecological risk assessment, environmental risk management measures, and remediation. These three processes are considered in the remedial option screening for the Site. The processes are defined as follows and our further discussed in the following sections:

- Human Health and Ecological Risk Assessment (RA): the development of site-specific criteria (SSC) defining the acceptable concentrations of impacts in soil and groundwater based on the scientific evaluation of exposure pathways and contaminant distribution in the subsurface;
- Environmental Risk Management Measures (RMMs): exposure pathway blocking or mitigating features that allow an elevated level of impacts to be left in place while simultaneously protecting the appropriate receptors (e.g., on-site workers, off-site ecology, etc.); and,
- Remediation: the removal, degradation or destruction of a contaminant to acceptable exposure criteria or concentrations based on the land use without the requirement for additional environmental controls.

Effective and efficient environmental management options for a site generally include components from each of the above noted processes. For the purposes of this remedial option screening exercise it is assumed that remediation of soil and groundwater to low level generic Tier I CCME SQG concentrations (most conservative value, regardless of pathway applied) is not mandated, and that environmental management options that include both RA processes and implementation of pathway blocking RMMs may be considered for the management of soil and groundwater impacts. In the following sections further details of these processes will be discussed on how they relate to the NWSR site.

2.1.2 Cost Recovery and Maximizing Land Use

An additional remedial objective is to maximize site recovery and use. The real estate market in the surrounding industrial park was examined in December 2014, to provide cost considerations and re-sale value of impacted and non-impacted land. Based on market data, the most effective path forward for minimizing liability and cost recovery is based on the scenario of an unimpacted, southern site. The anticipated re-sale value for an unimpacted southern site, and capped northern site has been estimated to be $0.6M, based on the current real estate market and re-sale values of neighbouring properties (see **Appendix B**). It is anticipated that a 'split-titles' approach may be adopted to improve cost recovery ($0.4M for the southern site, $0.2M for the northern site). The site use limitations on the northern portion of the site for staging and yard storage are not (at the present time) a market-driven limitation. Neighbouring properties have expressed a need for more staging and yard storage.

The specific remedial objectives for the Site are:

- Remediate impacts to remove identified risks to both human and environmental health;
- Increase property value and potential land use; and,
- Cost-recovery (minimize remedial costs).

2.2 Risk Assessment to Define Remediation and Risk Management Goals

Human health and ecological risk assessments (RAs) are a scientific process used to develop SSC for soil and groundwater concentrations of the impacts present at a site above background levels that are different from the generic Tier I CCME SQG concentrations that may be overly conservative and impractical to achieve. SSC derived through an RA offer a site-specific alternative to the Tier II CCME SQGs and are considered to be Tier III criteria, under the CCME approach. RAs consider such site-specific conditions as: soil type, contaminant transport mechanisms, depth to impacts, depth to groundwater, exposure pathways and site-specific receptors (human and ecological) based on land use in the development of SSC.

The development of SSCs is an important step in the subsequent selection and design of remediation and risk management measures. It is therefore recommended that a human-health RA be completed for the Site using the existing investigational data presented in the earlier sections of this report as the basis for the development of SSCs. The collection of additional data, especially with respect to groundwater, may be necessary to fill data gaps. It is further recommended that SCCs be developed for the Site's impacts (i.e., lead and other metals) for two options. The first option being a scenario where no pathway blocking RMMs are implemented. The second option being a scenario where pathway blocking RMMs are implemented. With the development of SSCs better decisions can be made on the practicality and feasibility of an environmental management program including the needs for long term monitoring and maintenance.

The development of SSC can be used in site closure activities to evaluate various risk management and remedial strategies as applied to the Site.

2.3 Remediation and Risk Management Technologies

The following sections summarize applicable and non-applicable remedial and risk management technologies that were considered for the Site.

2.3.1 Non-Applicable Technologies

This section briefly discusses a number of common remediation technologies and reason why they are not applicable to this Site.

- In situ / ex-situ thermal desorption and/or incineration. This range of technologies using heat from various sources at various temperatures focuses on the removal or destruction of organic contaminants (e.g., fuels, pesticides, PCBs, wood preservatives, chlorinated solvents). It has little effect on the removal of typical metal impacts and is therefore not consider further;
- In situ / ex-situ chemical oxidation or reduction. This suite of technologies focuses on the degradation or destruction of organic contaminants. It has little effect on the bulk removal of metals, but can positively and negatively influence the subsurface mobility metals;
- Phytoremediation. This technology relies on the biological process of the plant growth and the uptake (or stabilization) of metals in the plant material as a metals removal option; however, this technology is limited by rooting depth and mass removal rates which make it an impractical technology for this Site;
- Bioremediation and monitored natural attenuation. The remedial processes associated with bioremediation and monitored natural attenuation are targeted at the natural biotic (e.g., bacterial) and abiotic degradation, retardation and dispersion of organic contaminants. There is some limited applicability to dissolved metals species from the retardation and dispersion perspective, but these generally rely on dilution to achieve targets and are not believed to be a favourable option for this Site. Furthermore, this technology does not address source zone impacts (e.g., in the shallow soils); and,
- Remediation through Pump and Treat. Extracting impacted groundwater as a method of mass removal for dissolved impacts is an effective technology for mass reduction of highly soluble contaminants. From a metals remediation perspective its effectiveness is limited by the slow dissolution of contaminants into the groundwater and the achievable extraction flow rates of collected groundwater; therefore it is not considered further. However, it can be effectively implemented as a boundary control feature to limited the off-site migration of impacted groundwater.

2.3.2 Applicable Technologies

Technologies that were seen as applicable and potentially practical for the environmental management of the Site are summarized as follows:

- **Excavation, Disposal and Backfill:** This is the most common and basic remedial technology for the management of impacts in shallow soils and groundwater. The feasibility of this option is greatly influenced by the disposal requirements of the excavated material. For example, if the excavated material is considered a hazardous or special waste it may require special handling and disposal conditions that increase costs over those of a typical solid waste. Companion technologies can be incorporated with the excavation and disposal options that assist reducing disposal costs, examples include:

  - Segregation/screening of waste types removing oversized material that is typically non-hazardous and can be disposed of at a lower rate.
  - Stabilization and/or solidification of impacted soils and waste by the addition of cementitous products (e.g., Portland cement, cement kiln dust, fly ash, lime) or chemical binders such as apatites minerals which reduce the leachability of the matrix, attempting to reclassify the treated soil and waste as a non-hazardous waste for lower disposal costs.

- **Excavation, Soil Washing and Replacement/Backfill:** Soil washing can be an effective technique to segregate waste streams from re-useable soil and granular products. Soil washing is a combination of size dependent separation (physical screening), magnetic separation (removing ferrous metals) and density separation removing particles that are heavier or lighter that typical soil particles. Upon washing segregated wastes are appropriately disposed of and the remaining soil reused on the site. However, it is not recommended that this technology be further considered for this Site for the following reasons. Set-up and mobilization costs are known to be high for an on-site soil washing facility, and based on our experience remediation quantities in excess of 50,000 tonnes are required for the technology to become cost competitive with standard disposal options. Also, this technology is promoted for coarse grained soils, soils with fines (fine sand, silt and clay) in excess of 30% by weight are amenable to cost effective soil washing.
- **Surface Capping and Management in Place**: Surface capping is a common and practical risk management method used to block the exposure of surface receptors (humans and ecological receptors) from the subsurface impacts. Caps can also be upgraded and designed to provide a level of protection to the underlying groundwater by minimizing infiltration of rain water and snow melt through the impacted soils and waste, and the resultant leaching of metals to groundwater.
- **Solidification/Stabilization:** The leachability of metals can be reduce through the in situ or ex-situ addition of cementitous products (e.g., Portland cement, cement kiln dust, fly ash, lime) or chemical binders such as apatites minerals or sulphide products. This would provide for the improved protection of groundwater, but as a standalone option it does not address surface receptors and or off-site migration through surface water and wind erosion. This technology needs to be combined with a surface capping option (see above) for the protection of surface receptors.
- **Permeable Reactive Barriers:** An option for passively treating groundwater is by installing treatment curtains to intercept the off-site groundwater transport pathway. Materials are permeable and treat the groundwater (treatment type depends on barrier material chosen, i.e., sorption, precipitation, degradation pathways) as it passes through the reactive portion of the in situ curtain.
- **Hydraulic Control:** This option uses groundwater extraction to minimize the plume migration and to reduce the contaminant concentrations in the impacted aquifer. The extracted water often needs to be treated prior to reinjection in the aquifer or disposed off-site.
- **Groundwater Containment**: Impermeable materials (such as sheet piling walls) can be built to completely surround the contaminated portion of an aquifer, effectively halting lateral migration of contaminants.

In brief summary, practical technologies for this Site are believed to be a combination of remediation through excavation and disposal and risk management through surface capping for the environmental management of the site that allows for the industrial redevelopment. Possible approaches and further screening is provided for each APEC in the following sections.

2.4 APECS – Options, Screening and Recommendation

2.4.1 APEC 1 – North End Dump

Site Conditions

Based on the data presented in the Site assessment sections of this report the following conditions and assumptions have been used for the assessment of environmental management options in APEC #1:

- A thin non-engineered cap (comprised of sandy fill) overlies landfilled waste consisting battery casings, industrial debris and construction and demolition debris related to the historic metal (lead) recovery and recycling activities of the Site;
- Underlying waste has a high potential for metals (lead and cadmium) leachability and if excavated and disposed of would likely classify as a hazardous waste (Man. Reg. 282/87);
- Native soils underlying the waste are fine grained silty clays;
- Bulk metal impacts in the fill, waste and underlying soil above Tier I CCME SQG (lowest value irrespective of pathway) extend from ground surface to 2.5 mbgs with an average depth of 2 m. The approximate area of impacts is 7,000 m^2 for an approximated impacted volume of 14,000 m^3. The reduced volume of 13,600 m^3 has been estimated using known concentrations and a calculated soil-cut volume with the Surfer software program;
- Bulk metal impacts the fill, waste, and underlying soil above Tier II CCME SQG (ingestion of soil pathway, protection of human health) extend within the waste layer, below the soil cap to 2.5 mbgs with an average depth of 1.5 m. The approximate area of impacts is 7,000 m^2 for an approximated impacted volume of 10,500 m^3;
- Groundwater is located at 1.35 to 3.61 mbgs and contains dissolved concentrations of metals above the applicable surface water discharge criteria (MOE Table 3, 2011); and,
- Metals dissolved in groundwater are anticipated to have limited mobility due to the low hydraulic conductivity of the native soils, the shallow horizontal gradients, and also due to the amenability of the metal impacts to retardation through adsorption in to / on to the organic matter contained within the silty clay soil matrix; however, further assessment is required.

Environmental Management Options

Four scenarios or options for the management of APEC #1 are presented below for further screening and evaluation.

Scenario 1 – Excavation and Disposal to CCME SQG Tier I Criteria

As the most conservative option, full scale excavation and removal of waste and impacted soil needs to be considered as a baseline for comparison of the other scenarios. This approach consists of excavating the buried waste and impacted fill for off-site disposal (and/or off-site treatment), along with the importation and placement of clean fill for site grading. Through mass excavation with an excavator, waste hauling trucks would be directly loaded removing the impacted fill, waste and soil from APEC #1 to a licensed facility. Based on the delineation of impacts it is expected that an estimated 14,000 cubic metres of material needs to be removed to achieve the CCME SQG Tier I Criteria target (lead in soil, 600 mg/kg). As necessary, dewatering and/or excavation support would be implemented to allow for the removal of the impacted materials. Appropriately licensed disposal facilities may include both municipal landfills for non-hazardous wastes and secure hazardous waste receiving facilities depending on the waste classification. Following removal of the impacted materials, the excavation would be backfilled with a compacted non-impacted granular fill that could support future redevelopment include the construction of industrial buildings.

Advantages

The excavation of impacted materials physically removes the impacts from the site, and requires no additional long-term management of the surface impacts. Through the collection of confirmatory soil samples, removal via excavation can be verified. This option protects the groundwater by removing the source of impacts, the leachable metals. The excavation option could be implemented quickly and allows for a more encompassing redevelopment of the site. The removal of the impacts would have the greatest positive effect on future property value.

Disadvantages

Excavation and off-site disposal of impacted materials would be disruptive. It requires the export of 14,000 m^3 of waste materials and the import of a corresponding volume of clean fill. Due to the trucking and subsequent landfill disposal this option has a low sustainability rating. Considerable effort may be required to control groundwater and surface water infiltration in the area during the excavation.

Cost

A preliminary and budgetary cost estimate for the excavation and off-site disposal of the impacted soils and waste is greater than $2,240,000 assuming the excavated material is solid non-hazardous waste. Assuming 50% of the waste is a hazardous waste (i.e., lead leachate concentrations greater than 5 mg/L) the budgetary cost estimate increases to greater than $6,790,000. This is based on the following assumptions:

- 14,000 m^3 of impacted material;
- Excavation and loading at a rate of \$30/m^3;
- Solid non-hazardous waste transportation and disposal rate of \$90 to \$120/m^3;
- Hazardous waste transportation and disposal rate of \$500 to \$1000/m^3; and,
- Imported, placed and compacted backfill at a rate of \$30/m^3.

Waste reduction and stabilization options to reduce the disposal costs were discussed in **Section 2.3** above. The implementation of these options could result in a reduction of the amount of material to be disposed of as a hazardous waste, for budgetary purposes it is suggested that a cost reduction of 25% to 50% may be achieved on the hazardous waste disposal component only. This translates to a savings of approximately $1,697,500 (25% cost reduction) to $3,395,000 (50% cost reduction) for the 50% hazardous waste scenario.

Scenario 2 – Excavation and Disposal to CCME SQG Tier II Criteria

This scenario is similar to the above scenario, the only difference being that the target to be achieved is the Tier II CCME SQG for lead at 8,200 mg/kg versus the generic 600 mg/kg target. This results in a reduced amount of material to be removed. Based on the delineation of impacts it is expected that 10,500 m^3 of material needs to be removed to achieve the Tier II target. However, since only materials with the highest concentration of impacts will be removed it is assumed that all the material will be considered a hazardous waste.

Advantages

The excavation of impacted materials physically removes the impacts from the Site, and requires no additional long-term management of the surface impacts. Through the collection of confirmatory soil samples, removal via excavation can be verified. This option protects the groundwater by removing the highest concentrations of the leachable metal source material. The excavation option could be implemented quickly and allows for a more encompassing redevelopment of the site. The removal of the highest level of impacts and the ability to redevelop the area would have positive effects on the future property value.

Disadvantages

Excavation and off-site disposal of impacted materials would be disruptive. It requires the export of 10,500 m^3 of waste materials and the import of a corresponding volume of clean fill. Due to the trucking and subsequent landfill disposal this option has a low sustainability rating. Considerable effort may be required to control groundwater and surface water infiltration in the area during the excavation.

Cost

A preliminary and budgetary cost estimate for the excavation and offsite disposal of the impacted soils and waste is greater than $1,680,000, assuming the excavated material is solid non-hazardous waste. Assuming 50% of the waste is a hazardous waste (i.e., lead leachate concentrations greater than 5 mg/L) the budgetary cost estimate increases to greater than $5,092,000. This is based on the following assumptions:

- 10,500 m^3 of impacted material;
- Excavation and loading at a rate of $30/$m^3$;
- Hazardous waste transportation and disposal rate of $500 to $1000/$m^3$; and,
- Imported, placed and compacted backfill at a rate of $30/$m^3$.

Waste reduction and stabilization options to reduce the disposal costs were discussed in **Section 2.3** above. The implementation of these options could result in a reduction of the amount of material to be disposed of as a hazardous waste, for budgetary purposes it is suggested that a cost reduction of 25% to 50% may be achieved on the hazardous waste disposal component only. This could result in a savings of approximately $1,273,000 to $2,546,000 for the 50% hazardous waste scenario.

Scenario 3 – Engineered Low Permeability Surface Cap (Risk Management)

The construction of a low permeability engineered cap is a risk management option that allows the impacts in APEC #1 to be managed in place. The cap blocks surface receptors from exposure to the underlying impacts and further reduces infiltration of storm water through the impacted soil and waste for the protection of groundwater. An engineered cap would be conceptually designed as follows. The north area of the Site would be re-graded removing local depressions and surface irregularities. The surface would be prepared and a low permeability cap constructed of a combination of geotextiles, geomembranes and compacted soil or granular material. As necessary, surface water control features (catchbasis, storm sewers) will be designed and constructed into the cap to convey storm water towards municipal ditches and storm sewer system. To allow for redevelopment of this northern area of the Site, the top surface of the cap could be completed with an asphalt surface providing a further level of pathway blocking while also providing a staging area for the outdoor storage of materials or equipment. Overall it is expected that the cap thickness would be approximately 0.5 m.

This capping option is not compatible with the construction of industrial buildings without significant additional design considerations.

Advantages

In a cost effective manner the engineered cap provides improved protection of surface receptors and the groundwater from the underlying impacts that allows for the control use of the Site. This option can be constructed quickly and is less disruptive than excavation or ex-situ options. Since only minimal materials will be shipped to or from the site and no landfill space will be used this option has a higher sustainability rating the Scenarios 1 and 2 above.

Disadvantages

The impacts are left in place and the Site would become a perpetual care site with long-term monitoring and maintenance requirements. The uses for the area of APEC #1 would be restricted to surface uses such as material staging, equipment storage and parking, and would not be compatible with future building construction. It is likely that some legal registration on the property title would be required to ensure the perpetual maintenance of the cap. Overall, these requirements would negatively impact future property value. However, the limitations of the northern site for staging and yard storage, is not (at the present time of this report) a market-driven limitation. Neighbouring properties have expressed a need for more staging and yard storage. It is likely that some legal registration on the property title would be required to ensure the perpetual maintenance of the cap. Overall, these requirements would negatively impact future property value.

Cost

A preliminary and budgetary cost estimate for the construction of a low permeability cap is approximately $715,000 to $935,000. This is based on the following assumptions:

- 11,000 m^2 surface area for capping; and,
- Cap includes grading, geotextile, geomembrane and asphalt components for an inclusive unit rate of $65 to $85/$m^2$.

Scenario 4 – Compacted Granular Surface Cap – Risk Management

The construction of a compacted granular cap is a minimal intervention risk management option that allows the impacts in APEC #1 to be managed in place. The cap blocks surface receptors from exposure to the underlying impacts, but does not provide for the further protection of groundwater. A compacted granular cap would be conceptually designed as follows. The north area of the Site would be re-graded removing local depressions and surface irregularities. The surface would be prepared by placing a lightweight indicator geotextile to delineate non-impacted cap material from the underlying impacted material, and 0.5 m of granular material would be placed and compacted at surface (e.g., 0.25 m of Granular B overlain by 0.25 m of Granular A). This compacted granular cap provides a staging area for the outdoor storage of materials or equipment.

This capping option is not compatible with the construction of industrial buildings without significant additional design considerations.

Advantages

This is the most cost effective environmental option for the protection of surface receptors and the management of the erosion of impacted material. This option can be constructed quickly and is less disruptive than excavation or ex-situ options. Since only minimal materials will be shipped to or from the site and no landfill space will be used this option has a higher sustainability rating the Scenarios 1 and 2 above. Due to its lower cost, this risk management measure could be considered as interim risk management measure implemented until such time that resources become available for the construction of improved risk management measures or for a higher level of remediation. In the event of a future remediation, the granular materials used to construct the cap could easily be reused at the Site for either surface treatments or as backfill.

Disadvantages

The impacts are left in place and the Site would become a perpetual care site with long-term monitoring and maintenance requirements and does not provide protection to groundwater. A higher level of maintenance and monitoring requirements would also be likely in comparison to Scenario 3. The uses for the area of APEC #1 would be restricted to surface uses such as material staging, equipment storage and parking, and would not be compatible with future building construction. However, the limitations of the northern site for staging and yard storage, is not (at the present time of this report) a market-driven limitation. Neighbouring properties have expressed a need for more staging and yard storage. It is likely that some legal registration on the property title would be required to ensure the perpetual maintenance of the cap. Overall, these requirements would negatively impact future property value.

Cost

A preliminary and budgetary cost estimate for the construction of a compacted granular cap is approximately $275,000 to $445,000. This is based on the following assumptions:

- 11,000 m^2 surface area for capping; and,
- Cap includes grading geotextile, and placement of 0.25 m of Granular B and 0.25 m of Granular A for a unit rate of $25 to $40/$m^2$.

Summary

The scenarios considered for the remediation and/or risk management of APEC #1 are summarized below:

TABLE 2:APEC 1 REMEDIAL OPTION SUMMARY

Scenario	Cost	Advantages	Disadvantages
Scenario 1 – Excavation and Disposal to CCME SQG Tier I Criteria	Budgetary estimate of: – greater than $2.2M assuming no haz-waste – greater than $6.7M assuming 50% haz-waste	– Remediation and removal of impacted materials – Highest protection for groundwater – Minimal long-term monitoring and maintenance requirements – Unrestricted site use – Quickly implemented	– High cost – Lowest sustainability rating – Highly disruptive

Scenario	Cost	Advantages	Disadvantages
		– Positive influence on property value	
Scenario 2 – Excavation and Disposal to CCME SQG Tier II Criteria	Budgetary estimate of: – greater than $1.6M assuming no haz-waste – greater than $5.0M assuming 50% haz-waste	– Remediation and removal of most impacted materials – Protects groundwater – Minimal long-term monitoring and maintenance requirements – Unrestricted site use – Quickly implemented – Slightly positive influence on property value	– Leaves lower level impacts in place – Low sustainability rating – Disruptive
Scenario 3 – Engineered Low Permeability Surface Cap – Risk Management	Budgetary estimate of $715,000 to $935,000	– Protects surface receptors – Moderate protection of groundwater – Less disruptive – Higher sustainability rating – Lower cost – Allows limited/control redevelopment	– Leaves impacts in place – Long-term maintenance and monitoring – Land use restricted to outside staging and parking[1]
Scenario 4 – Compacted Granular Surface Cap – Risk Management	Budgetary estimate of $275,000 to $440,000	– Protects surface receptors – Less disruptive – Higher sustainability rating – Lowest cost – Allows limited/control redevelopment – Interim measure supporting future remediation or risk management	– Leaves impacts in place – No additional protection for groundwater – Long-term maintenance and monitoring – Land use restricted to outside staging and parking[1]

[1]It should be noted that this is not, at the time this report was written, a limitation. There is a current, real market need for this type of land use in the immediate vicinity.

2.4.2 APEC #2 Surficial Impacts, Southern Portion of Site

Site Conditions

Based on the data presented in the Site assessment sections of this report the following conditions and assumptions have been used for the assessment of environmental management options in APEC #2:

- A layer of fill impacted with metals, approximately 1 m thick, overlays the native silty clay soil. Much of the area is covered by the historical building floors and foundations;

- Bulk metal impacts exist throughout the fill horizon (and assumed to extend below the building floors) above Criteria 1 (CCME SQG Tier I Criteria). The approximate area of impacts is 10,000 square metres for an approximated impacted volume of 10,000 m^3;
- Bulk metal impacts off-site to the west exist throughout the fill horizon above Criteria 1 (CCME SQG Tier I Criteria). The approximate are of impacts is 1,300 m^2 for an approximated impacted volume of 390 m^3;
- Bulk metal impacts above Criteria 2 (CCME SQG Tier II Criteria) are limited in the area of APEC #2 Bulk metal impacts above CCME SQG Tier II Criteria (for the protection of human health) are estimated to be 3,240 m^3, assuming an aerial extent of 2,160 m^2 and an observed depth to impacts of 1.5 mbgs;
- Groundwater is located at 1.35 to 3.61 mbgs and contains dissolved concentrations of metals above the applicable surface water discharge criteria (MOE Table 3, 2011); and,
- Metals dissolved in groundwater are anticipated to have limited mobility due to the low hydraulic conductivity of the native soils, the shallow horizontal gradients, and also due to the amenability of the metal impacts to retardation through adsorption in to / on to the organic matter contained within the silty clay soil matrix; however, further assessment is required.

Environmental Management Options

The scenarios considered for APEC #2 are similar to the four considered for APEC #1, for brevity only the differences will be presented in the following subsections. One additional scenario is also considered as Scenario 5, which makes use of the excavations at APEC #1 as a location for the placement of impacted material from APEC #2.

Scenario 1 – Excavation and Disposal to CCME SQG Tier I Criteria

As the most conservative option, full scale excavation and removal of waste and impacted soil is considered as a baseline for comparison of the other scenarios. The differences in the excavation approach between APEC #2 and APEC #1 are:

- Dewatering and excavation support needs are unlikely, and have been removed the costing assumption;
- Additional work may be required for the removal of building floors and foundations prior to excavation; and,
- Less of the material is assumed to be hazardous waste.

Advantages

The excavation of impacted materials physically removes the impacts from the Site, and requires no additional long-term management of the surface impacts. Through the collection of confirmatory soil samples, removal via excavation can be verified. This option protects the groundwater by removing the source of impacts, the leachable metals. The excavation option could be implemented quickly and allows for a more encompassing redevelopment of the site. The removal of the impacts would have the greatest positive effect on future property value. The additional advantage to this scenario at APEC #2 is that it fulfills the remedial objective of removing impacts from the southern portion of the property.

Disadvantages
Excavation and off-site disposal of impacted materials would be disruptive. It requires the export of 10,390 m^3 of waste materials and the import of a corresponding volume of clean fill. Due to the trucking and subsequent landfill disposal this option has a low sustainability rating. Considerable effort may be required to control groundwater and surface water infiltration in the area during the excavation.

Cost
A preliminary and budgetary cost estimate for the excavation and off-site disposal of the impacted soils and waste is greater than $1,662,000, assuming the excavated material is solid non-hazardous waste. Assuming 50% of the soil is considered to be a hazardous waste (i.e., lead leachate concentrations greater than 5 mg/L) the budgetary cost estimate increases to greater than $5,039,000. This is based on the following assumptions:

- 10,390 m^3 of impacted material;
- Excavation and loading at a rate of $30/$m^3$ (increased for floor and foundation removal) plus $20/$m^3$ (reduced for removal of dewatering and excavation support);
- Solid non-hazardous waste transportation and disposal rate of $90 to $120/$m^3$;
- Hazardous waste transportation and disposal rate of $500 to $1000/$m^3$; and,
- Imported, placed and compacted backfill at a rate of $30/$m^3$.

Waste reduction and stabilization options to reduce the disposal costs were discussed in **Section 2.3** above. The implementation of these options could result in a reduction of the amount of material to be disposed of as a hazardous waste, for budgetary purposes it is suggested that a cost reduction of 25% to 50% may be achieved on the hazardous waste disposal component only. This could result in a savings of approximately $1,260,000 (25%) to $2,520,000 (50%) for the 50% hazardous waste scenario.

Scenario 2 – Excavation and Disposal to CCME SQG Tier II Criteria
The differences in the excavation approach between APEC #2 and APEC #1 for this scenario are:

- Dewatering and excavation support needs are unlikely, and have been removed the costing assumption;
- Assumed material under floors is suitable to remain; and,
- Less of the material is assumed to be hazardous waste.

Advantages
The excavation of impacted materials physically removes the impacts from the Site, and requires no additional long-term management of the surface impacts. Through the collection of confirmatory soil samples, removal via excavation can be verified. This option protects the groundwater by removing the source of impacts, the leachable metals. The excavation option could be implemented quickly and allows for a more encompassing redevelopment of the Site. The removal of the impacts would have the greatest positive effect on future property value. The additional advantage to this scenario at APEC #2 is that it fulfills the remedial objective of removing impacts from the southern portion of the property. The additional advantage to this scenario at APEC #2 is that it fulfills the remedial objective of removing impacts from the southern portion of the property.

Disadvantages

Excavation and off-site disposal of impacted materials would be disruptive. It requires the export of 3,240 m^3 of waste materials and the import of a corresponding volume of clean fill. Due to the trucking and subsequent landfill disposal this option has a low sustainability rating. Considerable effort may be required to control groundwater and surface water infiltration in the area during the excavation.

Cost

A preliminary and budgetary cost estimate for the excavation and offsite disposal of the impacted soils and waste is greater than $1,539,000, assuming the excavated material is 50% hazardous waste (i.e., lead leachate concentrations greater than 5 mg/L). This is based on the following assumptions:

- 3,240 m^3 of impacted material;
- Excavation and loading, at a rate of $20/m^3 (reduced for removal of dewatering and excavation support);
- Hazardous waste transportation and disposal rate of $500 to $1000/m^3; and,
- Imported, placed and compacted backfill at a rate of $30/m^3.

Waste reduction and stabilization options to reduce the disposal costs were discussed in **Section 2.3** above. The implementation of these options could result in a reduction of the amount of material to be disposed of as a hazardous waste, for budgetary purposes it is suggested that a cost reduction of 25% to 50% may be achieved on the hazardous waste disposal component only. This could result in a savings of approximately $385,000 (25%) to $770,000 (50%) for the 50% hazardous waste scenario.

Scenario 3 – Engineered Low Permeability Surface Cap – Risk Management

The engineered low permeability cap for APEC #2 is not seen a pragmatic option since there is no waste materials buried in the area and the groundwater concentrations of the impacts are lesser in this area, reducing the importance of a low permeability cap. As such this option has not been consider further for this area. A compacted granular cap is considered a more appropriate option and is discuss below.

Scenario 4 – Compacted Granular Surface Cap – Risk Management

The construction of a compacted granular cap is a minimal intervention risk management option that allows the shallow impacts in APEC #2 to be managed in place. Details of this scenario are provided in the discussion under APEC #1. The differences in the excavation approach between APEC #2 and APEC #1 are:

- The building floors and foundation walls already provide a cap for much of the area, approximately 3,000 m^2 of the 10,000 m^2 area; and,
- For an additional cost the area could be paved to support industrial facilities.

Advantages

Please see discussion under APEC #1. However, since there is no waste located below the cap this scenario would also allow for the future construction of industrial buildings with minimal additional engineering effort.

Disadvantages

Please see discussion under APEC #1. This remedial option does not fulfill all remedial objectives as the southern portion of the site will have limited development, reducing both future site use and cost recovery efficiencies.

Cost

A preliminary and budgetary cost estimate for the construction of a compacted granular cap is approximately $75,000 to $120,000. This is based on the following assumptions:

- 3,000 m^2 surface area for capping;
- Cap includes grading geotextile, and placement of 0.25 m of Granular B and 0.25 m of Granular A for a unit rate of $25 to $40/$m^2$; and,
- No pavement included (Add approximately $40/$m^2$ if a paved surface is desired).

Scenario 5 – Excavation and Impacted Material Relocation to APEC #1

The excavation and relocation of impacted material from APEC #2 to APEC #1 is an option to be considered in association with Scenarios 2, 3, and 4 presented for APEC #1. In this scenario, impacted material removed from APEC #2 is relocated to APEC #1. For Scenario 2 only material below the CCME SQG Tier II Criteria from APEC #2 could be placed in the void space created by the removal of material exceeding CCME SQG Tier II Criteria in APEC #1, such that the material placed and remaining in APEC #1 is below CCME SQG Tier II Criteria. For Scenarios 3 and 4, the excavated material from APEC #2 would be spread across the APEC #1 prior to the placement of the selected capping option. This would result in the increase of the ground surface in the northern portion of the Site by approximately 1 m. The areas of APEC #2 excavated to remove impacted fill would be backfilled with imported, non-impacted fill.

Advantages

The consolidation of impacted materials to one area (i.e., APEC #1) of the Site provides a substantial cost savings opportunity, and improves the sustainability of the Site's environmental management. It also improves the cost efficiency of the capping options by increasing the amount of impacted material managed by the cap without increasing the size of the cap. By removing the impacted material from APEC #2 this allows for the efficient redevelopment of this area, and increases the value of this area similar to the excavation and disposal options, but at a reduced cost.

The other advantages noted for the excavation is disposal options extend to this scenario as well.

Disadvantages

Relocation of the impacted material to APEC #1 may be seen as unfavourable. The raising of the ground surface in APEC #1 elevates the Site from the surround properties and may be seen as unfavourable.

Cost

A preliminary and budgetary cost estimate for the relocation of the impacted material from APEC #2 to APEC #1 is approximately $146,000. This is based on the following assumptions:

- Only 3,240 m^3 of material (exceeding Tier II criteria) requires relocation to APEC #1;
- Excavation and relocation is estimated at $15/$m^3$;
- Imported, placed and compacted fill unit rate of 30/m^3; and,

- There are various options to be considered within this scenario that depending on soil/fill classification and the selected remediation criteria. The cost estimate provided above is only for one of these scenarios where 3,240 m^3 of material is relocated and the remaining material is assumed to meet the SSC/Tier II criteria and can remain in place within APEC #2.

Summary

TABLE 3:APEC 2 REMEDIAL OPTION SUMMARY

Scenario	Cost	Advantages	Disadvantages
Scenario 1 – Excavation and Disposal to CCME SQG Tier I Criteria	Budgetary estimate of: – greater than \$1.6M assuming no haz-waste – greater than \$5.0M assuming 50% haz-waste	– Remediation and removal of impacted materials – Highest protection for groundwater – Minimal long term monitoring and maintenance requirements – Building floors and foundations removed for unrestricted industrial site use and redevelopment – Quickly implemented – Positive influence on property value	– High cost – Lowest sustainability rating – Highly disruptive
Scenario 2 – Excavation and Disposal to CCME SQG Tier II Criteria	– greater than \$0.4 M assuming no haz-waste – greater than \$1.5M assuming 50% haz-waste	– Remediation and removal of most impacted materials – Protects groundwater – Minimal long-term monitoring and maintenance requirements – Unrestricted industrial site use – Quickly implemented – Slightly positive influence on property value	– Leaves lower level impacts in place – Low sustainability rating – Disruptive – Building foundations and floors left in place
Scenario 3 – Engineered Low Permeability Surface Cap – Risk Management	Not Evaluated	– N/A	– N/A

Scenario	Cost	Advantages	Disadvantages
Scenario 4 – Compacted Granular Surface Cap – Risk Management	Budgetary estimate of $75,000 to $120,000 (excluding a pavement surface)	– Protects surface receptors – Less disruptive – Higher sustainability rating – Low cost – Allows limited/control redevelopment – Interim measure supporting future more comprehensive remediation or risk management	– Leaves impacts in place – No additional protection for groundwater – Long-term maintenance and monitoring
Scenario 5 – Impacted Material Relocation to APEC #1	Budgetary estimate of $146,000 (for the described scenario)	– Protects surface (and groundwater) receptors – Minimal long-term monitoring and maintenance requirements – Higher sustainability rating – Low cost – Unrestricted industrial site use – Quickly implemented – Positive influence on property value	– Long-term maintenance and monitoring requirements transferred to APEC #1

2.4.3 APEC #3 Site Groundwater Impacts

Groundwater impacts have been identified throughout the Site. However, based on the observed concentrations and known exposure pathways, they do not pose ecological or human health risks, as no nearby receptors have been identified.

The present groundwater data set is limited to one sampling period. Additional monitoring and qualitative assessment of exposure pathways to support the no risk to ecological and/or human receptors is recommended. Pending results of future, additional monitoring, environmental management measures that could be considered for the mitigation of groundwater impacts may include:

- Site Management (e.g., reduced infiltration through an impermeable cap);
- Boundary control to minimize off-site migration including:
  - Permeable reactive barriers to reduce contaminant concentration as they flow towards Site boundaries.
  - Hydraulic control and extraction of groundwater (pumped from trenches or wells) before it can migrate off-site, with extracted groundwater treatment prior to discharge.
  - Groundwater containment through the installation of impermeable or low permeability walls such as a soil bentonite wall or Waterloo Barrier®.

Note: Site management options adopted for APECs #1 and #2 will contribute positively to recommended site management options identified for APEC #3. At present, there is no identified need to contain and/or remediate groundwater impacts (APEC #3).

2.5 Recommended Environmental Management Options for APEC #1 and APEC #2.

From the information provided above, a Remedial Action Plan should be prepared with the following remedial recommendations and site considerations:

- Conduct a human-health risk assessment to verify risk acceptibility upon completing remedial activities. The risk assessment should also include the development of SSC;
- Adopt the above Scenario 5 under APEC #2. Relocate impacted soil and fill from the southern portion of the Site (APEC #2) and place within the landfill area of the northern portion of the Site (APEC #1);
- Adopt Scenario 3 or 4 Under APEC #1: Construct an engineered low permeability cap over the northern portion of the site where the impacted materials have been consolidated from APEC #1 and APEC #2. The type of cap chosen (e.g., Scenario 3 versus 4) will depend on the intended future land use;
- Design and implement a long-term monitoring and maintenance plan to ensure the integrity of the constructed cap; and,
- Complete a drainage management plan to assess impacts associated with transferring soils and capping, and provide design solutions to the above remedial recommendations.

The recommendation has been based on the following considerations:

- While excavation and disposal options provided the highest level of protection, the high cost of implementation is not expected to justify the increase in property value, nor savings associated with lower maintenance and monitoring requirements. For example, the cost differential between the scoped excavation of Scenario 2 for APEC #1 of $1,680,000 and the estimated costs for Scenario 3 the low permeability cap of $715,000 to $935,000 is approximately $1,000,000. This differential increases when comparing the other scenarios. These differentials are believed to be more than sufficient to offset long term monitoring and maintenance costs related to the capping options while still providing the necessary protection to surface receptors. It should be noted that the type of cap preferred for the northern portion of the site will depend on the future buyers site use needs. It may be possible to implement the lower cost granular cap.
- The implementation of a low permeability cap versus a compacted granular cap was seen as a best management practice consistent with typical solid waste landfills. In addition to protecting surface receptors, the low permeability cap also improves the protection of groundwater, potentially reducing or removing the need for future groundwater mitigation.
- For APEC #2, the ability to place impacted materials into APEC #1 greatly improves the cost efficiency of the excavation and remediation option and provides the highest level of protection for both surface receptors and groundwater. This option also imposes the fewest restrictions on land use and redevelopment of the southern area of the Site – enabling better cost recovery with a greater resale value. Should further assessment (e.g., drainage) find that the placement of additional material on top of APEC #1 to be unsuitable, the material will be hauled for disposal to a nearby, licensed facility (as per Option #2 for

APEC #2). For budgeting purposes (as described in **Table 4**), we are assuming that 50% of the material exceeding Tier I criteria will be placed on-site (APEC #1), and the remainder removed for off-site disposal.

- Since all of the presented scenarios can be implemented in a single construction season, implementation time was not a factor in deciding with options to recommend.
- The combination of options recommended for APEC #1 and #2, allows for the unrestricted redevelopment (e.g., allows for the construction of industrial buildings) of the southern area of the Site, while allowing controlled redevelopment of the northern area for outside storage and staging. This is consistent with the adjacent properties uses; current and immediate future real estate market needs for the area, and is typical of industrial developments in this area of the City.
- The Remedial Action Plan should include both the development of Tier III criteria and site closure assessment criteria, and a drainage management plan that corresponds with the above recommended solution. The development of Tier III Criteria at a preliminary stage may result in additional cost savings by reducing the amount of volume of soil to be excavated. The development of site closure criteria can be used to evaluate implementation of the selected remedial options (e.g., Site Management Plan).

3.0 SUMMARY

In 2012 and 2013, Dillon conducted environmental investigations at 2185 Logan Ave, in Winnipeg, MB. A preliminary remedial options analysis was conducted based on the results from the 2012 and 2013 Site Investigations. The specific remedial objectives for the site are:

- Remediate impacts to remove identified risks to both human and environmental health;
- Increase property value and potential land use; and,
- Cost-recovery (minimize remedial costs).

The real estate market in the surrounding industrial park was examined in December 2014, to provide cost considerations and re-sale value of impacted and non-impacted land. Based on market data, the most effective path forward for minimizing liability and cost recovery is based on the scenario of an unimpacted, southern site. It is anticipated that a 'split-titles' approach may be adopted to improve cost recovery ($0.4M for the southern site, $0.2M for the northern site). The site use limitations on the northern portion of the site for staging and yard storage are not (at the present time) a market-driven limitation. Neighbouring properties have expressed a need for more staging and yard storage.

Cost estimates provided above are used to compare the various remedial option scenarios. The cost to implement a remediation program at NWSR includes the following further components:

- Remedial Action Plan (including RA and Drainage Management Plan);
- Design Specifications and Tender Documents;
- Contract Administration and Site Management; and,
- Closure Reporting.

The following table summarizes the recommended environmental management options and costing to carry out the program of work:

TABLE 4: METHODS SUMMARY OF RECOMMENDED REMEDIATION METHODS

Environmental Concern	Site Assessment Findings	Recommended Remediation Method
APEC 1 - Historical Dump at North End of Site	Given the observed average thickness of waste of 1.09 m (ranging in depth from 0.3 to 1.8 m below the soil cap), the approximate volume of waste material buried in the northern portion of the Site is 10,500 m^3. The buried waste is overlain by approximately 3,100 m^3 of fill material, taken from the Site. The soil cover appeared to be non-engineered and remained intact, with a minimum thickness of 0.10 m, and an average thickness of 0.45 m.	Re-stabilize and leave in situ. Re-cap and add more cover. ($375,000[1] to $1,035,000[2])

Environmental Concern	Site Assessment Findings	Recommended Remediation Method
APEC 2 - Metal Impacted Soils South End (includes identified off-site impacts to the west of the site)	Lead concentrations in soil were found to exceed federal soil quality guidelines (600 mg/kg) to depths greater than 2 m. Results in soil were not observed to exceed criteria at depths greater than 3 m in APEC 2.	Excavate Material and cap in place in APEC 1. ($246,000 to $942,000[3])
APEC 3 - Impacted Groundwater	Lead and cadmium in groundwater were observed in each stratigraphic unit (fill, clay/silt, till). The greatest impacts in groundwater were found at the greatest depths (till), along the eastern boundary of the Site property. No observed immediate ecological or human receptors.	Risk Management[4]

Notes:
$ denotes $CAD
Includes costing for development of Remedial Action Plan (containing Risk Management/Risk Assessment, Drainage Management Plan), Design Specifications for Tender, Contract Administration, Site Activity Management and Closure Reporting.
[1]Scenario 4 Impermeable Cap under APEC #1
[2]Scenario 3 Granular Cap under APEC #1
[3]50% of material is moved to APEC #1; the remainder is removed for off-site disposal at a licensed facility.
[4]Costs included above.

The combination of options recommended for APEC #1 and #2, allows for the unrestricted redevelopment (e.g., allows for the construction of industrial buildings) of the southern area of the Site, while allow controlled redevelopment of the northern area for outside storage and staging. This is consistent with the adjacent properties land use, and is typical of industrial developments in this area of the City.

The implementation of a low permeability cap versus a compacted granular cap was seen as a best management practice consistent with typical solid waste landfills. In addition to protecting surface receptors, the low permeability cap also improves the protection of groundwater, potentially reducing or removing the need for future groundwater mitigation, however, cap selection for APEC #1 (granular vs. impermeable) may be subject to a future buyer's proposed land use.

For APEC #2 the ability to place impacted materials into APEC #1 greatly improves the cost efficiency of the excavation and remediation option and provides the highest level of protection for both surface receptors and groundwater. This option imposes the fewest restrictions on land use and redevelopment of the southern area of the Site, and optimizes cost recovery.

Human health and ecological receptors were not identified for the Site. Regional groundwater is non-potable and the nearest surface water body or sensitive ecological habitat is located less than 1 km to the northwest of the site (pond at Woodsworth Park). Lead in groundwater concentration exceedances were noted at a significant distance away from any possible fish habitats. Given that there are no observed immediate ecological or human receptors, a site-specific Tier III Criteria or risk management strategy may be more appropriate.

The combination of options recommended for APEC #1 and #2, allows for the unrestricted redevelopment (e.g., allows for the construction of industrial buildings) of the southern area of the Site, while allow controlled redevelopment of the northern area for outside storage and staging. This is consistent with the adjacent properties land use, and is typical of industrial developments in this area of the City.

The preliminary budgetary cost estimates are order of magnitude estimate only and will change as more detailed information becomes available and more detailed designs and plans prepared for the site.

It is recommended that these items be carried forward in the development of a detailed remedial action plan for the Site which will critically evaluate the assumption and estimates presented herein, and proceed with further planning and basic design details which are beyond the scope of this document.

4.0 LIMITATIONS

This report was prepared exclusively for the purposes, project and site location(s) outlined in the report. The report is based on information provided to, or obtained by Dillon as indicated in the report, and applies solely to site conditions existing at the time of the site investigation(s). Dillon's report represents a reasonable review of available information within an agreed work scope, schedule and budget. It is therefore possible that currently unrecognized contamination or potentially hazardous materials may exist at the site(s), and that the levels of contamination or hazardous materials may vary across the site(s). Further review and updating of the report may be required as local and site conditions, and the regulatory and planning frameworks, change over time.

This report was prepared by Dillon for the sole benefit of our Client (Thompson Dorfman Sweatman). The material in the report reflects Dillon's judgment in light of the information available to Dillon at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties. Dillon accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Respectfully Submitted:

DILLON CONSULTING LIMITED

Indra Kalinovich, PhD, C.Chem., E.I.T.

Doug Bell, MSc, P.Geo., F.G.C.

IKK/knp

APEGM
Certificate of Authorization
Dillon Consulting Limited (MB)
No. 1789 Date: 2015.08.10

PROVINCE OF MANITOBA
D. D. BELL
Member
20503G
Aug. 10/2015
REGISTERED PROFESSIONAL GEOSCIENTIST

Appendix A

Environmental Site Investigation, Dillon 2014

See Appendix B of the Remediation Plan for North West Smelting and Refining, July 2017

Appendix B

2014 Real Estate Listings for Neighbouring Sites

For Sale

Industrial/Office on 2.21 Acres

Owner/User Opportunity Available

DTZ
CENTREPORT CANADA

180 Ryan Street, Winnipeg, MB

Main Building (+/-) 13,180 sq ft plus (+/-) 4,300 sq ft Cold Storage

- Immediate development opportunity strategically located within CentrePort Canada – the country's only inland port which offers companies unparalleled access to tri-modal transportation and Foreign Trade Zone benefits
- Prime location on Ryan Street with excellent access to a well-established road network including Logan Avenue, Route 90 and CentrePort Canada Way
- Close proximity to major cargo operations including an international trucking hub, Winnipeg's James Armstrong Richardson International Airport, and three class I rail carriers
- Building is situated on 2.21 acres of land with 18 per cent site coverage providing excellent truck maneuverability and ample parking
- Property is serviced and ready for immediate development. Amenities include: dock and grade level loading, fully fenced lot is graveled with a paved parking lot in front and zoned M2
- **Sale Price:** $1,200,000.00
- **Property Taxes:** $25,079.00 (2014)

Jane Arnot
Sales & Leasing Associate
Email: jane.arnot@dtzwinnipeg.com
Direct Tel: 204 928 5018

Martin McGarry
President
Email: martin.mcgarry@dtzwinnipeg.com
Direct Tel: 204 928 5005

DTZ Winnipeg Ltd.
Unit 5 - 986 Lorimer Boulevard
Winnipeg, Manitoba R3P 0Z8
Tel: 204 928 5000 Fax: 204 928 5010

180 Ryan Street, Winnipeg, MB
(+/-) 13,180 sq ft

180 RYAN STREET	SQ FT	CEILING HEIGHT (FT)	YEAR BUILT	NOTES
Main Building				
Office Section	2,400		1964	Masonry, 1,200 sq ft floor plate
Warehouse	5,440	15	1964	Masonry, ramp to loading door plus 2 dock loading doors
Large Warehouse (N)	4,040	25	1992	Pre-engineered addition, dock loading
Small Warehouse (NE)	1,300	13	2003	Steel frame, non-heated, grade
Total Main Building	13,180			
Free Standing Building				
Warehouse	4,300	18 to 24	2003	Metal, pre-engineered construction, pitched roof, insulated and non-heated
Total Both Buildings	17,480			

Jane Arnot
Sales & Leasing Associate
Email: jane.arnot@dtzwinnipeg.com
Direct Tel: 204 928 5018

Martin McGarry
President
Email: martin.mcgarry@dtzwinnipeg.com
Direct Tel: 204 928 5005

DTZ Winnipeg Ltd.
Unit 5 - 986 Lorimer Boulevard
Winnipeg, Manitoba R3P 0Z8
Tel: 204 928 5000 Fax: 204 928 5010

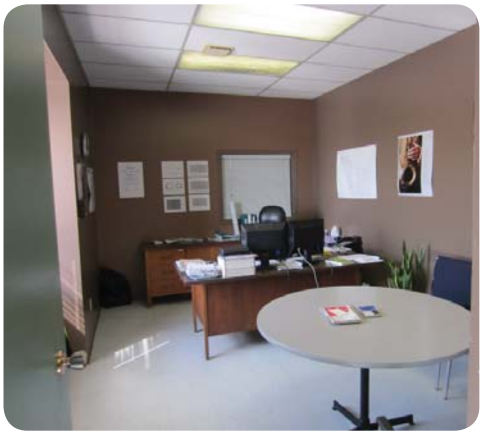
180 Ryan Street, Winnipeg, MB
(+/-) 13,180 sq ft

Jane Arnot
Sales & Leasing Associate
Email: jane.arnot@dtzwinnipeg.com
Direct Tel: 204 928 5018

Martin McGarry
President
Email: martin.mcgarry@dtzwinnipeg.com
Direct Tel: 204 928 5005

DTZ Winnipeg Ltd.
Unit 5 - 986 Lorimer Boulevard
Winnipeg, Manitoba R3P 0Z8
Tel: 204 928 5000 Fax: 204 928 5010

180 Ryan Street, Winnipeg, MB
(+/-) 13,180 sq ft









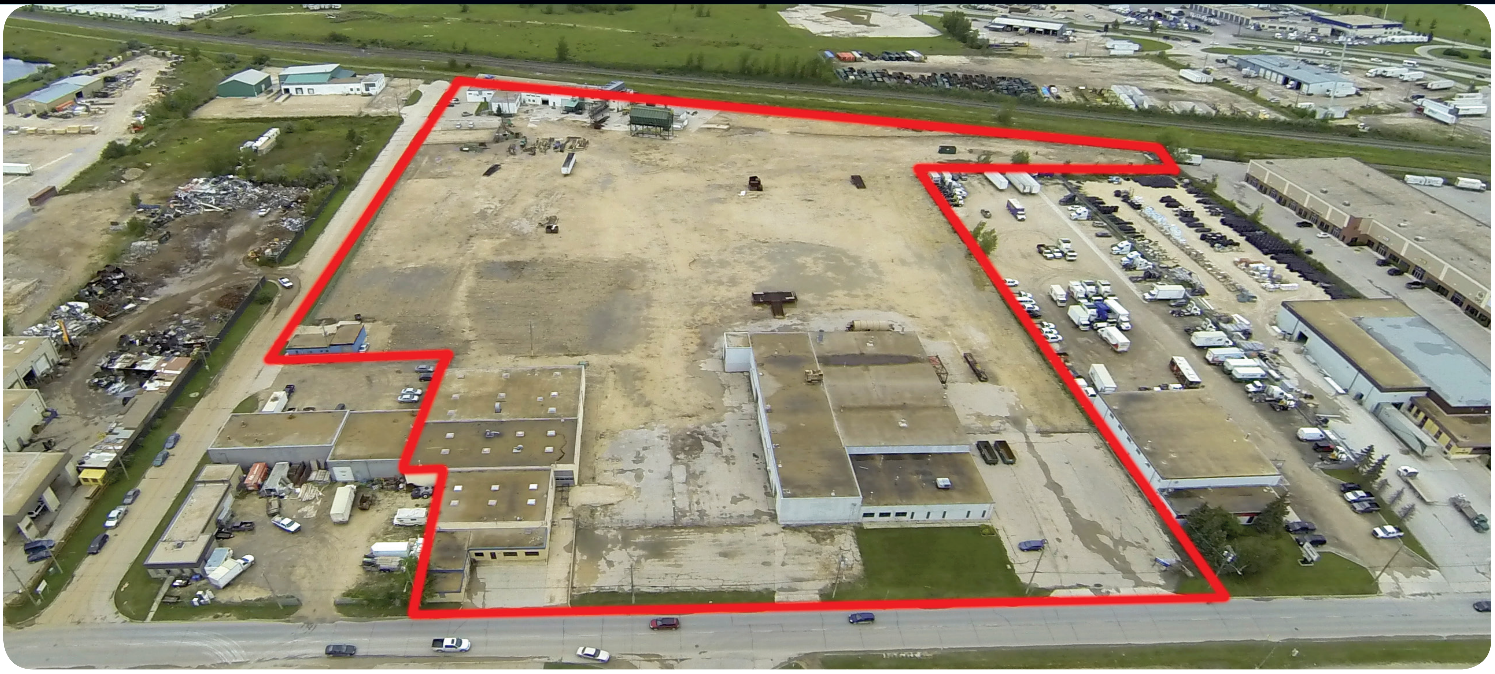
Jane Arnot
Sales & Leasing Associate
Email: jane.arnot@dtzwinnipeg.com
Direct Tel: 204 928 5018

Martin McGarry
President
Email: martin.mcgarry@dtzwinnipeg.com
Direct Tel: 204 928 5005

DTZ Winnipeg Ltd.
Unit 5 - 986 Lorimer Boulevard
Winnipeg, Manitoba R3P 0Z8
Tel: 204 928 5000 Fax: 204 928 5010

For Sale
6 Parcels Of Land

Well Located Industrial Development Opportunity!



Prime Industrial Land with Frontage on Logan Avenue and Ryan Street
(+/-) 13.51 Acres

- Strategically located within CentrePort Canada - the country's only inland port which offers companies unparalleled access to tri-modal transportation and Foreign Trade Zone benefits
- Prime, highly visible location on the corner of Logan Avenue and Ryan Street with excellent access to a well-established road network including Route 90 and CentrePort Canada Way
- Close proximity to major cargo operations including an international trucking hub and Winnipeg's James Armstrong Richardson International Airport
- Property includes 6 parcels of land with 4 buildings totaling (+/-) 67,830 square feet
- Property is serviced and ready for immediate development
- Excellent rail access, fully serviced, graded, leveled and graveled land
- Zoned M2
- **Portfolio Sale Price:** $5,800,000.00
- **Property Taxes:** For all 6 Titles $116,662.68 (2014)

Jane Arnot
Sales & Leasing Associate
Email: jane.arnot@dtzwinnipeg.com
Direct Tel: 204 928 5018

Martin McGarry
President
Email: martin.mcgarry@dtzwinnipeg.com
Direct Tel:204 928 5005

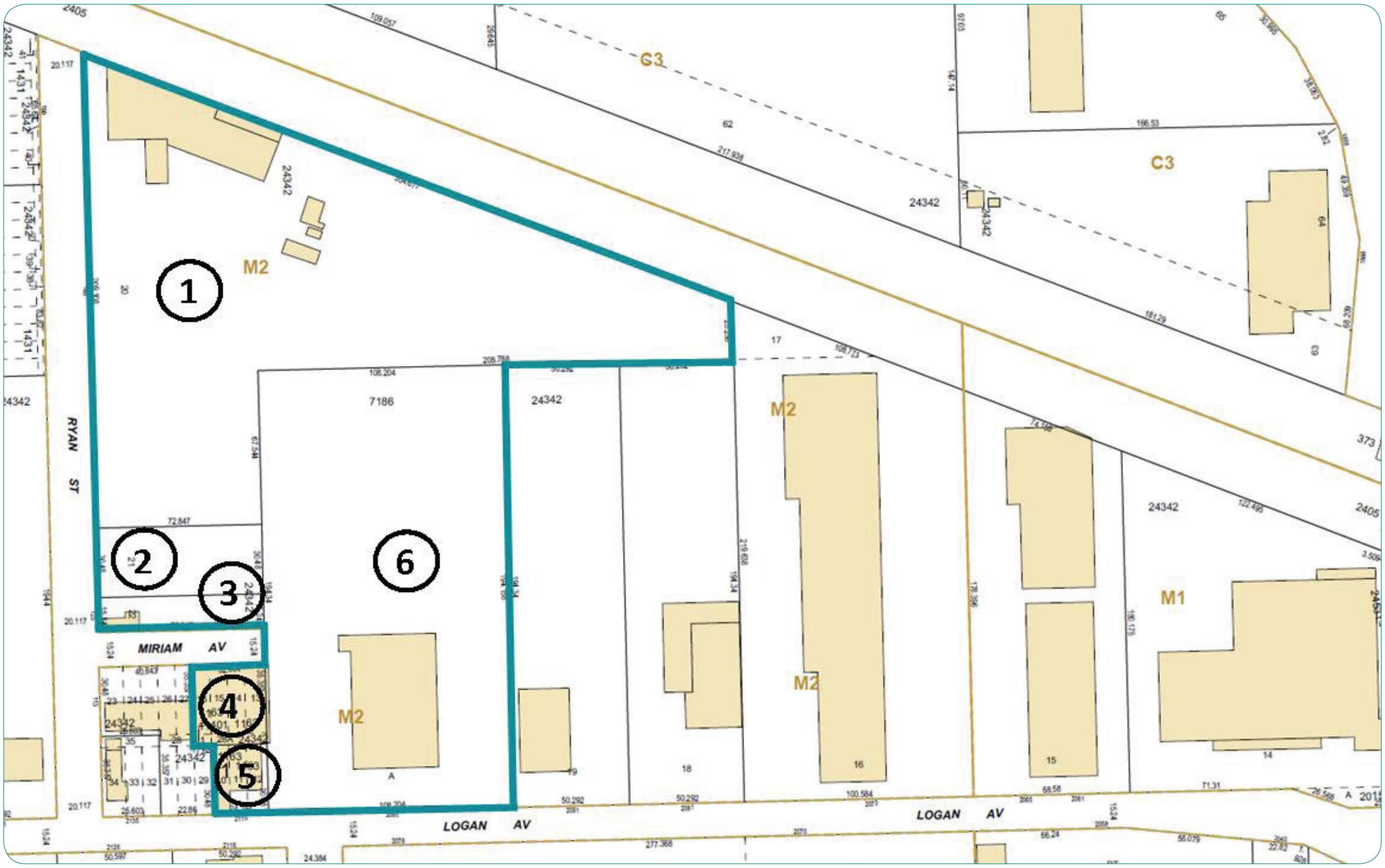
DTZ Winnipeg Ltd.
Unit 5 - 986 Lorimer Boulevard
Winnipeg, Manitoba R3P 0Z8
Tel: 204 928 5000 Fax: 204 928 5010

Industrial Development Opportunity
(+/-) 13.51 Acres

CentrePort Canada

DTZ

SITE	ADDRESS	BUILDING SQ FT (+/-)	ACRES (+/-)	CEILING HEIGHT
1	165 Ryan Street	22,338	7.028	14′ 4″ - 20′
	- Basement(Bonus Space)	2,114		8' 2"
2	Lot 21		0.549	
3	123 Ryan Street	1,374	0.275	
4, 5	2115 Logan Avenue	17,072	0.463	
6	2095 Logan Avenue	24,932	5.196	
	GRAND TOTAL (excludes basement)	**67,830**		



Jane Arnot
Sales & Leasing Associate
Email: jane.arnot@dtzwinnipeg.com
Direct Tel: 204 928 5018

Martin McGarry
President
Email: martin.mcgarry@dtzwinnipeg.com
Direct Tel:204 928 5005

DTZ Winnipeg Ltd.
Unit 5 - 986 Lorimer Boulevard
Winnipeg, Manitoba R3P 0Z8
Tel: 204 928 5000 Fax: 204 928 5010

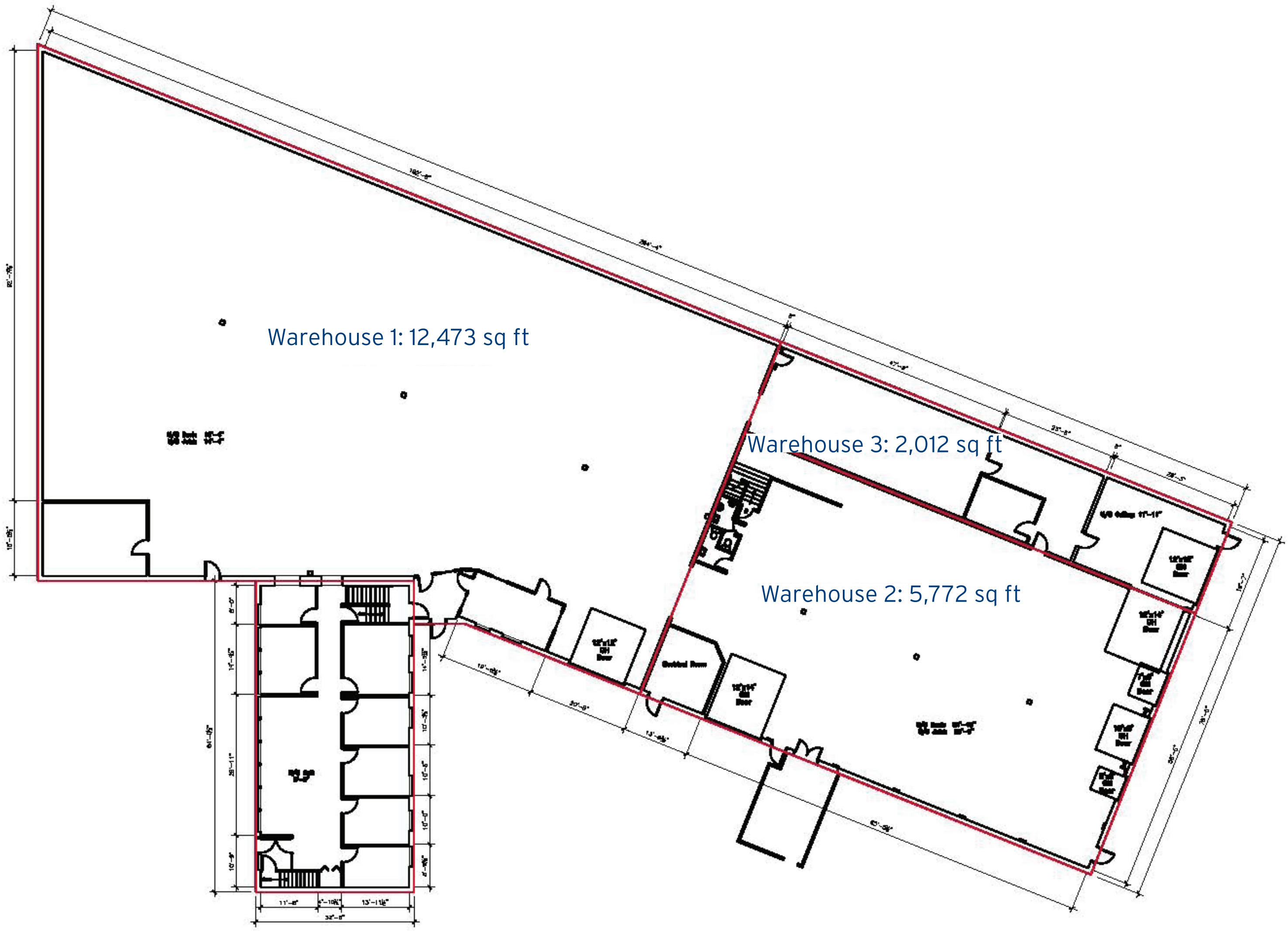
Industrial Development Opportunity
(+/-) 13.51 Acres

Jane Arnot
Sales & Leasing Associate
Email: jane.arnot@dtzwinnipeg.com
Direct Tel: 204 928 5018

Martin McGarry
President
Email: martin.mcgarry@dtzwinnipeg.com
Direct Tel:204 928 5005

DTZ Winnipeg Ltd.
Unit 5 - 986 Lorimer Boulevard
Winnipeg, Manitoba R3P 0Z8
Tel: 204 928 5000 Fax: 204 928 5010

Industrial Development Opportunity
165 Ryan Street: (+/-) 22,338 sq ft



Jane Arnot
Sales & Leasing Associate
Email: jane.arnot@dtzwinnipeg.com
Direct Tel: 204 928 5018

Martin McGarry
President
Email: martin.mcgarry@dtzwinnipeg.com
Direct Tel:204 928 5005

DTZ Winnipeg Ltd.
Unit 5 - 986 Lorimer Boulevard
Winnipeg, Manitoba R3P 0Z8
Tel: 204 928 5000 Fax: 204 928 5010

References

Canadian Geotechnical Journal, Vol. 7, No. 3, 1970.

CCME, 1999. Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment, 1999. Various Updates 2001, 2002, 2003, 2004, 2005, 2006 and 2007.

I.D. Systems Ltd. 1991. Investigations into Lead Contamination at North West Smelting & Refining Ltd. 2185 Logan Avenue Winnipeg, Manitoba.

I.D. Engineering Canada Inc. 1993. Draft Off-Site Environmental Site Assessment Northwest Smelting & Refining 2185 Logan Avenue Winnipeg, Manitoba. File 01-145.

KGS Group. 2005. Phase II Environmental Site Assessment Pa D'Or Manufacturing 2201 Logan Avenue Winnipeg Manitoba.

M.P. Wiebe Environmental Engineering. 2013. Phase II Environmental Site Assessment Industrial Property 2201 Logan Avenue Winnipeg, Manitoba.

Province of Manitoba, Groundwater Availability Maps, Bedrock Geology and Drift Thickness maps, 1980.

Province of Manitoba. 2013. GWDrill 2013, Provincial Groundwater Well Data Base.

Quigley, R.M., 1968. Soil Mineralogy, Winnipeg Swelling Clays. Canadian Geotechnical Journal, Vol. 2, No. 2, pp 120-122.

Render, F.W. Geohydrology of the Metropolitan Winnipeg Area as related to Groundwater Supply and Construction. Canadian Geotechnical Journal, Vol. 7, No. 3, 1970.

University of Manitoba Department of Engineering. 1983. Geological Engineering Report for Urban Development of Winnipeg.