

**Appendix H: Geochemical Characterization Program for Feasibility Study, Marathon PGM-Cu
Project (Golder Associates)**

DRAFT

REPORT ON

**GEOCHEMICAL CHARACTERIZATION PROGRAM
FOR FEASIBILITY STUDY
MARATHON PGM-Cu PROJECT
MARATHON, ONTARIO**

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EXECUTIVE SUMMARY

A geochemical characterization program was undertaken for the Marathon PGM-Cu Definitive Feasibility Study. The project is located 300 km east of Thunder Bay on the north-eastern shore of Lake Superior, near the town of Marathon, Ontario, Canada. Geochemical investigations were completed to assess the acid generation and metal leaching characteristics of material that is anticipated to be representative of waste rock and tailings associated with the Marathon PGM-Cu ore body. Based on available drill core logs and cross-sections, six (6) general lithologies were identified as follows:

Major Rock Types:

- 1) Eastern Gabbro
- 2) Two Duck Lake Gabbro

Minor Rock Types:

- 3) Volcanic
- 4) Heterolithic Breccia
- 5) Syenite
- 6) Serpentinite

Background information, including data from previous site investigations, was provided and used to select representative samples of rock. In total, one hundred and fourteen (114) waste rock samples were selected for geochemical analysis. In addition, a single rougher-cleaner combined tailings sample, plus eleven (11) samples of tailings from locked cycle and variability floatation testing were submitted for geochemical analysis. Nine (9) waste rock samples and one (1) average ore grade combined tailings sample were selected for kinetic testing and mineralogical analysis. The results of the static testing, kinetic testing and mineralogical analysis are presented herein.

Waste Rock

Overall, the results of the screening level assessment are in general agreement with past geochemical work. Based on our current understanding of the site geology and deposit, the key results and conclusions related to the geochemical and mineralogical characteristics of the waste rock are as follows:

- Mineralogical analysis of the rock samples indicates that the principal mineralogical assemblage consists of plagioclase, and to a lesser extent diopside, quartz and amphibole. Sulphide minerals predominately consist of pyrrhotite, chalcopyrite and pyrite, and carbonate minerals (i.e., calcite and dolomite) were detected in trace amounts.
- Acid-base accounting (ABA) results show that the majority of the rock samples collected are not expected to be acid generating. However, based on the overall quantities of sulphide minerals observed, it is possible that acid generating conditions could develop in the overall pile, if sufficient NP is not provided by the non-carbonate minerals and the

oxidation processes are not mitigated. Based on samples with a sulphide content greater than 0.3 wt% as S, the Volcanic rock type has the greatest percentage of samples that are expected to be acid generating (~40%), followed by Heterolithic Breccia (~33%), Eastern Gabbro (~7%) and Two Duck Lake Gabbro (~6%). Although the acid generation potential of most of the waste rock samples is low, approximately 7% of the samples are considered to be acid generating.

- Net acid generation (NAG) testing results are in general agreement with the ABA results and indicate that the majority of samples are non-acid generating. In addition, the NAG results indicate that some rock with sulphide contents greater than 0.3 wt% as S may be non-acid generating due to the abundance of neutralizing minerals. However, the NAG samples with sulphide contents greater than 0.5 wt% as S have the capacity to generate moderate to highly acidic conditions.
- Short-term leach testing suggests that several metals require further evaluation with respect to implications to the overall site water quality, including Al, Ag, B, Co, Cr, Cu, Fe, Pb, V and Zn,.
- In addition to the short-term leach testing, analysis of the NAG supernatant suggests that several metals require further evaluation with respect to implications to the overall site water quality, including Al, Cd, Co, Cr, Cu, Ni, Zn, and to a lesser extent B, Fe, Pb and Tl.
- Concentrations in the kinetic test leachate for the waste rock samples showed that Al, As, Cu, and to a lesser extent Cd and U, occurred at concentrations greater than PWQOs during the 56 week test period.

Tailings

Based on the analysis of the preliminary tailings samples, the key conclusions related to the geochemical characteristics of the tailings are as follows:

- Acid-base accounting (ABA) and net acid generation (NAG) testing suggest that majority of the tailings samples are not expected to be acid generating. However, the NAG test results indicate that tailings with a sulphide content as low as 0.2 wt% as S has the capacity to generate acidic conditions, if the sulphide minerals are rapidly oxidized.
- Short-term leach testing suggests that several metals require further evaluation with respect to implications to the overall site water quality, including Al, Ag, B, Co, Cr, Cu, Fe, Pb, V and Zn,.
- In addition to the short-term leach testing, analysis of the NAG supernatant suggests that several metals require further evaluation with respect to implications to the overall site water quality, including Al, Cd, Co, Cr, Cu, Ni, Zn, and to a lesser extent B, Fe, Pb and Tl.
- Concentrations in the kinetic test leachate for the single combined tailings sample (average ore grade) showed that Al, Cu and Mo occurred at concentrations greater than PWQOs at some point during the 36 week test period.
- Water quality analysis of the tailings decant indicates that some metals (i.e., Al, Fe, Mo and Zn) could be present at concentrations above PWQOs in the process water.

Water Quality Modeling

Direct runoff from the tailings is expected to be near neutral, whereas the runoff from the waste rock may reflect small zones where acidic conditions occur. When effluent/runoff water quality estimates from tailings and waste rock are fully mixed, water quality model calculations indicate that the pH is expected to be near-neutral and concentrations of some metals are expected to be low (i.e., below PWQO). However, concentrations of cadmium, cobalt, copper, iron, nickel and zinc are expected to be elevated in the mixed tailings and waste rock effluent. It is important to note that load contributions from the tailings assume that the sulphide content of the tailings will be 0.1 wt% as S. In addition, loading sources, such as runoff from the open pit, runoff from the plant site and tailings process water, were not included in the water quality modeling, but will influence the overall site water quality.

Although the majority of waste rock samples do not have acid generating properties, a portion of the waste rock could be potentially acid generating and metal leaching. Depending on the site water balance, flow logic and baseline water quality, and thus the overall site water quality, waters coming into contact with waste rock drainage or tailings effluent may require treatment or settling to reduce the total metal concentrations.

Recommendations

Based on the above results and conclusions, the following recommendations are provided:

- Preparation of a general mitigation plan considering options is recommended. For example, segregation of acid generating materials (high sulphide wastes) into a chemically stable environment (i.e., under non-acid generating tailings or underwater) may be an option that is considered.
- Confirmation and segregation, based on operational monitoring, is recommended for low sulphide material that may be considered for use in construction on-site.
- Results of the short-term, NAG, longer term repetitive leach testing (kinetic testing) and the preliminary water quality estimates should be used in conjunction with the mine plan and other baseline data (e.g., water balance and water quality) to develop estimates of overall site water quality and to develop a site water management plan.
- It is recommended that an evaluation of containment, treatment and discharge options be conducted as well as an evaluation of potential downstream impacts from the release of any water coming in contact with discharge from waste rock pile(s) and tailings management area(s).

Sulphide contents greater 0.1–0.2 wt% as S in tailings may result in the production of acidic and metal-rich waters. Thus, it is recommended that the sulphide removal processes be sufficient to maintain sulphide contents at and less than 0.1 wt% as S. If sulphide removal processes cannot maintain sulphide contents less than 0.1 wt% as S, mitigation strategies should be evaluated to reduce sulphide oxidation rates (i.e., sub-aqueous deposition, low sulphide cover over tailings or staged deposition with progressive rehabilitation).

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by Micon International Ltd. (Micon) to participate in select engineering and environmental services as part of the Definitive Feasibility Study for the Marathon PGM-Cu Project. Micon has been retained by Marathon PGM Corporation (Marathon PGM) to complete the feasibility study, including the incorporation of work being conducted by Golder. Part of Golder's involvement includes a geochemical investigation to evaluate the acid generating and metal leaching characteristics of the waste rock and tailings that are to be deposited on-site, and to conduct preliminary water quality estimates of a mixed waste rock and tailings effluent. This report provides background and results of the initial geochemical test work and preliminary water quality estimates.

1.1 Study Objectives

The primary objective of the geochemical characterization program is to provide sufficient data for the evaluation of the chemical stability of the various materials expected to be produced during mining and mineral processing. The evaluation allows for comparisons to be made with existing environmental conditions.

Other specific objectives of a baseline geochemistry program include:

- Development of a defensible geochemical database that is sufficient for mine planning and decision making purposes;
- Development of estimates of the potential for acid rock drainage (ARD) and metal leaching (ML) for use in site water quality assessments; and
- Development of appropriate data to support decisions related to environmental management strategies, material handling strategies or mitigation measures, as required.

The study objectives were addressed by collecting and analyzing the geochemical properties of samples that are representative of waste rock and tailings. This report presents the results available at that time of reporting for the geochemical characterization program for the Marathon PGM-Cu Project.

2.0 BACKGROUND

In mining operations, the natural weathering of soils and rock is typically accelerated as these materials are disturbed and exposed to the atmosphere. Enhanced weathering of soils and rock may result in acid generation and/or accelerated leaching of metals that can potentially impact water resources (i.e., groundwater, surface water). It is, therefore, necessary to evaluate the effect that the disturbed materials will have on water quality and to assess the resulting implications with respect to mine design and the environment. If environmental issues related to mine waste geochemistry are identified, mitigation measures or changes in the project can often be developed or implemented to prevent, reduce or eliminate the impact.

2.1 Geochemistry of Mine Wastes

The environmental impacts that are of most concern are those commonly associated with the presence of reactive sulphide minerals. If sulphide minerals are exposed to the atmosphere, the sulphide minerals can potentially react with oxygen and water to mobilize and release acid, sulphate, iron and other metals. The generation of acidic and metal-rich waters as a result of coming into contact with sulphide oxidation products is commonly referred to as acid rock drainage (ARD).

The acidity produced through oxidation reactions may be attenuated by minerals that contain neutralizing capacity. Carbonate minerals are particularly important neutralizing minerals, since carbonate minerals are generally the most effective in counteracting acidic conditions. Other minerals (e.g., aluminosilicates or silicates) may also contribute to the overall neutralization potential, but the dissolution of aluminosilicate and silicate minerals is kinetically limited. Thus, silicate minerals are only significant neutralizing minerals under low pH conditions (<4.5) or where water-rock interaction times are very long (Blowes et al., 2004). If the amount of neutralizing minerals is insufficient, significant quantities of acidity may be released from the mine wastes.

In addition to acid generation properties, the leaching of metals is also an important aspect to investigate as part of a geochemical baseline study. Metal leaching can be enhanced by the generation of acidic conditions, but can also occur in the absence of reactive sulphides and under non-acidic conditions through the dissolution of soluble mineral phases. Thus, if metals are soluble under near-neutral pH conditions, even mine wastes with an abundance of neutralization potential can affect the overall site water quality.

2.2 Project Overview

The Marathon PGM-Cu Project is located 300 km east of Thunder Bay on the north-eastern shore of Lake Superior near the town of Marathon (Figure 1, Index Map). The site is located in a temperate climate that is typical of northern areas of the Canadian Shield. The winters have an

average temperature of approximately -15°C , and the summers have temperatures averaging approximately 15°C . The annual average precipitation is approximately 800 mm and the monthly average precipitation ranges from approximately 37 mm to 102 mm. The property is located in a boreal ecosystem that is characterized by a mixed forest of coniferous and hardwood trees. The terrain has moderate to steep relief, which is typical of the rugged peninsula of Lake Superior's northern shore.

In the 1920's, exploration activities in the area were initiated in search for copper and nickel resources. In the 1940's, exploration activities discovered the presence of titaniferous magnetite with associated disseminated deposits of chalcopyrite. The deposit was later found to contain economical quantities of copper, gold and platinum group metals (PGM; platinum and palladium).

As a result of the discovery of the PGM-Cu deposit, the site has undergone several stages of investigations. To better understand the site and the characteristics of the ore, numerous studies have been conducted, including geophysical surveys, prospecting, trenching, drilling programs, geological studies, resource estimates and economical analyses. Since the 1940's, several companies have continued work at the site as follows:

- 1960's – Anaconda Canada Exploration Ltd.
- 1980's – Fleck Resources Ltd.
- 2000-2001 – Geomaque Exploration Ltd. (Geomaque; now Defiance Mining Corporation).

2.2.1 Ore Extraction and Processing

Since Marathon PGM purchased the property in 2004, investigations of the site have continued as part of economic and feasibility studies. A Preliminary Economic Assessment (PEA) was completed in February 2007, and subsequently updated in April 2007, by P & E Mining Consultants (P & E, 2007). Since then, the mineral resource estimates have been updated (P & E, 2008).

The method of ore extraction will be by open pit mining, which is expected to produce 79 million tonnes (Mt) of mineable resource. The updated PEA also indicated that the average grade is expected to be 0.27% Cu, 0.08 g/t Au, 0.23 g/t Pt and 0.76 g/t Pd. The average stripping ratio (i.e., ratio of waste rock to ore) is expected to be 3.66. Thus, it is expected that more than 287 million tonnes (Mt) of waste rock will be extracted over the life-of-mine. It is anticipated that the waste rock will be stored subaerially in a waste rock management facility that will be located to the west of the open pit.

As currently understood, the ore beneficiation process will consist of typical a crushing, grinding and flotation circuit that will produce a combined concentrate from hi-grade and bulk streams. As a result, rougher and cleaner tailings will be produced and combined before deposition into the tailings management area that is located on-site.

2.3 Regional Geology

The Marathon PGM-Cu project is located within and near the eastern border of a geologic region that is referred to as the Coldwell Complex (Figure 2). The Coldwell Complex is characterized by alkalic, plutonic rocks that were emplaced into an assemblage of Archean metavolcanic and gneissic rocks approximately 1.1 billion years ago during the Proterozoic Era. Six major rock types that are grouped into three intrusive centers make-up the Coldwell Complex (P & E, 2007):

- 1) Western syenite, syenodiorite, ferroaugite-amphibole syenite which are bordered to the east and northeast by a layered gabbroic unit referred to as Eastern Gabbro.
- 2) Massive alkalic gabbro and layered nepheline syenite intrusives.
- 3) Barkevikite syenite, quartz syenite and granite.

The volcanics that underlie the eastern edge of the Coldwell Complex consist of mafic to felsic rocks, such as tuffs and rhyolite breccia.

2.4 Property Geology

The Marathon PGM-Cu property is underlain by a variety gabbroic rocks that consist mostly of layered olivine-rich gabbro (Figure 2). The major gabbroic unit is referred to as Eastern Gabbro of the Coldwell Complex. Along the eastern edge of the Eastern Gabbro, an intrusive rock unit is present that consists of coarse-grained to pegmatitic gabbro-diorite. This intrusive coarse-grained gabbro is referred to as Two Duck Lake Gabbro. The ore deposit is hosted by the Two Duck Lake Gabbro, with the sulphide mineralization predominately disseminated and sparsely distributed throughout this rock type. Sulphide minerals principally consists of pyrrhotite [$\text{Fe}_{(1-x)}\text{S}$] and chalcopyrite [CuFeS_2], and to a lesser extent bornite [Cu_5FeS_4], pentlandite [$(\text{Fe},\text{Ni})_9\text{S}_8$], marcasite [FeS_2] and pyrite [FeS_2] (P & E, 2007). The palladium-platinum-gold ore is associated with the sulphide mineralization (chalcopyrite and pyrrhotite) in the Two Duck Lake Gabbro.

2.5 Previous Studies on Geochemistry

Prior to current investigations, there were two campaigns of acid-base accounting (ABA) sampling and analyses as follows:

- 2001 – B.C. Research Inc. (BC Research) completed an ABA study for Geomaque Explorations Ltd. (Geomaque), which included analysis of 25 samples of waste rock (as provided by Geomaque).

- 2005 – N.A.R. Environmental Consultants Inc. (NAR) completed an ABA study for Marathon PGM, which included analysis of 18 waste rock samples.

A summary of the results of the ABA testing by B.C. Research and NAR is included in Section 4.1.3. The previous studies did not include net acid generation testing nor kinetic testing.

3.0 METHODS

3.1 Sample Selection

Waste Rock

The objective of the waste rock sample collection process was to collect core samples that are spatially and lithologically representative of the major and minor rock units associated with the PGM-Cu deposit. To confirm the environmental representativeness of the selected samples, as well as to develop a working knowledge of the site layout and geology, a site visit was completed by M. Gunsinger and K. Salzsauler (P.Geol.) of Golder Associates. Prior to the site visit, core logs and cross-sections were reviewed and used to select core intervals of interest. After a review of site background information and core logs that were available at the time, two (2) major and four (4) minor rock types, for a total of six (6) rock types, were identified.

The number of samples collected for each rock type is based on the overall abundance of each rock type. The proportion or abundance of each rock type was visually estimated using the available background information, including geology maps, core logs and cross-sections. Based on the rock distribution, a total of 114 samples of rock were collected, from 21 different drill holes. The number of samples per rock type and the estimated proportion of rock is summarized as follows (Table 1):

Major Rock Types:

- Eastern Gabbro (~44–52% of overall rock) – 57 samples (~50% of samples)
- Two Duck Lake Gabbro (~27–29% of overall rock) – 32 samples (~28% of samples)

Minor Rock Types:

- Volcanic (~14–18% of overall rock) – 10 samples (~8% of samples)
- Heterolithic Breccia (~0.3–12% of overall rock) – 6 samples (~6% of samples)
- Syenite (~0.6–4 of overall rock) – 7 samples (~6% of samples)
- Serpentinite (<1% of overall rock) – 2 samples (~2% of samples)

The core logs identified that sub-rock types are evident within each of the above listed major and minor units. However, based on the overall rock types, these sub-rock types are expected to be geochemically similar and are grouped into the generalized rock types for the purposes of the geochemical investigations. Although the discussion in the result sections only refer to the generalized rock types, the sample selection process did consider the estimated proportions of each lithological unit and sub-rock type.

A list of the all the samples collected, along with the drill hole number, depth interval and a general description of the sample is shown in Appendix A. A site plan is shown in Figure 1 that indicates the locations of the drill holes that were used to select the rock samples.

Tailings

Samples of tailings, as provided by SGS Lakefield in Ontario, Canada, under the direction of Marathon's designated metallurgist, were also selected for geochemical analysis (Table 1). A limited quantity of bench-scale rougher-cleaner concentrate (combined) tailings was generated by SGS Research Mineral Services in November 2007. A sample of the supernatant was collected from the combined tailings sample and submitted for water quality analysis by SGS.

In addition to the combined tailings sample, cleaner and rougher tailings samples were produced by SGS from locked cycle testing and variability floatation testing. The six (6) locked cycle test cleaner and rougher tailings samples were combined in different ratios to formulate 6 composite samples that represent a range of sulphide contents. Similarly, the five (5) variability floatation test cleaner and rougher tailings samples were combined in different ratios to formulate 5 composite samples. Although the blending the cleaner and rougher tailings was completed in effort to produce tailings composites with specific sulphide contents, in many cases, the targeted sulphide content was not achieved. However, the locked cycle and floatation tailings composites do represent a range of sulphide contents (0.1–0.8 wt% as S and 0.07–0.3 wt% as S, respectively), and thus achieved the overall objective of blending the tailings.

3.2 Sample collection

Waste Rock

During the site visit, sections of drill core were retrieved from storage and laid out for visual inspection. The lithology was then compared to the core logs to ensure the logs were consistent with the retrieved sections. Once the core log was compared to the retrieved section, small sections of the core (approximately 0.1 to 0.5 m) were collected over, approximately, a 10 m interval. Some samples were collected over shorter or longer intervals depending on the amount of core available and the representativeness of the rock type present in each section of core. Samples were bagged and labelled with a unique sample identifier (ID). The samples were then shipped to SGS Lakefield in Lakefield, Ontario, for geochemical testing. Sections of core that were removed from storage were indicated on the core box with the initials "GC".

Tailings

All samples of tailings were internally submitted by SGS Research Mineral Services to SGS Analytical Services for geochemical testing. Instructions to the laboratory called for the tailings sample to be immediately submerged under process water to maintain saturated conditions and to

prevent oxidation prior to analysis. In addition, the locked cycle and variability floatation composite tailings were blended internally at SGS before being submitted for geochemical analysis.

3.3 Geochemical Testing Program

The geochemical test work completed on the waste rock samples and tailings samples included the following:

- Mineralogy;
- Whole rock and bulk metal analysis;
- Acid-base accounting (ABA);
- Net acid generating (NAG) tests;
- Short-term leach tests (modified SPLP 1312); and
- Kinetic tests.

The following sub-section outlines the details of the testing methods.

3.3.1 Mineralogy

Mineralogical testing was completed on ten (10) waste rock samples (those that were chosen for kinetic testing) and the single tailings sample. The mineralogical analyses included qualitative X-Ray Diffraction and optical microscopy of polished thin sections. Mineralogical analysis was completed to identify the major, minor and trace mineralogical assemblages.

3.3.2 Whole Rock and Bulk Metal Analysis

Whole rock and bulk metal analysis was completed on all 114 samples of rock and the single tailings collected in 2007. Whole rock and bulk metal analyses measure the solid-phase chemical composition of waste rock and tailings. Descriptions of whole rock and bulk metal analyses are summarized as follows:

- Whole rock analysis – measures the concentrations of major oxide species by X-ray fluorescence (XRF) to determine the percentage of the following major elements, reported as oxides: SiO₂, Al₂O₃, Fe₂O₃, CaO, MgO, Na₂O, K₂O, TiO₂, MnO, P₂O₅, Cr₂O₃ and V₂O₅.
- Bulk metal analysis – determines the concentrations of major and trace elements by a multi-acid leach followed by an ICP finish to determine the concentrations of the following elements: Ag, Al, As, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Ni, Pb, Sb, Se, Sn, Sr, Ti, Tl, U, V, Y and Zn.

The bulk metal composition provides a basis for comparison between samples of rock and typical crustal abundances. It can also be further used to identify samples that contain greater amounts of elements that have environmental significance. In addition, the results of the bulk metal analyses were used to select candidates for short-term leach testing.

3.3.3 Acid-Base Accounting (ABA)

As part of the 2007 geochemical investigations, ABA was conducted on all 114 rock samples and the single tailings sample. In 2008, ABA was conducted on 11 tailings samples, which included 6 locked cycle test composite samples and 5 floatation variability composite samples.

As part of ABA, bulk quantities of acid generating minerals (e.g., sulphide minerals) and acid neutralizing minerals (e.g., carbonate minerals) are measured to assess whether the materials tested will have sufficient capacity to neutralize the acid potential or if the materials have the potential to generate acidic effluents. The methodology performed on the samples is a modified Sobek method (Sobek et al., 1978) that includes analysis for paste pH, sulphur species (total sulphur, sulphate content and sulphide content), acid potential (AP) and neutralization potential (NP), and carbon species (total carbon and carbonate content).

Paste pH

Paste pH is measured from a mixture of crushed rock or tailings sample and water. Thus, paste pH is used to determine the pH of water that is in contact with the test material and assesses the effects that readily soluble constituents will have on the pH. Paste pH is, therefore, a qualitative indicator of the presence of stored acidity or readily soluble neutralizing minerals (most commonly carbonate minerals).

Acid Potential (AP)

Acid potential is calculated from the sulphide content and assumes that the sulphide minerals are present as pyrite. Sulphide content is used in the calculation of AP because the total sulphur content can over-estimate AP by including non-acid generating forms of sulphur (i.e., sulphate minerals).

Neutralization Potential (NP)

Neutralization potential (NP) is determined by acidifying the sample with sulphuric acid. Following the acidification of the sample, the amount of acid that is consumed during the test period is determined by a reverse titration.

Carbonate neutralization potential (CaNP) is not measured directly, but is calculated from either:

- 1) Total carbon content (wt% as C), or
- 2) Carbonate content (wt% as CO₃).

Using the total carbon to calculate CaNP assumes that all the carbon in the sample is present as calcite [CaCO₃]. Using the carbonate content to calculate the CaNP assumes that all the carbonate is present as calcite.

The difference between the NP and CaNP is that the NP is a “bulk” neutralization potential, whereas CaNP is solely based on the carbon or carbonate content of a sample. In addition to the consumption of acid by readily soluble carbonate minerals, the “bulk” NP incorporates the consumption of acid by less soluble aluminosilicate, silicate or other minerals. Under ambient conditions, the dissolution of these other minerals is typically quite slow. Because the dissolution of aluminosilicate and silicate minerals is kinetically limited, aluminosilicates and silicates are only significant neutralizing minerals under low pH conditions or where water-rock interaction times are long (Blowes et al., 2004). Generally, the CaNP's are considered to give a more reliable estimate of the material's ability to consume acid because the CaNP's represent the neutralization potential based on the dissolution of soluble carbonate minerals.

Supplemental calculations of net neutralization potential (Net NP, also known as the net acid production potential or NAPP), net potential ratio (NP/AP), net carbonate neutralization potentials (Net CaNP) and net carbonate potential ratios (CaNP/AP) were completed to assist in interpreting the results of the ABA analyses. More information on the standard methods of acid-base accounting can be found in Price (1997) or MEND (2005).

3.3.4 Net Acid Generating (NAG) Tests

Net acid generating (NAG) test were completed on eighteen (18) samples of waste rock and twelve (12) samples of tailings. Along with ABA, NAG is used as a tool to classify acid generating or non-acid generating materials. The method consists of adding hydrogen peroxide to the sample to induce complete oxidation of the sulphide minerals in the sample. The acid produced as a result of sulphide oxidation reacts with neutralizing minerals. Once the oxidation reaction is complete, the final pH is measured. In addition, the acidity is measured at two distinct pH values by titrating to a pH of 4.5 and 7.0. The titration determines the amount of acidity (kg H₂SO₄/tonne) with respect to an acidic and a neutral pH value. Thus, the acidity values at pH 4.5 and 7.0 provide an indication of whether the sample will produce enough acidity to drop the pH below 4.5 and 7.0, respectively. If the material has sufficient neutralization potential to maintain near-neutral pH conditions, then there will be no detectable acidity at pH 4.5 and limited to negligible amounts of acidity at pH 7.0. Detectable acidity at pH of 4.5 suggests that significant amounts of acidity may be released and in proportions that will likely result in the generation of acidic effluents.

Before the titrations to determine the acidity were completed, the concentrations of sulphate and metals in the NAG supernatant were measured. The NAG supernatant water quality represents concentrations resulting from conditions of rapid and complete oxidation of all the sulphide minerals present in the sample. Thus, the NAG supernatant chemistry can be used to assist in formulating a water quality for waste rock and tailings effluent under fully oxidized conditions (often considered worst case) from samples with a range of sulphide contents.

3.3.5 Short-term Leach Tests

Short-term leach testing was completed on forty one (41) samples of rock and on the single, 2007 tailings sample. The samples of rock were selected from the overall sample set to represent a range of available rock types. The leach tests were completed to measure the concentrations of constituents in the sample leachate that are readily soluble. The leach testing method is a modified Synthetic Precipitation Leaching Procedure (U.S.EPA, 1998), whereby a standard dilute sulphuric/nitric acid solution at a pH of 4.2 was added to the sample solids and thoroughly mixed for 18 hours. The procedure used is called a 'modified' SPLP leach test because the liquid to solid ratio was adjusted from 20:1 to 3:1 to limit dilution and to better identify potential parameters of concern. Information from leach testing is useful in developing initial estimates of metal leaching from different rock types. In addition, the results of the leach testing were used along with the results of the ABA and bulk metal analyses to select candidates for kinetic testing.

3.3.6 Kinetic Tests

Kinetic testing or humidity cell testing was completed on ten (10) samples of waste rock and on the single combined (average ore grade) tailings sample. A humidity cell is a weathering chamber designed to provide simple control over air, temperature and moisture, while allowing for the removal of weathering products (principally oxidation products) in solution. For the kinetic testing, a standard humidity cell procedure as described in ASTM D5744-96 Standard Test Method for Accelerated Weathering of Solid Materials Using a Modified Humidity Cell (ASTM, 2001) was implemented. Kinetic testing provides the fundamental data necessary to complete a preliminary evaluation of reaction rates for acid generating minerals, reaction rates for neutralizing minerals, metal leaching rates, mass loading rates and possible water quality implications as a result of oxidation of mine wastes.

Samples are placed in a humidity cell and immediately rinsed. The effluent from the initial rinse is collected and analyzed. This initial flush is known as "week 0". Kinetic testing continues by subjecting the samples to a 6 day cycle of dry and humid air: 3 days of dry air and 3 days of humid air, followed by a flush with water on the 7th day. The 7th day flush is the end of "week 1" and the process is repeated. The effluent was then collected from the bottom of the humidity cell and analyzed for general parameters, including pH, acidity, alkalinity, conductivity, sulphate, iron and calcium, and a suite of metals.

3.3.7 Water Quality Modeling

Water quality modeling was completed to estimate the water quality of mixed drainage consisting of effluents from tailings and waste rock. The geochemical speciation model PHREEQC was used to perform the mixing cell calculations. Further information on PHREEQC is provided in Parkhurst and Appelo (1999) and USGS (2008).

Mixing calculations were completed by combining the expected water quality of tailings drainage with the expected water quality of waste rock drainage. The volumetric mixing fractions (i.e., ratio at which the two water qualities were mixed) at which the two water qualities were mixed is based on the proportion of tailings and waste rock runoff flow rates relative to the total mine waste runoff flow rate. The proportion of the tailings runoff and waste rock runoff relative to the total mine waste runoff is based on the site water balance at the end of mining operations. During the final year of operations, runoff from the tailings represents 49% of total mine waste runoff and runoff from the waste rock represents 51% of the total mine waste runoff (annual flow rates for tailings and waste rock runoff are 116,036 m³/mon and 119,872 m³/mon, respectively, based on site water balance) (Golder, 2008).

Based on the static test results, a proportion of the waste rock is expected to be acid generating (approximately 7%, based on samples analyzed). To estimate conditions in the field after several years of oxidation, the waste rock effluent is assumed to consist of 93% neutral rock drainage (NRD) and 7% acid rock drainage (ARD). Overall, there are three components to the model: 1) tailings effluent, 2) NRD waste rock effluent, and 3) ARD waste rock effluent.

The proportions at which the effluent water quality for the tailings, NRD waste rock and ARD waste rock were mixed are as follows:

- Tailings – 49%;
- NRD waste rock – 47.3%; and
- ARD waste rock – 3.70%.

Input effluent water qualities for the tailings, NRD waste rock and ARD waste rock were derived as follows:

- Tailings effluent – calculated from weeks 15 to 20 of humidity cell testing on the combined, average ore grade tailings sample (assumes appropriate management of tailings to eliminate ARD);
- NRD waste rock effluent – calculated from weeks 35 to 40 of humidity cell testing on the samples of major rock types. An average water quality was calculated for rock types with more than one humidity cell. The water quality of the effluent is based on the expected proportions of rock in the waste rock pile as follows: 48% Eastern Gabbro, 28% Two Duck Lake Gabbro, 16% Volcanics, 6% Heterolithic Breccia and 2% Syenite. The proportion or abundance of each rock type was visually estimated by using the available background information, including geology maps, core logs and cross-sections (Table 1);

- ARD waste rock effluent – derived from NAG supernatant chemistries. An average water quality was calculated from samples that are expected to be acid generating. The NAG test data was used because the acidity released from kinetic test samples that are expected to be acid generating have not yet fully consumed the neutralization potential of the samples. Thus, the average NAG test data is considered to better represent an, oxidized water quality.

Two estimates of combined tailings and waste rock effluent water qualities were calculated: a “mix” and an “equilibrated mix”. The “mix” is the mass balance from mixing cell calculations that includes the loads from the tailings, NRD waste rock and ARD waste rock effluents. The “equilibrated mix” is also calculated from the mass balance from mixing cell calculations, but considers mineral solubility. Thus, the “equilibrated mix” includes controls of dissolved concentrations through the precipitation of secondary minerals typically associated with mine wastes (e.g., ferric oxyhydroxides).

It is important to note that load contributions from other sources, such as runoff from the open pit, runoff from the plant site and tailings process water, were not included in the water quality estimates.

4.0 RESULTS AND DISCUSSION

4.1 Waste Rock

4.1.1 Mineralogy

The qualitative X-ray diffraction (XRD) results for samples of waste rock are presented in Table 2. Photos of thin-sections from the optical microscopy are shown in Appendix B and the XRD scans are shown in Appendix C.

The XRD results indicate that the predominant mineral in waste rock and tailings is plagioclase. There are also moderate amounts of diopside and quartz in the Two-Duck Lake and Eastern Gabbros. Amphibole and ferropargasite are also observed in moderate to minor amounts in most rock types.

The sulphide mineral assemblage principally consists of pyrrhotite, chalcopyrite and to a lesser extent pyrite. Bornite and covellite [CuS] were also detected in select samples. Minor amounts of calcite [CaCO₃] are present in some rock samples, with ankerite [Ca(Fe,Mg,Mn)(CO₃)₂], dolomite [CaMg(CO₃)₂] and siderite [FeCO₃] also detected. Photographs of examples of the above identified sulphide and carbonate minerals are presented in Appendix B.

4.1.2 Whole Rock and Bulk Metal Analysis

The solid-phase composition of the rock material is measured as a screening level step to identify parameters that may require additional consideration with respect to overall site water quality and management. A statistical summary of the whole rock and bulk metal analyses are presented in Tables 3 and 4, respectively. All the whole rock and bulk metal data is presented in Appendix D.

Overall, the compositions of the major oxides are very similar between lithological groups, with the exception of samples of Syenite that have lower average compositions of MgO (1%) and CaO (5%) and higher average compositions of K₂O (4%) and Na₂O (5%) contents. The solid-phase concentrations of Fe and Mg in samples of Eastern Gabbro, Two Duck Lake Gabbro, and Heterolithic Breccia are generally higher than those in samples of Volcanic and Syenite and Serpentinite.

The results of the bulk metal analyses are compared to average crustal abundances for reference, as recommended by Price (1997). This comparison is meant only as a guide at this stage of the geochemical characterization and it should be noted that, as expected for mining properties, some metal concentrations will be elevated relative to crustal abundances. However, elevated concentrations of metals in the solid phase do not necessarily increase the potential for impacts, but rather identifies parameters for further consideration. The notable metals that have average

concentrations observed to be greater than the average crustal abundance, for most rock types, include: Ag, As, Bi, Co, Cr, Cu, Fe, Mn, Ni, Sb, Se, V and Zn.

Of these metals, As, Cu, Co, Cr, Ni and Zn frequently occur above the average crustal abundance as follows:

- Concentrations of arsenic in four (4) samples of Eastern Gabbro (4–26 mg/kg), one (1) sample of Two Duck Lake Gabbro (3 mg/kg), one (1) sample of Volcanic (4 mg/kg), and two (2) samples of Heterolithic Breccia (3–7 mg/kg) are greater than the average crustal abundance (2 mg/kg).
- Concentrations of copper in the majority of samples of Eastern Gabbro (29–6300 mg/kg), Two Duck Lake Gabbro (43–7300 mg/kg), Volcanic (33–3300 mg/kg) and Heterolithic Breccia (79–5700 mg/kg) are greater than the average crustal abundance (60 mg/kg).
- Concentrations of cobalt in the majority of samples of Eastern Gabbro (19–170 mg/kg), Two Duck Lake Gabbro (27–140 mg/kg), Volcanic (16–56 mg/kg) and Heterolithic Breccia (37–180 mg/kg) are greater than the average crustal abundance (25 mg/kg).
- Concentrations of chromium in the majority of samples of Eastern Gabbro (56–1150 mg/kg), Two Duck Lake Gabbro (52–460 mg/kg), Volcanic (75–220 mg/kg) and Heterolithic Breccia (110–290 mg/kg) are greater than the average crustal abundance (102 mg/kg).
- Concentrations of nickel in the majority of samples of Eastern Gabbro (37–1050 mg/kg), Two Duck Lake Gabbro (4–490 mg/kg), Volcanic (42–220 mg/kg) and Heterolithic Breccia (92–580 mg/kg) are greater than the average crustal abundance (84 mg/kg).
- Concentrations of zinc in the majority of samples of Eastern Gabbro (58–280 mg/kg), Two Duck Lake Gabbro (51–230 mg/kg), Volcanic (60–210 mg/kg) and Heterolithic Breccia (66–220 mg/kg) are greater than the average crustal abundance (70 mg/kg).

Frequency diagrams (histograms) were used to assess the sulphide and bulk metals contents of waste rock (Appendix E). The histograms were used to assist in the selection of sample candidates for short-term leach testing and longer term kinetic testing. The histograms can also be used to determine if the concentrations of particular elements in the samples of a lithology are geochemically representative of the lithology. Generally, the histograms for the Eastern Gabbro and Two Duck Lake Gabbro show smooth and complete trends with the greatest frequency skewed toward the median and tails present at the minimum and maximum extremes. As a result of a smaller sample group, the trend observed in the histograms for the Volcanic and Heterolithic Breccia rock types are not as smooth and complete, but still show tails at the extremes. Thus, the histograms for the Eastern Gabbro and Two Duck Lake Gabbro, and to a lesser extent for the Volcanic and Heterolithic Breccia rock types, show that a representative range of solid-phase concentrations has been captured for the majority of parameters. The histograms for Syenite and Serpentinite show the least amount of completeness, but the two rock types only represent a small percentage of the rock at the project site.

The standard deviations are frequently greater than the average for various elements including: Ag, As, Ba, Be, Bi and Cu. Thus, the solid-phase concentrations of many metals are variable and

exhibit the geochemical heterogeneity within each rock type. This is particularly true for Cu that shows a wide range in solid-phase concentrations (15–7300 mg/kg).

4.1.3 Acid-Base Accounting (ABA)

The statistical summary of the ABA results is presented in Table 5 and plotted in Figures 3 to 7. All the ABA data is included in Appendix D. To put the 2007-2008 results presented herein into context, the results of the two previous testing programs are summarized below.

Previous Studies

The results of the 25 samples from the 2001 BC Research testing program (only ABA tests were performed) are summarized as follows:

- Comparing the NP:AP ratios to acid generating criteria shows that 5 samples are “likely” to be acid generating, 3 samples have a “possible” potential to generate acidity and 3 samples have a “low” potential to generate acidity. The acid generating potential of the remaining 14 samples is characterized as “none”, or the acid generation potential is expected to be negligible.
- Therefore, based on 25 samples of rock, approximately 20% of the samples were determined to be “likely” acid generating.

The usefulness of the results from this study is limited as there is no indication of the sample locations and lithologies.

The results of the 18 samples from the 2005 NAR ABA testing program are summarized as follows:

- Sulphide content of 6 of the 18 samples was greater than 0.3 wt% as S (3 of the 6 samples are from the ore zone).
- The acid generation potentials for the different rock zones is summarized as follows:
 - Hanging wall zone (6 samples) – acid generation potential ranges from “none” to “low”.
 - Ore zone (7 samples) – acid generation potential ranges from “none” to “likely”.
 - Foot wall zone (5 samples) – acid generation potential ranges from “none” to “likely”.

Paste pH and Sulphide Content

Results of paste pH and sulphide content can be used as screening tools to assess the potential for acid generation. Materials with a sulphide content less than 0.3% and a paste pH greater than 5.5 have low potential for acid generation (Price, 1997). Paste pH was plotted versus the sulphide content in Figure 3 with reference lines at sulphide contents of 0.3 wt% as S and paste pH values of 5.5.

The plots of paste pH versus sulphide content show that the paste pH values are alkaline in all samples and range from 8.86 to 10.22. No samples had a paste pH less than 5.5. Thus, quantities of readily soluble, stored net acidity are negligible. Statistics calculated for the paste pH data show that the data for each rock type have low standard deviations relative to the mean values. Thus, the range of paste pH values is narrow indicating that there is only a marginal variation in the samples.

The sulphide mineralization is predominately disseminated and sparsely distributed throughout the ore zone and associated rock types. Overall, the sulphide content ranged from <0.01 to 10 wt% as S. The range, average and standard deviation of sulphide contents are summarized by lithology as follows:

- Eastern Gabbro – range: 0.01 to 4 wt% as S; mean: 0.1 ± 0.6 wt% as S.
- Two Duck Lake Gabbro – range: 0.01 to 4 wt% as S; mean: 0.2 ± 0.6 wt% as S.
- Volcanic – range: 0.01 to 10 wt% as S; mean: 2 ± 3 wt% as S.
- Heterolithic Breccia – range: 0.01 to 0.7 wt% as S; mean: 0.3 ± 0.3 wt% as S.
- Syenite – range: 0.01 to 0.1 wt% as S; mean: 0.04 ± 0.05 wt% as S.
- Serpentinite – range: 0.01 to 0.09 wt% as S; mean: 0.05 ± 0.06 wt% as S.

The high sulphide content standard deviation relative to the mean values demonstrates the broad range of sulphide contents in all rock types. The broad range of sulphide contents is particularly true for Eastern Gabbro, Two Duck Lake Gabbro and Volcanic rocks that have sulphide contents ranging over two orders of magnitude.

Although the majority of samples have low sulphide contents, there are several samples with sulphide contents greater than 0.3 wt% as S, including:

- 4 samples of Eastern Gabbro (MAR07-16, MAR07-27, MAR07-99 and MAR07-101);
- 2 samples of Two Duck Lake Gabbro (MAR07-15 and MAR07-107);
- 4 samples of Volcanic (MAR07-33, MAR07-66, MAR07-96 and MAR07-110); and
- 2 samples of Heterolithic Breccia (MAR07-49 and MAR07-100).

Two of these samples, MAR07-15 and MAR07-110, are likely within the ore zone as the concentration of copper across the interval where these samples were collected ranges from 0.3% Cu to 0.6% Cu. Based on the threshold value for sulphide content of 0.3 wt% as S, respectively, the 12 samples listed above have potential for acid generation.

Sulphur Speciation

The sulphide content is plotted as a function of total sulphur in Figure 4. Added to the plot is a 1:1 reference line to assess the speciation of the sulphur minerals in the samples of rock. The sulphur speciation results for all samples show that the distribution of data is very close to the 1:1 reference line; thus, the dominant form of sulphur in the samples is sulphide, presumably contained within sulphide minerals. The sulphur speciation observed in the rock samples is consistent with reports of the ore mineralogy that suggest the host rock contains sulphide mineralization and the absence of sulphate minerals (P & E, 2007).

Carbon Speciation

The concentrations of total carbon (%C) and carbonate (%CO₃) were measured as part of the ABA analyses. The total carbon content ranges from <0.01 to 0.9 wt% as C and the carbonate content ranges from <0.01 to 3 wt% as CO₃. Generally, the concentrations of carbonate follow a similar trend to that of total carbon, with the following lithologies having the highest to lowest average concentrations of carbonate and total carbon: Syenite, Serpentinite, Two Duck Lake Gabbro, Volcanic, Heterolithic Breccia and Eastern Gabbro.

As the carbonate values are a better representation of carbonate minerals, the most effective mineral at buffering acidity, CaNP values were calculated using the carbonate content and not total carbon content.

Neutralization Potentials

Carbonate neutralization potential (CaNP) is presented as a function of neutralization potential (Bulk NP or NP) in Figure 5. The ranges of the neutralization potentials for all rock types are listed as follows:

- Bulk NP (NP) – 0 to 120 t CaCO₃/1000 t
- CaNP – 0.08 to 156 t CaCO₃/1000 t

Samples from all rock types show a wide range of NP values, but exhibit a relatively narrow range of CaNP values. To assess the proportion of NP that consists of CaNP, a 1:1 reference line was added to the graph. Where NP is equal to the CaNP, the NP is derived from carbonate minerals. Sample points that are not located on or near the 1:1 reference line have a significant proportion of bulk NP from non-carbonate minerals, such as aluminosilicate and silicate minerals.

Overall, the samples from all rock types show a variable relationship with the 1:1 reference line and are described as follows:

- Most samples of Eastern Gabbro and Heterolithic Breccia are clustered near the x-axis, with a small proportion of samples showing a limited relationship with the 1:1 reference line. Thus, the majority of the samples of Eastern Gabbro and Heterolithic Breccia have neutralization potentials principally derived from non-carbonate minerals, with carbonates contributing only minor to negligible amounts of NP in most samples.
- The neutralization potential data for the Two Duck Gabbro and Volcanic rock types is similar to the data for the Eastern Gabbro and Heterolithic Breccia rock types; the chief exception is the greater percentage of samples that are near the reference line. Thus, the bulk neutralization potential in the Two Duck Lake Gabbro and the Volcanic rocks is principally derived from both carbonate and non-carbonate minerals.
- The neutralization potential data for the samples of Syenite shows a linear pattern that reflects the 1:1 reference line. Thus, a significant proportion of the neutralization potential within the samples of Syenite is likely derived from carbonate minerals.
- The two samples of Serpentinite that were analyzed for ABA characteristics show the neutralization potential principally derived from non-carbonate sources.

Acid Generation Potential

Criteria that have been established to assess the acid generation potential of mine wastes are summarized in Price (1997) and are provided in the chart below. This approach compares the AP and the NP through the use of a ratio, referred to as the neutralization potential ratio (NP/AP). The specific ratio at which materials produce acidity depends on several variables. Some of these variables include: presence and amounts of acid generation and acid neutralization minerals, morphology, crystallinity, grain size, chemical composition, paragenesis, texture, and site-specific exposure conditions.

Criteria, as suggested by Price (1997), for the evaluation of the potential for the generation of acidic conditions uses the bulk NP values to determine NP/AP ratios and is presented as follows:

Potential for Acid Generation	NP/AP Criteria	Notes
None	> 4	Non-acid generating – not expected to generate acidity.
Low	4 to 2	Not potentially acid generating – unless the sulphide minerals are extremely reactive and the NP is insufficiently reactive.
Possibly	2 to 1	Possibly acid generating – if NP is insufficiently reactive or is depleted at a faster rate than sulphide minerals.
Likely	< 1	Likely acid generating – unless sulphide minerals are non-reactive.

A more conservative approach is to apply the same criteria using the CaNP to calculate carbonate neutralization potential ratios (CaNP/AP). This approach is considered more conservative as it only considers the neutralizing capacity provided by the faster acting carbonate minerals, and not the slow dissolution rates of aluminosilicate and silicate minerals.

In addition to the ratios as discussed above, materials with a sulphide-sulphur content less than 0.3 wt% and a paste pH greater than 5.5 are considered non-potentially acid generating (non-AG). Exceptions occur where the rock matrix consists of base poor minerals (e.g., quartz) (Price, 1997). Values of NP and CaNP are plotted versus AP in Figures 6 and 7, respectively. Added to the plots are the criteria used to compare the acid generating and acid neutralization potentials of the samples and a line showing the minimum sulphide content required to generate appreciable acidity (0.3 wt% as S). Table 6 evaluates the acid generation potential of the rock samples by comparing the net potential ratios to the criteria and sulphide content as outlined above.

Based on the sulphide content of the sample and the Bulk NP/AP criteria, the number of acid generating samples is summarized by rock type as follows:

- Eastern Gabbro – of the 57 samples, 2 samples are considered to be acid generating, one sample is possibly acid generating and one sample has low acid generating potential.
- Two Duck Lake Gabbro – of the 32 samples, 1 sample is considered to be acid generating and one sample has low acid generation potential.
- Volcanic – of the 10 samples, 6 samples are considered non-acid generating and 4 samples are considered to be acid generating.
- Heterolithic Breccia – of the 6 samples, one sample is considered to be acid generating, and one sample has low acid generation potential.

The remaining samples of Eastern Gabbro, Two Duck Lake Gabbro, Volcanic and Heterolithic Breccia have relatively low sulphide contents (<0.3 wt% as S) and paste pH values greater than 5.5, thus are considered to be non-acid generating. In addition, all of the 7 samples of Syenite and 2 samples of Serpentinite are expected to be non-acid generating. The Volcanic rock type has the greatest percentage of samples that have potential for acid generation (~40%), followed by Heterolithic Breccia (~33%), Eastern Gabbro (~7%) and Two Duck Lake Gabbro (~6%).

Overall, based on the ABA conducted on 114 samples, it is expected that approximately 7% (8 of 114) of the total rock is expected to be acid generating, if unmitigated. The average sulphide content and NP:AP for all the rock samples are 0.30 wt% as S and 3.80, respectively. Thus, assessing the total sulphide content and total NP estimated to be present in the waste rock pile as a whole suggests that the acid generation potential is low. However, the drainage quality is likely to be strongly influenced by the distribution of acid generating materials throughout the waste rock pile. For example, if the acid generating material is concentrated in “pockets” throughout the pile, acidic and metal-rich waters may locally develop. Acid rock drainage that develops in localized areas of the pile are particularly problematic if these areas are close to or in contact with

preferential flow pathways that will rapidly transport the impacted water through and out of the waste rock pile. Unless a waste rock segregation plan is included in the mine waste management strategies, the acid generating material may impact drainage quality. Therefore, the resulting drainage water quality may reflect a mix of acid rock and neutral rock drainage.

4.1.4 Net Acid Generation (NAG) Tests

The results of the net acid generation (NAG) testing were conducted, according to AMIRA (2002), to assess the acid potential of the samples of waste rock and tailings. As with ABA, NAG test data can assist in evaluating the acid generation/neutralization potential of rock materials. The samples submitted for NAG testing were not selected based on proportional representation of rock types. Rather, for each lithology, the data from the ABA and trace metals analyses data sets were used to select NAG test samples that represent a reasonable range of sulphide and metal contents. The NAG test results do not represent field conditions, but conditions under which all the sulphide minerals in the sample undergo rapid and complete oxidation. As such, the NAG tests can provide useful information on possible oxidized water quality.

The results of NAG testing (i.e., NAG pH and NAG acidity) can be evaluated based on the following criteria (AMIRA, 2002):

NAG pH	NAG Acidity (to pH 4,5) (kg H ₂ SO ₄ / tonne)	Potential for Acid Generation
> 4.5	0	Non-acid forming (NAF).
< 4.5	≤ 5*	Potentially acid forming – low capacity (PAF-LC).
< 4.5	> 5*	Potentially acid forming (PAF).

* The NAG criteria used to specify PAF-LC may vary from site to site (AMIRA, 2002).

The results of the NAG testing are presented in Table 7. Five (5) of the 18 samples have a final pH that is less than 4.5 and acidity values that are greater than 5 kg H₂SO₄/ tonne. Thus, the 5 samples are considered to be potentially acid forming. Two of the 18 samples have a final pH that is less than 4.5 with detectable acidity that is less than 5 kg H₂SO₄/tonne, and thus are considered to be potentially acid forming: low capacity. Overall, the 7 samples that are considered to be potentially acid forming are from the Eastern Gabbro, Two Duck Lake Gabbro and Volcanic rock types as follows:

- Eastern Gabbro – MAR07-16, MAR07-27 and MAR07-101;
- Two Duck Lake Gabbro – MAR07-15 and MAR07-107; and
- Volcanic – MAR07-33 and MAR07-96.

The listed 7 samples are also considered to be acid generating, based on the ABA data, and thus the NAG testing results are generally consistent with the ABA results. Two exceptions are the Eastern Gabbro sample MAR07-99 and the Heterolithic Breccia sample MAR07-49 that have sulphide contents of 0.36 wt% as S and 0.71 wt% as S, respectively. Both of these samples are considered to be possibly acid generating based on ABA results, but are considered non-acid forming based on the NAG testing. The NAG test results, therefore, indicate that some rock with sulphide contents greater than 0.3 wt% as S may be non-acid forming because of the abundance of neutralizing minerals. However, caution needs to be used when interpreting these results as not all rock will have sufficient neutralizing capacity to buffer acidity that can be produced by rocks with sulphide contents near and greater than 0.3 wt% as S.

4.1.5 Short-term Leach Tests

Short-term leach testing is used to determine the concentrations of readily soluble constituents in the sample leachate. Thus, the results of leach tests can be used to develop preliminary knowledge of metal leaching behaviour of specific sample types. It is important to note, however, that the results of short-term leach tests do not directly measure the expected effluent chemistry of the test material under ambient conditions as the tests do not consider ongoing sulphide oxidation. Because the tests are conducted under laboratory conditions, variables, such as sample size, sample volume, test duration and the area of the reaction surface or the water-solid interface, are subjective and may not reflect actual field conditions. Short-term leach testing should therefore be used to qualitatively identify elements that require additional consideration with respect to overall site water quality or management.

The modified SPLP was used to conduct leachate experiments on the rock material. The results of the SPLP tests are summarized and compared to the Provincial Water Quality Objectives (MOEE, 1994) in Table 8. The PWQOs are also summarized in Appendix F. Although it is not practical to directly compare short-term leachate chemistry to PWQOs, these comparisons provide insights (at a screening level) regarding parameters that may require further consideration. All the SPLP data is included in Appendix D. The key parameters associated with the short-term leachate from samples of waste rock are summarized below.

Aluminum

Concentrations of aluminum range from 0.005 mg/L to 1.4 mg/L, with maximum concentrations occurring in the leachate from samples of Eastern Gabbro and Serpentinite. Concentrations of aluminum in the leachate of the majority of samples from Eastern Gabbro, Two Duck Lake Gabbro and Heterolithic Breccia are greater than the PWQO (0.015 mg/L). Concentrations of aluminum in the leachate from all samples of Volcanic, Syenite and Serpentinite are greater than the PWQO.

Arsenic

Concentrations of arsenic range from <0.0002 mg/L to 0.02 mg/L, with the maximum concentrations occurring in the leachate from samples of Eastern Gabbro. Concentrations of arsenic in the leachate of one sample of Eastern Gabbro (MAR07-99) are greater than the PWQO (0.005 mg/L). Concentrations of arsenic in the leachate of some samples of Two Duck Lake Gabbro, Heterolithic Breccia, Syenite and Serpentinite are marginally below or near the PWQO.

Copper

Concentrations of copper range from 0.0004 mg/L to 0.03 mg/L, with the highest concentrations occurring in the leachate from samples of Two Duck Lake Gabbro and Eastern Gabbro. The average concentrations of copper in the leachate of samples of Two Duck Lake Gabbro and Heterolithic Breccia are greater than the PWQO (0.001 mg/L).

Iron

Concentrations of iron range from <0.01 mg/L to 1.6 mg/L, with the highest concentrations occurring in the leachate of samples of Eastern Gabbro. Concentrations of iron in the leachate in some samples of Eastern Gabbro, Two Duck Lake Gabbro, Volcanic, Heterolithic Breccia and Serpentinite are greater than the PWQO (0.3 mg/L).

Lead

Concentrations of lead range from 0.0007 mg/L to 0.05 mg/L. Average concentrations of lead in the leachate from the majority of samples from Eastern Gabbro, Two Duck Lake Gabbro, Heterolithic Breccia and Syenite are greater than the PWQO (0.001 mg/L). Although solid-phase concentrations of lead are generally low in most rock types, the results of the short-term leach tests suggest that further consideration of leachate potential of lead will be required.

Vanadium

Concentrations of vanadium range from 0.0003 mg/L to 0.09 mg/L, with the highest concentrations occurring in the Heterolithic Breccia. Concentrations of vanadium in the leachate from several samples of Eastern Gabbro, Two Duck Lake Gabbro, Volcanic, Heterolithic Breccia and Serpentinite are greater than the PWQO (0.006 mg/L).

Zinc

Concentrations of zinc range from 0.003 mg/L to 0.07 mg/L. Concentrations of zinc in the leachate from some samples of Eastern Gabbro and Heterolithic Breccia are greater than the PWQO (0.02 mg/L).

Other Parameters

Concentrations of cobalt (0.00004–0.001 mg/L) and molybdenum (0.001–0.06 mg/L) in the leachate from a few samples of Eastern Gabbro are greater than the PWQOs (0.0009 mg/L and 0.04 mg/L, respectively). Concentrations of chromium in the leachate of some samples are elevated relative to the PWQO; however, the average concentration of chromium is below the PWQO (0.001 mg/L) for all rock types except Serpentinite. Concentrations of antimony and uranium in the leachate of one sample of Heterolithic Breccia (MAR07-02) and Syenite (MAR07-75), respectively, are greater than the PWQOs (0.02 mg/L and 0.005 mg/L, respectively). All other metals are below the PWQOs.

4.1.6 Net Acid Generating (NAG) Test Supernatant Chemistry

The NAG test supernatant chemistry is presented in Table 9. As with the short-term leachate chemistry, the concentrations of metals in the NAG test supernatant are compared to the PWQOs (MOEE, 1994) to provide insights (at a screening level) regarding parameters that may require further consideration. It is important to note that the NAG supernatant water quality represents concentrations resulting from conditions of rapid and complete oxidation of all the sulphide minerals present in the sample. Thus, the NAG supernatant chemistry often represents worst case water qualities for waste rock effluent; however, these parameters and concentrations must be further evaluated in the context of overall site water management.

The key metals in the NAG supernatant are summarized as follows:

Aluminum

Concentrations of aluminum range from 0.08 mg/L to 20 mg/L, with the highest concentrations occurring in the supernatant from samples of Volcanic, Eastern Gabbro and Two Duck Lake Gabbro. Concentrations of aluminum are greater than the PWQO (0.015 mg/L) in all rock samples submitted for NAG testing.

Copper

Concentrations of copper range from 0.0008 mg/L to 43 mg/L, with the highest concentrations occurring in the supernatant from samples of Eastern Gabbro and Two Duck Lake Gabbro. The magnitude of the concentrations of copper is associated with the sulphide content, with the lower concentrations from samples with lower sulphide contents and higher concentrations from samples with higher sulphide content. Concentrations are also high in the two samples of volcanic rock (11–27 mg/L) and are greater than the PWQO (0.001 mg/L) in the majority of samples submitted for NAG testing.

Iron

Concentrations of iron range from 0.01 mg/L to 228 mg/L, with the highest concentrations occurring in the supernatant from samples of Volcanic, Eastern Gabbro and Two Duck Lake Gabbro. The concentrations of iron are strongly associated with the sulphide content. Although the concentrations are very high in select samples, the majority of the samples submitted for NAG testing have concentrations of iron in the NAG supernatant below the PWQO (0.3 mg/L).

Nickel

Concentrations of nickel range from <0.0001 mg/L to 3.8 mg/L, with the highest concentrations occurring in the supernatant from samples of Eastern Gabbro, Two Duck Lake Gabbro and Volcanics. The concentrations of nickel in the NAG supernatant are generally below PWQO, except for samples that have relatively high sulphide contents (>0.5 wt% as S).

Zinc

Concentrations of zinc range from 0.001 mg/L to 3.3 mg/L, with the highest concentrations occurring in the supernatant from samples of Eastern Gabbro, Two Duck Lake Gabbro and Volcanics. As with the concentrations of copper, nickel and iron, the concentrations of nickel in the NAG supernatant are associated with the sulphide content.

Other Parameters

To a lesser extent, the concentrations of Ag, B, Be, Cd, Co, P, Pb, Tl, U and V are elevated in the NAG test supernatant. All other metals are generally low and are expected to be below PWQOs. In addition, the concentrations of sulphate are elevated in the NAG supernatant (<5–110 mg/L).

Overall, the concentrations of metals in the NAG supernatant do not seem to be linked to specific rock types. Rather, the highest concentrations of metals, specifically some of the key metals (i.e., Cu, Fe, Ni and Zn), are observed in the NAG supernatant from samples with relatively higher sulphide contents (i.e., >0.3 wt% as S). It is important to note that the concentrations of metals in the NAG supernatant from samples with lower sulphide contents (<0.3 wt% as S) were also elevated (i.e. >PWQO) for select metals, including Al, Cu and Zn. Thus, the NAG supernatant chemistry suggests that rock with low sulphide contents can generate elevated concentrations of metals, assuming that the rock is rapidly oxidized and all sulphide minerals are available for oxidation. The NAG testing also indicates that effluents from rock with higher sulphide contents will have more of an influence on the overall site water quality, as compared to leachate from rock with relatively lower sulphide contents. However, the weathering rates under actual field conditions will not be as rapid as those simulated through NAG testing. In addition, not all sulphide minerals will be available for oxidation as a significant proportion of the sulphide content will be present within the matrix of the waste rock material and not on or near the surface

where oxidation reactions occur. The NAG test results should only be used within the context of an overall site water quality assessment.

4.1.7 Kinetic Testing

Currently, the humidity cells for the 10 waste rock samples have been operating for 56 weeks and are currently ongoing. The samples submitted for kinetic testing were not selected based on proportional representation of rock types. Rather, for each lithology, the data from the ABA and trace metals analyses data sets were used to select samples that represent a reasonable range of rock types and sulphide contents. The kinetic test samples along with the rock type and initial sulphide content are summarized as follows:

- MAR07-18 – Eastern Gabbro, 0.09 wt% as S;
- MAR07-99 – Eastern Gabbro, 0.36 wt% as S;
- MAR07-16 – Eastern Gabbro, 4.02 wt% as S;
- MAR07-98 – Two Duck Lake Gabbro, 0.01 wt% as S;
- MAR07-80 – Two Duck Lake Gabbro, 0.19 wt% as S;
- MAR07-15 – Two Duck Lake Gabbro, 3.52 wt% as S;
- MAR07-33 – Volcanic, 1.63 wt% as S;
- MAR07-96 – Volcanic, 6.30 wt% as S;
- MAR07-49 – Heterolithic Breccia, 0.71 wt% as S; and
- MAR07-92 – Syenite, 0.01 wt% as S.

Humidity cell MAR07-92 was terminated at week 27 following evaluation of the data at that time. The available kinetic test data for waste rock is presented in Figures 8 through 17 for select parameters. The data is compared to Provincial Water Quality Objectives (PWQOs; MOEE, 1994) and Municipal/Industrial Strategy for Abatement (MISA) effluent discharge limits (MISA, 1994). The PWQOs and MISA discharge limits are summarized in Appendix F. In the previous sections, comparisons of PWQO to the short-term leachate and NAG test supernatant chemistry utilized the lowest PWQO value for parameters that have different PWQOs depending on the water chemistry. However, for the case of the kinetic test results, the PWQOs that were compared to the concentrations in the humidity cell effluent are the values that related to specific water chemistries. For example, the PWQO for aluminum depends on pH and the PWQO for cadmium and copper depends on hardness. The PWQO of 0.075 mg/L for aluminum was used for comparison for the kinetic results because the pH of the humidity cell leachates are near-neutral

(>6.5–9.0). Furthermore, the PWQOs of 0.0001 mg/L and 0.001 mg/L for cadmium and copper, respectively, were used because the hardness of the kinetic test effluents are typically low in the kinetic test effluent (<20 mg/L as CaCO₃).

The key observations from kinetic testing data for the samples of waste rock are as follows:

- Effluents from all samples generally have near-neutral pH values (6.5–8.5). Over the first 10 weeks, most samples had pH trends that were decreasing over time. From week 10 to week 56, the pH values of most samples were comparably stable, except for sample MAR07-98, which has pH values gradually decreasing until week 25 and have stable pH values from week 25 to week 56. The pH of the effluent during the first 56 weeks was outside the MISA (6.0 – 9.5) and PWQO (6.5 – 8.5) ranges for the following samples:
 - MAR07-99 – during week 2 and 29, the pH values (8.7 and 9.3, respectively) were higher than the PWQO upper value, and during week 30 the pH value (5.1) was less than the lower values of both PWQO and MISA;
 - MAR07-16 – during weeks 27, 42, 43 and 48, the pH values (6.2, 6.4, 6.4 and 6.4, respectively) were less than the lower value of PWQO, during week 29 and 33 the pH values (5.7 and 4.1, respectively) were less than the lower values of both PWQO and MISA. However, the low pH value during week 33 could be the result of a lab error because the value does not follow the overall trend;
 - MAR07-98 – during weeks 0 to 13, the pH (7.5–9.6) was intermittently greater than the PWQO upper value and greater than the MISA upper limit during week 4 (9.6);
 - MAR07-80 – during weeks 17, 29, and 30, the pH values (6.2, 6.3, and 6.2, respectively) were less than the lower PWQO value and during week 27 the pH (4.4) was less than the lower values of both PWQO and MISA. However, the low pH value during week 27 could be the result of a lab error because the value does not follow the overall trend;
 - MAR07-33 – during week 30, the pH (6.3) was less than the PWQO lower value;
 - MAR07-96 – during weeks 16 and 43, the pH values (6.2 and 6.4, respectively) were less than the PWQO lower value and during weeks 27, 29, 33 and 34, the pH values (5.9, 5.9, 5.8 and 5.8, respectively) were less than the lower values of both PWQO and MISA;
 - MAR07-49 – during week 22, the pH (6.2) was less than the PWQO lower value, and during week 27, the pH (5.8) was less than the lower values of both PWQO and MISA;
 - MAR07-92 – during week 21, the pH (4.9) was less than the PWQO lower value and less than the MISA lower limit, and during week 27, the pH (6.1) was less than the PWQO lower value; and
- Concentrations of most metals generally decrease and stabilize over time and all are below MISA limits. However, concentrations of some metals (e.g., aluminum, arsenic, cadmium, copper and uranium) were observed to be greater than Provincial Water

Quality Objectives (PWQO; MOEE, 1994). Concentrations of metals that were observed to be greater than PWQOs are summarized by metal below:

Aluminum (PWQO = 0.075 mg/L)

- MAR07-18 – concentrations of aluminum (0.09–0.29 mg/L) are greater than the PWQO from week 15 to 56;
- MAR07-98 – concentrations of aluminum are greater than the PWQO during weeks 0 and 10 (0.09 and 0.08 mg/L, respectively).

Arsenic (PWQO = 0.005 mg/L, MISA = 0.5 mg/L)

- MAR07-18 – the concentration of arsenic during week 10 (0.01 mg/L) is greater than the PWQO;
- MAR07-99 – concentrations of arsenic (0.0013–0.04 mg/L) are near or greater than the PWQO from week 0 to 56;
- MAR07-98 – the concentration of arsenic during week 5 (0.007 mg/L) is greater than the PWQO.

Cadmium (PWQO = 0.0001 mg/L)

- MAR07-16 – the concentration of cadmium measured during week 5 (0.0005 mg/L) is greater than the PWQO.

Copper (PWQO = 0.001 mg/L, MISA = 0.3 mg/L)

- All waste rock humidity cells had concentrations of copper in the effluent that, at some point during the first 56 weeks of testing, was greater than the PWQO;
- Concentrations of copper were consistently high in the effluent from the kinetic samples that have relatively higher sulphide contents (>0.3 wt% as S). The key samples to note that have consistently high concentrations of copper are as follows:
 - MAR07-99 – <0.0005–0.0029 mg/L;
 - MAR07-16 – 0.0006–0.011 mg/L;
 - MAR07-80 – 0.0014–0.0026 mg/L;
 - MAR07-15 – 0.0010–0.0071 mg/L;
 - MAR07-33 – 0.0011–0.0042 mg/L;
 - MAR07-96 – 0.0016–0.010 mg/L;
 - MAR07-49 – 0.0009–0.0033 mg/L.

Uranium (PWQO = 0.005 mg/L)

- MAR07-92 – concentration of uranium during week 2 (0.0054 mg/L) is marginally greater than the PWQO.

Concentrations of sulphate and acidity are higher in the humidity cells with samples that are expected to be acid generating, including MAR07-16, MAR07-99, MAR07-15, MAR07-96, MAR07-33 and MAR07-49. The relatively high concentrations of sulphate and acidity indicate that sulphide oxidation reactions are occurring. Furthermore, although the pH of the effluent remains near-neutral for all humidity cells, the concentrations of some metals are greater than PWQOs, which indicates that metal mobilization can occur under near-neutral conditions.

Depletion Calculations

To evaluate the rate of consumption (or depletion) of acid producing minerals, as compared to the rate of consumption of neutralizing minerals, calculations were completed that are based on geochemical and mineralogical properties of the rock. Depletion calculation details are provided in Price (1997). If the acid producing minerals become depleted before the soluble neutralizing minerals, then it is likely that a long-term non-ARD chemistry will prevail. Conversely, if the soluble neutralizing minerals become depleted before the acid producing minerals, then acidic waters, which are favourable for metal leaching, will dominate. Evaluation of initial mineral contents and comparing the time to depletion for sulphide minerals with the time to depletion for neutralization potential (NP) provides an indication on whether the acidic conditions will develop.

Preliminary depletion rates were completed, whereby the mass of sulphide and neutralizing minerals was calculated from the leachate chemistry on a weekly basis. From these preliminary calculations, a depletion rate was derived using the last 5 weeks of the 56 week test period. Multiple depletion rates for NP were calculated based on calcium, sulphate and alkalinity production rates.

The preliminary depletion calculations are presented in Table 10. Overall, the depletion calculations are in agreement with the ABA and NAG test results. Samples with a sulphide content of 1.6 wt% as S or greater (MAR07-16, MAR07-15, MAR07-33, MAR07-96) were calculated to be acid generating (i.e., the depletion time of neutralization potential is shorter than that of sulphide content). The acid generation potential for samples with sulphide contents ranging from 0.2 to 0.7 wt% as S (MAR07-18, MAR07-99, MAR07-80) are uncertain and depend on the depletion calculation method. The other samples (MAR07-98, and MAR07-92) have depletion times of neutralization potential that are longer than that of sulphide content for all calculation methods.

4.2 Tailings

4.2.1 Mineralogy

The qualitative X-ray diffraction results for the combined tailings sample are presented in Table 11. The tailings mineralogical composition is similar to the parent waste rock with major

amounts of plagioclase, moderate diopside and minor and trace amounts of clays, micas and magnetite. The main difference between the tailings and waste rock mineralogy is the low amounts of sulphide minerals that predominately consist of pyrrhotite with trace amounts of pyrite. The carbonate minerals observed in the combined tailings sample consist mostly of calcite with lesser amounts of dolomite and ankerite.

4.2.2 Whole Rock and Bulk Metal Analysis

A summary of whole rock and bulk metal results of a rougher-cleaner combined tailings is presented in Tables 12 and 13, respectively. The major oxides of the tailings are similar to the other waste rock lithologies, with the exception of syenite.

The results of the trace metals were compared to average crustal abundance, as presented in Price (1997). Concentrations of antimony, arsenic, bismuth, chromium, cobalt, copper, iron, manganese, molybdenum, nickel, selenium, silver, strontium, vanadium and zinc are greater than crustal abundances. Of these parameters, the following is important to note:

- Concentrations of antimony in the tailings sample is 5 times greater than the crustal abundance; and
- Concentrations of bismuth, molybdenum and selenium have concentrations 10 or more times greater than the average crustal values.

4.2.3 Acid Base Accounting (ABA)

One rougher-cleaner combined tailings sample, six locked cycle test tailings composite samples, and five variability floatation test tailings composite samples were tested for ABA. The results are provided in Table 14.

Paste pH and Sulphide Content

Paste pH was plotted versus the sulphide content in Figure 18 with reference lines at sulphide content of 0.3 wt% as S and at paste pH value of 5.5. The paste pH of all 12 tailings samples are alkaline ranging from 8.26 to 8.82. No samples had a paste pH less than 5.5. Thus, quantities of readily soluble, stored net acidity are negligible. The sulphide content range from 0.07 to 0.82 wt% as S. Two locked cycle test composite samples (LCT5 and LCT6) and one variability floatation test composite sample (F089) have sulphide contents (0.44, 0.82 and 0.31 wt% as S, respectively) greater than 0.3 wt% as S.

Sulphur Speciation

The sulphide content is plotted as a function of total sulphur in Figure 19 with a 1:1 reference line to assess the sulphur speciation in the tailings samples. Data of all samples are closer to the 1:1

reference line than to the abscissa, so sulphide is the dominant sulphur species. The data of locked cycle test composite samples are closer to the 1:1 reference line than those of the combined tailings sample and variability floatation test composite samples. Thus, the locked cycle test tailings composite samples generally have a higher proportion of total sulphur consisting of sulphides as compared to the variability floatation test tailings composite samples. Overall, the variability floatation test tailings composites have a higher sulphate content relative to the other tailings samples.

Carbon Speciation

The total carbon content ranges from 0.06 to 0.13 wt% as C and the carbonate content ranges from 0.17 to 0.48 wt% as CO₃. About 50 to 75% of total carbon is carbonate. There is no distribution difference between the rougher-cleaner combined tailings sample, locked cycle test composite samples and variability floatation test composite samples.

Neutralization Potentials

Carbonate neutralization potential (CaNP) is presented as a function of neutralization potential (Bulk NP or NP) in Figure 20 with a 1:1 reference line. The range of the neutralization potentials for all rock types are listed as follows:

- Bulk NP (NP) – 20 to 28 t CaCO₃/1000 t
- CaNP – 2.8 to 8.0 t CaCO₃/1000 t

All samples show a narrow range of both NP and CaNP values. The data are closer to the abscissa than the 1:1 reference line, indicating most bulk NP comes from non-carbonate minerals, such as aluminosilicate and silicate minerals.

Acid Generation Potential (AP)

The ranges of the acid potential are listed as follows:

- Combined tailing sample – 3.1 t CaCO₃/1000 t
- Locked cycle test tailings composite samples – 3.1 to 25.6 t CaCO₃/1000 t
- Variability floatation test tailings composite samples – 2.2 to 9.7 t CaCO₃/1000 t

Variability floatation test tailings composite samples have higher values and wider ranges of AP than those of the combined tailings sample and variability floatation test tailings composite samples.

Acid generation potential vs. neutralization potential is plotted in Figure 21 and acid generation potential vs. carbonate neutralization potential is plotted in Figure 22 and compared to the Price (1997) criteria as outlined in Section 4.1.3. Two of the six locked cycle test samples are

considered to be “possibly” acid generating based on the NP/AP. In addition, five of the six locked cycle test tailings composite samples and three of the five variability floatation tailings composite samples are considered to be “likely” acid generating based on the CaNP/AP. Overall, based on the sulphide content of the sample and the net potential ratios (NP/AP), the samples LCT5 and LCT6 are “possibly” acid generating and sample F089 is considered to have a “low” acid generation potential.

4.2.4 Net Acid Generation (NAG) Tests

Net acid generation (NAG) tests were conducted on the 12 tailings samples. The final pH and NAG acidity values at pH 4.5 and 7.0 are presented in Table 15. Similar to the waste rock NAG results, the tailings NAG test results were evaluated based on the criteria as outlined in Section 4.1.4 (AMIRA, 2002).

No samples are considered to be simply acid forming, as the NAG acidity is below 5 kg H₂SO₄/tonne for all samples. However, 4 of the 12 samples have final pH values (3.53–4.23) less than 4.5 and non-zero NAG acidity values (2.6–4.8 kg H₂SO₄/tonne) that are less than 5 kg H₂SO₄/tonne. Thus, 4 of the 12 samples are potentially acid forming: low capacity. The four samples are as follows:

- Locked cycle test tailings composite samples – LCT3, LCT4 and LCT6 ;
- Variability floatation test tailings composite samples – F089.

Of the 4 listed samples considered to be acid generating by NAG testing, only two (LCT6 and F089) are considered to be acid generating based on the ABA data. The other two samples (LCT3 and LCT4) have sulphide contents (0.23 and 0.25 wt% as S, respectively) that are below the 0.3 wt% as S criteria. The NAG testing of the tailings suggests therefore that tailings with sulphide contents near or greater than 0.2 wt% as S can generate acidic conditions, if the sulphides are rapidly oxidized. The weathering rates under actual field conditions will not be as rapid as those simulated through NAG testing.

4.2.5 Decant Water Analysis

An analysis of the decant tailings water, that was provided with the generation of the tailings solids, was also performed. The decant water analysis is useful because it can be used as a preliminary estimate of process water chemistry associated with tailings deposition. The total and dissolved concentrations are presented in Table 16.

Total concentrations of aluminium, arsenic, cadmium, chromium, cobalt, copper, iron, lead, molybdenum, nickel, silver, vanadium and zinc were greater in comparison to the PWQO's with aluminium, iron, lead, copper and zinc with concentrations far greater than the PWQOs. Concentrations of dissolved metals were significantly lower with only aluminium, chromium,

iron, molybdenum and zinc concentrations greater than the PWQO's. Concentrations above PWQO should be evaluated in the context of overall site water management.

4.2.6 Short-term Leach Tests

The results of the short-term leaching testing are presented in Table 17. Concentrations of aluminum, boron, chromium, cobalt, copper, iron, lead, silver, vanadium and zinc are greater than PWQO's. The short-term leach testing of the combined tailings sample, therefore, indicates that several metals may be present in the tailings effluent at concentrations that require further consideration with respect to overall site water quality and management.

4.2.7 Net Acid Generating (NAG) Test Supernatant Chemistry

The NAG test supernatant chemistry for the 12 tailings samples are presented in Table 18. As with the short-term leachate chemistry, the concentrations of metals in the NAG test supernatant are compared to the PWQOs (MOEE, 1994) to provide insights (at a screening level) regarding parameters that may require further consideration. Furthermore, as with the NAG testing on the samples of waste rock, the NAG supernatant water quality represents concentrations resulting from conditions of rapid and complete oxidation of all the sulphide minerals present in the sample.

The key metals, with concentrations in the NAG supernatant that are greater than PWQOs in the majority of samples, are summarized as follows:

- Aluminum – <0.01 mg/L to 1.54 mg/L;
- Cadmium – 0.000004 mg/L to 0.003 mg/L;
- Cobalt – 0.0001 mg/L to 0.3 mg/L;
- Chromium – 0.002 mg/L to 0.08 mg/L;
- Copper – 0.0007 mg/L to 2 mg/L;
- Nickel – <0.0001 mg/L to 1 mg/L; and
- Zinc – <0.001 mg/L to 0.8 mg/L.

The NAG testing of the tailings suggests therefore that tailings with sulphide contents near or greater than 0.1 wt% as S can generate metal-rich waters, if the sulphides are rapidly oxidized. However, under field conditions the oxidation reactions are slower, and thus the NAG test results represent worst case water qualities under aerobic conditions. Depending on the waste management practices, the water qualities represented by the NAG results may not be present on site; thus, the values need to be evaluated in the context of the overall site water management.

4.2.8 Kinetic Testing

The kinetic testing was conducted only on the rougher-cleaner combined tailings sample (MAR07-Tailings). Based on the first 36 weeks of kinetic testing, the key observations for the sample of tailings are as follows:

- Effluent from the tailings humidity cell is alkaline to near-neutral with most pH values within the range of 7.1 - 8.0. The pH during week 0 (8.9) is greater than PWQO upper value (8.5), and the pH during week 14 (6.2) is less than PWQO lower value (6.5).
- Concentrations of acidity are below detection limit (<1 mg/L as CaCO₃).
- Concentrations of alkalinity oscillated between 10 mg/L to 50 mg/L during the first 36 weeks.
- Concentrations of sulphate during weeks 0 and 1 were relatively high (up to 88 mg/L), decrease sharply during weeks 2 and 3, and then stabilized to a concentration of approximately 10 mg/L over time. The high concentrations during the early weeks may be a result of: 1) release from sulphide oxidation reactions, 2) a flush of process water from the tailings sample, or 3) the dissolution of soluble sulphate minerals (i.e., gypsum [CaSO₄·2H₂O]).
- Concentrations of metals are generally decreasing over time and are below MISA limits. However, concentrations of aluminum, copper and molybdenum were observed to be greater than PWQO (MOEE, 1994):
 - Concentrations of aluminum (0.02–0.13 mg/L) are frequently greater than or near the PWQO (0.075 mg/L);
 - Concentration of copper at week 0 and week 10 (0.0013 and 0.0041 mg/L, respectively) are greater than the PWQO (0.001 mg/L);
 - Concentrations of molybdenum, during weeks 0, 1 and 2 (0.054–0.088 mg/L), are greater than the PWQO (0.04 mg/L), but decrease to below the PWQO from week 5 to week 35;
 - Concentrations of other metals are below PWQOs.

Depletion Calculation

The depletion times of neutralization potential of MAR07-Tailings humidity cell are longer than the depletion times of the acid potential (Table 10). Thus, as with the static test and NAG results, the depletion calculations suggest that the combined (average ore grade) tailings sample is non-acid generating.

4.3 Water Quality Modeling

Water quality modeling consisted of mixing calculations to estimate the long-term, steady state water quality of mixed drainage consisting of effluents from tailings, NRD waste rock and ARD

waste rock. Input effluent water qualities for the tailings, NRD waste rock and ARD waste rock are summarized in Table 19. The results of the water quality estimates are shown in Table 20.

Based on the water quality estimates of the mixed waste rock and tailings effluent, the key results are as follows:

- The equilibrated mixture of tailings and waste rock effluent is expected to have a near neutral pH (7.88), due to the moderate concentrations of alkalinity (~20 mg/L as CaCO₃).
- Concentrations of alkalinity are expected to be sufficient to buffer the acidity produced by acid generating rock. However, if the alkalinity is lower than expected, the non-equilibrated mixture of tailings and waste rock effluent suggests that the drainage from the mine wastes may become acidic (pH~3.69).
- Concentrations of cadmium, cobalt, copper, iron, nickel and zinc are expected to be elevated in the mixed tailings and waste rock effluent (i.e., >PWQOs), despite the near-neutral pH conditions. In addition, concentrations of aluminum are likely to be elevated, but are expected to decrease as a result of precipitation and sedimentation processes. Concentrations of other metals are expected to be low (i.e., below PWQO).

5.0 LIMITATIONS

This document is provided for the information of Micon International Ltd. and Marathon PGM Corporation only. Third party reliance on the information provided in this document is at the sole risk of the third party. The document is not for publishing or to be presented in part or in whole in a public context, such as in a feasibility study, which will be used by the public for the purposes of investing, as such, costs do not include certification of the document under National Instrument 43-101 (NI 43-101). Should certification of the document be required, then a written request from the site owner (Marathon PGM Corporation) would be required and additional scope and cost may result, which are not currently included.

This report is based on a geological data set. Conditions between sampling points may vary. Should observations between sampling points differ from those anticipated based on the current data set, additional evaluation would be necessary, which may result in changes to the conclusions and recommendations of this report.

The water quality modeling has limitations, including:

- Inflows to the mine waste management areas from natural watershed sources (i.e., direct precipitation, natural runoff and groundwater seepage) are not included in the calculations;
- Other significant load sources, such as open pit runoff, plant site runoff or tailings process water are not included in the calculations; and
- Adsorption or biological processes (i.e., biodegradation, attenuation) that may be controlling concentrations in solution are not included in the model.

It is important to note that load contributions in addition to the tailings and waste rock effluents, such as runoff from the open pit, runoff from the plant site and tailings process water, will influence the overall site water quality. Thus, as the project progresses, additional water quality estimates should be completed to further assess the water quality implications from other site aspects (i.e., open pit and process waters).

All models are just estimations of projected site conditions based on a limited data set. Site monitoring is required as the project progresses and should be used to routinely update water quality estimates. Adaptive management based on monitoring data and updated water quality estimates will be required as the project progresses.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Based on our current understanding of the site geology and deposit, the key conclusions related to the geochemical and mineralogical characteristics of the waste rock are as follows:

- Mineralogical analysis of the rock samples indicates that the principal mineralogical assemblage consists of plagioclase, and to a lesser extent diopside, quartz and amphibole. Sulphide minerals predominately consist of pyrrhotite, chalcopyrite and pyrite, and carbonate minerals (i.e., calcite and dolomite) were detected in trace amounts.
- Acid-base accounting (ABA) results show that the majority of the rock samples collected are not expected to be acid generating. However, based on the overall quantities of sulphide minerals observed, it is possible that acid generating conditions could develop in the overall pile, if sufficient NP is not provided by the non-carbonate minerals and the oxidation processes are not mitigated. Based on samples with a sulphide content greater than 0.3 wt% as S, the Volcanic rock type has the greatest percentage of samples that are expected to be acid generating (~40%), followed by Heterolithic Breccia (~33%), Eastern Gabbro (~7%) and Two Duck Lake Gabbro (~6%). Although the acid generation potential of most of the waste rock samples is low, approximately 7% of the samples are considered to be acid generating.
- Net acid generation (NAG) testing results are in general agreement with the ABA results and indicate that the majority of samples are non-acid generating. In addition, the NAG results indicate that some rock with sulphide contents greater than 0.3 wt% as S may be non-acid generating due to the abundance of neutralizing minerals. However, the NAG samples with sulphide contents greater than 0.5 wt% as S have the capacity to generate moderate to highly acidic conditions.
- Short-term leach testing suggests that several metals require further evaluation with respect to implications to the overall site water quality, including Al, Ag, B, Co, Cr, Cu, Fe, Pb, V and Zn.
- In addition to the short-term leach testing, analysis of the NAG supernatant suggests that several metals require further evaluation with respect to implications to the overall site water quality, including Al, Cd, Co, Cr, Cu, Ni, Zn, and to a lesser extent B, Fe, Pb and Tl.
- Concentrations in the kinetic test leachate for the waste rock samples showed that Al, As, Cu, and to a lesser extent Cd and U, occurred at concentrations greater than PWQOs during the 56 week test period.

Tailings

Based on the analysis of the preliminary tailings samples, the key conclusions related to the geochemical characteristics of the tailings are as follows:

- Acid-base accounting (ABA) and net acid generation (NAG) testing suggest that majority of the tailings samples are not expected to be acid generating. However, the NAG test results indicate that tailings with a sulphide content as low as 0.2 wt% as S has the capacity to generate acidic conditions, if the sulphide minerals are rapidly oxidized.
- Short-term leach testing suggests that several metals require further evaluation with respect to implications to the overall site water quality, including Al, Ag, B, Co, Cr, Cu, Fe, Pb, V and Zn.

- In addition to the short-term leach testing, analysis of the NAG supernatant suggests that several metals require further evaluation with respect to implications to the overall site water quality, including Al, Cd, Co, Cr, Cu, Ni, Zn, and to a lesser extent B, Fe, Pb and Tl.
- Concentrations in the kinetic test leachate for the single combined tailings sample (average ore grade) showed that Al, Cu and Mo occurred at concentrations greater than PWQOs at some point during the 36 week test period.
- Water quality analysis of the tailings decant indicates that some metals (i.e., Al, Fe, Mo and Zn) could be present at concentrations above PWQOs in the process water.

Water Quality Modeling

Based on the sample data and water quality estimates of the mixed waste rock and tailings effluent, pH is expected to be near-neutral and concentrations of cadmium, cobalt, copper, iron, nickel and zinc are expected to be above PWQOs in the mixed tailings and waste rock effluent. Furthermore, it is important to note that load contributions from the tailings assume that the sulphide content of the tailings will be 0.1 wt% as S (or less) and (or) assumes appropriate management to prohibit potential ARD from forming in the tailings. In addition, loading sources, such as runoff from the open pit, runoff from the plant site and tailings process water, were not included in the water quality modeling, but will influence the overall site water quality.

Although the majority of waste rock samples do not have acid generating properties, a portion of the waste rock could be potentially acid generating and metal leaching. Depending on the site water balance, flow logic and baseline water quality, and thus the overall site water quality, waters coming into contact with waste rock drainage or tailings effluent may require treatment or settling to reduce the total metal concentrations.

Recommendations

Based on the above results and conclusions, the following recommendations are provided:

- Preparation of a general mitigation plan considering options is recommended. For example, segregation of acid generating materials (high sulphide wastes) into a chemically stable environment (i.e., under non-acid generating tailings or underwater) may be an option that is considered.
- Confirmation and segregation, based on operational monitoring, is recommended for low sulphide material that may be considered for use in construction on-site.
- Results of the short-term, NAG, longer term repetitive leach testing (kinetic testing) and the preliminary water quality estimates should be used in conjunction with the mine plan and other baseline data (e.g., water balance and water quality) to develop estimates of overall site water quality and to develop a site water management plan.
- It is recommended that an evaluation of containment, treatment and discharge options be conducted as well as an evaluation of potential downstream impacts from the release of any water coming in contact with discharge from waste rock pile(s) and tailings management area(s).

Sulphide contents greater 0.1–0.2 wt% as S in tailings may result in the production of acidic and metal-rich waters. Thus, it is recommended that the that sulphide removal processes be sufficient to maintain sulphide contents at and less than 0.1 wt% and S. If sulphide removal processes cannot maintain sulphide contents less than 0.1 wt% as S, mitigation strategies should be evaluated to reduce sulphide oxidation rates (i.e., sub-aqueous deposition, low sulphide cover over tailings or staged deposition with progressive rehabilitation).

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TABLES

**SUMMARY OF SAMPLES COLLECTED FOR GEOCHEMICAL TESTING
MARATHON PGM-Cu PROJECT**

ROCK TYPE	NUMBER OF SAMPLES	PERCENTAGE OF TOTAL SAMPLES	ESTIMATED PERCENTAGE OF WASTE ROCK ⁽¹⁾
WASTE ROCK			
Eastern Gabbro	57	50%	44-52%
Two Duck Lake Gabbro	32	28%	27-29%
Volcanic	10	8%	14-18%
Heterolithic Breccia	6	6%	0.3-12%
Syenite	7	6%	0.6-4%
Serpentinite	2	2%	<1%
Total	114	100%	-
TAILINGS			
Combined Tailings – Average Ore Grade ⁽²⁾	1	8%	-
Locked Test Tailings Composite ⁽³⁾	6	50%	-
Floatation Test Tailings Composite ⁽⁴⁾	5	42%	-
Total	12	100%	-

Notes:

(1) Estimated percentage of waste rock for each rock type was visually estimated using the available background information, including geology maps, core logs and cross-sections.

(2) **The combined tailings consist of rougher and cleaner tailings combined as a by-product from the processing of average grade ore.

(3) **Samples from locked testing were combined to formulate composite samples that represent a range of sulphide contents.

(4) **Samples from variability floatation testing were combined to formulate composite samples that represent a range of sulphide contents.

**The tailings samples were generated by SGS Mineral Services from bench-scale, locked and floatation testing and were internally submitted the sample to the environmental department for geochemical testing.

TABLE 2
SUMMARY OF QUALITATIVE X-RAY DIFFRACTION RESULTS: WASTE ROCK
MARATHON PGM-Cu PROJECT

SAMPLE ID	CRYSTALLINE MINERAL ASSEMBLAGE (relative proportions based on peak height)			
	Major	Moderate	Minor	Trace
EASTERN GABBRO				
MAR07-16	plagioclase	quartz	diopside, pyrrhotite	*chalcopyrite, *chalcoalumite, *mica, *amphibole
	plagioclase	diopside	ilmenite, magnetite	*quartz, *mica, *calcite, *kaolinite, *olivine, *grossular, *pyrite, *chlorite, *ferropargasite
MAR07-99	plagioclase	diopside	chlorite	*quartz, *calcite, *talc, *ferropargasite, *chalcopyrite
TWO DUCK LAKE GABBRO				
MAR07-15	plagioclase	diopside	quartz, magnetite, pyrrhotite, amphibole	*chlorite, *dolomite, * mica, *talc, *chalcopyrite
	plagioclase	diopside		*quartz, *chalcopyrite, *mica, *rhodochrosite, *chlorite, *zodacite, *schachnerite, *amphibole, *rutile
MAR07-98	plagioclase	ferropargasite	chlorite	*quartz, *mica *talc, *alunite, *calcite, *periclase, osbornite, *diopside
VOLCANIC				
MAR07-33	plagioclase	amphibole	quartz, diopside	*chlorite, *calcite, *chalcopyrite, *epidote, *pyrrhotite, *potassium-feldspar
	plagioclase		pyrrhotite, amphibole, mica	*quartz, *chlorite, *diopside, *calcite
HETEROLITHIC BRECCIA				
MAR07-49	plagioclase	diopside		*chlorite, *calcite, *dolomite, *quartz, *amphibole, *talc, *pyrrhotite, *chalcopyrite
SYENITE				
MAR07-92	plagioclase		potassium-feldspar, quartz	*diopside, *calcite, *mica, *amphibole, *chlorite, *fluorite, *chalcopyrite, *pyrite

Notes:

Interpretations do not reflect the presence of non-crystalline / amorphous compounds. Mineral proportions are based on relative peak heights and may be strongly influenced by crystallinity, structural group or preferred orientations. Interpretations and relative proportions should be accompanied by supporting petrographic and geochemical data (WRA, ICP-OES).

*Tentative identification due to low concentrations, diffraction line overlap or poor crystallinity.

**TABLE 3
STATISTICAL SUMMARY OF WHOLE ROCK RESULTS: WASTE ROCK
MARATHON PGM-Cu PROJECT**

PARAMETERS	UNITS	EASTERN GABBRO					TWO DUCK LAKE GABBRO					VOLCANIC				
		MIN	MAX	MED	AVG	STDEV	MIN	MAX	MED	AVG	STDEV	MIN	MAX	MED	AVG	STDEV
SiO ₂	(%)	18	55	46	45	6	29	50	47	46	4	44	64	59	56	7
Al ₂ O ₃	(%)	4	18	14	13	3	6	21	16	15	3	14	16	15	15	1
Fe ₂ O ₃	(%)	8	45	16	18	7	7	35	13	15	6	5	19	9	10	5
MgO	(%)	2	21	8	9	4	4	15	7	3	3	2	6	4	4	1
CaO	(%)	4	15	11	10	2	5	14	11	11	2	5	13	8	8	2
Na ₂ O	(%)	0.4	5	3	2	1	1	4	3	3	1	2	5	3	3	1
K ₂ O	(%)	0.1	2	0.4	1	0.3	0.3	1	1	1	0.2	0.3	2	1	1	1
TiO ₂	(%)	0.2	7	1	1	1	0.3	5	1	1	1	0.3	2	1	1	0.4
P ₂ O ₅	(%)	0.0	7	0.2	1	1	0.1	4	0.3	1	1	0.1	0.4	0.3	0.3	0.1
MnO	(%)	0.1	0.5	0.2	0.3	0.1	0.1	0.4	0.2	0.2	0.1	0.1	0.4	0.2	0.2	0.1
Cr ₂ O ₃	(%)	0.01	0.3	0.04	0.05	0.04	0.01	0.1	0.03	0.03	0.02	0.03	0.1	0.04	0.04	0.01
V ₂ O ₅	(%)	0.01	0.3	0.1	0.1	0.1	0.02	0.2	0.04	0.1	0.04	0.01	0.1	0.02	0.03	0.02
LOI	(%)	-2	3	0.3	0.3	1	-2	5	1	1	1	0.2	3	1	1	1
Sum	(%)	99	102	101	101	1	99	102	100	100	1	99	102	100	100	1
PARAMETERS	UNITS	HETEROLITHIC BRECCIA					SYENITE					SERPENTINITE				
		MIN	MAX	MED	AVG	STDEV	MIN	MAX	MED	AVG	STDEV	MIN	MAX	MED	AVG	STDEV
SiO ₂	(%)	35	49	47	44	5	54	67	60	59	4	54	57	55	55	2
Al ₂ O ₃	(%)	5	17	15	13	4	11	16	14	13	2	14	15	14	14	1
Fe ₂ O ₃	(%)	11	34	12	17	9	5	17	7	9	5	5	10	7	7	3
MgO	(%)	4	17	7	8	4	0.3	2	1	1	1	3	6	4	4	2
CaO	(%)	4	14	12	11	3	2	7	4	5	2	8	9	8	8	1
Na ₂ O	(%)	1	4	2	2	1	3	6	5	5	1	4	5	4	4	1
K ₂ O	(%)	0.2	1	0.4	0.5	0.2	3	5	4	4	1	1	1	1	1	0.1
TiO ₂	(%)	1	2	1	1	0.4	0.3	2	0.4	1	1	1	1	1	1	0.3
P ₂ O ₅	(%)	0.1	1	0.3	0.3	0.2	0.0	1	0.1	0.2	0.2	0.2	0.4	0.3	0.3	0.2
MnO	(%)	0.2	0.5	0.2	0.2	0.1	0.1	0.4	0.2	0.2	0.1	0.1	0.2	0.1	0.1	0.04
Cr ₂ O ₃	(%)	0.02	0.1	0.04	0.04	0.01	0.01	0.04	0.02	0.02	0.01	0.03	0.1	0.04	0.04	0.02
V ₂ O ₅	(%)	0.03	0.1	0.04	0.1	0.04	0.01	0.01	0.01	0.01	0.00	0.02	0.04	0.03	0.03	0.01
LOI	(%)	1	4	1	2	1.2	1	4	2	2	1	3	5	4	4	1
Sum	(%)	98	102	100	100	1	98	101	99	99	1	100	100	100	100	0.1

Notes:
MIN - Minimum; MAX - Maximum; MED - Median; AVG - Average; STDEV - Standard Deviation.

TABLE 4
STATISTICAL SUMMARY OF BULK METAL RESULTS: WASTE ROCK
MARATHON PGM-Cu PROJECT

PARAMETERS	UNITS	TYPICAL CRUSTAL ABUNDANCE ⁽¹⁾	EASTERN GABBRO					TWO DUCK LAKE GABBRO					VOLCANIC					HETEROLITHIC BRECCIA					SYENITE					SERPENTINITE				
			MIN	MAX	MED	AVG	STDEV	MIN	MAX	MED	AVG	STDEV	MIN	MAX	MED	AVG	STDEV	MIN	MAX	MED	AVG	STDEV	MIN	MAX	MED	AVG	STDEV	MIN	MAX	MED	AVG	STDEV
Ag	mg/kg	0.08	0.05	3	0.2	0.3	0.5	0.05	3	0.2	0.5	0.7	0.07	3	0.2	0.5	0.9	0.07	4	1	1	2	0.2	2	1	0.0	0.6	0.2	0.2	0.2	0.2	0.02
Al	mg/kg	82300	18000	95000	70000	66684	15808	30000	110000	78000	74969	17891	69000	80000	76000	74778	3383	26000	85000	72000	66143	20277	52000	78000	70000	67429	9914	68000	72000	70000	70000	2828
As	mg/kg	2	<2	26	1	2	4	<2	3	1	1	0.4	1	4	1	1	1	1	7	1	2	2	<2	<2	1	<2	-	<2	<2	1	<2	-
Ba	mg/kg	425	140	1800	320	352	245	220	2800	390	541	603	200	570	360	347	114	120	380	280	274	106	200	1200	540	610	345	180	270	225	225	64
Be	mg/kg	3	0.2	7	0.4	0.7	1	0.3	2	1	0.7	0.4	0.3	2	1	0.9	0.5	0.3	2	0.5	0.7	0.5	3	11	6	7	3	0.8	1	1	1	0.4
Bi	mg/kg	0.009	0.01	0.5	0.04	0.08	0.1	0.01	0.6	0.04	0.1	0.1	0.01	0.5	0.1	0.1	0.1	0.02	0.4	0.2	0.2	0.2	0.04	0.4	0.3	0.1	0.1	0.1	0.2	0.2	0.2	0.02
Ca	mg/kg	41,500	25000	94000	67000	64105	15790	34000	92000	73000	71000	14018	34000	89000	54000	55889	17681	28000	88000	72000	67714	21375	16000	45000	27000	29286	10307	47000	57000	52000	52000	7071
Cd	mg/kg	3	0.07	4	0.2	0.3	0.5	0.002	0.7	0.1	0.3	0.2	0.08	0.9	0.1	0.22	0.3	0.09	0.6	0.4	0.3	0.2	0.1	0.6	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0
Co	mg/kg	25	19	170	66	76	34	27	140	57	61	28	16	56	41	36	15	37	180	65	90	56	4	14	10	9	4	21	43	32	32	16
Cr	mg/kg	102	56	1150	160	241	197	52	460	115	143	90	75	220	160	154	47	100	290	150	166	69	39	130	96	89	34	51	180	116	116	91
Cu	mg/kg	60	29	6300	230	569	1145	43	7300	255	865	1646	33	3500	180	550	1046	79	5700	1300	2058	2087	15	77	42	44	28	85	96	91	91	8
Fe	mg/kg	56,300	50000	290000	110000	121930	48477	49000	240000	85500	98656	47665	34000	94000	60000	61333	22243	71000	230000	78000	116857	63310	32000	110000	54000	62714	30614	35000	63000	49000	49000	19799
K	mg/kg	20,850	1400	14000	4700	5058	2477	3000	12000	5450	5919	1857	3100	16000	7000	9322	5142	2400	8400	4000	4629	1905	27000	37000	28000	30000	3742	9700	9800	9750	9750	71
Li	mg/kg	20	3	19	3	5	4	3	23	3	6	5	3	15	6	6	4	3	13	3	5	4	6	27	11	13	6	3	6	4	4	2
Mg	mg/kg	23300	13000	120000	46000	51684	21647	20000	96000	38000	42761	17123	12000	37000	24000	23778	8772	23000	99000	40000	46143	26561	1800	12000	5600	6800	3959	16000	35000	25500	25500	13435
Mn	mg/kg	950	800	3100	1400	1610	590	800	2800	1200	1373	518	720	2500	1100	1246	560	880	3300	1100	1429	858	490	2900	1300	1527	795	730	1000	865	865	191
Mo	mg/kg	1	0.2	7	1	1	1	0.3	3	1	1	0.6	0.3	3	1	1	1	0.4	5	1	1.6	1.8	2	12	4	6	4	1	2	2	2	0.4
Ni	mg/kg	84	37	1800	160	203	154	4	490	125	150	110	42	220	72	90	56	92	580	300	266	166	5	51	18	19	17	36	200	118	118	116
Pb	mg/kg	14	1	14	3	4	3	1	18	4	4	3	2	11	5	6	3	1	11	8	6	4	12	47	20	22	12	7	7	7	7	-
Sb	mg/kg	0.2	<0.1	4	0.1	0.3	0.7	<0.1	0.3	0.1	0.1	0.08	0.05	1	0.2	0.3	0.4	0.05	1	0.1	0.3	0.4	<0.1	0.5	0.2	0.3	0.2	<0.1	<0.1	0.05	<0.1	-
Se	mg/kg	0.05	<1	5	1	1	0.9	<1	3	1	1	0.7	0.5	2	1	1	1	0.5	4	2	2	1.1	<1	2	1	0.9	0.7	<1	<1	0.5	<1	-
Sn	mg/kg	2	0.2	8	1	1	1	0.4	2	1	0.8	0.3	0.5	2	1	1	1	0.4	6	1	1.6	2.1	1	6	3	3	2	0.9	1	1	1	0.4
Sr	mg/kg	370	200	760	420	441	136	230	1300	585	599	222	250	580	420	414	103	190	610	540	479	146	96	360	180	198	91	240	300	270	270	42
Ti	mg/kg	5650	940	25000	5000	5667	4135	1400	18000	3300	4638	3955	1600	7300	3800	3778	1690	2000	6900	2800	3371	1658	1200	7600	2200	2757	2225	2900	4200	3550	3550	919
Tl	mg/kg	0.9	<0.1	0.3	0.1	0.08	0.06	0.05	0.2	0.1	0.06	0.03	0.05	0.4	0.1	0.10	0.1	0.05	0.1	0.1	0.06	0.02	0.3	0.7	0.4	0.4	0.1	<0.1	<0.1	0.05	<0.1	-
U	mg/kg	3	0.08	8	0	0.8	1	0.3	2	1	0.7	0.4	0.05	2	1	0.81	0.7	0.3	2	0.4	0.7	0.53	5	15	12	11	4	0.7	0.9	1	0.8	0.1
V	mg/kg	120	56	1600	280	346	315	72	780	215	262	165	74	280	140	172	86	130	650	200	299	187	6	74	40	40	23	100	180	140	140	57
Y	mg/kg	33	2	110	12	18	19	8	46	13	16	8	11	29	13	16	6	9	19	12	13	4	23	160	67	76	42	15	18	17	17	2
Zn	mg/kg	70	58	280	110	123	47	51	230	92	101	47	60	210	84	94	45	66	220	92	104	53	28	280	160	157	95	76	100	88	88	17

Notes:
 MIN - Minimum; MAX - Maximum; MED - Median; AVG - Average; STDEV - Standard Deviation.
 (1) Typical crustal abundance for continental rocks taken from Price (1997).
 100 - Concentration greater than typical crustal abundance.
 100 - Concentration greater than 5 x the typical crustal abundance.
 100 - Concentration greater than 10 x the typical crustal abundance.

**TABLE 5
STATISTICAL SUMMARY OF ACID-BASE ACCOUNTING (ABA) RESULTS: WASTE ROCK
MARATHON PGM-Cu PROJECT**

SAMPLE ID	Paste pH	Solid-phase Chemistry					Acid Potential (t CaCO ₃ /1000 t)	Neutralization Potentials		Net Neutralization Potentials		Net Potential Ratios	
		Total Sulphur (wt% as S)	Sulphide (wt% as S)	Sulphate (wt% as S)	Total Carbon (wt% as C)	Carbonate (wt% as CO ₃)		NP (t CaCO ₃ /1000 t)	CaNP (t CaCO ₃ /1000 t)	NNP (t CaCO ₃ /1000 t)	CaNNP (t CaCO ₃ /1000 t)	NP:AP	CaNP:AP
EASTERN GABBRO (n = 57)													
Min	8.86	0.01	0.01	<0.4	0.01	0.01	0.3	6	0.08	-107	-123	0.15	0.02
Max	10.22	4	4	<0.4	0.4	1	126	120	18	120	17	387	29
Median	9.81	0.03	0.01	<0.4	0.08	0.2	0.3	32	3	30	1	103	8
Average	9.54	0.2	0.1	<0.4	0.1	0.2	4	33	4	29	-0.3	8	1
Std Dev	0.27	0.6	0.6	-	0.08	0.2	17	18	4	27	18	-	-
TWO DUCK LAKE GABBRO (n = 32)													
Min	9.12	0.01	0.01	<0.4	0.01	0.01	0.3	0	0.08	-84	-96	0.24	0.04
Max	10.05	4	4	<0.4	0.5	2	110	64	36	57	36	172	116
Median	9.81	0.05	0.01	<0.4	0.2	0.5	0.5	39	8	36	6	84	16
Average	9.70	0.2	0.2	<0.4	0.2	0.7	5	39	11	34	6	8	2
Std Dev	0.20	0.7	0.6	-	0.2	0.6	19	11	11	24	22	-	-
VOLCANICS (n = 10)													
Min	8.94	0.01	0.01	<0.4	0.05	0.07	0.3	11	1	-277	-300	0.08	0.01
Max	10.08	10	10	<0.4	0.3	1	302	36	17	26	10	74	28
Median	9.51	0.2	0.1	<0.4	0.1	0.2	4	20	4	14	1	5	1
Average	9.33	2	2	<0.4	0.1	0.3	59	23	5	-36	-53	0.4	0.1
Std Dev	0.39	3	3	-	0.09	0.3	105	7	5	104	107	-	-
HETEROLITHIC BRECCIA (n = 6)													
Min	9.52	0.01	0.01	<0.4	0.1	0.2	0.3	17	3	-3	-17	0.84	0.16
Max	10.15	1	0.7	<0.4	0.2	0.9	22	76	15	75	14	244	33
Median	9.72	0.2	0.1	<0.4	0.2	0.5	3	32	8	31	5	10	2
Average	9.70	0.4	0.3	<0.4	0.2	0.5	8	40	8	32	-0.3	5	1
Std Dev	0.23	0.4	0.3	-	0.05	0.2	10	22	4	29	14	-	-
SYENITE (n = 7)													
Min	9.19	0.01	0.01	<0.4	0.2	0.6	0.3	20	13	19	10	12	7
Max	9.60	0.4	0.1	<0.4	0.9	3	5	66	156	61	44	134	88
Median	9.44	0.03	0.01	<0.4	0.4	1	0.3	37	49	36	20	118	159
Average	9.36	0.09	0.04	<0.4	0.5	1	1	37	72	36	22	28	53
Std Dev	0.16	0.1	0.05	-	0.2	0.7	2	15	57	13	11	-	-
SERPENTINITE (n = 2)													
Min	9.86	0.1	0.01	<0.4	0.2	0.6	0.3	48	11	45	8	17	4
Max	9.95	0.2	0.09	<0.4	0.5	2	3	71	29	71	29	230	94
Median	9.90	0.2	0.05	<0.4	0.3	1	2	60	20	58	18	38	13
Average	9.90	0.2	0.05	<0.4	0.3	1	2	60	20	58	18	38	13
Std Dev	0.06	0.08	0.06	-	0.2	0.8	2	16	13	18	15	-	-

**TABLE 6
EVALUATION OF THE ACID GENERATION POTENTIALS: WASTE ROCK
MARATHON PGM-Cu PROJECT**

SAMPLE ID	SULPHIDE CONTENT (wt% as S)	NET POTENTIAL RATIOS		ACID GENERATION POTENTIAL
		NP:AP	CaNP:AP	
EASTERN GABBRO (n = 57)				
MAR07-01	0.08	13.10	0.27	Non-AG, Low S ²⁻
MAR07-03	0.10	9.04	1.24	Non-AG, Low S ²⁻
MAR07-04	0.03	27.10	6.49	Non-AG, Low S ²⁻
MAR07-05	0.01	46.60	13.88	Non-AG, Low S ²⁻
MAR07-06	0.01	80.60	29.38	Non-AG, Low S ²⁻
MAR07-07	0.01	45.60	7.10	Non-AG, Low S ²⁻
MAR07-08	0.01	139.00	0.27	Non-AG, Low S ²⁻
MAR07-10	0.01	142.00	0.27	Non-AG, Low S ²⁻
MAR07-12	0.01	145.00	0.27	Non-AG, Low S ²⁻
MAR07-16	4.02	9.15	0.02	AG Potential
MAR07-18	0.09	13.50	3.21	Non-AG, Low S ²⁻
MAR07-23	0.06	16.30	1.88	Non-AG, Low S ²⁻
MAR07-24	0.01	68.10	10.81	Non-AG, Low S ²⁻
MAR07-25	0.09	7.69	0.26	Non-AG, Low S ²⁻
MAR07-27	0.54	1.27	0.17	Possible AG Potential
MAR07-32	0.05	26.90	11.47	Non-AG, Low S ²⁻
MAR07-36	0.08	9.50	0.79	Non-AG, Low S ²⁻
MAR07-37	0.01	44.30	21.04	Non-AG, Low S ²⁻
MAR07-38	0.01	110.00	20.50	Non-AG, Low S ²⁻
MAR07-39	0.01	99.00	17.75	Non-AG, Low S ²⁻
MAR07-42	0.02	64.80	6.70	Non-AG, Low S ²⁻
MAR07-43	0.02	48.90	21.52	Non-AG, Low S ²⁻
MAR07-44	0.01	43.20	8.12	Non-AG, Low S ²⁻
MAR07-45	0.02	42.40	14.90	Non-AG, Low S ²⁻
MAR07-46	0.04	27.70	7.19	Non-AG, Low S ²⁻
MAR07-48	0.02	44.80	8.82	Non-AG, Low S ²⁻
MAR07-50	0.02	53.50	0.13	Non-AG, Low S ²⁻
MAR07-51	0.01	88.00	5.38	Non-AG, Low S ²⁻
MAR07-53	0.01	62.10	2.47	Non-AG, Low S ²⁻
MAR07-54	0.01	59.30	4.30	Non-AG, Low S ²⁻
MAR07-55	0.01	66.80	4.41	Non-AG, Low S ²⁻
MAR07-56	0.01	111.00	2.58	Non-AG, Low S ²⁻
MAR07-57	0.01	85.40	2.64	Non-AG, Low S ²⁻
MAR07-59	0.01	115.00	3.17	Non-AG, Low S ²⁻
MAR07-59	0.01	229.00	2.42	Non-AG, Low S ²⁻
MAR07-60	0.01	118.00	3.82	Non-AG, Low S ²⁻
MAR07-61	0.01	110.00	2.85	Non-AG, Low S ²⁻
MAR07-62	0.01	194.00	2.96	Non-AG, Low S ²⁻
MAR07-64	0.12	9.32	1.51	Non-AG, Low S ²⁻
MAR07-65	0.01	387.00	2.74	Non-AG, Low S ²⁻
MAR07-70	0.01	160.00	12.75	Non-AG, Low S ²⁻
MAR07-71	0.01	69.60	11.89	Non-AG, Low S ²⁻
MAR07-72	0.02	51.70	20.47	Non-AG, Low S ²⁻
MAR07-78	0.01	19.40	1.29	Non-AG, Low S ²⁻
MAR07-82	0.03	45.50	5.86	Non-AG, Low S ²⁻
MAR07-83	0.01	127.00	5.60	Non-AG, Low S ²⁻
MAR07-85	0.01	143.00	2.74	Non-AG, Low S ²⁻
MAR07-87	0.01	150.00	3.28	Non-AG, Low S ²⁻
MAR07-89	0.11	11.80	1.04	Non-AG, Low S ²⁻
MAR07-91	0.09	14.70	1.19	Non-AG, Low S ²⁻
MAR07-95	0.01	28.50	6.08	Non-AG, Low S ²⁻
MAR07-97	0.01	211.00	26.74	Non-AG, Low S ²⁻
MAR07-99	0.36	3.50	1.12	Low AG Potential
MAR07-101	1.16	0.41	0.06	AG Potential
MAR07-112	0.01	31.10	4.04	Non-AG, Low S ²⁻
MAR07-113	0.15	9.98	0.51	Non-AG, Low S ²⁻
MAR07-114	0.01	130.00	24.16	Non-AG, Low S ²⁻
TWO DUCK LAKE GABBRO (n = 32)				
MAR07-09	0.01	156.00	2.47	Non-AG, Low S ²⁻
MAR07-11	0.01	68.80	0.27	Non-AG, Low S ²⁻
MAR07-14	0.01	144.00	98.46	Non-AG, Low S ²⁻
MAR07-15	3.52	0.24	0.13	AG Potential
MAR07-19	0.10	18.80	2.24	Non-AG, Low S ²⁻
MAR07-21	0.07	19.40	4.15	Non-AG, Low S ²⁻
MAR07-22	0.02	62.80	18.45	Non-AG, Low S ²⁻
MAR07-28	0.02	72.10	0.73	Non-AG, Low S ²⁻
MAR07-29	0.01	99.50	9.20	Non-AG, Low S ²⁻
MAR07-30	0.01	144.00	25.77	Non-AG, Low S ²⁻
MAR07-31	0.01	138.00	73.71	Non-AG, Low S ²⁻
MAR07-41	0.02	41.50	10.03	Non-AG, Low S ²⁻

**TABLE 6
EVALUATION OF THE ACID GENERATION POTENTIALS: WASTE ROCK
MARATHON PGM-Cu PROJECT**

SAMPLE ID	SULPHIDE CONTENT (wt% as S)	NET POTENTIAL RATIOS		ACID GENERATION POTENTIAL
		NP:AP	CaNP:AP	
MAR07-47	0.01	132.58	13.50	Non-AG, Low S ²⁻
MAR07-63	0.25	4.91	3.25	Non-AG, Low S ²⁻
MAR07-67	0.02	50.00	11.14	Non-AG, Low S ²⁻
MAR07-68	0.02	44.40	5.68	Non-AG, Low S ²⁻
MAR07-69	0.01	158.00	92.00	Non-AG, Low S ²⁻
MAR07-76	0.12	5.15	0.34	Non-AG, Low S ²⁻
MAR07-77	0.05	21.70	5.64	Non-AG, Low S ²⁻
MAR07-79	0.14	13.60	1.16	Non-AG, Low S ²⁻
MAR07-80	0.19	7.89	0.66	Non-AG, Low S ²⁻
MAR07-84	0.01	110.00	5.49	Non-AG, Low S ²⁻
MAR07-86	0.01	99.60	7.91	Non-AG, Low S ²⁻
MAR07-88	0.01	89.90	12.48	Non-AG, Low S ²⁻
MAR07-90	0.01	90.90	25.39	Non-AG, Low S ²⁻
MAR07-93	0.05	25.20	9.10	Non-AG, Low S ²⁻
MAR07-94	0.01	96.50	53.53	Non-AG, Low S ²⁻
MAR07-98	0.01	164.00	111.91	Non-AG, Low S ²⁻
MAR07-106	0.01	122.00	56.49	Non-AG, Low S ²⁻
MAR07-107	0.55	3.70	0.04	Low AG Potential
MAR07-108	0.05	27.90	15.12	Non-AG, Low S ²⁻
MAR07-109	0.01	172.00	116.21	Non-AG, Low S ²⁻
VOLCANIC (n = 10)				
MAR07-17	0.21	4.98	2.50	Non-AG, Low S ²⁻
MAR07-33	1.63	0.71	0.12	AG Potential
MAR07-34	0.01	36.80	4.68	Non-AG, Low S ²⁻
MAR07-52	0.01	73.90	19.91	Non-AG, Low S ²⁻
MAR07-66	0.82	0.70	0.07	AG Potential
MAR07-96	6.34	0.10	0.01	AG Potential
MAR07-102	0.01	55.60	3.71	Non-AG, Low S ²⁻
MAR07-105	0.01	67.10	27.60	Non-AG, Low S ²⁻
MAR07-111	0.03	21.10	5.39	Non-AG, Low S ²⁻
MAR07-110	9.67	0.00	0.01	AG Potential
HETEROLITHIC BRECCIA (n = 6)				
MAR07-02	0.04	26.20	13.33	Non-AG, Low S ²⁻
MAR07-35	0.01	112.00	24.00	Non-AG, Low S ²⁻
MAR07-49	0.71	1.28	0.22	Possible AG Potential
MAR07-74	0.01	244.00	33.36	Non-AG, Low S ²⁻
MAR07-81	0.18	9.99	1.40	Non-AG, Low S ²⁻
MAR07-100	0.66	0.04	0.16	AG Potential
SYENITE (n = 7)				
MAR07-13	0.09	11.70	6.67	Non-AG, Low S ²⁻
MAR07-20	0.03	40.70	21.82	Non-AG, Low S ²⁻
MAR07-26	0.01	84.70	44.06	Non-AG, Low S ²⁻
MAR07-40	0.01	134.00	87.70	Non-AG, Low S ²⁻
MAR07-73	0.01	118.00	81.78	Non-AG, Low S ²⁻
MAR07-75	0.14	14.60	10.75	Non-AG, Low S ²⁻
MAR07-92	0.01	63.00	34.81	Non-AG, Low S ²⁻
SERPENTINITE (n = 2)				
MAR07-103	0.09	17.20	3.76	Non-AG, Low S ²⁻
MAR07-104	0.01	230.00	94.16	Non-AG, Low S ²⁻

Notes:

(1) Net potential ratios are compared to Price (1997) criteria as follows:

1.00	= NP/AP is greater than 4 - potential to generate acidic conditions is "none".
1.00	= NP/AP is between 2 and 4 - potential to generate acidic conditions is "low".
1.00	= NP/AP is between 1 and 2 - potential to generate acidic conditions is "possible".
1.00	= NP/AP is less than 1 - potential to generate acidic conditions is "likely".

(2) Acid generation potentials are based on the sulphide content and NP:AP as follows:

Non-AG, Low S ²⁻	= Non-AG, low S ²⁻ : sulphide content less than 0.3 wt% as S and net potential ratio (NP:AP) is greater than 4 (no acid generation potential).
Low AG Potential	= Low AG Potential: sulphide content greater than 0.3 wt% as S and net potential ratio (NP:AP) is between 2 and 4.
Possible AG Potential	= Possible AG Potential: sulphide content greater than 0.3 wt% as S and net potential ratio (NP:AP) is between 1 and 2.
AG Potential	= AG: sulphide content greater than 0.3 wt% as S and net potential ratio (NP:AP) is less than 1.

**NET ACID GENERATION (NAG) TEST RESULTS: WASTE ROCK
MARATHON PGM-Cu PROJECT**

SAMPLE ID	SULPHIDE CONTENT (wt% as S)	NAG pH	NAG ACIDITY ⁽¹⁾ @ pH 4.5 (kg H ₂ SO ₄ / t)	NAG ACIDITY ⁽²⁾ @ pH 7.0 (kg H ₂ SO ₄ / t)	ACID GENERATION POTENTIAL ⁽³⁾
EASTERN GABBRO					
MAR07-16	4.02	2.69	21	50	PAF
MAR07-18	0.09	9.53	0.00	0.00	NAF
MAR07-27	0.54	4.29	0.33	2.6	PAF-LC
MAR07-78	0.01	7.58	0.00	0.00	NAF
MAR07-99	0.36	9.69	0.00	0.00	NAF
MAR07-101	1.16	3.00	11	20	PAF
TWO DUCK LAKE GABBRO					
MAR07-15	3.52	2.87	11	35	PAF
MAR07-41	0.02	9.44	0.00	0.00	NAF
MAR07-63	0.25	9.17	0.00	0.00	NAF
MAR07-80	0.19	7.07	0.00	0.00	NAF
MAR07-98	0.01	10.82	0.00	0.00	NAF
MAR07-107	0.55	4.40	0.32	6.3	PAF-LC
VOLCANIC					
MAR07-33	1.63	3.17	6.1	13	PAF
MAR07-96	6.34	2.53	26	51	PAF
HETEROLITHIC BRECCIA					
MAR07-35	0.01	9.42	0.00	0.00	NAF
MAR07-49	0.71	5.41	0.00	1.9	NAF
SYENITE					
MAR07-75	0.14	8.98	0.00	0.00	NAF
MAR07-92	0.01	9.93	0.00	0.00	NAF

Notes:**4.00**- Denotes NAG pH values less than 4.5 or NAG acidity values greater than 5 kg H₂SO₄/ tonne.

(1) NAG Acidity @ pH 4.5 - measured by a titration to a pH of 4.5.

(2) NAG Acidity @ pH 7.0 - measured by a titration to a pH of 7.0.

(3) Acid generation potential is evaluated according to AMIRA (2002) as follows:

NAF

- Non-acid forming: NAG pH >4.5 and (or) NAG acidity is zero.

PAF-LC- Potentially acid forming - low capacity: NAG pH <4.5 and NAG acidity @ pH 4.5 is less than 5 kg H₂SO₄/ tonne.**PAF**- Potentially acid forming: NAG pH <4.5 and NAG acidity @ pH 4.5 is greater than 5 kg H₂SO₄/ tonne.

**TABLE 8
STATISTICAL SUMMARY OF SHORT-TERM LEACH TEST RESULTS: WASTE ROCK
MARATHON PGM-Cu Project**

PARAMETER	UNIT	PROVINCIAL WATER QUALITY OBJECTIVES ⁽¹⁻⁸⁾	EASTERN GABBRO					TWO DUCK LAKE GABBRO					VOLCANIC					HETEROLITHIC BRECCIA					SYENITE					SERPENTINITE				
			MIN	MAX	MED	AVG	STDEV	MIN	MAX	MED	AVG	STDEV	MIN	MAX	MED	AVG	STDEV	MIN	MAX	MED	AVG	STDEV	MIN	MAX	MED	AVG	STDEV	MIN	MAX	MED	AVG	STDEV
Al	mg/L	0.015	0.005	1.42	0.2	0.3	0.3316	0.05	0.9	0.2	0.3	0.3	0.08	0.6	0.09	0.2	0.3	0.02	1.0	0.3	0.4	0.5	0.08	0.22	0.15	0.15	0.099	0.98	1.42	1.2	1.2	0.3111
As	mg/L	0.005	0.0001	0.0222	0.0006	0.0018	0.0048	0.0002	0.0038	0.0006	0.001	0.0011	0.0004	0.001	0.0006	0.0007	0.0003	0.0001	0.0039	0.0003	0.0014	0.0021	0.0008	0.002	0.0014	0.0014	0.0008	0.0029	0.0034	0.0032	0.0032	0.0004
Ag	mg/L	0.0001	5E-05	5E-05	5E-05	5E-05	-	5E-05	5E-05	5E-05	5E-05	-	5E-05	5E-05	5E-05	5E-05	-	5E-05	5E-05	5E-05	5E-05	-	5E-05	5E-05	5E-05	5E-05	-	5E-05	5E-05	5E-05	5E-05	-
Ba	mg/L	---	0.2	0.4	0.3	0.3	0.0639	0.2	0.4	0.3	0.3	0.0674	0.2	0.377	0.318	0.284	0.1139	0.0951	0.3	0.2	0.2	0.0907	0.253	0.407	0.33	0.33	0.1089	0.245	0.301	0.273	0.273	0.0396
Be	mg/L	0.011	0.0002	0.0002	0.0002	0.0002	-	0.0002	0.0002	0.0002	0.0002	-	0.0002	0.0002	0.0002	0.0002	-	0.0002	0.0002	0.0002	0.0002	-	0.0002	0.0002	0.0002	0.0002	-	0.0002	0.0002	0.0002	0.0002	-
B	mg/L	0.2	0.016	0.09	0.0465	0.0475	0.0189	0.034	0.073	0.0505	0.05	0.0133	0.042	0.058	0.052	0.0507	0.0081	0.04	0.1	0.075	0.078	0.0396	0.055	0.067	0.061	0.061	0.0085	0.086	0.09	0.088	0.088	0.0028
Bi	mg/L	---	1E-05	0.0005	1E-05	4E-05	0.0001	1E-05	0.0001	1E-05	3E-05	4E-05	1E-05	1E-05	1E-05	1E-05	-	1E-05	1E-05	1E-05	1E-05	-	2E-05	0.0002	0.0001	0.0001	0.0001	1E-05	2E-05	1E-05	1E-05	7E-06
Ca	mg/L	---	1.3	18	4.135	5.759	4.4389	1.53	19.4	4.74	6.002	5.2594	7.04	13.2	7.39	9.21	3.4599	2.5	60.8	8.55	23.95	32.056	5.14	14.4	9.77	9.77	6.5478	1.21	1.24	1.225	1.225	0.0212
Cd	mg/L	0.0001	3E-05	1E-04	3E-05	4E-05	2E-05	3E-05	8E-05	3E-05	4E-05	2E-05	3E-05	3E-05	3E-05	3E-05	-	3E-05	3E-05	3E-05	3E-05	-	3E-05	3E-05	3E-05	3E-05	-	3E-05	3E-05	3E-05	3E-05	-
Co	mg/L	0.0009	5E-05	0.0014	0.0001	0.0003	0.0004	4E-05	0.0006	0.0002	0.0002	0.0002	4E-05	0.0004	5E-05	0.0002	0.0002	0.0002	0.0004	0.0004	0.0003	0.0001	7E-05	8E-05	8E-05	8E-05	6E-06	0.0004	0.0008	0.0006	0.0006	0.0002
Cr	mg/L	0.001	0.0002	0.002	0.0002	0.0003	0.0004	0.0002	0.0012	0.0002	0.0003	0.0003	0.0002	0.0022	0.0002	0.0008	0.0012	0.0002	0.0006	0.0005	0.0004	0.0002	0.0002	0.0002	0.0002	0.0002	0	0.0021	0.0035	0.0028	0.0028	0.001
Cu	mg/L	0.001	0.0004	0.0147	0.0011	0.0025	0.0034	0.0005	0.0259	0.001	0.0057	0.0094	0.0007	0.0057	0.0015	0.0026	0.0027	0.0009	0.0176	0.0019	0.0088	0.0094	0.0004	0.0046	0.0025	0.0025	0.003	0.0007	0.0012	0.001	0.001	0.0004
Fe	mg/L	0.3	0.005	1.66	0.1	0.3	0.4	0.005	0.88	0.2	0.3	0.3	0.01	0.6	0.02	0.2033	0.3	0.005	0.4	0.3	0.235	0.2186	0.01	0.24	0.125	0.125	0.1626	1.07	1.41	1.24	1.24	0.2404
Hg	mg/L	0.0002	5E-05	5E-05	5E-05	5E-05	-	5E-05	5E-05	5E-05	5E-05	-	5E-05	5E-05	5E-05	5E-05	-	5E-05	5E-05	5E-05	5E-05	-	5E-05	5E-05	5E-05	5E-05	-	5E-05	5E-05	5E-05	5E-05	-
K	mg/L	---	0.4	13.8	1.53	3.32	3.813	0.6	15	2.85	4.41	4.1251	0.5	1.7	1.11	1.09	0.6	0.8	1.75	1.65	1.3933	0.5335	0.71	1.9	1.305	1.305	0.8415	0.95	1.08	1.015	1.015	0.0919
Li	mg/L	---	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	-
Mg	mg/L	---	0.2	19.6	0.8	2.6588	5.3873	0.4	1.76	1.02	1.0349	0.5	0.2	1.0	0.6	0.6	0.4	0.3	3.16	0.792	1.4137	1.5331	0.893	2.32	1.6065	1.6065	1.009	0.506	0.829	0.6675	0.6675	0.2284
Mn	mg/L	---	0.0005	0.2	0.003	0.0115	0.0332	0.0005	0.013	0.0035	0.0043	0.0034	0.001	0.006	0.005	0.004	0.0026	0.003	0.019	0.004	0.0087	0.009	0.008	0.018	0.013	0.013	0.0071	0.017	0.019	0.018	0.018	0.0014
Mo	mg/L	0.04	0.0012	0.0595	0.004	0.0077	0.0127	0.0024	0.0083	0.0032	0.0037	0.0018	0.003	0.0114	0.0073	0.0072	0.0042	0.0044	0.0358	0.0044	0.0149	0.0181	0.0123	0.0212	0.0167	0.0167	0.0063	0.0085	0.0569	0.0327	0.0327	0.0342
Na	mg/L	---	4.82	20.4	11.4	11.584	5.37	4.55	23.7	10.75	11.77	5.4678	6.18	15.1	11.5	10.927	4.4876	19.3	21.8	19.9	20.333	1.3051	7.36	9.59	8.475	8.475	1.5768	68.2	78.2	73.2	73.2	7.0711
Ni	mg/L	0.025	0.0004	0.0028	0.0006	0.0009	0.0007	0.0004	0.0017	0.0009	0.0009	0.0005	0.0004	0.0017	0.0004	0.0008	0.0008	0.001	0.0113	0.0015	0.0046	0.0058	0.0004	0.0004	0.0004	0.0004	0	0.0012	0.0041	0.0027	0.0027	0.0021
Pb	mg/L	0.001	0.0007	0.0521	0.0018	0.0107	0.015	0.0008	0.0358	0.0013	0.0074	0.0131	0.0012	0.0025	0.0019	0.0018	0.0007	0.0017	0.0242	0.0022	0.0093	0.0129	0.0207	0.0251	0.0229	0.0229	0.0031	0.0019	0.0249	0.0134	0.0134	0.0163
Sb	mg/L	0.02	0.0006	0.0046	0.0009	0.0012	0.0009	0.0006	0.0033	0.0009	0.0011	0.0008	0.0009	0.0018	0.0014	0.0014	0.0005	0.0004	0.0493	0.0009	0.0169	0.0281	0.0011	0.0014	0.0012	0.0012	0.0002	0.0015	0.0015	0.0015	0.0015	-
Se	mg/L	0.1	0.0005	0.006	0.0005	0.0008	0.0012	0.0005	0.001	0.0005	0.0006	0.0002	0.0005	0.0005	0.0005	0.0005	-	0.0005	0.0005	0.0005	0.0005	-	0.0005	0.0005	0.0005	0.0005	-	0.0005	0.0005	0.0005	0.0005	-
Sn	mg/L	---	0.0002	0.0016	0.0006	0.0007	0.0004	0.0002	0.0012	0.0005	0.0006	0.0004	0.0004	0.0089	0.0005	0.0033	0.0049	0.0004	0.0007	0.0007	0.0006	0.0002	0.0007	0.0009	0.0008	0.0008	0.0001	0.0004	0.0005	0.0005	0.0005	7E-05
Sr	Bq/L	---	0.0164	0.1	0.0383	0.0486	0.0299	0.0217	0.2	0.0423	0.0594	0.0522	0.0421	0.1	0.0697	0.0739	0.0341	0.0251	0.4	0.085	0.171	0.2031	0.0413	0.163	0.1022	0.1022	0.0861	0.0135	0.0145	0.014	0.014	0.0007
Ti	mg/L	---	0.0001	0.1	0.002	0.0094	0.0257	0.0002	0.0136	0.0066	0.0059	0.0051	0.0007	0.0256	0.0007	0.009	0.0144	0.0025	0.0144	0.0058	0.0076	0.0061	0.0004	0.0027	0.0016	0.0016	0.0016	0.0496	0.0502	0.0499	0.0499	-
Tl	mg/L	0.0003	5E-05	0.0002	5E-05	6E-05	3E-05	5E-05	5E-05	5E-05	5E-05	7E-21	5E-05	5E-05	5E-05	5E-05	-	5E-05	5E-05	5E-05	5E-05	-	5E-05	5E-05	5E-05	5E-05	-	5E-05	5E-05	5E-05	5E-05	-
U	mg/L	0.005	1E-05	0.0003	1E-05	5E-05	9E-05	1E-05	0.0004	1E-05	6E-05	0.0001	2E-05	9E-05	3E-05	5E-05	4E-05	1E-05	0.0003	9E-05	0.0001	0.0001	0.0005	0.007	0.0038	0.0038	0.0045	0.0002	0.0009	0.0005	0.0005	0.0005
V	mg/L	0.006	3E-05	0.0502	0.0096	0.0114	0.0121	0.0009	0.0287	0.0054	0.0107	0.0099	0.0018	0.0254	0.014	0.0137	0.0118	6E-05	0.0866	0.0122	0.033	0.0489	0.0009	0.0043	0.0026	0.0026	0.0024	0.048	0.118	0.083	0.083	0.0495
W	mg/L	0.03	0.0002	0.0016	0.0005	0.0006	0.0004	0.0002	0.0017	0.0005	0.0006	0.0004	0.0012	0.004	0.0013	0.0022	0.0016	0.0001	0.0079	0.0003	0.0028	0.0044	0.0006	0.0016	0.0011	0.0011	0.0007	0.002	0.0032	0.0026	0.0026	0.0009
Y	mg/L	---	8E-06	0.0003	1E-05	5E-05	9E-05	1E-05	0.0002	2E-05	4E-05	5E-05	7E-06	5E-05	1E-05	3E-05	3E-05	9E-06	0.0001	2E-05	6E-05	8E-05	6E-05	0.0004	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	7E-07
Zn	mg/L	0.02	0.0029	0.0433	0.0066	0.0096	0.0093	0.0026	0.0128	0.0058	0.0064	0.003	0.0048	0.0082	0.0062																	

**TABLE 9
NET ACID GENERATION (NAG) TEST SUPERNATANT CHEMISTRY: WASTE ROCK
MARATHON PGM-Cu PROJECT**

PARAMETER	UNITS	PROVINCIAL WATER QUALITY OBJECTIVES ⁽¹⁻⁴⁾	EASTERN GABBRO						TWO DUCK LAKE GABBRO						VOLCANIC		HETEROLITHIC BRECCIA		SYENITE	
			MAR07-18	MAR07-99	MAR07-16	MAR07-27	MAR07-78	MAR07-101	MAR07-98	MAR07-80	MAR07-15	MAR07-41	MAR07-63	MAR07-107	MAR07-33	MAR07-96	MAR07-49	MAR07-35	MAR07-75	MAR07-92
Sulphide Content	wt% as S	---	0.09	0.36	4.02	0.54	0.01	1.16	0.01	0.19	3.52	0.02	0.25	0.55	1.63	6.34	0.71	0.01	0.14	0.01
pH	units	6.5 to 8.5	9.49	9.67	2.55	3.63	7.17	2.89	10.5	3.62	2.71	9.08	8.96	3.12	2.93	2.4	4.78	8.76	3.92	10.1
Alkalinity	mg/L as CaCO ₃	---	40	47	< 2	< 2	17	< 2	79	< 2	< 2	41	37	< 2	< 2	< 2	< 2	39	< 2	76
Acidity	mg/L as CaCO ₃	---	< 2	< 2	534	38	< 2	217	< 2	18	473	< 2	< 2	112	160	862	28	< 2	17	< 2
Conductivity	uS/cm	---	196	331	2170	494	74	1180	227	370	1870	108	400	755	1220	2950	506	148	233	161
SO ₄	mg/L	---	49	100	730	180	6	390	< 5	110	750	6	110	210	420	1100	240	38	75	< 5
Ag	mg/L	0.0001	0.00009	0.00014	0.00006	0.00042	0.00003	0.00091	0.00016	0.00003	0.00036	0.00010	0.00012	0.00023	0.00165	0.00378	0.00020	0.00016	0.00003	0.00001
Al	mg/L	0.015	0.77	1.81	13.7	0.83	0.41	14.1	2.64	0.07	11.9	0.65	2.32	0.87	3.27	20.4	0.06	0.87	0.34	1.46
As	mg/L	0.005	0.0009	0.0029	0.0003	0.0004	0.0013	0.0005	< 0.0002	0.0003	0.0006	< 0.0002	0.0005	0.0004	0.0005	0.0006	0.0004	< 0.0002	0.0003	0.0015
B	mg/L	0.200	0.005	0.011	0.171	0.071	0.004	0.193	0.008	0.020	0.182	0.001	0.006	0.268	0.056	0.260	0.044	0.004	0.002	0.000
Ba	mg/L	---	< 0.00002	< 0.00002	0.0005	0.0001	< 0.00002	0.0020	< 0.00002	< 0.00002	0.0004	< 0.00002	< 0.00002	0.00008	0.0009	0.0014	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Be	mg/L	0.011	0.14	0.20	0.18	0.11	0.04380	0.23	0.15	0.05940	0.07230	0.08600	0.23	0.24	0.05930	0.08640	0.11	0.04180	0.10	0.19
Bi	mg/L	---	< 0.00001	< 0.00001	< 0.00001	< 0.00001	0.00002	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Ca	mg/L	---	28.2	59.9	61.2	34.8	5.3	49.6	31.7	29.2	92.8	15.4	67.5	21.2	105.0	60.0	67.3	20.3	22.6	28.1
Cd	mg/L	0.0001	< 0.00003	< 0.00003	0.00311	0.00187	0.00001	0.00143	0.000011	0.00026	0.00643	< 0.00003	0.000138	0.00327	0.00913	0.00992	0.00272	< 0.00003	0.00003	0.00018
Co	mg/L	0.0009	0.000187	0.000104	0.642	0.218	0.000112	0.814	0.000175	0.000397	0.902	0.000114	0.000564	0.168	0.398	0.999	0.146	0.0001	0.0001	0.00088
Cr	mg/L	0.001	0.0203	0.0250	0.0222	0.0021	0.0190	0.0132	0.0290	0.0148	0.0104	0.0523	0.0191	0.0016	0.0014	0.0289	< 0.0005	0.0408	0.0184	0.0280
Cu	mg/L	0.001	0.0067	0.0017	42.6	9.06	0.0029	6.74	0.0022	0.0893	30.6	0.0038	0.0086	42.0	27.1	11.3	13.7	0.0048	0.0017	0.0008
Fe	mg/L	0.300	0.05	0.03	109	0.24	0.04	21.7	0.09	0.05	119	0.03	0.3	1.76	9.57	228	0.07	0.01	0.08	0.04
Hg	mg/L	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
K	mg/L	---	8.58	3.89	6.82	1.64	4.84	8.04	11.30	3.99	3.58	2.58	3.10	6.88	0.65	11.20	1.35	6.20	4.72	3.91
Li	mg/L	---	0.0011	0.0026	0.0217	0.0092	0.0095	0.0412	< 0.0007	0.0041	0.0086	0.0021	0.0013	0.0061	0.0108	0.0553	0.0045	0.0012	0.0022	0.0009
Mg	mg/L	---	0.016	0.01	13.5	14.9	1.55	15.6	0.012	6.95	14	0.05	0.055	16	4.47	17	10.80	0.03	0.06	0.009
Mn	mg/L	---	0.00053	0.00055	1.32	0.698	0.00171	1.13	0.00178	0.0386	1.24	0.00068	0.00691	0.613	2.06	1.2	0.71	0.0005	0.0019	0.00161
Mo	mg/L	0.040	0.00491	0.00203	0.00017	0.00008	0.00796	0.00011	0.01151	0.00154	0.00021	0.00262	0.00478	0.00008	0.00010	0.00032	0.00006	0.00255	0.03872	0.02440
Na	mg/L	---	3.59	3.66	6.2	6.22	2.96	8.9	4.82	3.33	4.58	4.19	4.84	3.89	2.52	7.22	4.20	3.67	4.74	4.30
Ni	mg/L	0.025	0.0002	< 0.0001	2.84	0.696	< 0.0001	1.64	< 0.0001	< 0.0001	3.83	< 0.0001	0.0066	1.24	1.84	2.13	0.855	< 0.0001	< 0.0001	< 0.0001
P	mg/L	0.02	< 0.01	< 0.01	0.11	< 0.01	0.11	0.02	0.02	< 0.01	0.02	0.01	< 0.01	< 0.01	< 0.01	0.11	< 0.01	0.02	0.01	< 0.01
Pb	mg/L	0.0010	0.0001	0.0001	0.0087	0.0002	0.0003	0.0040	0.0008	0.0002	0.0156	0.0002	0.0067	0.0006	0.0041	0.0151	0.0001	0.0001	0.0001	0.0001
Sb	mg/L	0.02	0.00075	0.00067	0.00041	0.00047	0.00099	0.00032	0.00059	0.00052	0.00044	0.00065	0.00041	0.00041	0.00038	0.00035	0.00052	0.00064	0.00078	0.00127
Se	mg/L	0.100	0.007	0.033	0.011	0.007	< 0.001	0.008	< 0.001	0.028	0.016	0.001	0.019	0.026	0.014	0.014	0.019	0.002	0.003	< 0.001
Sn	mg/L	---	0.00016	0.00023	0.00020	0.00020	0.00116	0.00022	0.00025	0.00076	0.00038	0.00020	0.00026	0.00013	0.00017	0.00056	0.00016	0.00017	0.00015	0.00041
Sr	mg/L	---	0.0789	0.1890	0.207	0.244	0.025	0.290	0.140	0.121	0.378	0.080	0.169	0.173	0.182	0.265	0.239	0.110	0.090	0.0498
Ti	mg/L	---	0.0014	0.0006	0.0060	0.0016	0.0152	0.0022	0.0007	0.0013	0.0043	0.0025	0.0009	0.0011	0.0011	0.0069	0.0008	0.0006	0.0009	0.0009
Tl	mg/L	0.0003	< 0.00001	0.00006	0.00033	0.00010	< 0.00001	0.00039	0.00013	0.00003	0.00042	< 0.00001	0.00002	0.00019	0.00063	0.00061	0.00006	< 0.00001	< 0.00001	< 0.00001
U	mg/L	0.005	0.000003	< 0.000001	0.001360	0.001560	0.003220	0.005550	0.000021	0.000034	0.00095	0.000017	0.000679	0.000738	0.003940	0.004490	0.000034	0.000008	0.000355	0.000347
V	mg/L	0.006	0.0392	0.0886	0.00289	0.00005	0.0152	0.00010	0.0130	0.00575	0.00469	0.0285	0.0160	0.00011	0.00009	0.00342	< 0.00003	0.0327	0.0083	0.0111
W	mg/L	0.030	0.0047	0.00224	< 0.00003	0.00014	0.00304	0.00012	0.00131	0.00029	0.00003	0.00187	0.00045	< 0.00003	0.00004	0.00014	0.00005	0.00091	0.00599	0.0042
Y	mg/L	---	0.000010	0.000018	0.02450	0.00255	0.00003	0.08260	0.000126	0.000014	0.01320	0.000032	0.000051	0.00257	0.012100	0.027900	0.00146	0.00000	0.00004	0.000069
Zn	mg/L	0.02	0.001	0.002	0.455	0.382	0.002	0.801	0.006	0.094	0.691	0.002	3.260	0.240	1.700	0.533	0.239	0.002	0.002	0.002

Notes:
0.1 – Denotes a value that is greater than the Provincial Water Quality Objectives (PWQOs). Although it is not practical to directly compare NAG leachate chemistry to PWQOs, comparisons to PWQOs provide insights (at a screening level) regarding parameters for which aqueous geochemistry may be an important consideration. Where parameters have multiple PWQOs, the lowest was applied to be conservative.

- (1) MOEE [Ontario Ministry of Environment and Energy], 1994 Policies Guidelines Provincial Water Quality Objectives, Reprinted 1999.
- (2) PWQO for P is based on a value to prevent excessive algae growth.
- (3) PWQO for Al depends on pH as follows: pH = 4.5–5.5, PWQO = 0.015 mg/L; pH >5.5–6.5, PWQO = 10% of background concentration; pH >6.5–9.0, PWQO = 0.075 mg/L.
- (4) PWQO for Be depends on hardness as follows: hardness <75 mg/L as CaCO₃, PWQO = 0.011 mg/L; hardness >75 mg/L as CaCO₃, PWQO = 1.1 mg/L.
- (5) PWQO for Cd depends on hardness as follows: hardness 0–100 mg/L as CaCO₃, PWQO = 0.0001 mg/L; hardness >100 mg/L as CaCO₃, PWQO = 0.0005 mg/L.
- (6) PWQO for Cr(VI) (0.001 mg/L) was assumed to apply, and thus all the Cr is assumed to occur as Cr(VI).
- (7) PWQO for Cu depends on hardness as follows: hardness 0–20 mg/L as CaCO₃, PWQO = 0.001 mg/L; hardness >20 mg/L as CaCO₃, PWQO = 0.005 mg/L.
- (8) PWQO for Pb depends on hardness as follows: hardness <30 mg/L as CaCO₃, PWQO = 0.001 mg/L; hardness = 30–80 mg/L as CaCO₃, PWQO = 0.003 mg/L; hardness >80 mg/L as CaCO₃, PWQO = 0.005 mg/L.

**TABLE 10
SULPHIDE AND NEUTRALIZATION POTENTIAL DEPLETION RATES
MARATHON PGM-Cu PROJECT**

Sample ID	Test Duration (Weeks)	Sulphide Minerals				Initial NP (kg/t as CaCO ₃)	NP (Empirical)			NP (SO ₄ -based)			NP (Ca-based)			NP (Alkalinity-based)		
		Initial (wt% as S)	Remaining (%)	Depletion Rate (mg/kg/wk)	Years to Depletion		Remaining (%)	Depletion Rate (mg/kg/wk)	Years to Depletion	Remaining (%)	Depletion Rate (mg/kg/wk)	Years to Depletion	Remaining (%)	Depletion Rate (mg/kg/wk)	Years to Depletion	Remaining (%)	Depletion Rate (mg/kg/wk)	Years to Depletion
EASTERN GABBRO																		
MAR07-16	56	4.02	99.3	3.6	214	18	95	10	35	95	11	30	95	15	23	99	3	131
MAR07-18	56	0.09	95.8	0.5	33	38	97	14	50	100	2	467	99	11	64	98	14	52
MAR07-99	56	0.36	96.4	2	32	40	98	14	52	99	7	115	99	13	59	99	9	85
TWO DUCK LAKE GABBRO																		
MAR07-15	56	3.52	98.7	6.5	102	26	94	23	20	94	20	23	93	30	15	98	8	58
MAR07-80	56	0.19	95.8	0.6	58	47	99	3	354	99	2	482	99	4	235	99	4	246
MAR07-98	56	0.01	95.0	0.07	26	51	99	6	155	100	0.2	4543	99	4	226	99	7	141
VOLCANICS																		
MAR07-33	56	1.63	98.6	3.2	95	36	97	24	28	98	10	67	97	19	36	99	16	44
MAR07-96	56	6.34	99.5	6.3	193	20	98	20	19	95	19.7	19	91	39	9	98	23	18
HETEROLITHIC BRECCIA																		
MAR07-49	56	0.71	97.5	2.3	58	28	97	12	43	98	7	75	98	12	44	99	6	88
SYENITE																		
MAR07-92	27	0.01	96.9	0.08	25	20	99	6	62	100	0.2	1589	99	6	66	99	7	56
TAILINGS																		
Comb Tailings	36	0.1	81.3	2.91	5	24	93	39	11	98	9.1	50	95	34	13	95	31	14

Notes:

(1) Depletion calculations were used to determine if the neutralization potential is decreasing at a greater rate as compared to the sulphide content.

(2) The depletion calculations are based on the results of weeks 51-56 for the waste rock samples and of weeks 29-36 for the tailings sample.

1.00 - Time (years) to depletion for the neutralization potential is less than the time to depletion for the sulphide minerals, and thus indicates the samples that are likely to be net acid generating over the long term.

**TABLE 11
QUALITATIVE X-RAY DIFFRACTION RESULTS: TAILINGS
MARATHON PGM-Cu PROJECT**

SAMPLE ID	CRYSTALLINE MINERAL ASSEMBLAGE (relative proportions based on peak height)			
	Major	Moderate	Minor	Trace
Combined Tailings (Average Ore Grade)	plagioclase	diopside	chlorite, amphibole	*quartz, *mica, *talc, *montmorillonite, *magnetite, *ilmenite

Notes:

Interpretations do not reflect the presence of non-crystalline / amorphous compounds. Mineral proportions are based on relative peak heights and may be strongly influenced by crystallinity, structural group or preferred orientations. Interpretations and relative proportions should be accompanied by supporting petrographic and geochemical data (WRA, ICP-OES).

*Tentative identification due to low concentrations, diffraction line overlap or poor crystallinity.

TABLE 12
WHOLE ROCK RESULTS: TAILINGS
MARATHON PGM-Cu PROJECT

PARAMETERS	UNITS	COMBINED TAILINGS (Average Grade Ore)
SiO ₂	(%)	47
Al ₂ O ₃	(%)	16
Fe ₂ O ₃	(%)	13
MgO	(%)	7
CaO	(%)	13
Na ₂ O	(%)	2
K ₂ O	(%)	0.5
TiO ₂	(%)	1
P ₂ O ₅	(%)	0.3
MnO	(%)	0.2
Cr ₂ O ₃	(%)	0.06
V ₂ O ₅	(%)	0.06
LOI	(%)	1
Sum	(%)	100

TABLE 13
BULK METAL RESULTS: TAILINGS
MARATHON PGM-Cu PROJECT

PARAMETERS	UNITS	TYPICAL CRUSTAL ABUNDANCE ⁽¹⁾	COMBINED TAILINGS (Average Ore Grade)
Ag	mg/kg	0.08	0.26
Al	mg/kg	82300	76,000
As	mg/kg	2	4.0
Ba	mg/kg	425	300
Be	mg/kg	3	0.32
Bi	mg/kg	0.009	0.8
Ca	mg/kg	41,500	69,000
Cd	mg/kg	3	0.23
Co	mg/kg	25	46
Cr	mg/kg	102	310
Cu	mg/kg	60	62
Fe	mg/kg	56,300	63,000
K	mg/kg	20,850	4,700
Li	mg/kg	20	< 3
Mg	mg/kg	23300	36,000
Mn	mg/kg	950	1,200
Mo	mg/kg	1	13
Ni	mg/kg	84	200
Pb	mg/kg	14	6.1
Sb	mg/kg	0.2	1.4
Se	mg/kg	0.05	1.4
Sn	mg/kg	2	0.90
Sr	mg/kg	370	500
Ti	mg/kg	5650	3,800
Tl	mg/kg	0.9	0.06
U	mg/kg	3	0.44
V	mg/kg	120	280
Y	mg/kg	33	13
Zn	mg/kg	70	100

Notes:

(1) Typical crustal abundance for continental rocks taken from Price (1997).

100	- Concentration greater than typical crustal abundance.
100	- Concentration greater than <u>5 x</u> the typical crustal abundance.
100	- Concentration greater than <u>10 x</u> the typical crustal abundance.

**TABLE 14
ACID-BASE ACCOUNTING (ABA) RESULTS: TAILINGS
MARATHON PGM-Cu PROJECT**

SAMPLE ID	Paste pH	Solid-phase Chemistry					Acid Potential (t CaCO ₃ /1000 t)	Neutralization Potentials		Net Neutralization Potentials		Net Potential Ratios ⁽²⁾		ACID GENERATION POTENTIAL ⁽³⁾
		Total Sulphur (wt% as S)	Sulphide (wt% as S)	Sulphate (wt% as S)	Total Carbon (wt% as C)	Carbonate (wt% as CO ₃)		NP (t CaCO ₃ /1000 t)	CaNP ⁽¹⁾ (t CaCO ₃ /1000 t)	NNP (t CaCO ₃ /1000 t)	CaNNP ⁽¹⁾ (t CaCO ₃ /1000 t)	NP:AP	CaNP:AP	
COMBINED TAILINGS														
MAR07-Tailings	8.82	0.18	0.10	<0.4	0.11	0.32	3.1	24.0	5.3	20.9	2.2	7.7	1.7	Non-AG, Low S ²⁻
LOCKED TEST TAILINGS COMPOSITES														
LCT1	8.76	0.20	0.14	0.05	0.11	0.37	4.4	23.0	6.2	18.6	1.8	5.2	1.4	Non-AG, Low S ²⁻
LCT2	8.50	0.09	0.10	< 0.01	0.06	0.17	3.1	21.5	2.8	18.4	-0.3	6.9	0.9	Non-AG, Low S ²⁻
LCT3	8.42	0.26	0.23	0.03	0.07	0.19	7.2	21.4	3.1	14.2	-4.1	3.0	0.4	Non-AG, Low S ²⁻
LCT4	8.51	0.45	0.25	0.20	0.11	0.38	7.8	27.2	6.3	19.4	-1.5	3.5	0.8	Non-AG, Low S ²⁻
LCT5	8.26	0.51	0.44	0.06	0.10	0.38	13.8	25.1	6.4	11.3	-7.4	1.8	0.5	Possible AG
LCT6	8.46	1.04	0.82	0.22	0.12	0.38	25.6	28.2	6.3	2.6	-19.3	1.1	0.2	Possible AG
VARIABILITY FLOATATION TEST TAILINGS COMPOSITES														
F087	8.77	0.35	0.18	0.17	0.07	0.26	5.6	21.5	4.3	15.9	-1.3	3.8	0.8	Non-AG, Low S ²⁻
F088	8.64	0.30	0.20	0.11	0.07	0.21	6.2	21.6	3.5	15.4	-2.7	3.5	0.6	Non-AG, Low S ²⁻
F089	8.61	0.56	0.31	0.25	0.08	0.22	9.7	21.6	3.7	11.9	-6.0	2.2	0.4	Low AG
F090	8.49	0.31	0.16	0.14	0.08	0.30	5.0	20.0	5.0	15.0	0.0	4.0	1.0	Non-AG, Low S ²⁻
F091	8.75	0.22	0.07	0.15	0.13	0.48	2.2	24.8	8.0	22.6	5.8	11.3	3.6	Non-AG, Low S ²⁻

Notes:
 (1) CaNP is derived from concentration of carbonate as wt% CO₃. The CaNP is used to determine the carbonate net neutralization potential (CaNNP) from wt%CO₃ and the carbonate net potential ratio (CaNP/AP).

(2) Net potential ratios are compared to Price (1997) criteria as follows:

1.00	- NP/AP is greater than 4 - potential to generate acidic conditions is "none".
1.00	- NP/AP is between 2 and 4 - potential to generate acidic conditions is "low".
1.00	- NP/AP is between 1 and 2 - potential to generate acidic conditions is "possible".
1.00	- NP/AP is less than 1 - potential to generate acidic conditions is "likely".

(3) Acid generation potentials are based on the sulphide content and NP:AP as follows:

Non-AG, Low S ²⁻	- Non-AG, low S ²⁻ : sulphide content less than 0.3 wt% as S and net potential ratio (NP:AP) is greater than 4 (no acid generation potential).
Low AG	- Low AG Potential: sulphide content greater than 0.3 wt% as S and net potential ratio (NP:AP) is between 2 and 4.
Possible AG	- Possible AG Potential: sulphide content greater than 0.3 wt% as S and net potential ratio (NP:AP) is between 1 and 2.
AG	- AG: sulphide content greater than 0.3 wt% as S and net potential ratio (NP:AP) is less than 1.

**TABLE 15
NET ACID GENERATION (NAG) TEST RESULTS: TAILINGS
MARATHON PGM-Cu PROJECT**

SAMPLE ID	SULPHIDE CONTENT (wt% as S)	NAG pH	NAG ACIDITY ⁽¹⁾ @ pH 4.5 (kg H ₂ SO ₄ / t)	NAG ACIDITY ⁽²⁾ @ pH 7.0 (kg H ₂ SO ₄ / t)	ACID GENERATION POTENTIAL ⁽³⁾
COMBINED TAILINGS					
MAR07-Tailings	0.10	7.77	0.00	0.00	NAF
LOCKED TEST TAILINGS COMPOSITES					
LCT1	0.14	8.31	0.00	0.00	NAF
LCT2	0.10	5.94	0.00	0.97	NAF
LCT3	0.23	4.23	0.33	2.6	PAF-LC
LCT4	0.25	4.19	0.32	2.9	PAF-LC
LCT5	0.44	4.61	0.00	2.2	NAF
LCT6	0.82	3.98	0.65	3.3	PAF-LC
VARIABILITY FLOATATION TEST TAILINGS COMPOSITES					
F087	0.18	4.67	0.00	1.6	NAF
F088	0.20	5.60	0.00	0.33	NAF
F089	0.31	3.53	2.6	4.8	PAF-LC
F090	0.16	9.34	0.00	0.00	NAF
F091	0.07	9.33	0.00	0.00	NAF

Notes:

1.00 - Denotes NAG pH values less than 4.5 or NAG acidity values greater than 5 kg H₂SO₄/ tonne.

(1) NAG Acidity @ pH 4.5 – measured by a titration to a pH of 4.5.

(2) NAG Acidity @ pH 7.0 – measured by a titration to a pH of 7.0.

(3) Acid generation potential is evaluated according to AMIRA (2002) as follows:

NAF	- Non-acid forming: NAG pH >4.5 and (or) NAG acidity is zero.
PAF-LC	- Potentially acid forming - low capacity: NAG pH <4.5 and NAG acidity @ pH 4.5 is less than 5 kg H ₂ SO ₄ / tonne.
PAF	- Potentially acid forming: NAG pH <4.5 and NAG acidity @ pH 4.5 is greater than 5 kg H ₂ SO ₄ / tonne.

**TABLE 16
TAILINGS DECANT WATER QUALITY RESULTS
MARATHON PGM-Cu PROJECT**

PARAMETER	UNITS	PROVINCIAL WATER QUALITY GUIDELINES ⁽¹⁻⁸⁾	COMBINED TAILINGS (Average Ore Grade)	
			Total	Dissolved
pH		6.5 to 8.5	8.9	-
Conductivity	uS/cm	---	368	-
Alkalinity	mg/L as CaCO ₃	---	152	-
Acidity	mg/L as CaCO ₃	---	< 2	-
SO ₄	mg/L	---	51	-
Cl	mg/L	---	28	-
Hg	mg/L	0.0002	0.0001	< 0.0001
Al	mg/L	0.015	175	0.3
As	mg/L	0.005	0.005	0.001
Ag	mg/L	0.0001	0.0003	< 0.00001
Ba	mg/L	---	0.6	0.01
Be	mg/L	0.011	0.001	< 0.00002
B	mg/L	0.2	0.1	0.1
Bi	mg/L	---	0.0005	< 0.00001
Ca	mg/L	---	94	8.7
Cd	mg/L	0.0001	0.001	< 0.000003
Co	mg/L	0.0009	0.1	0.002
Cr	mg/L	0.001	0.3	0.001
Cu	mg/L	0.001	0.9	0.0005
Fe	mg/L	0.3	299	0.6
K	mg/L	---	16	10.6
Li	mg/L	---	0.03	< 0.002
Mg	mg/L	---	147	1.8
Mn	mg/L	---	2.8	0.02
Mo	mg/L	0.04	0.05	0.05
Na	mg/L	---	86	69
Ni	mg/L	0.025	0.5	0.003
P	mg/L	0.02	0.9	1.0
Pb	mg/L	0.001	0.2	0.0001
Sb	mg/L	0.02	< 0.003	0.003
Se	mg/L	0.1	0.002	< 0.001
Si	mg/L	---	146	3.8
Sn	mg/L	---	0.004	0.003
Sr	Bq/L	---	1	0.1
Tl	mg/L	---	2.2	0.002
Tl	mg/L	0.0003	0.0003	0.000004
U	mg/L	0.005	0.001	0.0001
V	mg/L	0.006	0.3	0.002
Zn	mg/L	0.02	1	0.03

Notes:**0.1**

- Denotes a value that is greater than the Provincial Water Quality Objectives (PWQOs). Although it is not practical to directly compare tailings decant chemistry to PWQOs, comparisons to PWQOs provide insights (at a screening level) regarding parameters for which aqueous geochemistry may be an important consideration. Where parameters have multiple PWQOs, the lowest was applied to be conservative.

(1) MOEE [Ontario Ministry of Environment and Energy], 1994. Policies Guidelines Provincial Water Quality Objectives. Reprinted 1999.

(2) PWQO for P is based on a value to prevent excessive algae growth.

(3) PWQO for Al depends on pH as follows: pH = 4.5-5.5, PWQO = 0.015 mg/L; pH >5.5-6.5, PWQO = 10% of background concentration; pH >6.5-9.0, PWQO = 0.075 mg/L.

(4) PWQO for Be depends on hardness as follows: hardness <75 mg/L as CaCO₃, PWQO = 0.011 mg/L; hardness >75 mg/L as CaCO₃, PWQO = 1.1

(5) PWQO for Cd depends on hardness as follows: hardness 0-100 mg/L as CaCO₃, PWQO = 0.0001 mg/L; hardness >100 mg/L as CaCO₃, PWQO =

(6) PWQO for Cr(VI) (0.001 mg/L) was assumed to apply, and thus all the Cr is assumed to occur as Cr(VI).

(7) PWQO for Cu depends on hardness as follows: hardness 0-20 mg/L as CaCO₃, PWQO = 0.001 mg/L; hardness >20 mg/L as CaCO₃, PWQO = 0.005

(8) PWQO for Pb depends on hardness as follows: hardness <30 mg/L as CaCO₃, PWQO = 0.001 mg/L; hardness = 30-80 mg/L as CaCO₃, PWQO = 0.003 mg/L; hardness >80 mg/L as CaCO₃, PWQO = 0.005 mg/L.

TABLE 17
STATISTICAL SUMMARY OF SHORT-TERM LEACH TEST RESULTS: TAILINGS
MARATHON PGM-Cu PROJECT

PARAMETER	UNIT	PROVINCIAL WATER QUALITY OBJECTIVES ⁽¹⁻⁸⁾	COMBINED TAILINGS (Average Ore Grade)
Al	mg/L	0.015	6.9
As	mg/L	0.005	0.002
Ag	mg/L	0.0001	0.0002
Ba	mg/L	---	0.6
Be	mg/L	0.011	0.00003
B	mg/L	0.2	0.7
Bi	mg/L	---	0.0001
Ca	mg/L	---	10.8
Cd	mg/L	0.0001	0.0001
Co	mg/L	0.0009	0.006
Cr	mg/L	0.001	0.025
Cu	mg/L	0.001	0.1
Fe	mg/L	0.3	12
Hg	mg/L	0.0002	0.00005
K	mg/L	---	1.8
Li	mg/L	---	0.001
Mg	mg/L	---	4.9
Mn	mg/L	---	0.1
Mo	mg/L	0.04	0.04
Na	mg/L	---	26
Ni	mg/L	0.025	0.02
Pb	mg/L	0.001	0.008
Sb	mg/L	0.02	0.0008
Se	mg/L	0.1	0.0005
Sn	mg/L	---	0.0004
Sr	Bq/L	---	0.1
Tl	mg/L	---	0.1
Tl	mg/L	0.0003	0.00001
U	mg/L	0.005	0.0001
V	mg/L	0.006	0.01
W	mg/L	0.03	0.002
Y	mg/L	---	0.0007
Zn	mg/L	0.02	0.2

Notes:

0.1

— Denotes a value that is greater than the Provincial Water Quality Objectives (PWQOs). Although it is not practical to directly compare short-term leachate chemistry to PWQOs, comparisons to PWQOs provide insights (at a screening level) regarding parameters for which aqueous geochemistry may be an important consideration. Where parameters have multiple PWQOs, the lowest was applied to be conservative.

(1) MOEE [Ontario Ministry of Environment and Energy], 1994. Policies Guidelines Provincial Water Quality Objectives. Reprinted 15

(2) PWQO for P is based on a value to prevent excessive algae growth.

(3) PWQO for Al depends on pH as follows: pH = 4.5-5.5, PWQO = 0.015 mg/L; pH >5.5-6.5, PWQO = 10% of background concentration; pH >6.5-9.0, PWQO = 0.075 mg/L.

(4) PWQO for Be depends on hardness as follows: hardness <75 mg/L as CaCO₃, PWQO = 0.011 mg/L; hardness >75 mg/L as CaCO₃, PWQO = 1.1 mg/L.

(5) PWQO for Cd depends on hardness as follows: hardness 0-100 mg/L as CaCO₃, PWQO = 0.0001 mg/L; hardness >100 mg/L as CaCO₃, PWQO = 0.0005 mg/L.

(6) PWQO for Cr(VI) (0.001 mg/L) was assumed to apply, and thus all the Cr is assumed to occur as Cr(VI).

(7) PWQO for Cu depends on hardness as follows: hardness 0-20 mg/L as CaCO₃, PWQO = 0.001 mg/L; hardness >20 mg/L as CaCO₃, PWQO = 0.005 mg/L.

(8) PWQO for Pb depends on hardness as follows: hardness <30 mg/L as CaCO₃, PWQO = 0.001 mg/L; hardness = 30-80 mg/L as CaCO₃, PWQO = 0.003 mg/L; hardness >80 mg/L as CaCO₃, PWQO = 0.005 mg/L.

**TABLE 18
NET ACID GENERATION (NAG) TEST SUPERNATANT CHEMISTRY: TAILINGS
MARATHON PGM-Cu PROJECT**

PARAMETER	UNITS	PROVINCIAL WATER QUALITY OBJECTIVES ⁽¹⁻⁸⁾	LOCKED TEST TAILINGS COMPOSITES						VARIABILITY FLOATATION TAILINGS COMPOSITES					COMBINED TAILINGS (Average Ore Grade)
			LCT1	LCT2	LCT3	LCT4	LCT5	LCT6	F087	F088	F089	F090	F091	
Sulphide Content	wt% as S	---	0.14	0.10	0.23	0.25	0.44	0.82	0.18	0.20	0.31	0.16	0.07	0.10
pH	units	6.5 to 8.5	6.99	5.24	3.86	4.83	6.24	4.18	4.58	5.54	3.59	6.55	9.38	6.67
Alkalinity	mg/L as CaCO ₃	---	25	< 2	< 2	< 2	3	< 2	< 2	< 2	< 2	5	45	7
Acidity	mg/L as CaCO ₃	---	< 2	4	16	5	3	13	8	3	39	< 2	< 2	< 2
Conductivity	uS/cm	---	170	190	330	320	270	430	260	200	440	190	150	179
SO ₄	mg/L	---	46	69	120	140	110	180	110	85	160	72	29	57
Ag	mg/L	0.0001	< 0.00001	0.00004	0.00005	< 0.00001	< 0.00001	0.00003	0.00006	0.00004	0.00004	< 0.00001	< 0.00001	0.00008
Al	mg/L	0.015	0.53	< 0.01	0.34	0.02	< 0.01	0.48	0.23	0.01	1.54	0.02	1.12	0.29
As	mg/L	0.005	0.0010	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	0.0007	0.0002
B	mg/L	0.200	0.193	0.088	0.146	0.121	0.054	0.222	0.070	0.126	0.057	0.111	0.243	0.008
Ba	mg/L	---	0.0057	0.0296	0.0894	0.0723	0.0320	0.148	0.0710	0.0308	0.113	0.0145	0.0042	< 0.00002
Be	mg/L	0.011	< 0.00002	0.00003	0.00008	< 0.00002	< 0.00002	0.00008	0.00004	< 0.00002	0.00025	< 0.00002	< 0.00002	0.09590
Bi	mg/L	---	0.00002	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	0.00002	< 0.00001	< 0.00001	< 0.00001
Ca	mg/L	---	26.9	20.5	28.3	41.6	37.8	51.9	29.1	24.4	30.2	26.2	25.1	26.9
Cd	mg/L	0.0001	0.000007	0.000099	0.00123	0.00073	0.000028	0.00321	0.00105	0.00035	0.00202	0.000009	0.000004	0.000007
Co	mg/L	0.0009	0.000155	0.017	0.188	0.102	0.00307	0.316	0.151	0.061	0.227	0.000409	0.000129	0.000129
Cr	mg/L	0.001	0.053	0.032	0.026	0.032	0.0127	0.017	0.027	0.022	0.0023	0.033	0.049	0.076
Cu	mg/L	0.001	0.0047	0.0127	1.2200	0.0668	0.0037	1.6400	1.0000	0.0595	2.4300	0.0037	0.0007	0.0035
Fe	mg/L	0.300	0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	2.38	< 0.01	< 0.01	< 0.01
Hg	mg/L	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
K	mg/L	---	3.10	3.76	3.65	4.66	4.05	5.44	3.51	2.85	4.93	4.96	4.12	2.69
Li	mg/L	---	0.0041	0.0059	0.0074	0.0090	0.0090	0.0108	0.0076	0.0056	0.0072	0.0050	0.0023	0.0024
Mg	mg/L	---	0.031	4.42	7.57	5.43	4.04	8.53	5.37	4.53	7.43	1.54	0.013	0.103
Mn	mg/L	---	0.0058	0.111	0.504	0.287	0.0206	0.721	0.455	0.257	0.80	0.00408	0.00017	0.00050
Mo	mg/L	0.040	0.00587	0.00079	0.00023	0.00023	0.00484	0.00020	0.00018	0.00017	0.00010	0.00453	0.00405	0.00692
Na	mg/L	---	1.34	0.91	1.55	1.59	1.41	2.52	1.22	1.06	1.69	1.01	1.49	1.45
Ni	mg/L	0.025	0.0004	0.0906	0.984	0.451	0.0107	1.31	0.695	0.296	1.07	0.0016	< 0.0001	< 0.0001
P	mg/L	0.02	< 0.01	< 0.01	0.02	0.01	< 0.01	0.03	0.02	< 0.01	0.02	0.04	0.03	< 0.01
Pb	mg/L	0.001	0.00004	0.00002	0.00029	0.00006	0.00004	0.00136	0.00027	0.00002	0.00487	0.00002	0.00004	0.00013
Sb	mg/L	0.02	0.00126	0.00079	0.00076	0.00063	0.00104	0.00054	0.00043	0.00049	0.00199	0.00068	0.00112	0.00055
Se	mg/L	0.100	0.002	0.006	0.008	0.007	0.005	0.010	0.006	0.007	0.009	0.006	0.002	0.003
Sn	mg/L	---	0.00049	0.00009	0.00021	0.00014	0.00018	0.00015	< 0.00001	< 0.00001	0.00045	< 0.00001	0.00009	0.00035
Sr	mg/L	---	0.0774	0.0997	0.155	0.153	0.126	0.222	0.134	0.124	0.162	0.104	0.0890	0.0832
Ti	mg/L	---	0.0007	0.0004	0.0011	0.0006	0.0005	0.0010	0.0006	0.0004	0.0008	0.0004	0.0006	0.0003
Tl	mg/L	0.0003	< 0.00001	0.00006	0.00016	0.00014	0.00007	0.00031	0.00015	0.00009	0.00026	0.00004	0.00001	0.00001
U	mg/L	0.005	0.000017	0.000002	0.000155	0.000004	< 0.000001	0.000312	0.000137	0.000001	0.001060	0.000005	0.000003	0.000010
V	mg/L	0.006	0.0171	0.00065	0.00126	0.00010	< 0.00003	0.00007	0.00142	0.00015	< 0.00003	< 0.00003	0.0110	0.0078
W	mg/L	0.030	0.0135	0.00044	0.00012	0.00004	0.00017	< 0.00003	< 0.00003	< 0.00003	< 0.00003	0.00330	0.0117	0.0045
Y	mg/L	---	0.000006	0.000007	0.00130	0.000058	0.000002	0.00127	0.000793	0.000015	0.00425	0.000002	0.000001	0.000013
Zn	mg/L	0.02	0.001	0.020	0.440	0.155	0.005	0.823	0.240	0.043	0.421	0.001	< 0.001	0.004

Notes:

0.1 - Denotes a value that is greater than the Provincial Water Quality Objectives (PWQOs). Although it is not practical to directly compare short-term leachate chemistry to PWQOs, comparisons to PWQOs provide insights (at a screening level) regarding parameters for which aqueous geochemistry may be an important consideration. Where parameters have multiple PWQOs, the lowest was applied to be conservative.

- (1) MOEE [Ontario Ministry of Environment and Energy], 1994. Policies Guidelines Provincial Water Quality Objectives. Reprinted 1999.
- (2) PWQO for P is based on a value to prevent excessive algae growth.
- (3) PWQO for Al depends on pH as follows: pH = 4.5-5.5, PWQO = 0.015 mg/L; pH >5.5-6.5, PWQO = 10% of background concentration; pH >6.5-9.0, PWQO = 0.075 mg/L.
- (4) PWQO for Cd depends on hardness as follows: hardness <75 mg/L as CaCO₃, PWQO = 0.011 mg/L; hardness >75 mg/L as CaCO₃, PWQO = 1.1 mg/L.
- (5) PWQO for Cu depends on hardness as follows: hardness 0-100 mg/L as CaCO₃, PWQO = 0.0001 mg/L; hardness >100 mg/L as CaCO₃, PWQO = 0.0005 mg/L.
- (6) PWQO for Cr(VI) (0.001 mg/L) was assumed to apply, and thus all the Cr is assumed to occur as Cr(VI).
- (7) PWQO for Pb depends on hardness as follows: hardness 0-20 mg/L as CaCO₃, PWQO = 0.001 mg/L; hardness >20 mg/L as CaCO₃, PWQO = 0.005 mg/L.
- (8) PWQO for Pb depends on hardness as follows: hardness <30 mg/L as CaCO₃, PWQO = 0.001 mg/L; hardness = 30-80 mg/L as CaCO₃, PWQO = 0.003 mg/L; hardness >80 mg/L as CaCO₃, PWQO = 0.005 mg/L.

TABLE 19
WATER QUALITY INPUTS
MARATHON PGM-Cu PROJECT

PARAMETER	UNITS	TAILINGS WATER QUALITY ⁽¹⁾	NEUTRAL ROCK DRAINAGE (NRD) WATER QUALITIES – KINETIC TEST RESULTS ⁽²⁾					ACID ROCK DRAINAGE (ARD) WATER QUALITIES – NAG TEST RESULTS ⁽³⁾							AVERAGE ARD WATER QUALITY
			Eastern Gabbro	Two Duck Lake Gabbro	Volcanics	Heterolithic Breccia	Syenite	Eastern Gabbro	Eastern Gabbro	Eastern Gabbro	Two Duck Lake Gabbro	Two Duck Lake Gabbro	Volcanics	Volcanics	
Humidity Cell Sample ID		MAR07-TAIL	MAR07-16 MAR07-18 MAR07-99	MAR07-15 MAR07-80 MAR07-98	MAR07-33 MAR07-96	MAR07-49	MAR07-92	MAR07-16	MAR07-27	MAR07-101	MAR07-15	MAR07-107	MAR07-33	MAR07-96	
Proportion ⁽⁴⁾		49.0%	23.0%	13.0%	7.60%	2.80%	0.90%	–	–	–	–	–	–	–	3.70%
pH	–	7.58	7.02	7.11	7.01	7.11	7.27	2.55	3.63	2.89	2.71	3.12	2.93	2.40	2.76
Alkalinity	mg/L as CaCO ₃	41.0	9.61	8.17	7.08	8.00	8.00	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Sulphate (SO ₄)	mg/L	12.1	8.7	11.7	14.0	10.7	0.3	730	180	390	750	210	420	1100	540
Calcium (Ca)	mg/L	16.7	6.0	6.9	10.5	7.2	2.2	61.2	34.8	49.6	92.8	21.2	105.0	60.0	61
Iron (Fe)	mg/L	0.005	0.005	0.005	0.005	0.005	0.005	109	0.24	21.7	119	1.76	9.57	228	70
Aluminum (Al)	mg/L	0.10	0.06	0.02	0.01	0.02	0.04	13.7	0.83	14.1	11.9	0.87	3.27	20.4	9.3
Arsenic (As)	mg/L	0.0003	0.0023	0.0013	0.0002	0.0001	0.0001	0.0003	0.0004	0.0005	0.0006	0.0004	0.0005	0.0006	0.00047
Barium (Ba)	mg/L	0.0029	0.0034	0.0019	0.0024	0.0003	0.0003	0.0005	0.0001	0.0020	0.0004	0.00008	0.0009	0.0014	0.00075
Beryllium (Be)	mg/L	0.0000100	0.00001	0.00001	0.00001	0.00001	0.00001	0.18	0.11	0.23	0.07230	0.24	0.06930	0.09640	0.14
Boron (B)	mg/L	0.0022	0.0012	0.0008	0.0010	0.0013	0.0004	0.171	0.071	0.193	0.182	0.266	0.056	0.260	0.17
Cadmium (Cd)	mg/L	0.000008	0.000005	0.000004	0.000003	0.000004	0.000002	0.00311	0.00187	0.00143	0.00643	0.00327	0.00913	0.00092	0.0037
Cobalt (Co)	mg/L	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.642	0.218	0.514	0.902	0.168	0.398	0.999	0.55
Chromium (Cr)	mg/L	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.0222	0.0021	0.0132	0.0104	0.0016	0.0014	0.0289	0.011
Copper (Cu)	mg/L	0.0003	0.0018	0.0022	0.0031	0.0020	0.0003	42.6	9.06	6.74	30.6	42.0	27.1	11.3	24
Potassium (K)	mg/L	2.59	1.66	1.08	0.72	0.11	0.19	6.82	1.64	8.04	3.58	6.88	0.65	11.20	5.5
Magnesium (Mg)	mg/L	1.51	0.33	0.47	0.27	0.38	0.37	13.5	14.9	15.6	14	16	4.47	17	14
Manganese (Mn)	mg/L	0.012	0.012	0.013	0.017	0.004	0.010	1.32	0.698	1.13	1.24	0.613	2.06	1.2	1.2
Molybdenum (Mo)	mg/L	0.00739	0.00034	0.00028	0.00017	0.00009	0.00104	0.00017	0.00008	0.00011	0.00021	0.00008	0.00010	0.00032	0.00015
Nickel (Ni)	mg/L	0.0005	0.0004	0.0004	0.0003	0.0002	0.0001	2.84	0.696	1.64	3.83	1.24	1.84	2.13	2.0
Lead (Pb)	mg/L	0.00006	0.00005	0.00001	0.00002	0.00001	0.00009	0.0087	0.0002	0.0040	0.0166	0.0006	0.0041	0.0151	0.0070
Selenium (Se)	mg/L	0.00050	0.0005	0.0005	0.0005	0.0005	0.0005	0.011	0.007	0.008	0.016	0.026	0.014	0.014	0.014
Strontium (Sr)	mg/L	0.092	0.039	0.040	0.041	0.055	0.015	0.207	0.244	0.290	0.378	0.173	0.182	0.265	0.25
Vanadium (V)	mg/L	0.00137	0.00055	0.00043	0.00016	0.00025	0.00045	0.00289	0.00005	0.00010	0.00469	0.00011	0.00009	0.00342	0.0016
Zinc (Zn)	mg/L	0.0018	0.0008	0.0018	0.0021	0.0005	0.0005	0.455	0.362	0.501	0.591	0.240	1.700	0.533	0.63

Notes:

(1) Tailings water quality is calculated from humidity cell test results weeks 15–20.

(2) Neutral drainage waste rock water qualities are calculated from humidity cell testing weeks 35–40. An average water quality was calculated for rock types with more than one humidity cell.

(3) Acid rock drainage waste rock water qualities were derived from the NAG supernatant chemistries for samples that are expected to be acid generating. These water qualities were used to calculate an average ARD water quality to be mixed with the NRD and tailings water qualities.

(4) Proportions at which the tailings, NRD waste rock and ARD waste rock water qualities were mixed in PHREEQC. Based on the site water balance, the proportion of tailings runoff flow rates versus waste rock runoff flow rates are constant for all months (49% of total mine waste runoff is from tailings and 51% of the total mine waste runoff is from waste rock, based on annual flow rates of 116,036 m³/mon for the tailings runoff and 119,872 m³/mon for the waste rock runoff). It is further assumed that the waste rock drainage will consist of 93% NRD and 7% ARD. Thus, the overall drainage from the mine waste management area consists of 49% tailings drainage, 47.3% NRD and 3.70% ARD.

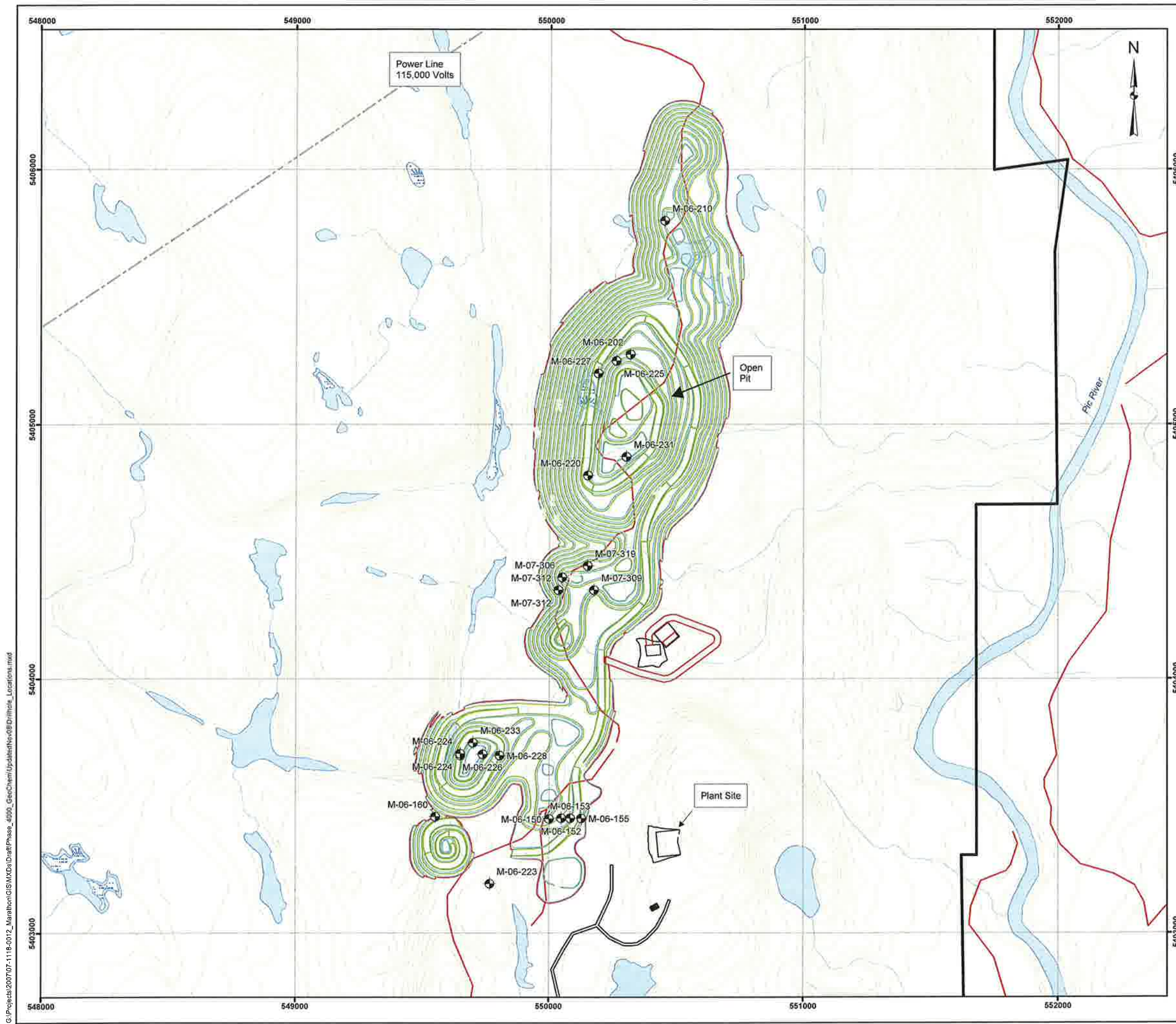
TABLE 20
WATER QUALITY MODELING RESULTS:
ESTIMATED COMBINED TAILINGS AND WASTE ROCK EFFLUENT WATER QUALITY
MARATHON PGM-Cu PROJECT

PARAMETER	UNITS	PROVINCIAL WATER QUALITY OBJECTIVES ⁽¹⁻⁸⁾	ESTIMATED COMBINED TAILINGS & WASTE ROCK EFFLUENT WATER QUALITY ⁽⁹⁾		INPUT WATER QUALITY						
			MIX	EQUILIBRATED MIX	TAILINGS EFFLUENT WATER QUALITY ⁽¹⁰⁾	Neutral Rock Drainage from Waste Rock ⁽¹¹⁾					Acid Rock Drainage from Waste Rock ⁽¹²⁾
						Eastern Gabbro	Two Duck Lake Gabbro	Volcanics	Heterolithic Breccia	Syenite	
pH	-	6.5-8.5	3.69	7.88	7.58	7.02	7.11	7.01	7.11	7.27	2.76
Alkalinity	mg/L as CaCO ₃	-	24	20	41	9.6	8.2	7.1	8.0	8.0	< 2
Aluminum	mg/L	0.075	0.41	0.0087	0.10	0.055	0.022	0.011	0.020	0.035	9.3
Arsenic	mg/L	0.005	0.00086	0.00086	0.00030	0.0022	0.0013	0.00018	0.00010	0.00010	0.00047
Boron	mg/L	0.2	0.0079	0.0078	0.0022	0.0012	0.00083	0.0010	0.0013	0.000400039	0.17
Barium	mg/L	-	0.0027	0.0026	0.0029	0.0034	0.0019	0.0024	0.00034	0.00029	0.00075
Beryllium	mg/L	0.011	0.0053	0.0053	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.14
Calcium	mg/L	-	14	14	17	6.0	6.9	11	7.2	2.2	61
Cadmium	mg/L	0.0001	0.00014	0.00014	0.0000077	0.0000045	0.0000041	0.0000034	0.0000040	0.0000015	0.0037
Cobalt	mg/L	0.0009	0.020	0.020	0.00012	0.00011	0.00015	0.00010	0.000032	0.000013	0.55
Chromium	mg/L	0.001	0.00066	0.00017	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.011
Copper	mg/L	0.001	0.90	0.89	0.00025	0.0018	0.0022	0.0031	0.0020	0.00025	24
Iron	mg/L	0.3	2.6	1.7	0.0050	0.0050	0.0053	0.0050	0.0050	0.0050	70
Potassium	mg/L	-	2.1	2.0	2.6	1.7	1.1	0.71	0.10	0.19	5.5
Magnesium	mg/L	-	1.4	1.4	1.5	0.33	0.47	0.27	0.38	0.37	14
Manganese	mg/L	-	0.056	0.055	0.012	0.012	0.013	0.017	0.0041	0.0097	1.2
Molybdenum	mg/L	0.04	0.0038	0.0037	0.0074	0.00034	0.00028	0.00017	0.000090	0.0010	0.00015
Nickel	mg/L	0.025	0.076	0.075	0.00045	0.00038	0.00044	0.00029	0.00018	0.000050	2.0
Lead	mg/L	0.001	0.00030	0.00030	0.000055	0.000050	0.000010	0.000017	0.000010	0.000090	0.0070
Selenium	mg/L	0.1	0.00099	0.00098	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.014
Sulphate	mg/L	-	31	31	12	8.7	12	14	11	0.25	540
Strontium	mg/L	-	0.073	0.073	0.092	0.039	0.040	0.041	0.055	0.015	0.25
Vanadium	mg/L	0.006	0.00093	0.00093	0.0014	0.00055	0.00043	0.00016	0.00025	0.00045	0.0016
Zinc	mg/L	0.02	0.025	0.024	0.0018	0.00075	0.0018	0.0021	0.00050	0.00050	0.63

Notes:
0.1 - Denotes a value that is greater than the Provincial Water Quality Objectives (PWQOs). Although it is not practical to directly compare the mixed tailings and waste rock effluent chemistry to PWQOs, comparisons to PWQOs provide insights (at a screening level) regarding parameters for which aqueous geochemistry may be an important consideration. Where parameters have multiple PWQOs, the lowest was applied to be conservative.

- (1) MOEE [Ontario Ministry of Environment and Energy], 1994. Policies Guidelines Provincial Water Quality Objectives. Reprinted 1999.
- (2) PWQO for P is based on a value to prevent excessive algae growth.
- (3) PWQO for Al depends on pH as follows: pH = 4.5-5.5, PWQO = 0.015 mg/L; pH >5.5-6.5, PWQO = 10% of background concentration; pH >6.5-9.0, PWQO = 0.075 mg/L.
- (4) PWQO for Be depends on hardness as follows: hardness <75 mg/L as CaCO₃, PWQO = 0.011 mg/L; hardness >75 mg/L as CaCO₃, PWQO = 1.1 mg/L.
- (5) PWQO for Cd depends on hardness as follows: hardness 0-100 mg/L as CaCO₃, PWQO = 0.0001 mg/L; hardness >100 mg/L as CaCO₃, PWQO = 0.0005 mg/L.
- (6) PWQO for Cr(VI) (0.001 mg/L) was assumed to apply, and thus all the Cr is assumed to occur as Cr(VI).
- (7) PWQO for Cu depends on hardness as follows: hardness 0-20 mg/L as CaCO₃, PWQO = 0.001 mg/L; hardness >20 mg/L as CaCO₃, PWQO = 0.005 mg/L.
- (8) PWQO for Pb depends on hardness as follows: hardness <30 mg/L as CaCO₃, PWQO = 0.001 mg/L; hardness = 30-80 mg/L as CaCO₃, PWQO = 0.003 mg/L; hardness >80 mg/L as CaCO₃, PWQO = 0.005 mg/L.
- (9) Water quality modeling results: estimated combined tailings and waste rock effluent water quality was determined using the geochemical speciation model PHREEQC. Two water qualities are presented: 1) a "Mix" that is simply a mix of all the input water qualities, and 2) an "Equilibrated Mix" that is also a mix of all the input water qualities, but also considers the solubility's of various secondary minerals. The precipitation of various secondary minerals (i.e., ferric oxyhydroxides) may reduce concentrations in solution; however, the "Equilibrated Mix" assumes that the concentrations are dissolved and not total concentrations.
- (10) Tailings water quality is calculated from humidity cell testing weeks 15-20.
- (11) Neutral rock drainage waste rock water qualities are calculated from humidity cell testing weeks 35-40. An average water quality was calculated for rock types with more than one humidity cell.
- (12) Acid rock drainage waste rock water qualities are calculated from the NAG supernatant chemistries (Table 19).

FIGURES

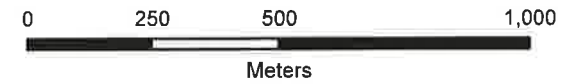


LEGEND

- Drill Hole
- Roads
- Hydro Line
- Rivers
- Site Design
- Gravel Road
- Pit Toe
- Pit Ramp
- Pit Crest
- Water Area, Permanent
- Wetland, Permanent
- Property Boundary



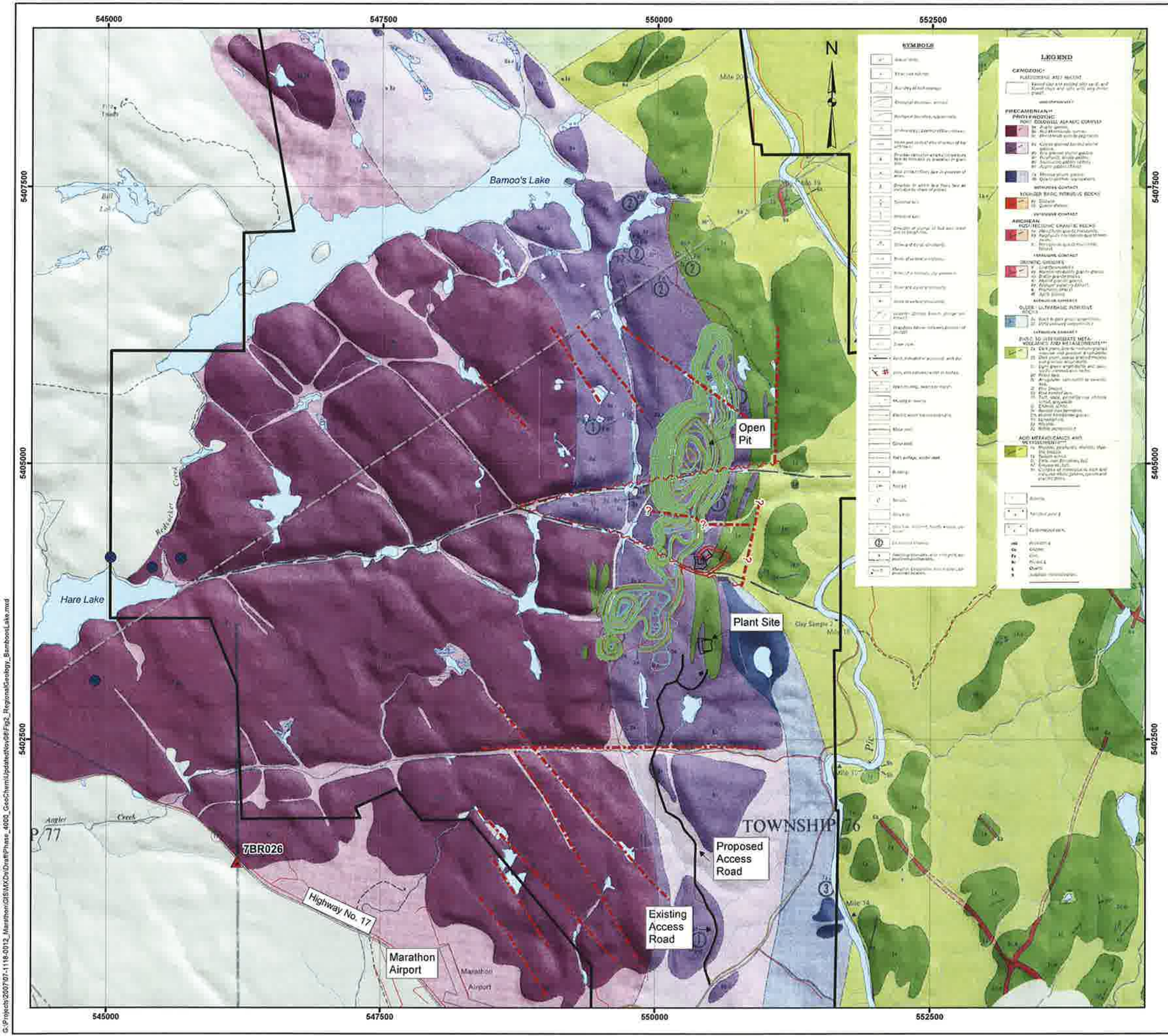
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 Produced by Golder Associates Ltd under licence from
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 Site Layout - Provided by P&E Mining Consultants, Oct 2006
 Datum: NAD 27 Projection: UTM Zone 16N



OWNER:			
PROJECT:	MARATHON PGM PROJECT		
TITLE:	GEOCHEMISTRY DRILL HOLE PLAN		
	PROJECT No. 07-1118-0012	SCALE 1:15,000	Ver. 1.0
	DESIGN SC 21 Feb. 2007		FIGURE: 1
	GIS SC 14 Nov. 2008		
	CHECK JW 14 Nov. 2008		
	REVIEW MG 14 Nov. 2008		

Golder Associates
 Mississauga, Ontario

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LEGEND

- ▲ Aggregate Testing Location
- Potential Quarry Sites
- Site Design
- Gravel Road
- - - Pit Toe
- Pit Ramp
- Pit Crest
- Roads
- - - Hydro Line
- Rivers
- Water Area, Permanent
- Wetland, Permanent
- Property Boundary

Structural Interpretation

- ~ Inferred Fault (See Note 1)
- - - Topographical Lineament (Selected)
- ? Denotes Uncertainty

NOTES

1. Inferred faults based on topographical lineaments and Ontario GSC Mapping 1:250000, 2003

REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2005.4
 Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2008
 Site Layout - Provided by P&E Mining Consultants, Feb 2008
 Geology Map - Bamoo's Lake Map sheet, M2099, Ontario Department of Mines, 1966
 Quarry Sites - Technical Report – Physical Work, "Block Extraction / Stripping / Sampling", McCoy Township, Augite Syenite Property (Thunder Bay Mining Division), Report 42D16SW0042. Yozipovic, A. for the Ontario Ministry of Northern Development and Mines, 1997
 Datum: NAD 27 Projection: UTM Zone 16N

1,000 0 1,000 2,000
Metres

OWNER	Marathon PGM CORPORATION		
PROJECT	MARATHON PGM PROJECT		
TITLE	REGIONAL GEOLOGY (BAMOOS LAKE SHEET) GEOLOGY (M2099)		
 Golder Associates Mississauga, Ontario	PROJECT No.	07-1118-0012	SCALE 1:35,000
	DESIGN	SC 21 Feb. 2007	Ver. 1.0
	GIS	SC 13 Nov. 2008	
	CHECK	JW 13 Nov. 2008	
	REVIEW	MG 13 Nov. 2008	

FIGURE: 2

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FIGURE 3
SULPHIDE CONTENT vs. PASTE pH: WASTE ROCK
MARATHON PGM-Cu PROJECT

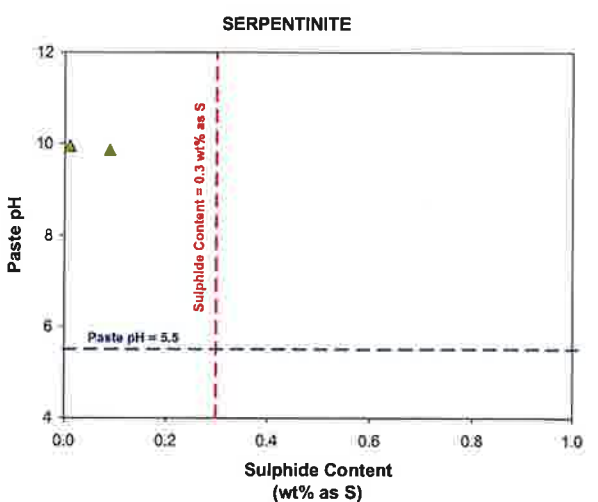
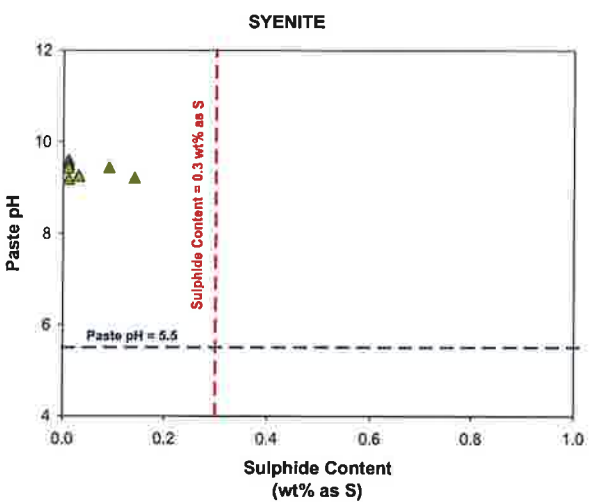
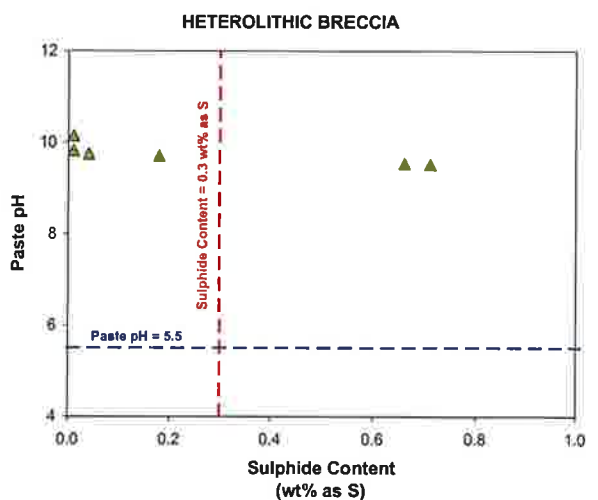
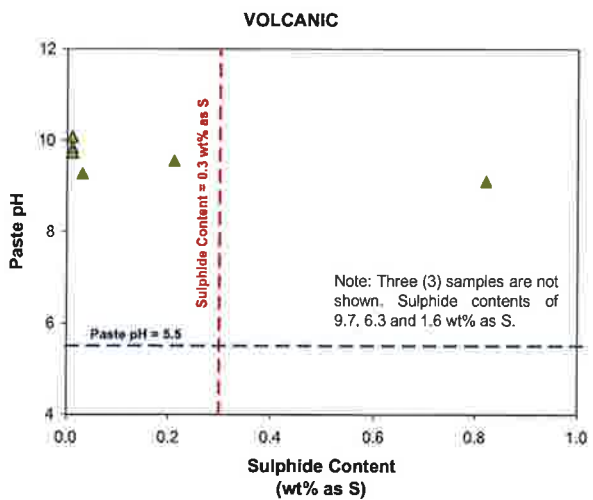
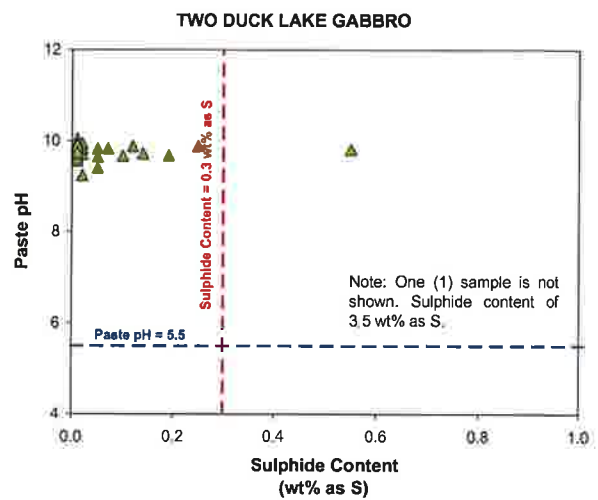
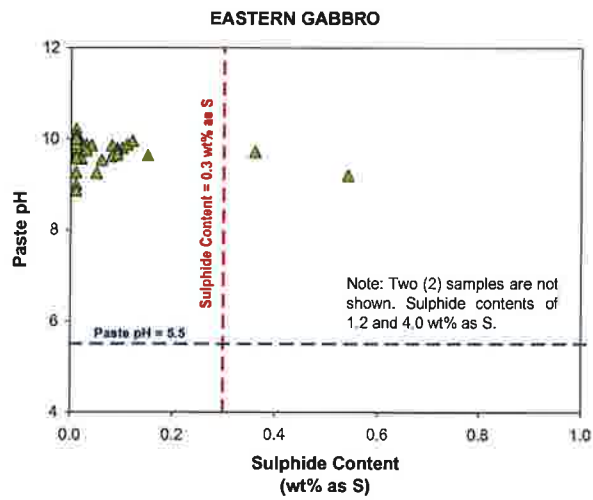


FIGURE 4
TOTAL SULPHUR CONTENT vs. SULPHIDE CONTENT: WASTE ROCK
MARATHON PGM-Cu PROJECT

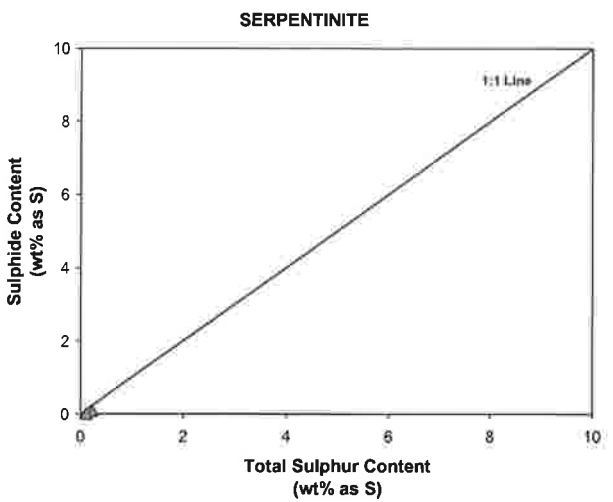
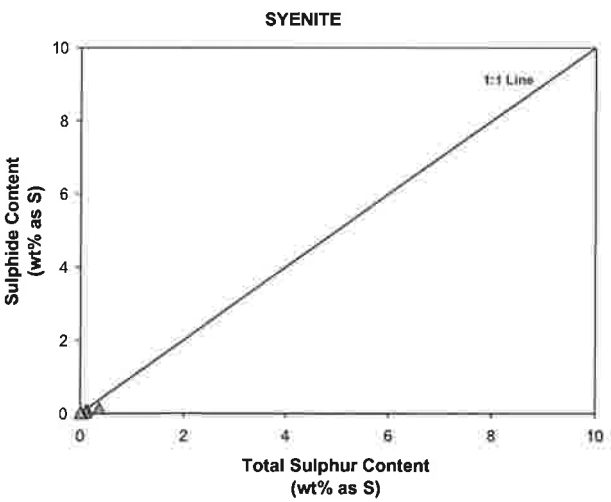
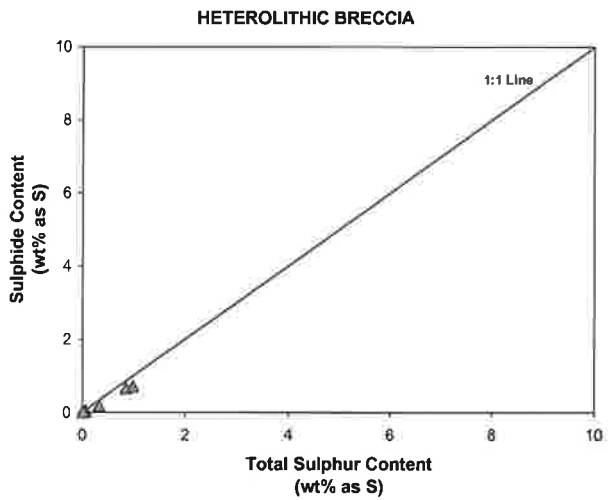
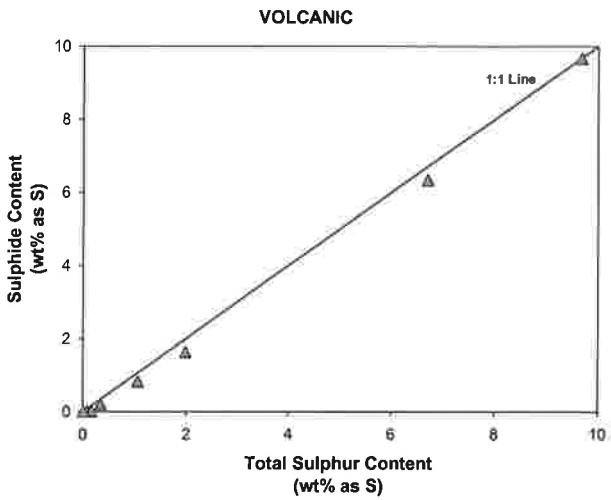
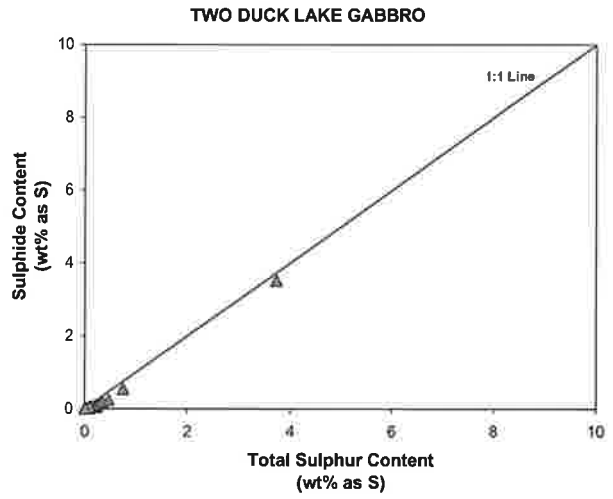
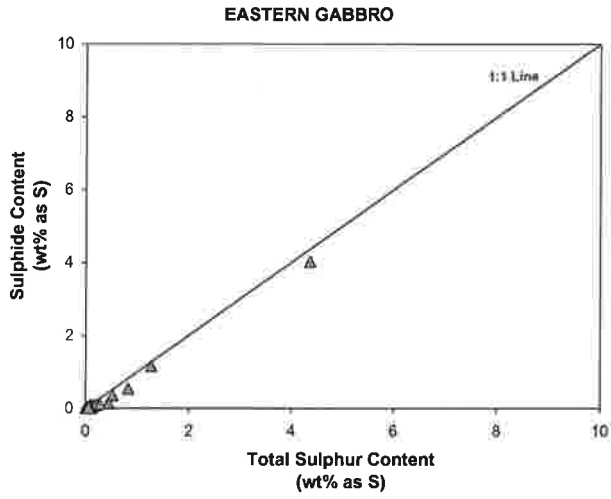


FIGURE 5
NEUTRALIZATION POTENTIAL (NP) vs. CARBONATE NEUTRALIZATION POTENTIAL (CaNP): WASTE ROCK
MARATHON PGM-Cu PROJECT

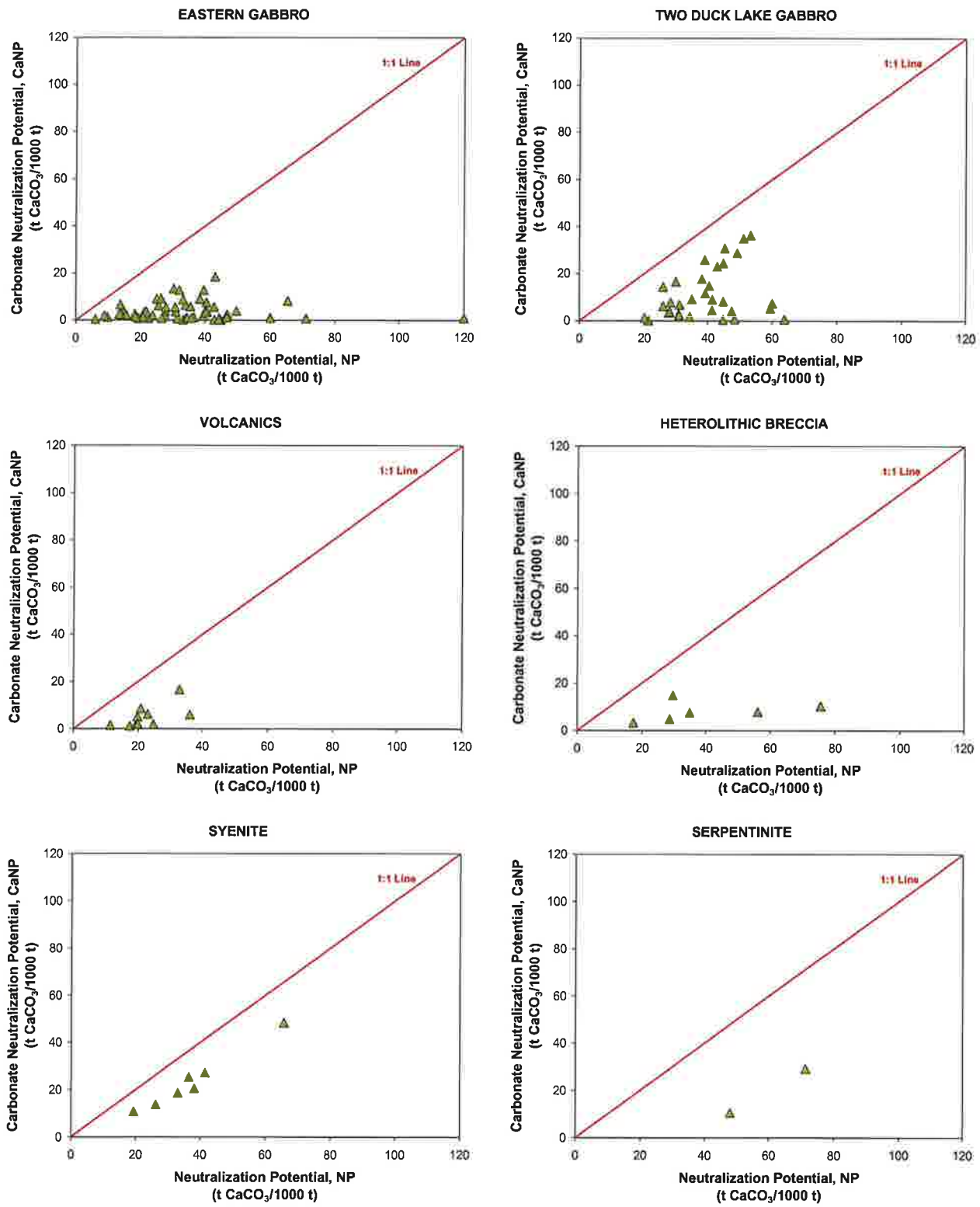
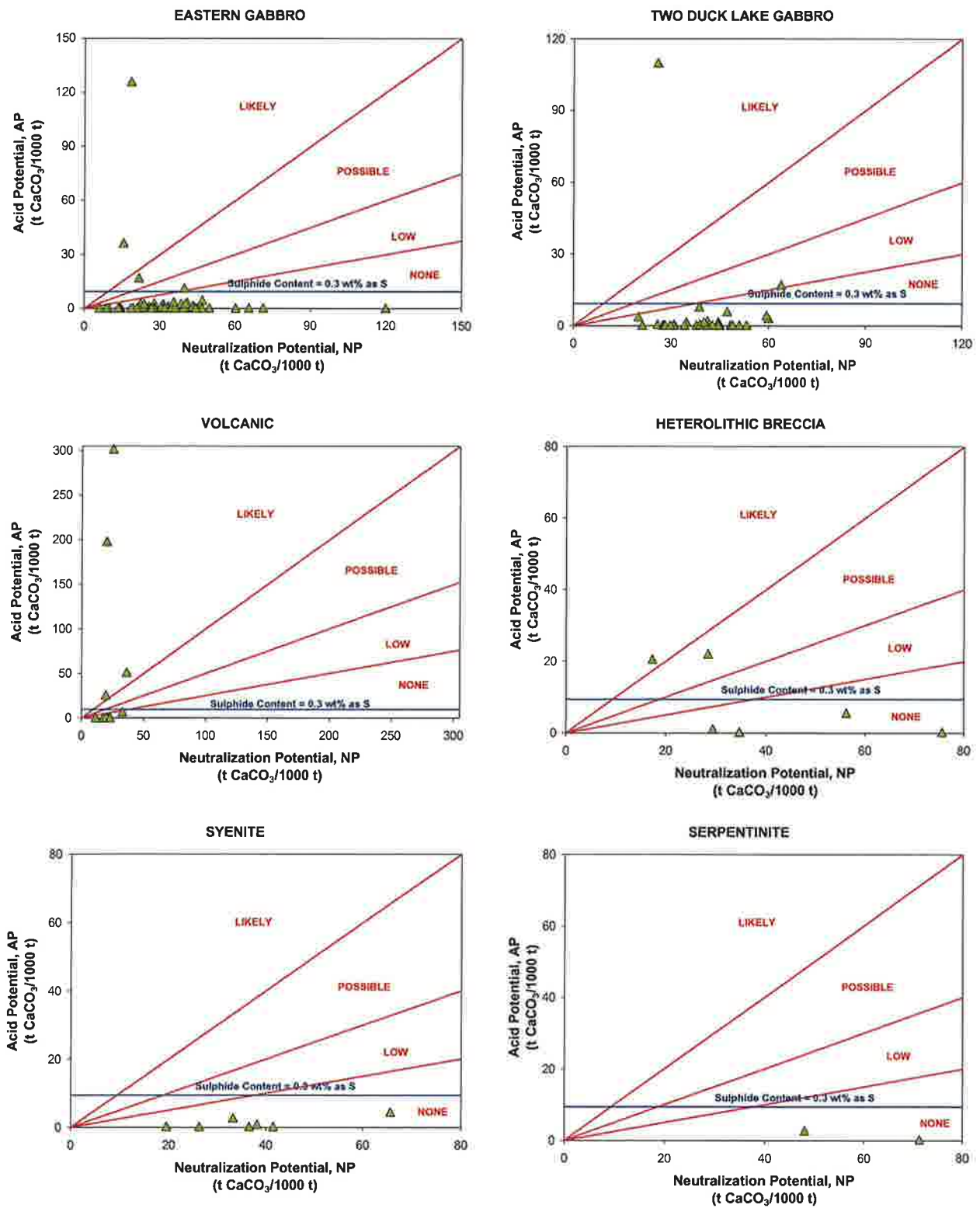
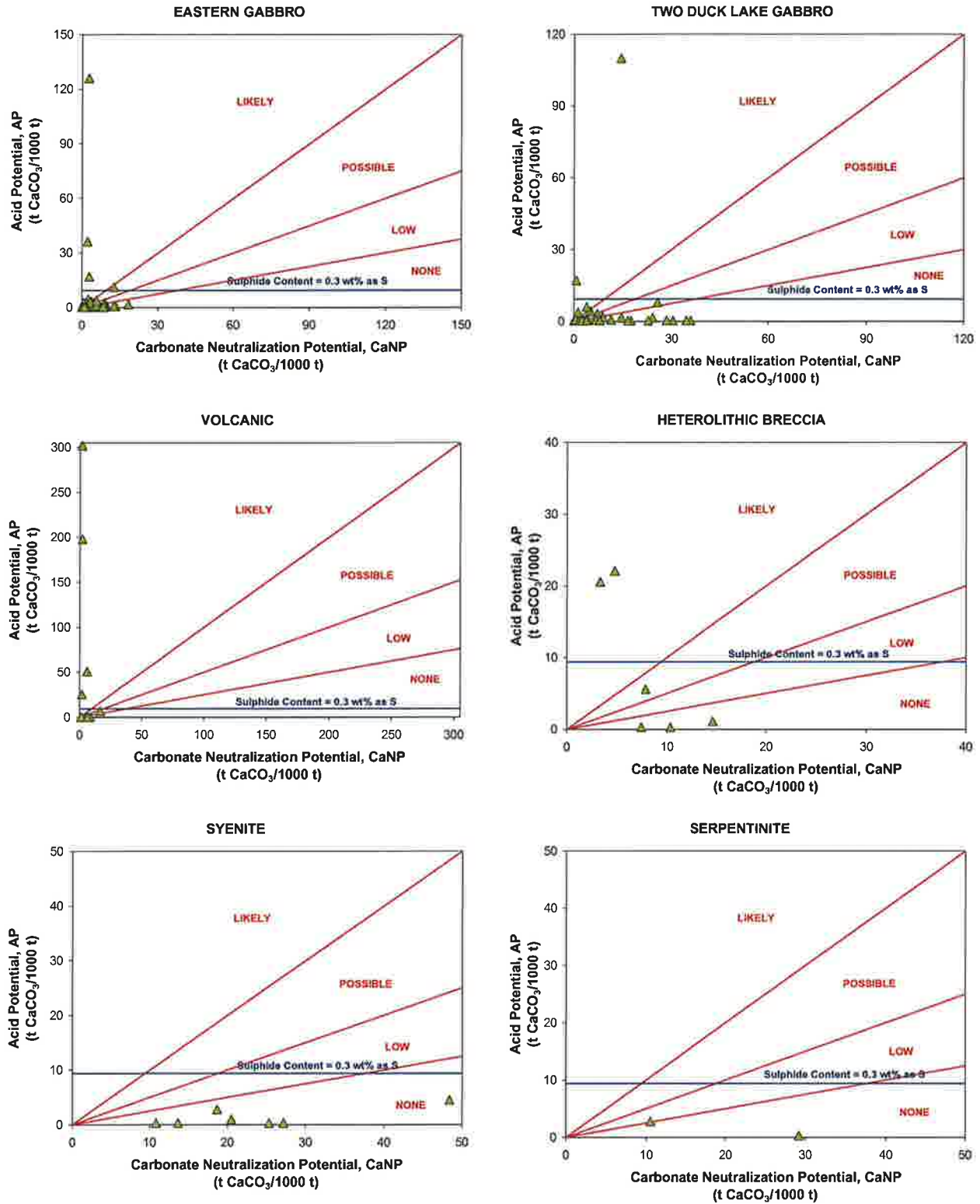


FIGURE 6
NEUTRALIZATION POTENTIAL (NP) vs. ACID POTENTIAL (AP): WASTE ROCK
MARATHON PGM-Cu PROJECT



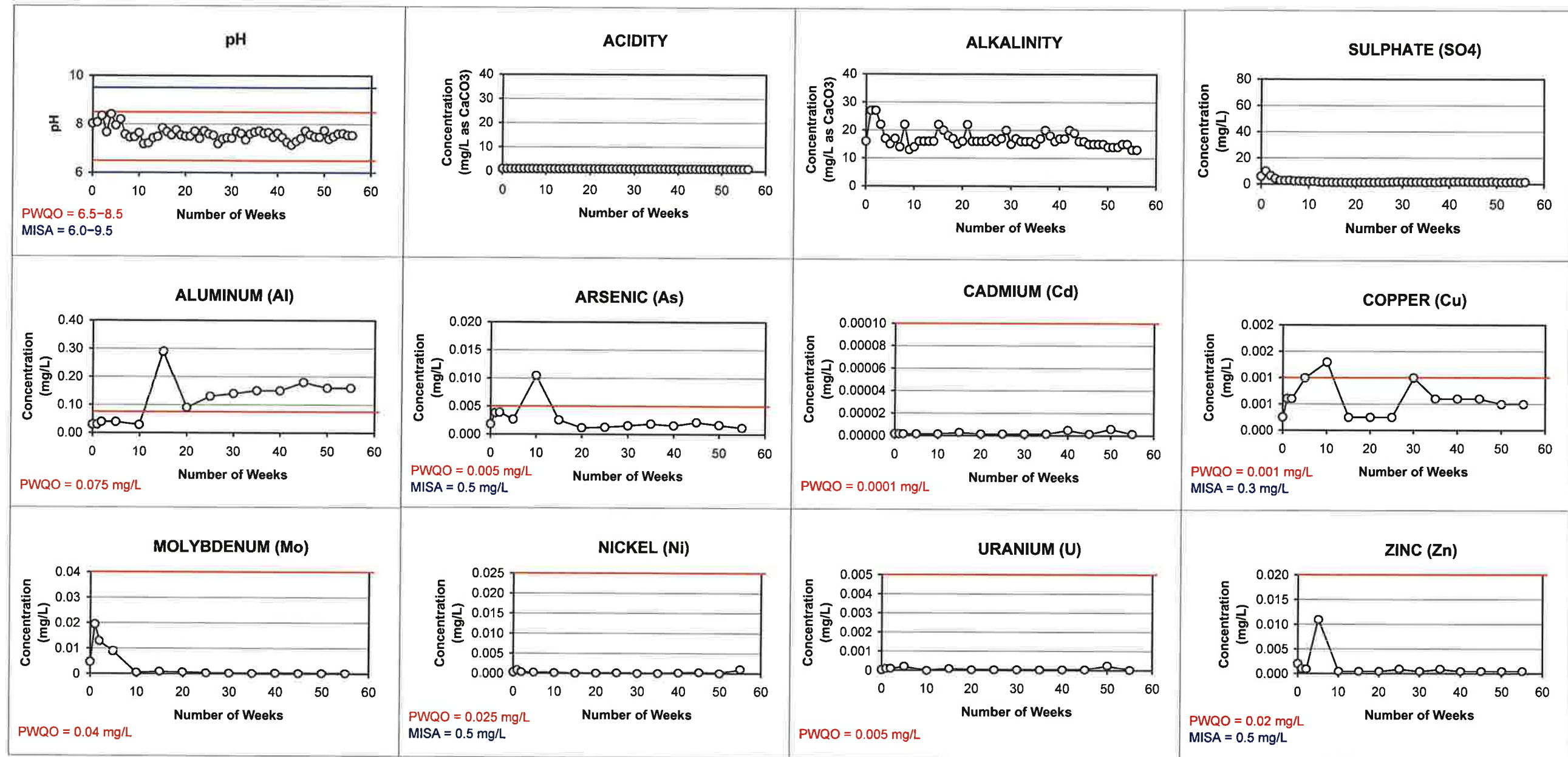
Note: The sulphide content of 0.3 wt% as S is equivalent to an AP value of 9.4. The value of 0.3 wt% as S is a basic guideline to serve as a starting point in interpreting the acid generating properties.

**CARBONATE NEUTRALIZATION POTENTIAL (CaNP) vs. ACID POTENTIAL (AP): WASTE ROCK
MARATHON PGM-Cu PROJECT**



Note: The sulphide content of 0.3 wt% as S is equivalent to an AP value of 9.4. The value of 0.3 wt% as S is a basic guideline to serve as a starting point in interpreting the acid generating properties.

FIGURE 8
GEOCHEMISTRY OF HUMIDITY CELL MAR07-18: EASTERN GABBRO
MARATHON PGM-Cu PROJECT



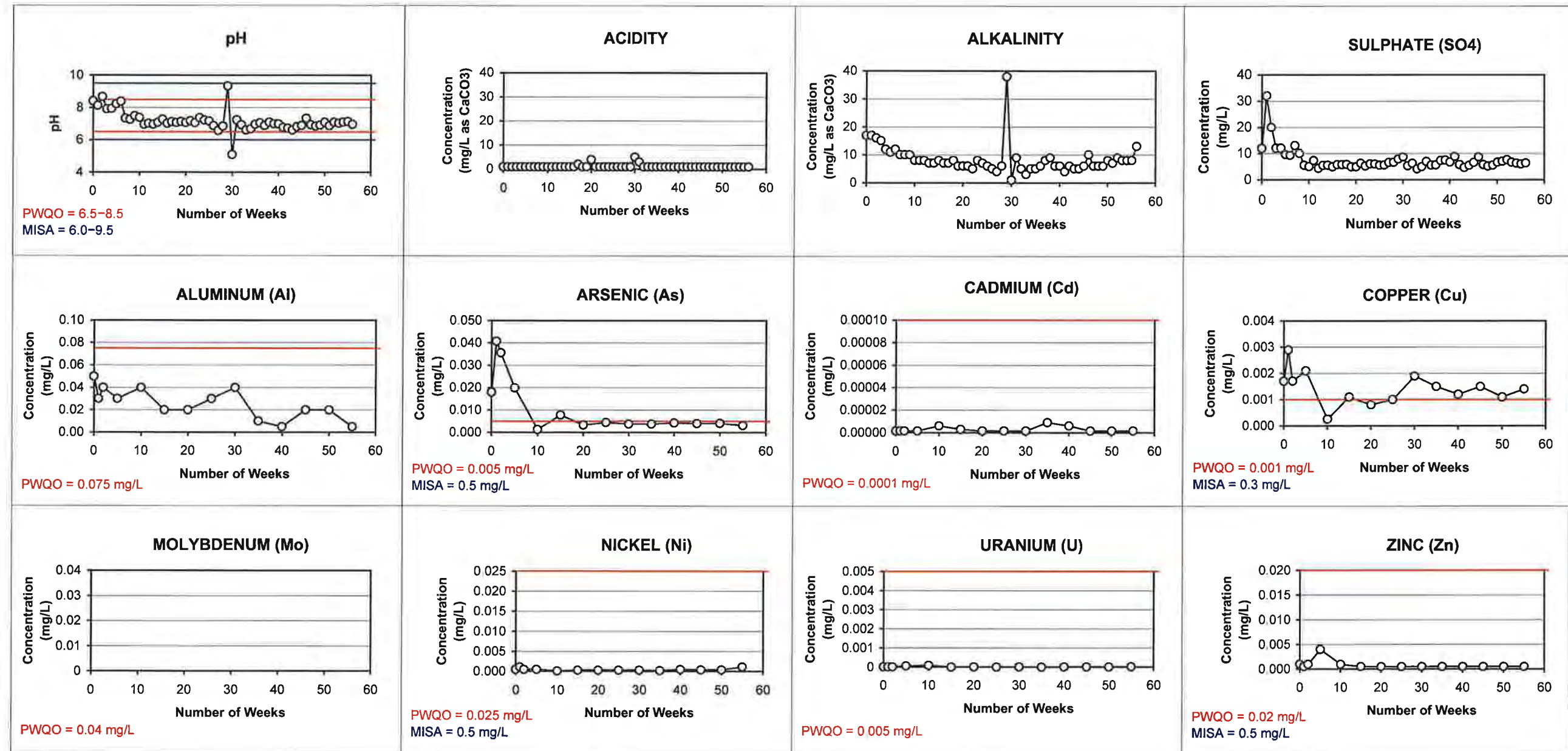
— Provincial Water Quality Objectives

— MISA Discharge Limits

ABA & Depletion Data

Sulphide Content: 0.09 wt% as S
 NP: 38.4 t CaCO₃/1000 t
 CaNP: 8.99 t CaCO₃/1000 t
 AP: 2.8 t CaCO₃/1000 t
 NP/AP: 14
 Time to depletion for AP: 33 year
 Time to depletion for NP: 50 year

FIGURE 9
GEOCHEMISTRY OF HUMIDITY CELL MAR07-99: EASTERN GABBRO
MARATHON PGM-Cu PROJECT



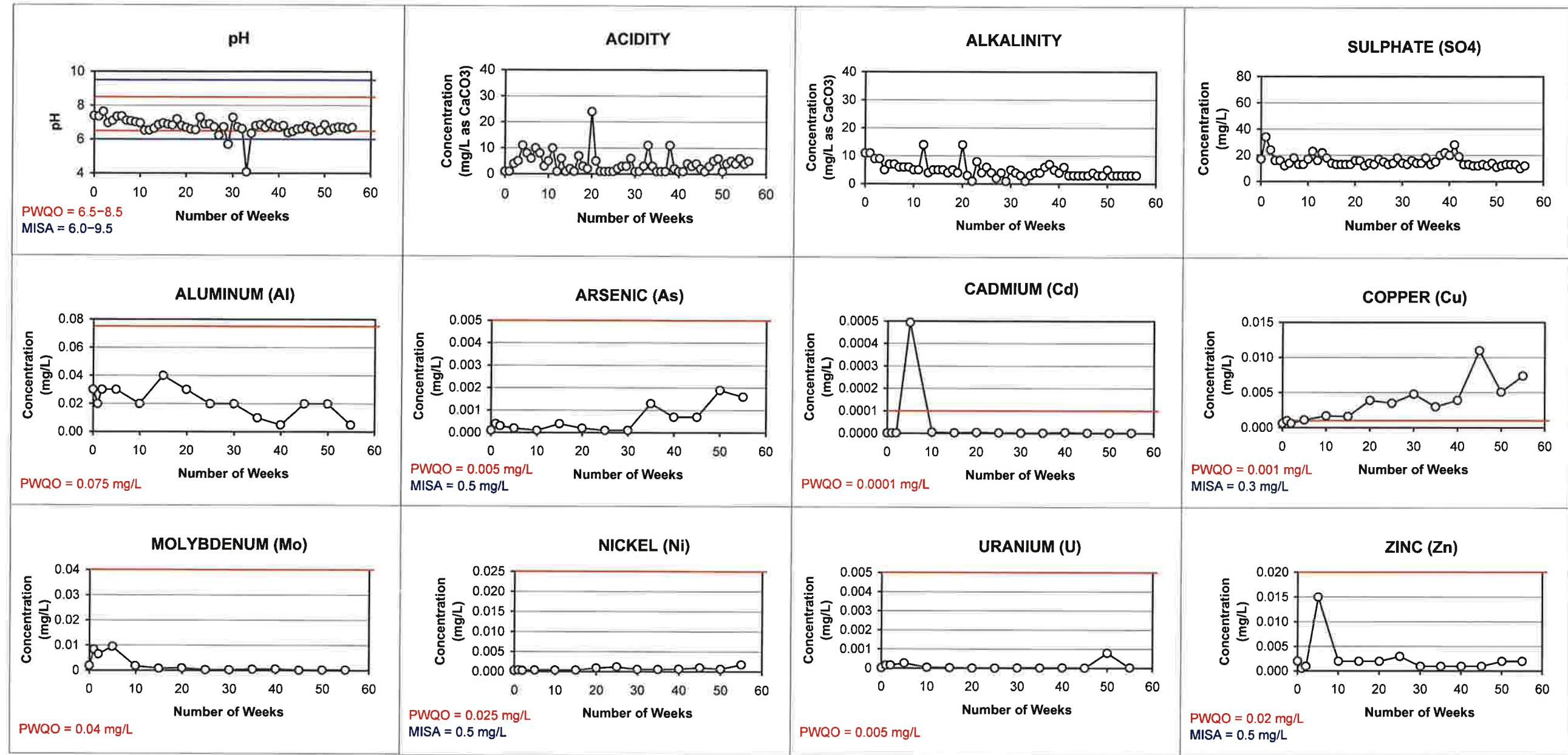
— Provincial Water Quality Objectives

— MISA Discharge Limits

ABA & Depletion Data

Sulphide Content: 0.36 wt% as S
 NP: 39.6 t CaCO₃/1000 t
 CaNP: 12.676 t CaCO₃/1000 t
 AP: 11.3 t CaCO₃/1000 t
 NP/AP: 3.5
 Time to depletion for AP: 32 year
 Time to depletion for NP: 52 year

FIGURE 10
GEOCHEMISTRY OF HUMIDITY CELL MAR07-16: EASTERN GABBRO
MARATHON PGM-Cu PROJECT



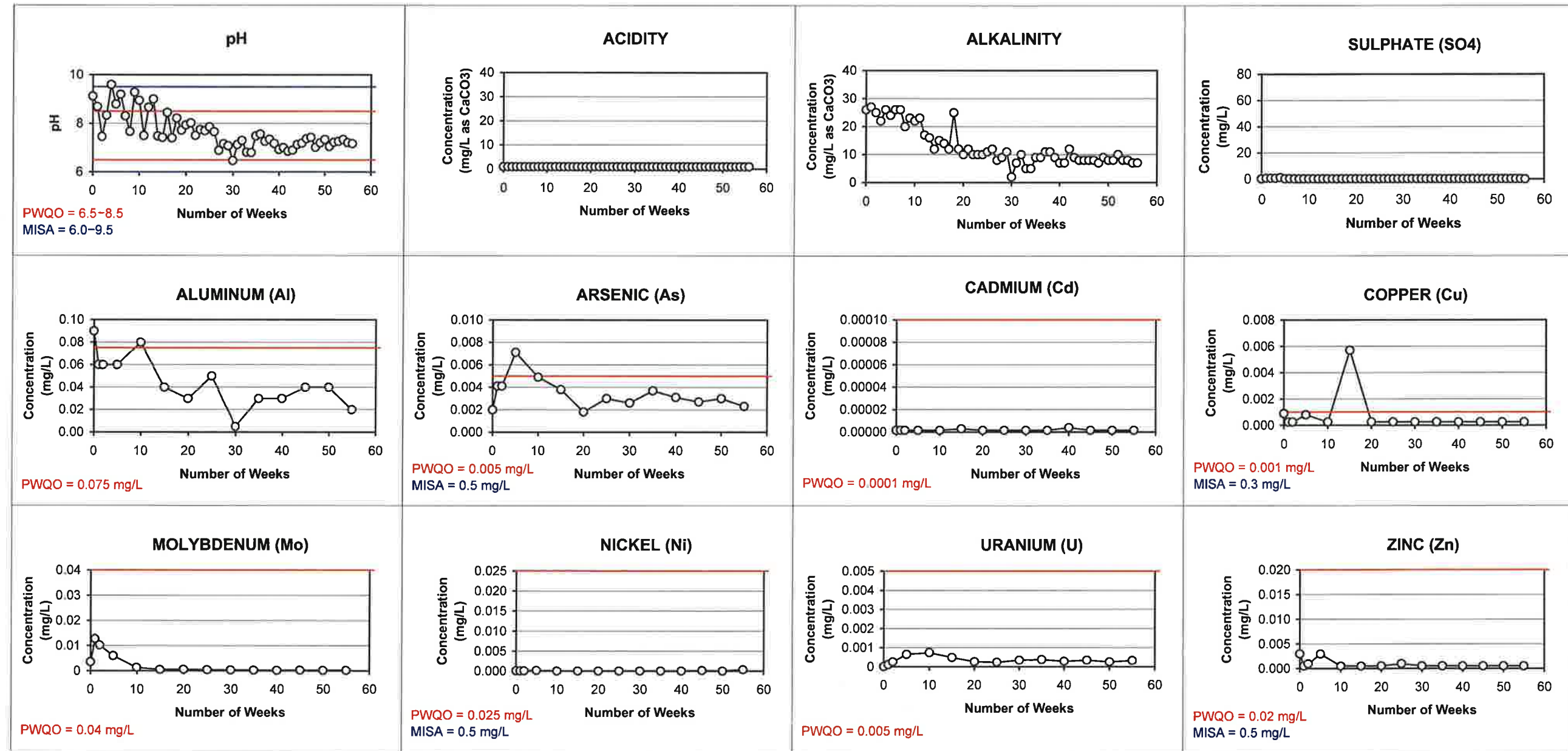
— Provincial Water Quality Objectives

— MISA Discharge Limits

ABA & Depletion Data

Sulphide Content: 4.02 wt% as S
 NP: 18.2 t CaCO₃/1000 t
 CaNP: 2.685 t CaCO₃/1000 t
 AP: 126 t CaCO₃/1000 t
 NP/AP: 0.2
 Time to depletion for AP: 214 year
 Time to depletion for NP: 35 year

FIGURE 11
GEOCHEMISTRY OF HUMIDITY CELL MAR07-98: TWO DUCK LAKE GABBRO
MARATHON PGM-Cu PROJECT



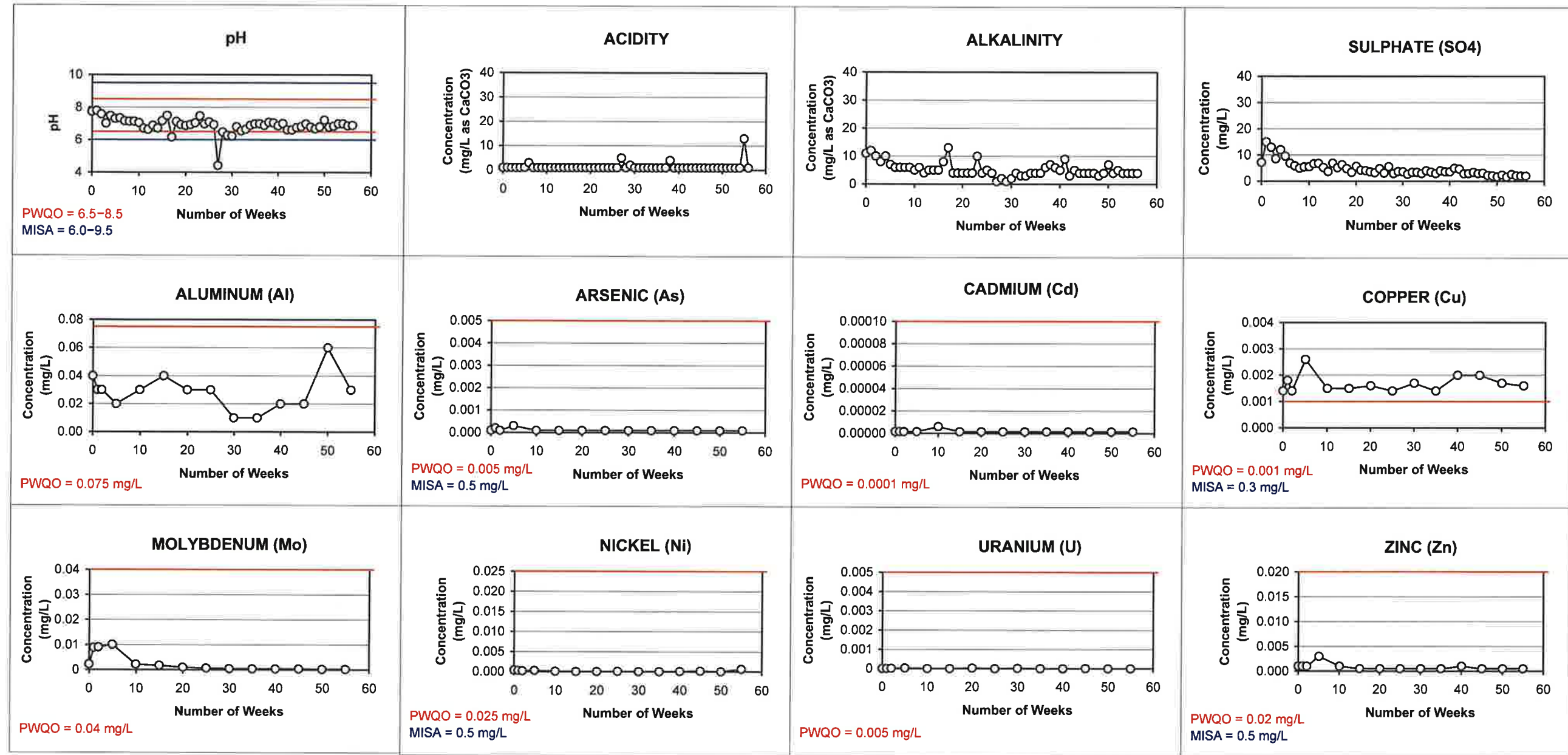
— Provincial Water Quality Objectives

— MISA Discharge Limits

ABA & Depletion Data

Sulphide Content: 0.01 wt% as S
 NP: 51 t CaCO₃/1000 t
 CaNP: 34.692 t CaCO₃/1000 t
 AP: 0.31 t CaCO₃/1000 t
 NP/AP: 164
 Time to depletion for AP: 26 year
 Time to depletion for NP: 155 year

FIGURE 12
GEOCHEMISTRY OF HUMIDITY CELL MAR07-80: TWO DUCK LAKE GABBRO
MARATHON PGM-Cu PROJECT



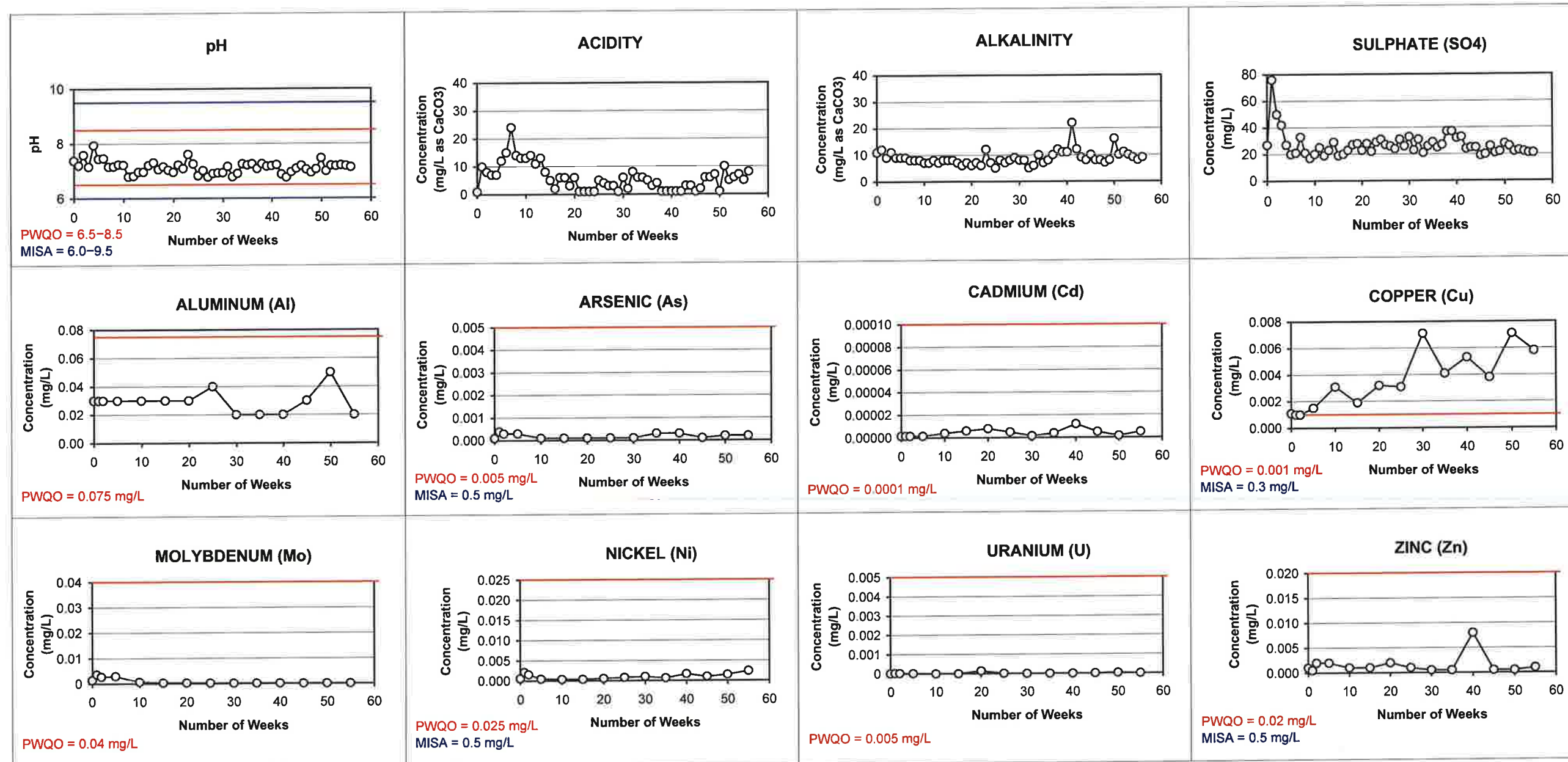
— Provincial Water Quality Objectives

— MISA Discharge Limits

ABA & Depletion Data

Sulphide Content: 0.19 wt% as S
 NP: 47.3 t CaCO₃/1000 t
 CaNP: 3.936 t CaCO₃/1000 t
 AP: 6 t CaCO₃/1000 t
 NP/AP: 7.9
 Time to depletion for AP: 58 year
 Time to depletion for NP: 354 year

FIGURE 13
GEOCHEMISTRY OF HUMIDITY CELL MAR07-15: TWO DUCK LAKE GABBRO
MARATHON PGM-Cu PROJECT

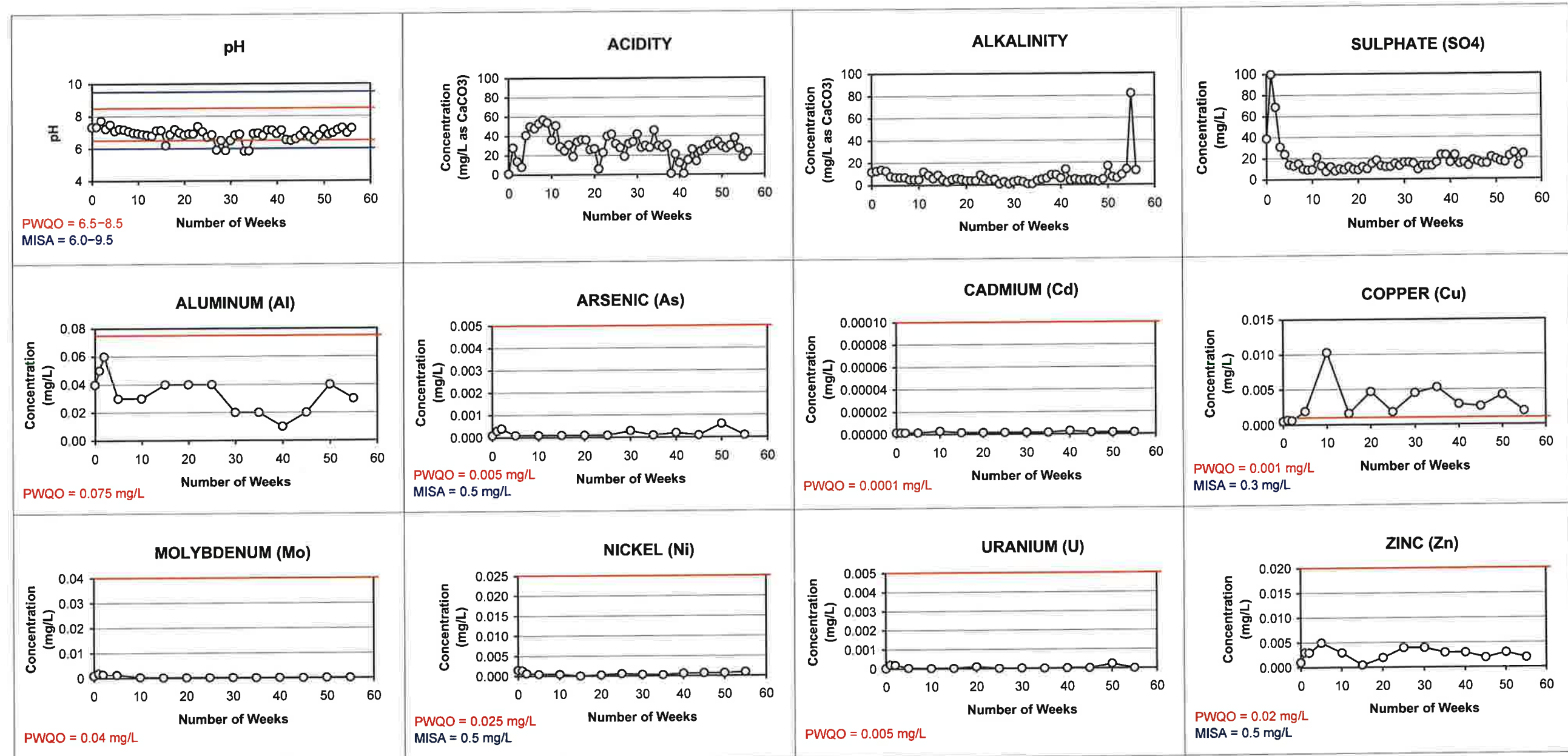


— Provincial Water Quality Objectives — MISA Discharge Limits

Relevant Information

Sulphide Content: 3.52 wt% as S
 NP: 25.9 t CaCO₃/1000 t
 CaNP: 14.377 t CaCO₃/1000 t
 AP: 110 t CaCO₃/1000 t
 NP/AP: 0.2
 Time to depletion for AP: 102 year
 Time to depletion for NP: 20 year

FIGURE 14
GEOCHEMISTRY OF HUMIDITY CELL MAR07-96: VOLCANIC
MARATHON PGM-Cu PROJECT



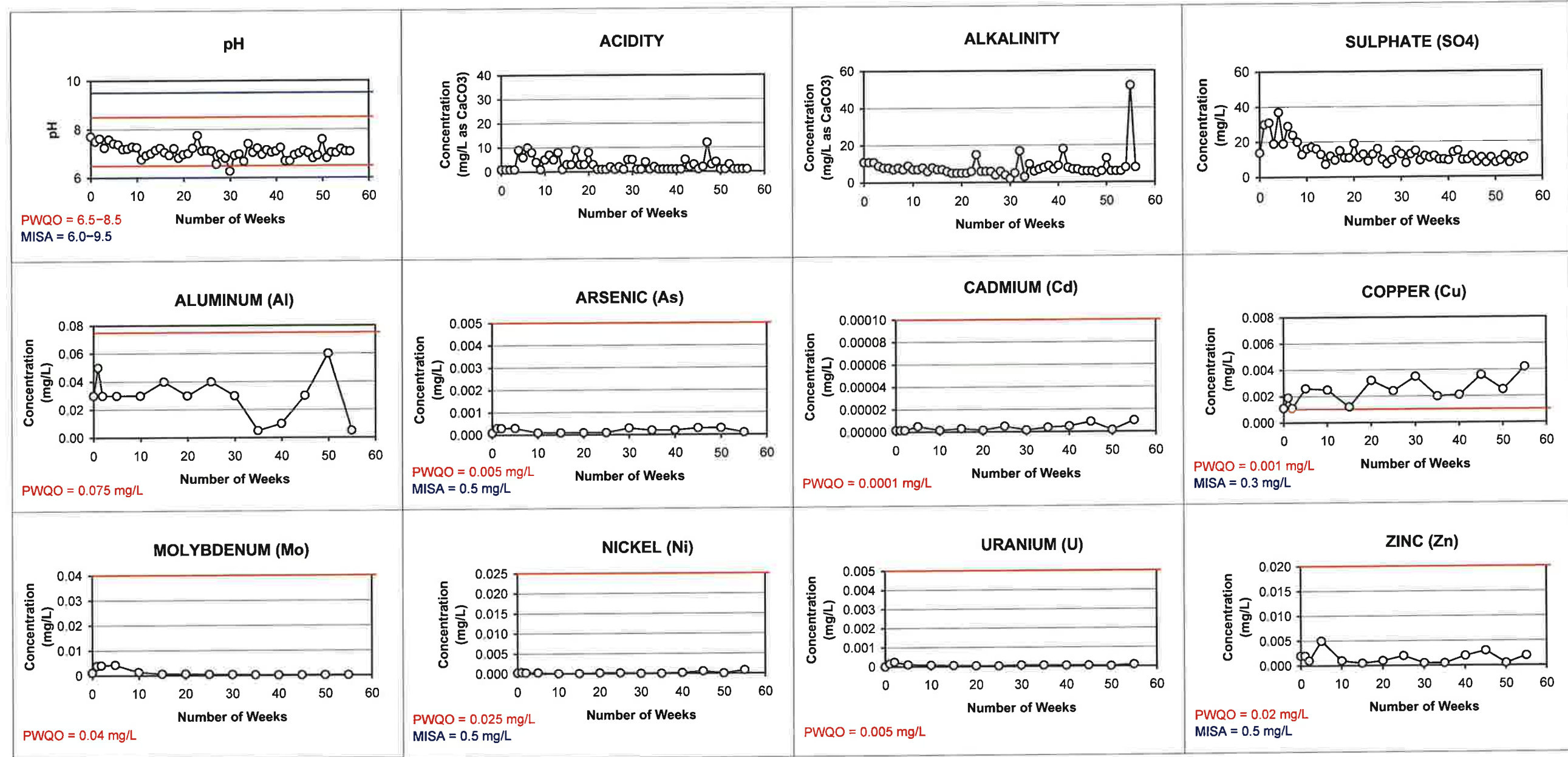
— Provincial Water Quality Objectives

— MISA Discharge Limits

ABA & Depletion Data

Sulphide Content: 6.34 wt% as S
 NP: 19.9 t CaCO₃/1000 t
 CaNP: 1.951 t CaCO₃/1000 t
 AP: 198 t CaCO₃/1000 t
 NP/AP: 0.1
 Time to depletion for AP: 193 year
 Time to depletion for NP: 19 year

FIGURE 15
GEOCHEMISTRY OF HUMIDITY CELL MAR07-33: VOLCANIC
MARATHON PGM-Cu PROJECT

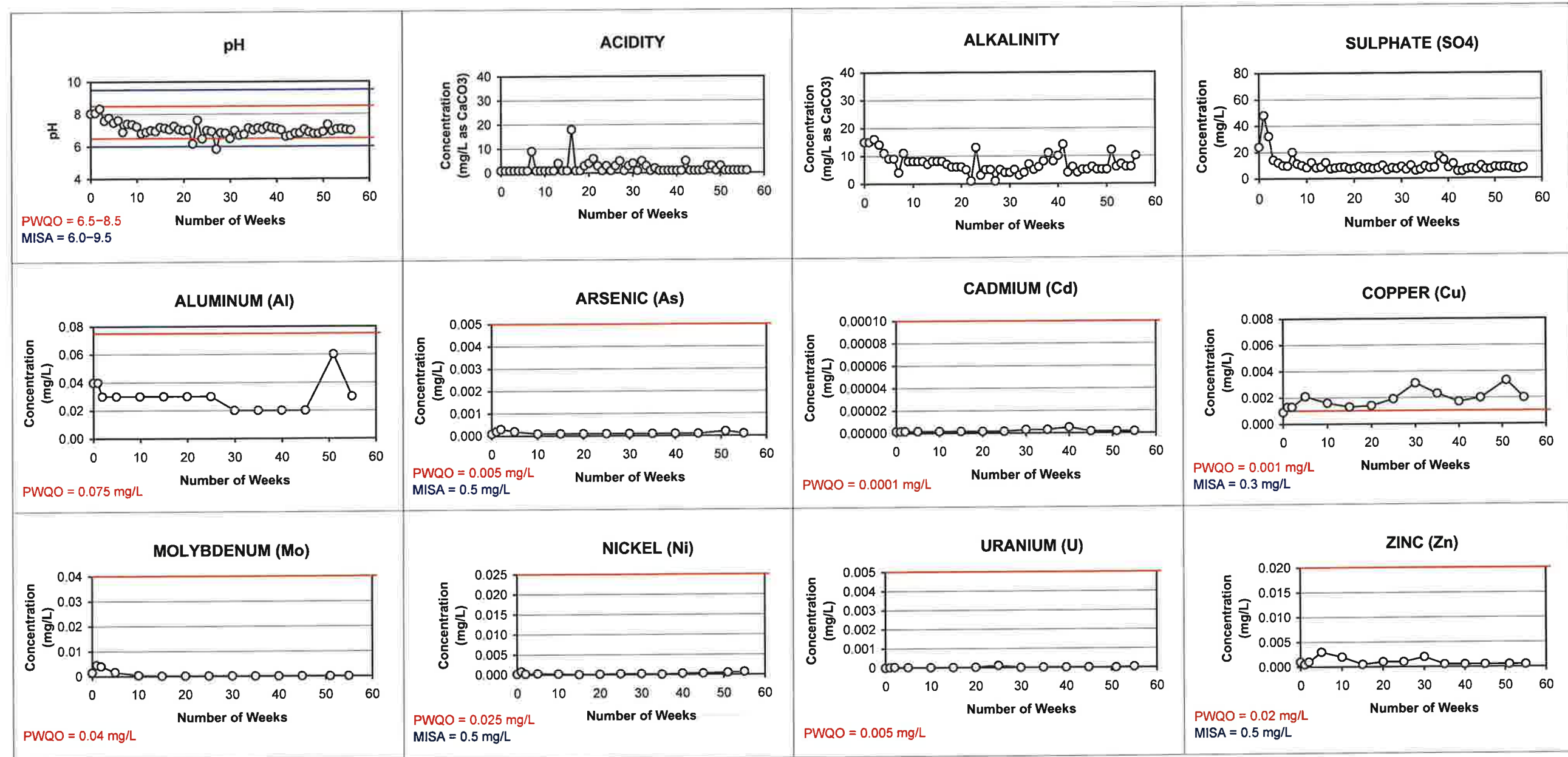


— Provincial Water Quality Objectives — MISA Discharge Limits

ABA & Depletion Data

Sulphide Content: 1.63 wt% as S
 NP: 36.1 t CaCO₃/1000 t
 CaNP: 5.954 t CaCO₃/1000 t
 AP: 51 t CaCO₃/1000 t
 NP/AP: 0.7
 Time to depletion for AP: 95 year
 Time to depletion for NP: 28 year

FIGURE 16
GEOCHEMISTRY OF HUMIDITY CELL MAR07-49: HETEROLITHIC BRECCIA
MARATHON PGM-Cu PROJECT

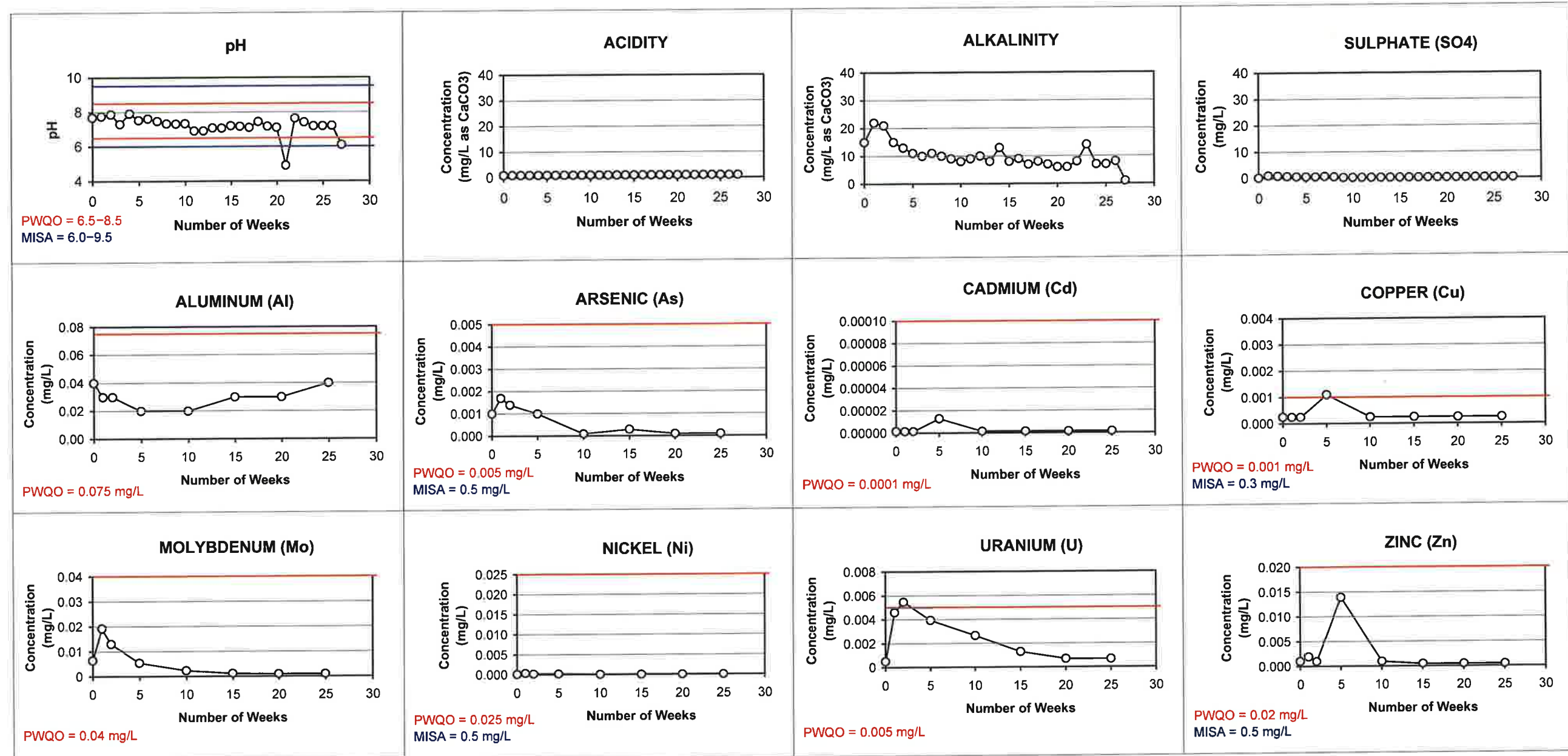


— Provincial Water Quality Objectives — MISA Discharge Limits

ABA & Depletion Data

Sulphide Content: 0.71 wt% as S
 NP: 28.4 t CaCO₃/1000 t
 CaNP: 4.753 t CaCO₃/1000 t
 AP: 22.1 t CaCO₃/1000 t
 NP/AP: 1.3
 Time to depletion for AP: 58 year
 Time to depletion for NP: 43 year

FIGURE 17
GEOCHEMISTRY OF HUMIDITY CELL MAR07-92: SYENITE
MARATHON PGM-Cu PROJECT



— Provincial Water Quality Objectives — MISA Discharge Limits

ABA & Depletion Data

Sulphide Content: 0.01 wt% as S
 NP: 19.5 t CaCO₃/1000 t
 CaNP: 10.7912400399143 t CaCO₃/1000 t
 AP: 0.31 t CaCO₃/1000 t
 NP/AP: 63
 Time to depletion for AP: 25 year
 Time to depletion for NP: 62 year

FIGURE 18
SULPHIDE CONTENT vs. PASTE pH: TAILINGS
MARATHON PGM-Cu PROJECT

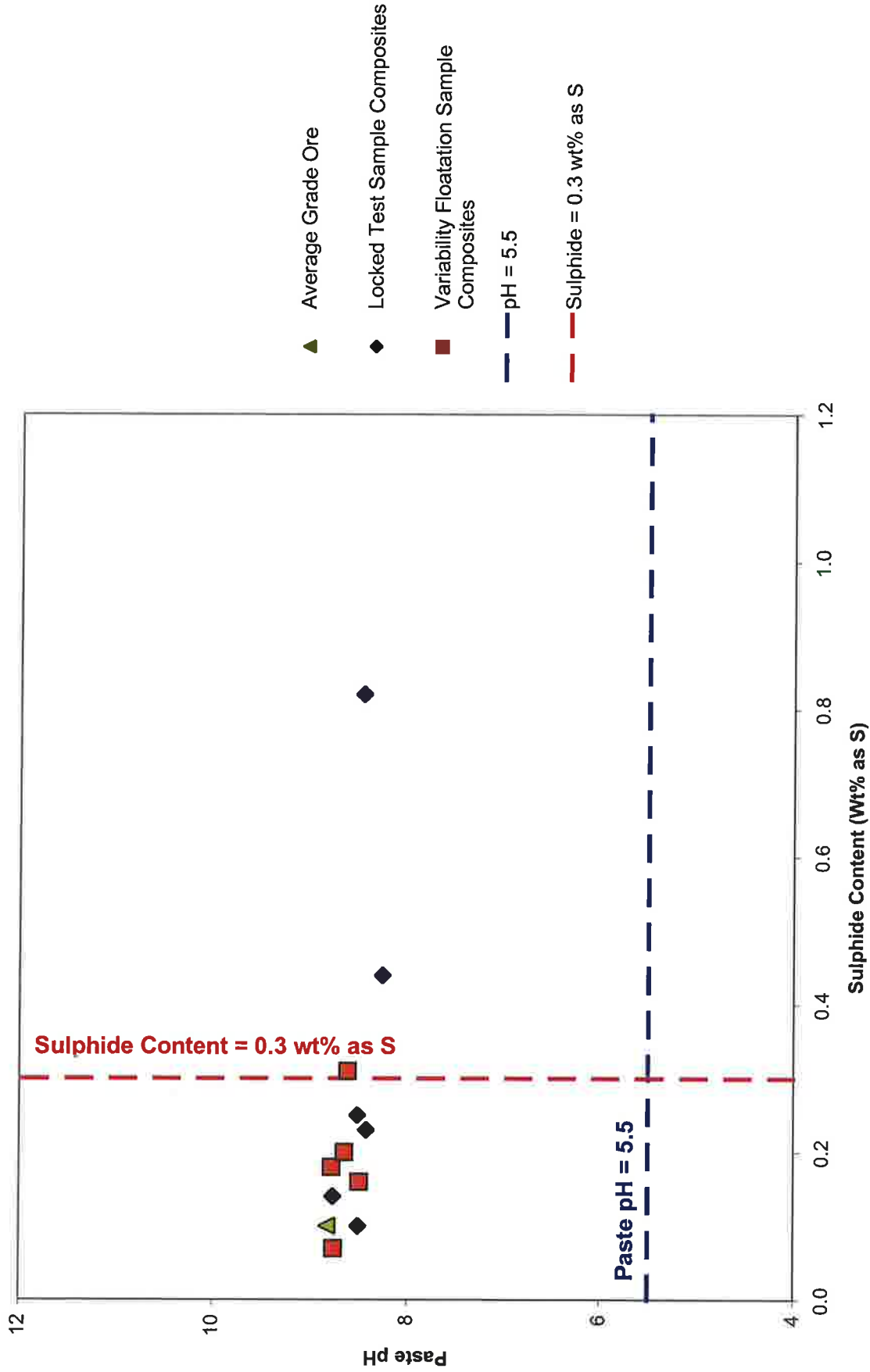


FIGURE 19
TOTAL SULPHUR CONTENT vs. SULPHIDE CONTENT: TAILINGS
MARATHON PGM-Cu PROJECT

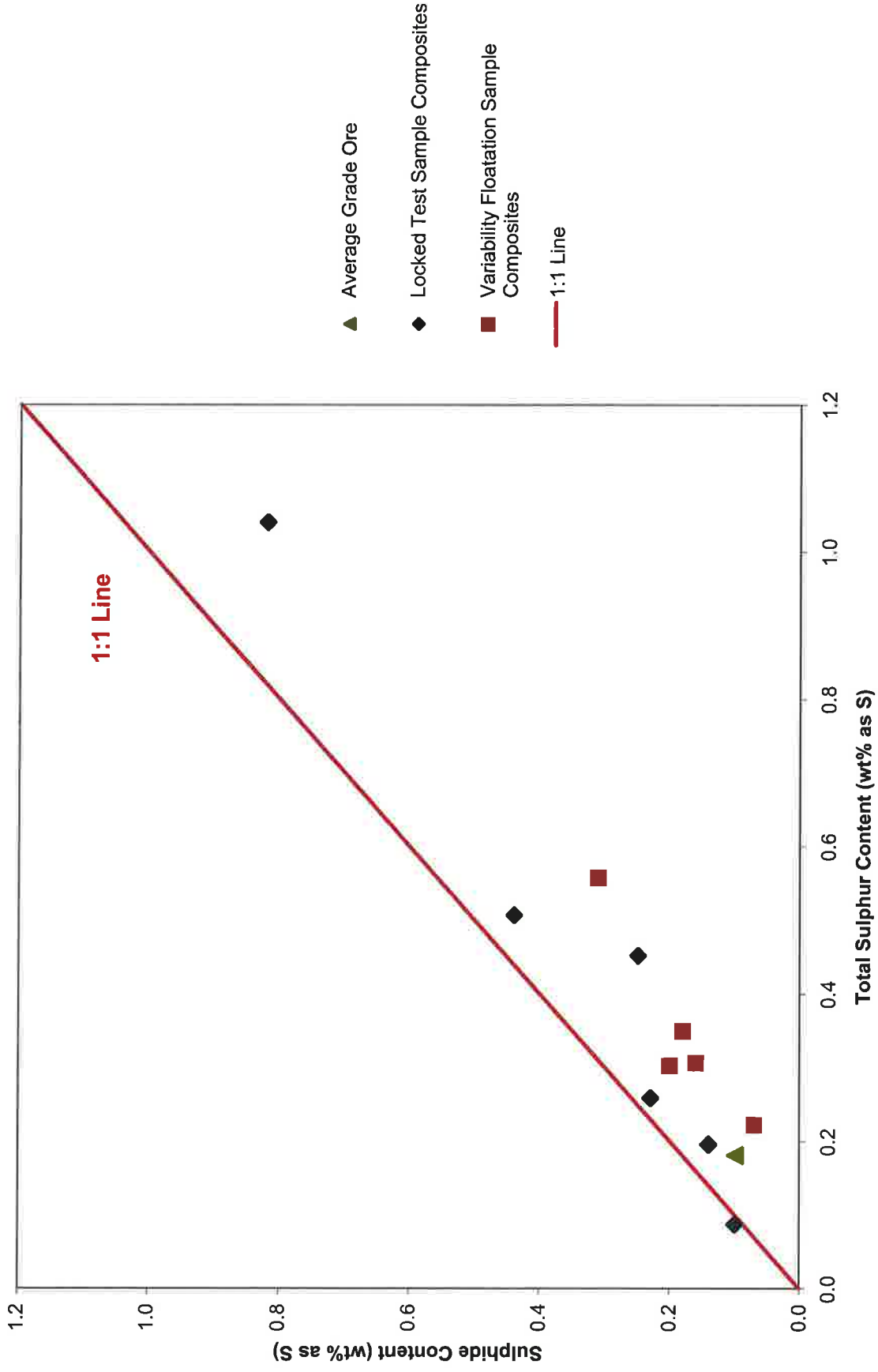


FIGURE 20 NEUTRALIZATION POTENTIAL (NP) vs. CARBONATE NEUTRALIZATION POTENTIAL (CaNP): TAILINGS MARATHON PGM-Cu PROJECT

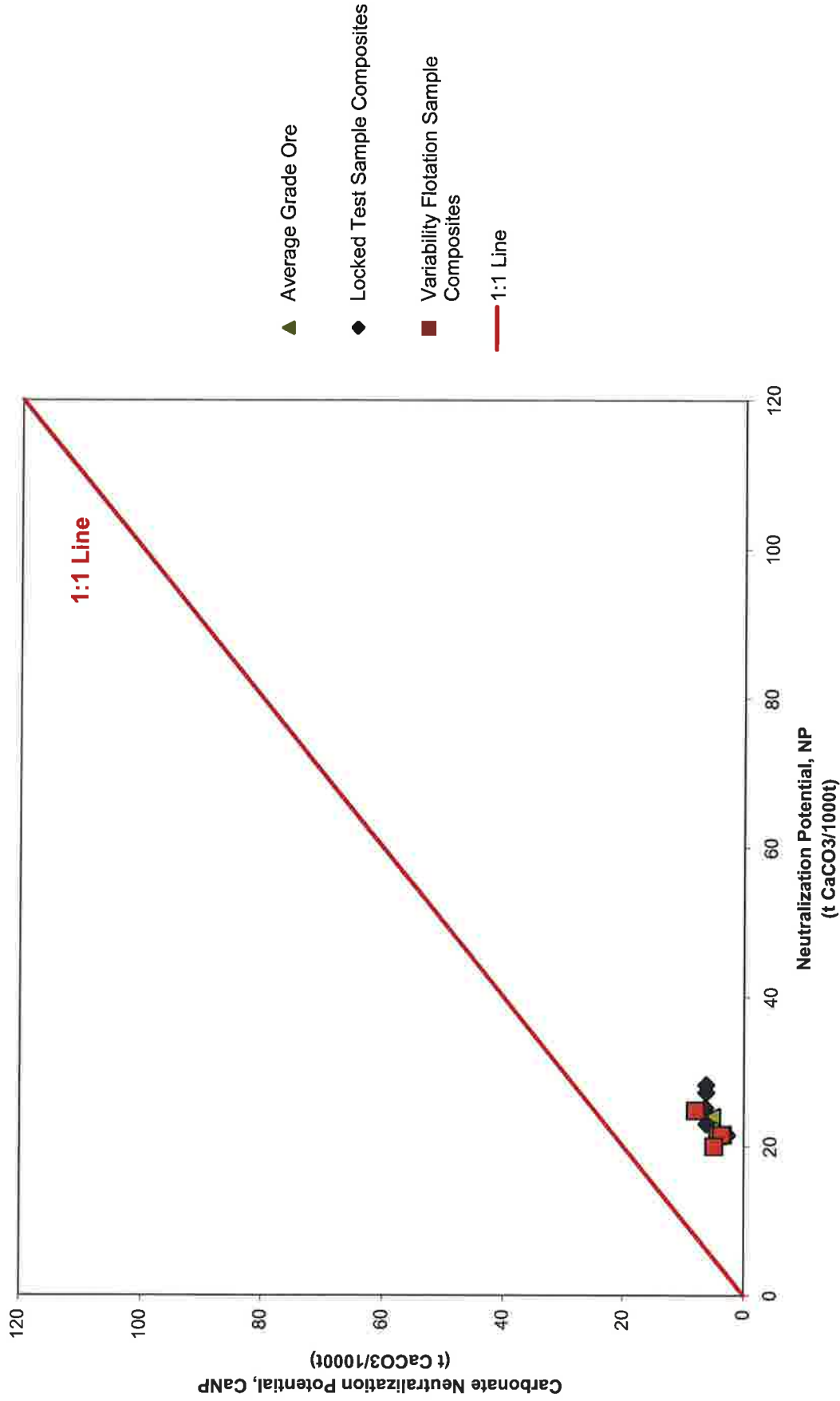


FIGURE 21
NEUTRALIZATION POTENTIAL (NP) vs. ACID POTENTIAL (AP): TAILINGS
MARATHON PGM-Cu PROJECT

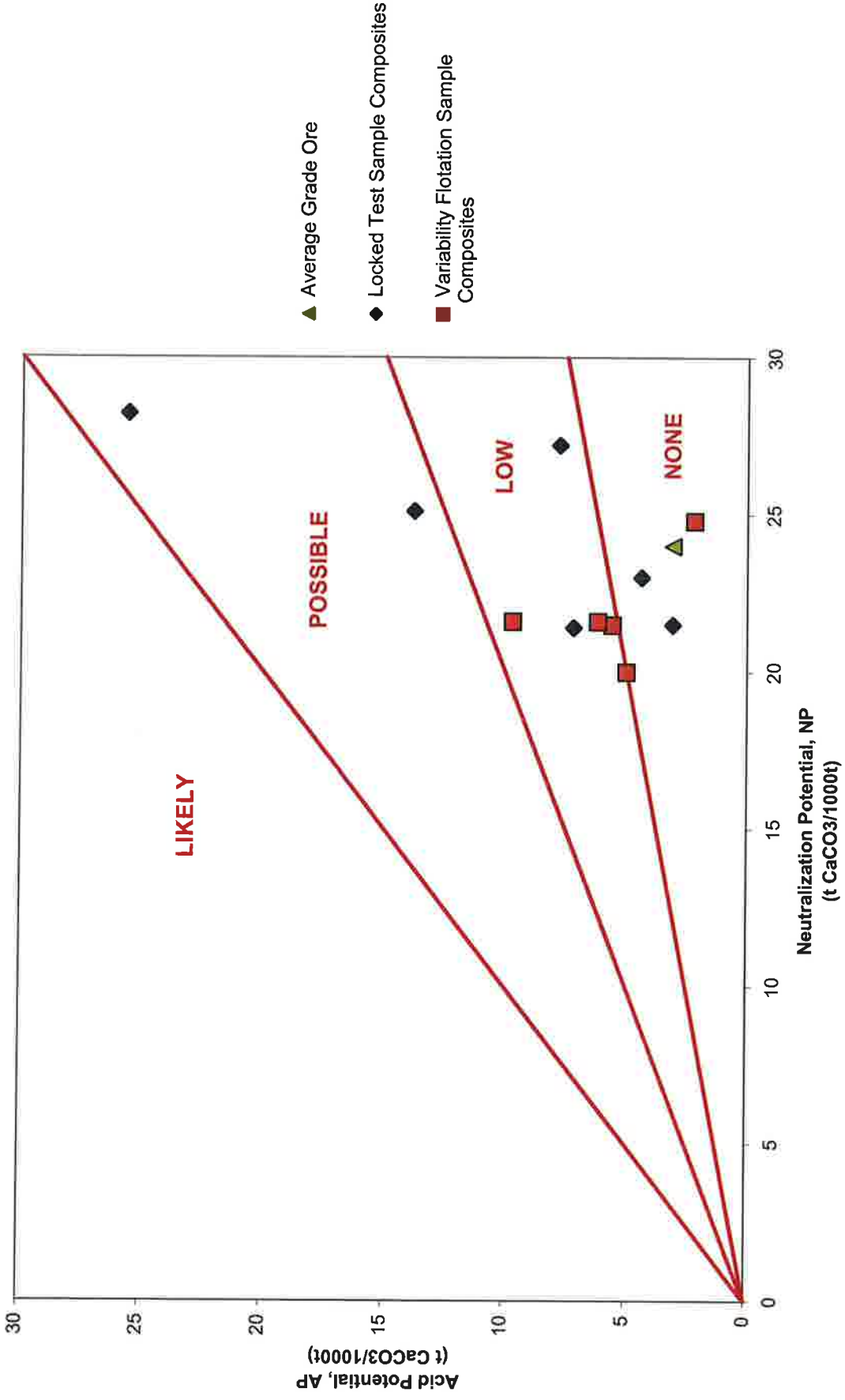


FIGURE 22
CARBONATE NEUTRALIZATION POTENTIAL (CaNP) vs. ACID POTENTIAL (AP): TAILINGS
MARATHON PGM-Cu PROJECT

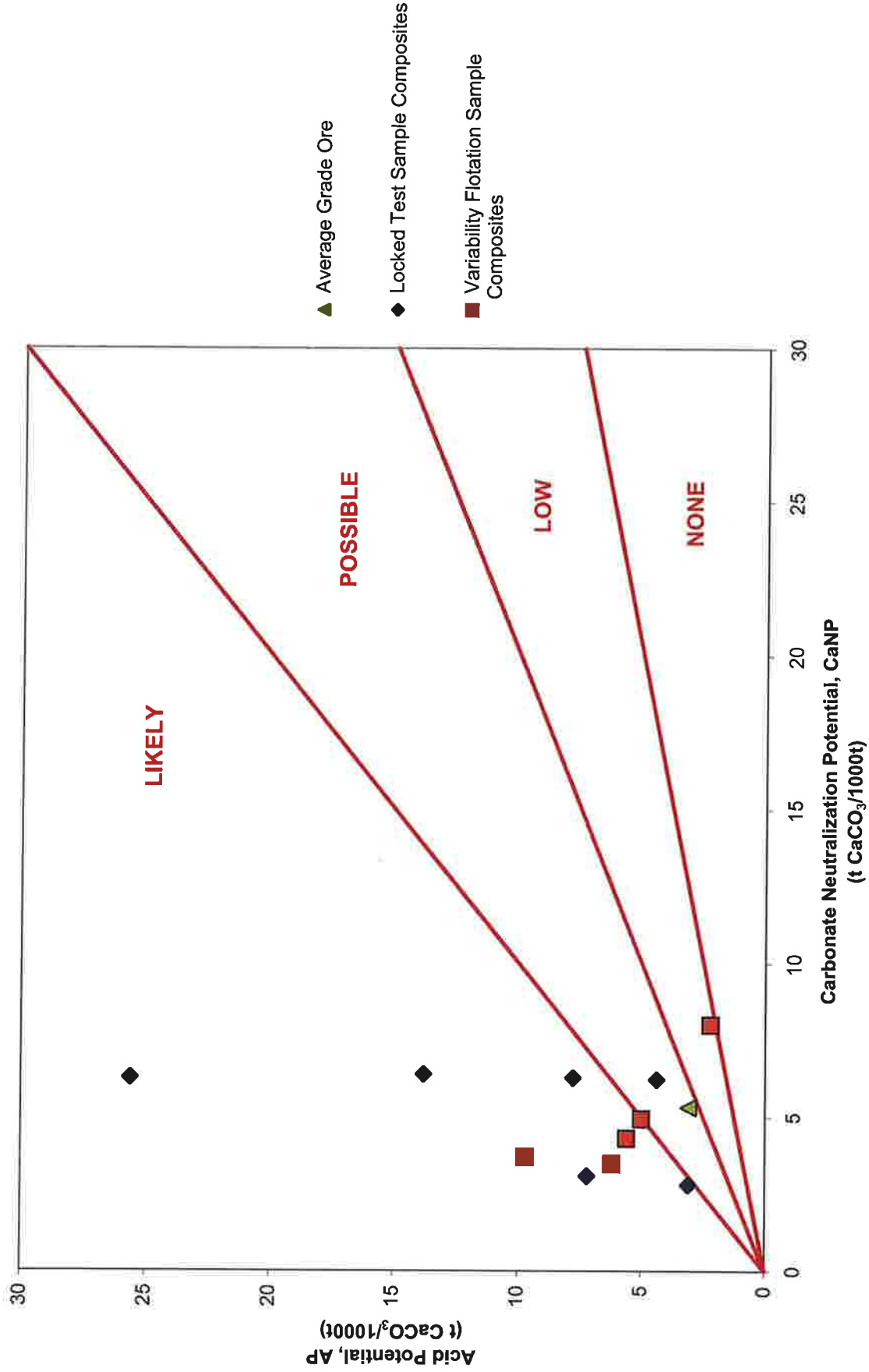
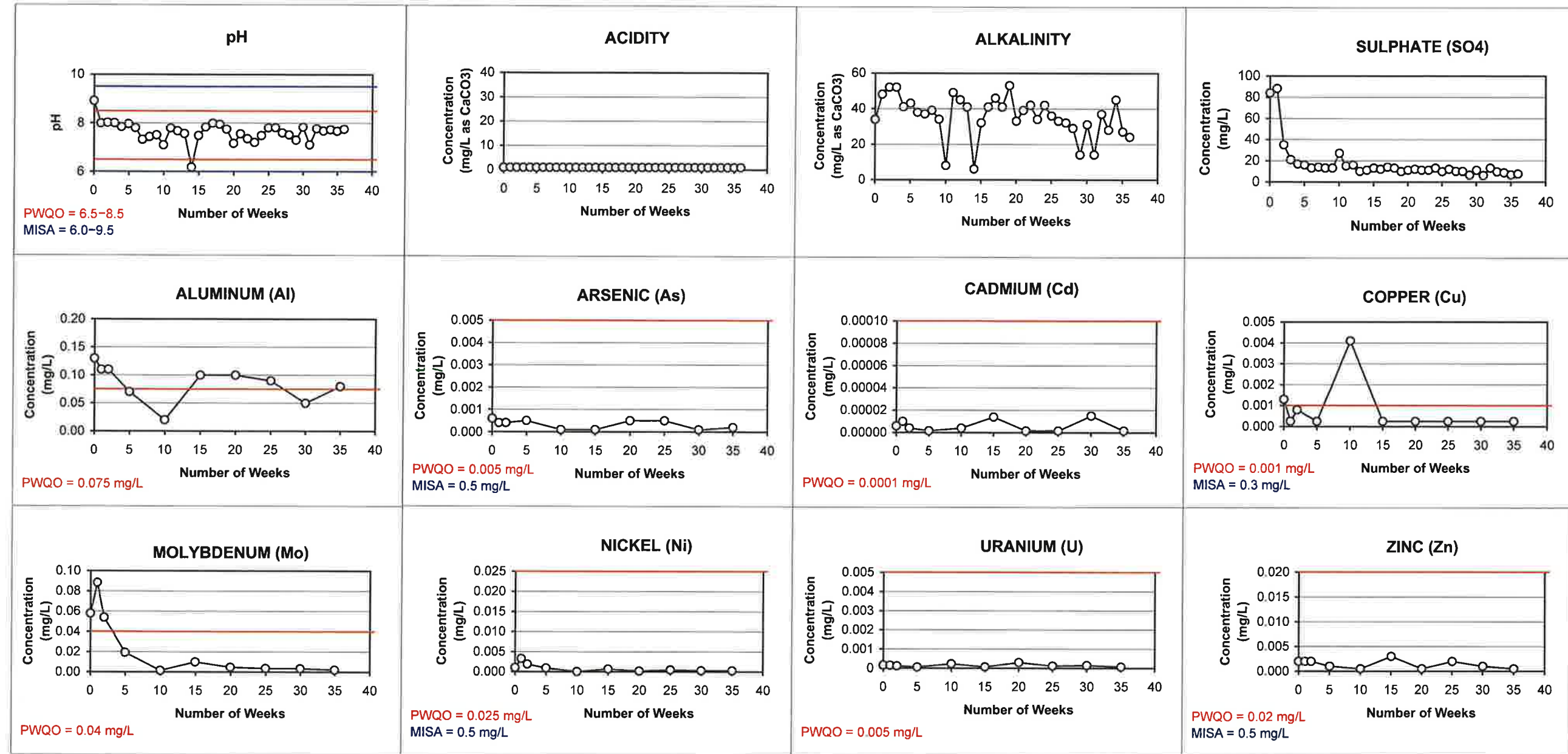


FIGURE 23
GEOCHEMISTRY OF HUMIDITY CELL MAR07-Tailings: TAILINGS
MARATHON PGM-Cu PROJECT



— Provincial Water Quality Objectives

— MISA Discharge Limits

ABA & Depletion Data

Sulphide Content: 0.1 wt% as S
 NP: 24 t CaCO₃/1000 t
 CaNP: 5.31 t CaCO₃/1000 t
 AP: 3.1 t CaCO₃/1000 t
 NP/AP: 7.74193548387097
 Time to depletion for AP: 5 year
 Time to depletion for NP: 11 year

APPENDIX A

**COMPLETE LIST OF SAMPLES SELECTED
FOR GEOCHEMICAL TESTING**

**TABLE A1
DETAILS OF CORE SAMPLES SELECTED FOR STATIC TESTING
MARATHON PGM-Cu PROJECT**

SAMPLE ID	CORE	DEPTH INTERVAL		ROCK TYPE	
		FROM	TO	CODE	DESCRIPTION
EASTERN GABBRO (n = 57)					
MAR07-01	M-07-312	87	98	2a	Fine grained gabbro.
MAR07-03	M-06-202	1.5	10.5	2d	Fine grained gabbro with coarse grained gabbro dikelets.
MAR07-04	M-06-202	10.5	19.4	2a, 2d	Fine grained gabbro, fine grained gabbro; coarse grained gabbro dikelets.
MAR07-05	M-06-202	36	45	2a	Fine grained gabbro.
MAR07-06	M-06-202	67	75	2d	Fine grained gabbro with coarse grained gabbro dikelets.
MAR07-07	M-06-202	72	80.1	2a	Fine grained gabbro.
MAR07-08	M-06-202	81.55	86.1	2a	Fine grained gabbro.
MAR07-10	M-06-202	90.3	99	2a, 3a, 3b	Fine grained gabbro; fine to medium grained gabbro (<5 mm); coarse grained gabbro (>5 mm).
MAR07-12	M-06-202	104	109	2a	Fine grained gabbro.
MAR07-16	M-06-202	321	324	2a, 1a	Fine grained gabbro; footwall volcanics.
MAR07-18	M-06-222	26	37	2a (minor 2f)	Fine grained gabbro, medium to coarse grained magnetite-rich gabbro; minor medium to coarse grained magnetite-rich gabbro.
MAR07-23	M-06-223	12.7	21.5	2d, 2a	Fine grained gabbro with coarse grained gabbro dikelets; fine grained gabbro.
MAR07-24	M-06-223	39	47	2d, 2a	Fine grained gabbro with coarse grained gabbro dikelets; fine grained gabbro.
MAR07-25	M-06-223	78.2	87	2d	Fine grained gabbro with coarse grained gabbro dikelets.
MAR07-27	M-06-223	243	251	2a	Fine grained gabbro.
MAR07-32	M-06-223	217	226	2d	Fine grained gabbro with coarse grained gabbro dikelets.
MAR07-36	M-06-224	15	23.9	2f	Medium to coarse grained magnetite-rich gabbro.
MAR07-37	M-06-225	0	9.5	2a	Fine grained gabbro.
MAR07-38	M-06-225	39	48.7	2a, 2d	Fine grained gabbro; fine grained gabbro with coarse grained gabbro dikelets.
MAR07-39	M-06-225	57	66	2a, 2f, 2d	Fine grained gabbro; medium to coarse grained magnetite-rich gabbro; fine grained gabbro with coarse grained gabbro dikelets.
MAR07-42	M-06-225	168	171	2a	Fine grained gabbro.
MAR07-43	M-06-225	71	79	2a, 2d	Fine grained gabbro.
MAR07-44	M-06-225	79	88	2a, 2d	Fine grained gabbro; fine grained gabbro with coarse grained gabbro dikelets.
MAR07-45	M-06-225	105	107	2f	Medium to coarse grained magnetite-rich gabbro.
MAR07-46	M-06-225	108	118	2a, 2d	Fine grained gabbro; fine grained gabbro with coarse grained gabbro dikelets.
MAR07-48	M-06-225	192	201	2d	Fine grained gabbro with coarse grained gabbro dikelets.
MAR07-50	M-06-226	28	33	2b, 2a	Fine grained gabbro with layering, fine grained gabbro.
MAR07-51	M-06-226	66	72	2a	Fine grained gabbro.
MAR07-53	M-06-220	6.9	11.2	2a (minor 2f)	Fine grained gabbro; minor medium to coarse grained magnetite-rich gabbro.
MAR07-54	M-06-220	12	20	2d	Fine grained gabbro with coarse grained gabbro dikelets.

**TABLE A1
DETAILS OF CORE SAMPLES SELECTED FOR STATIC TESTING
MARATHON PGM-Cu PROJECT**

SAMPLE ID	CORE	DEPTH INTERVAL		ROCK TYPE	
		FROM	TO	CODE	DESCRIPTION
MAR07-14	M-06-202	124	138	3b	Coarse grained gabbro (>5 mm).
MAR07-15	M-06-202	316	321	3b	Coarse grained gabbro (>5 mm).
MAR07-19	M-06-222	55	66	3a	Fine to medium grained gabbro (<5 mm).
MAR07-21	M-06-222	96	108	3b, 3a	Coarse grained gabbro (>5 mm); fine to medium grained gabbro (<5 mm).
MAR07-22	M-06-223	4	7.6	3c	Coarse grained gabbro with leuco pods.
MAR07-28	M-06-223	156.7	165.1	3b, 4a	Coarse grained gabbro (>5 mm), breccia of Eastern Gabbro fragments in Two Duck Lake Gabbro
MAR07-29	M-06-223	165	174	3b	Coarse grained gabbro (>5 mm).
MAR07-30	M-06-223	177	186	3b	Coarse grained gabbro (>5 mm).
MAR07-31	M-06-223	200	208	3b	Coarse grained gabbro (>5 mm).
MAR07-41	M-06-225	159	164	3a	Fine to medium grained gabbro (<5 mm).
MAR07-47	M-06-225	175	188	3a	Fine to medium grained gabbro (<5 mm).
MAR07-63	M-06-220	175	188	3b (minor 3d & 2e)	Coarse grained gabbro (>5 mm); minor coarse grained to pegmatitic gabbro and medium to coarse grained gabbro.
MAR07-67	M-07-309	91	100	3a	Fine to medium grained gabbro (<5 mm).
MAR07-68	M-07-309	100	108	3a	Fine to medium grained gabbro (<5 mm).
MAR07-69	M-07-309	113	123	3a	Fine to medium grained gabbro (<5 mm).
MAR07-76	M-06-160	41	50	3c	Coarse grained gabbro with leuco pods.
MAR07-77	M-06-160	53	63	3c	Coarse grained gabbro with leuco pods.
MAR07-79	M-06-153	31	40	3b	Coarse grained gabbro (>5 mm).
MAR07-80	M-06-153	53	62	3b	Coarse grained gabbro (>5 mm).
MAR07-84	M-06-150	5	14	3a, 3b	Fine to medium grained gabbro (<5 mm); coarse grained gabbro (>5 mm).
MAR07-86	M-06-152	5	14	3a, 3b	Fine to medium grained gabbro (<5 mm); coarse grained gabbro (>5 mm).
MAR07-88	M-06-210	19	32	3b, 4a	Coarse grained gabbro (>5 mm); breccia of Eastern Gabbro fragments in Two Duck Lake Gabbro.
MAR07-90	M-06-210	87	98	3b	Coarse grained gabbro (>5 mm).
MAR07-93	M-06-228	58	66	3b	Coarse grained gabbro (>5 mm).
MAR07-94	M-06-228	66	75	3b	Coarse grained gabbro (>5 mm).
MAR07-98	M-06-227	223	232	3b, 3a	Coarse grained gabbro (>5 mm); fine to medium grained gabbro (<5 mm).
MAR07-106	M-06-231	68	76	3b, 3d, 3c	Coarse grained gabbro (>5 mm); coarse grained to pegmatitic gabbro; coarse grained gabbro with leuco pods.
MAR07-107	M-06-231	184	192	3b, 2a	Coarse grained gabbro (>5 mm); fine grained gabbro.
MAR07-108	M-06-231	84	102	3b, 3d, 3c	Coarse grained gabbro (>5 mm); coarse grained to pegmatitic gabbro; coarse grained gabbro with leuco pods.

TABLE A1
DETAILS OF CORE SAMPLES SELECTED FOR STATIC TESTING
MARATHON PGM-Cu PROJECT

SAMPLE ID	CORE	DEPTH INTERVAL		ROCK TYPE	
		FROM	TO	CODE	DESCRIPTION
MAR07-109	M-06-231	124	133	3b, 3d, 3c	Coarse grained gabbro (>5 mm); coarse grained to pegmatitic gabbro; coarse grained gabbro with leuco pods.
VOLCANIC (n = 9)					
MAR07-17	M-06-202	323	339	1a, 1b	Footwall volcanics; very fine grained mafic volcanic.
MAR07-33	M-06-223	277	288	1a, 1b	Footwall volcanics; very fine grained mafic volcanic.
MAR07-34	M-06-224	49.5	58.1	1b	Very fine grained mafic volcanic
MAR07-52	M-06-226	138	147	1a	Footwall volcanics.
MAR07-66	M-06-220	302	310	1a (minor 2a)	Footwall volcanics; minor fine grained gabbro.
MAR07-96	M-06-227	301	310	1a, 2a	Footwall volcanics; fine grained gabbro.
MAR07-102	M-06-231	0	9.4	1a	Footwall volcanics.
MAR07-105	M-06-231	56	63	1a	Footwall volcanics.
MAR07-111	M-06-231	257	261	1a	Footwall volcanics.
HETEROLITHIC BRECCIA (n = 7)					
MAR07-02	M-07-213	157	165	4a, 3a, 5a	Breccia of Eastern Gabbro fragments in Two Duck Lake Gabbro; fine to medium grained gabbro (<5 mm), quartz syenite dikelet.
MAR07-35	M-06-224	183.4	192.2	4a (minor 3b, 2f)	Breccia of Eastern Gabbro fragments in Two Duck Lake Gabbro; minor coarse grained gabbro (>5 mm) and medium to coarse grained magnetite-rich gabbro.
MAR07-49	M-06-225	228	232	4a	Breccia of Eastern Gabbro fragments in Two Duck Lake Gabbro.
MAR07-74	M-07-319	76	84	4a	Breccia of Eastern Gabbro fragments in Two Duck Lake Gabbro.
MAR07-81	M-06-155	14	22	4a	Breccia of Eastern Gabbro fragments in Two Duck Lake Gabbro.
MAR07-100	M-06-227	275	280	4a	Breccia of Eastern Gabbro fragments in Two Duck Lake Gabbro.
MAR07-110	M-06-231	248	257	4b	Heterolithic breccia.
SYENITE (n = 7)					
MAR07-13	M-06-202	109	123	5b	Augite syenite.
MAR07-20	M-06-222	83	87.9	5a	Quartz syenite dikelet.
MAR07-26	M-06-223	93	104.6	5a	Quartz syenite dikelet.
MAR07-40	M-06-225	67.75	69.75	5a	Quartz syenite dikelet.
MAR07-73	M-07-319	20	30	5a	Quartz syenite dikelet.
MAR07-75	M-06-160	28	37	5a	Quartz syenite dikelet.
MAR07-92	M-06-227	28	33	5a	Quartz syenite dikelet.
SERPENTINITE (n = 2)					
MAR07-103	M-06-231	13	25	6	Serpentinite.
MAR07-104	M-06-231	35	44	6	Serpentinite.

APPENDIX B
OPTICAL MICROSCOPY

FIGURE B1
Plane-polarized reflected light photomicrograph showing pyrrhotite and pyrite along with chalcopyrite and sphalerite in sample MAR07-15.

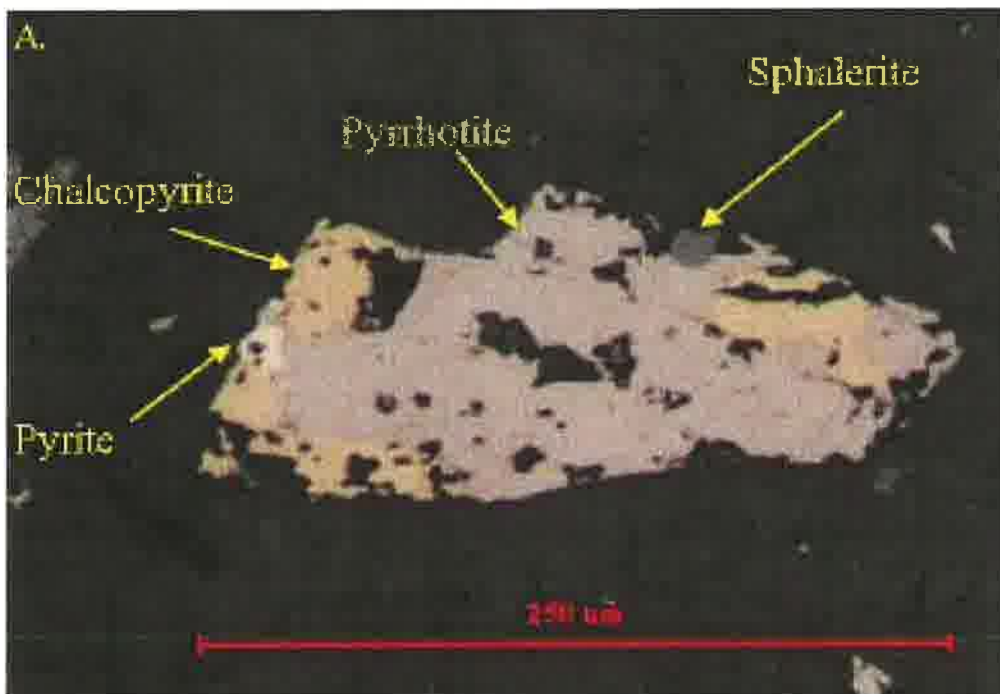
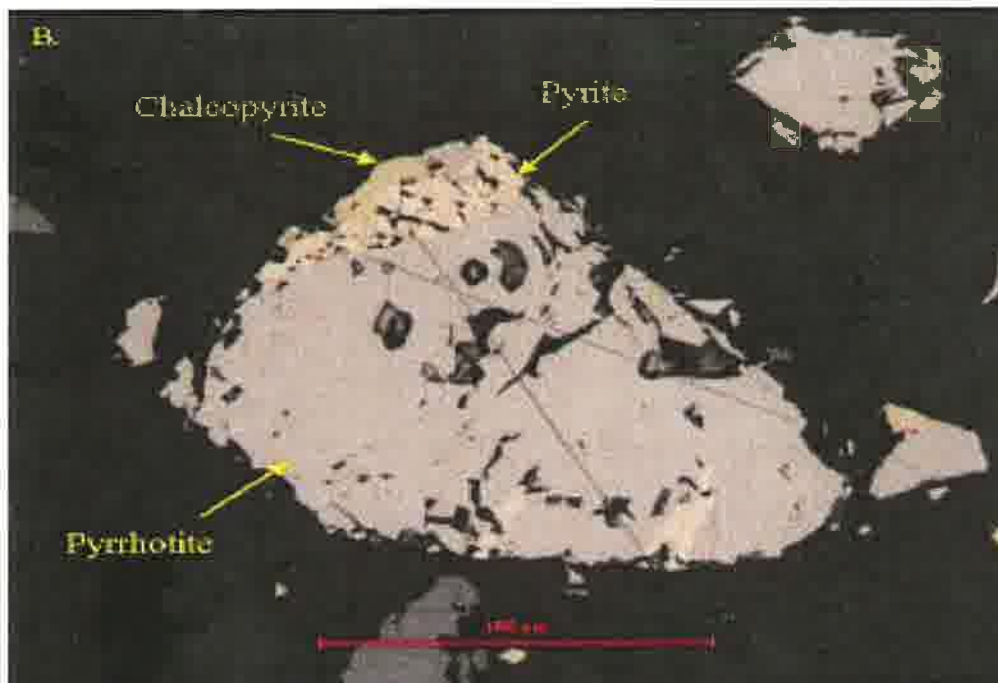


FIGURE B2
Plane-polarized reflected light photomicrograph showing pyrrhotite and pyrite along with chalcopyrite in sample MAR07-16.



Date: Dec-08
Project: 07-1118-0012 (4000)

Drawn: MRG
Chkd: CMC/KJD

Golder Associates

FIGURE B3
Cross-polarized transmitted light photomicrograph showing calcite in sample MAR07-49.

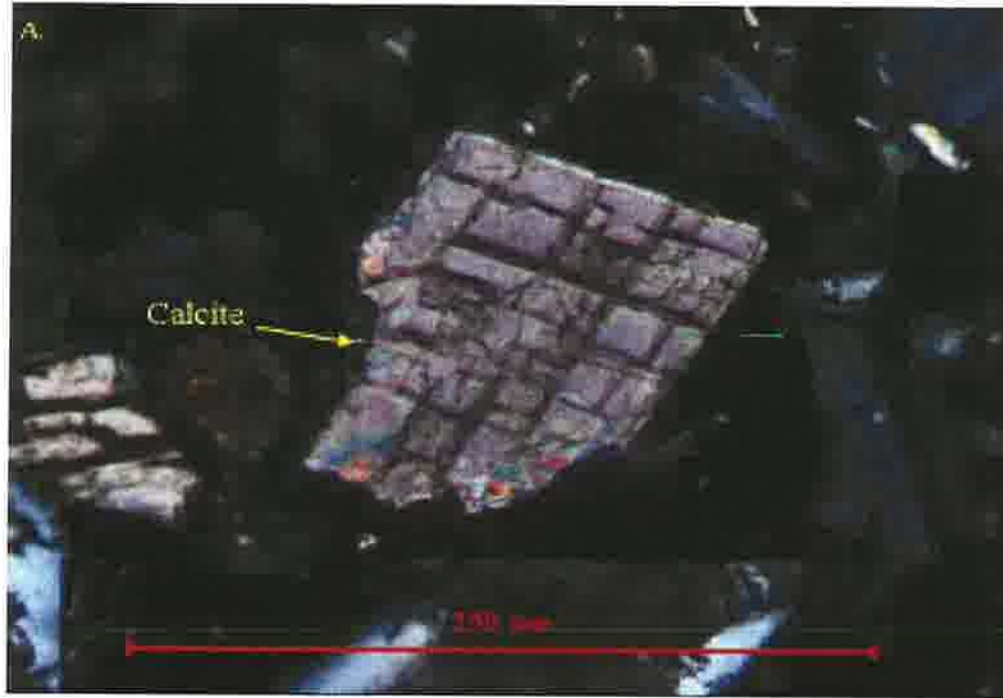
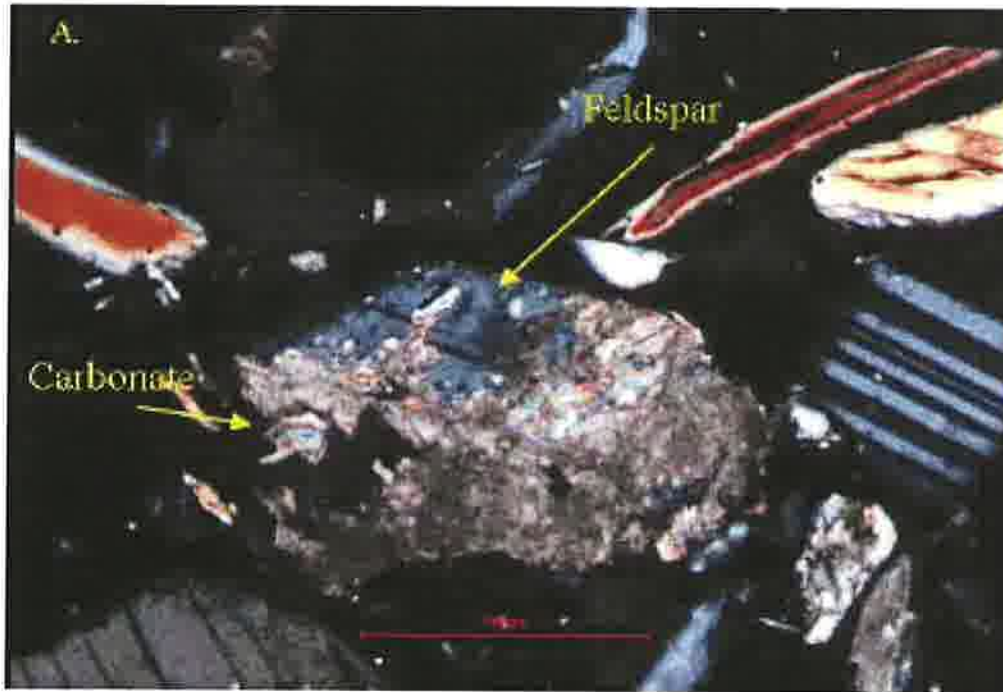


FIGURE B4
Cross-polarized transmitted light photomicrograph showing unidentified carbonate mineral with feldspar in sample MAR07-18.



Date: Dec-08
Project: 07-1118-0012 (4000)

Drawn: MRG
Chkd: CMC/KJD

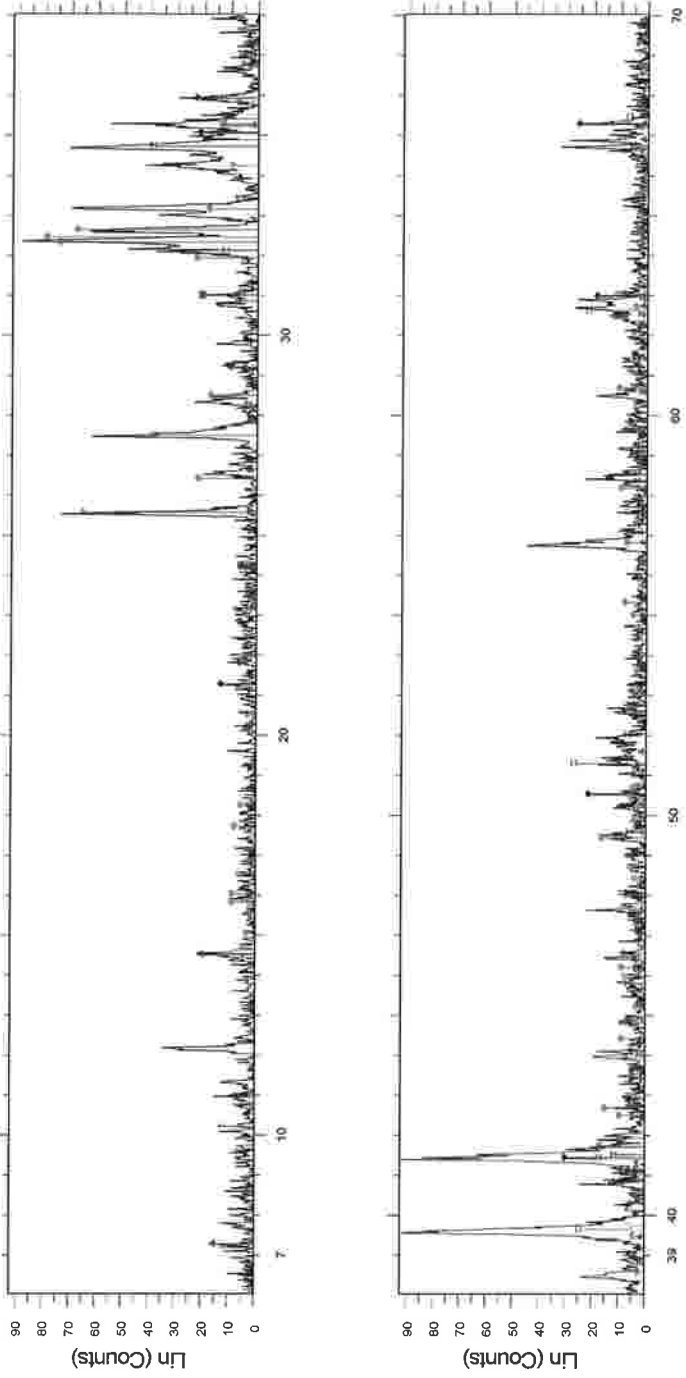
Golder Associates

APPENDIX C
QUALITATIVE X-RAY DIFFRACTION SCANS

XRD RESULTS FOR MAR07-15

FIGURE C1

MAR07-15



- MAR07-15 - File: Nov6019-1.raw - Type: 2Th/Th locked - Start: 6.000 ° - End: 70.00
- 01-079-1910 (C) - Quartz - SiO2
- 00-011-0614 (D) - Magnetite - Fe3O4
- 00-020-0528 (C) - Anorthite, sodian, ordered - (Ca,Na)(Al,Si)2Si2O8
- 01-079-1270 (C) - Clinocllore - (Mg,Fe)5Si8O22(OH)2
- 01-074-1687 (C) - Dolomite - CaMg(CO3)2
- 00-022-0388 (D) - Pyrrhotite 6C - Fe1-xS
- 00-037-0471 (*) - Chalcopyrite - CuFeS2
- 01-080-1109 (C) - Biotite - KFeMg2(AlSi3O10)(OH)2
- 01-073-0267 (C) - Tremolite - Ca2Mg5Si8O22(OH)2
- 00-002-0669 (D) - Talc Sessatite Soapstone - 3MgO·4SiO2·H2O
- 01-081-0487 (C) - Diopside - (Ca0.96970.041)(Mg0.98740.013)(Si1.90640.0936O6)

DATE: FEBRUARY 2008

CAD:

PROJECT: 07-1118-0012 (4000)

CHK: MRG/KJDF

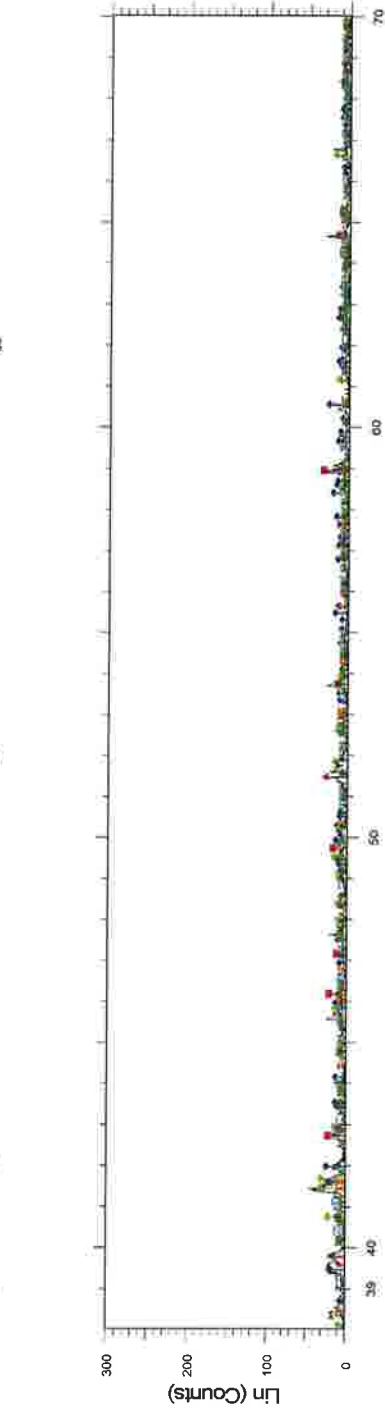
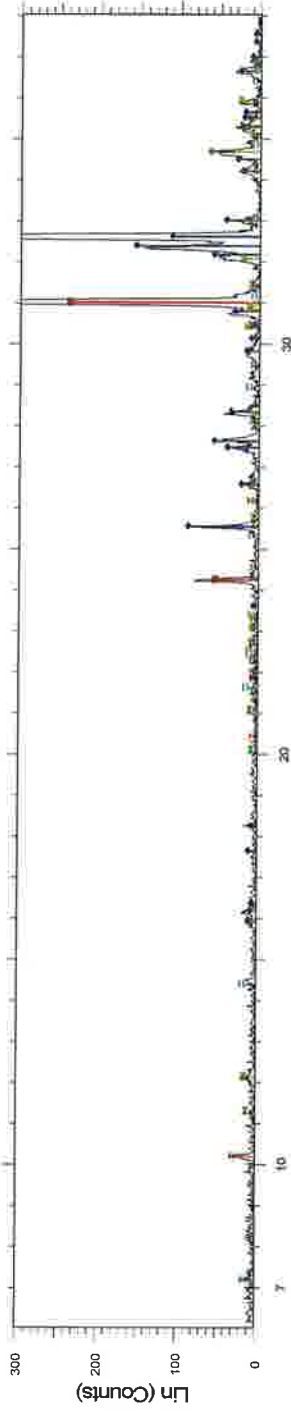


N:\Active\2007\118\07-1118-0012\Appendices\MAR07-15 Fig1

XRD RESULTS FOR MAR07-16

FIGURE C2

MAR07-16



2-Theta - Scale

Legend:

- 01-079-1910 (C) - Quartz - SiO₂
- 01-083-1939 (C) - Andesine - Na_{0.685}Ca_{0.347}Al_{1.46}Si_{2.64}O₈
- 01-086-0932 (C) - Diopside - CaMgSiO₆
- 00-003-1028 (D) - Pyrrhotite - Fe₉S₈
- 01-071-0607 (C) - Chalcopyrite - CuFeS₂
- 01-080-1108 (C) - Biotite - KFe₃Mg₂(AlSi₃O₁₀)(OH)₂
- 01-082-0038 (C) - Clinoclinoite lib-s (Cr, Mg-rich) - (Mg_{0.99}Al_{0.01})₈(Al_{0.67}Fe_{0.33})₄

DATE: FEBRUARY 2008

CAD: _____

PROJECT: 07-1118-0012 (4000)

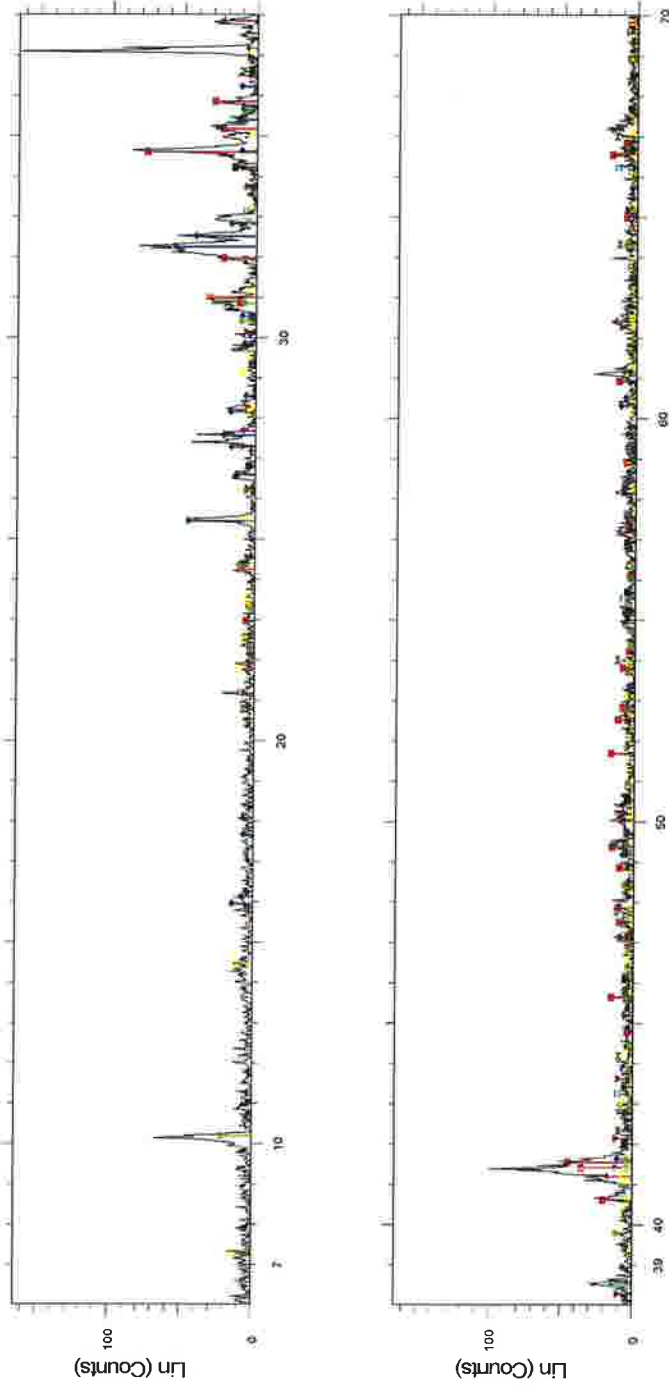
CHK: MRG/KJDF



XRD RESULTS FOR MAR07-18

FIGURE C3

MAR07-18



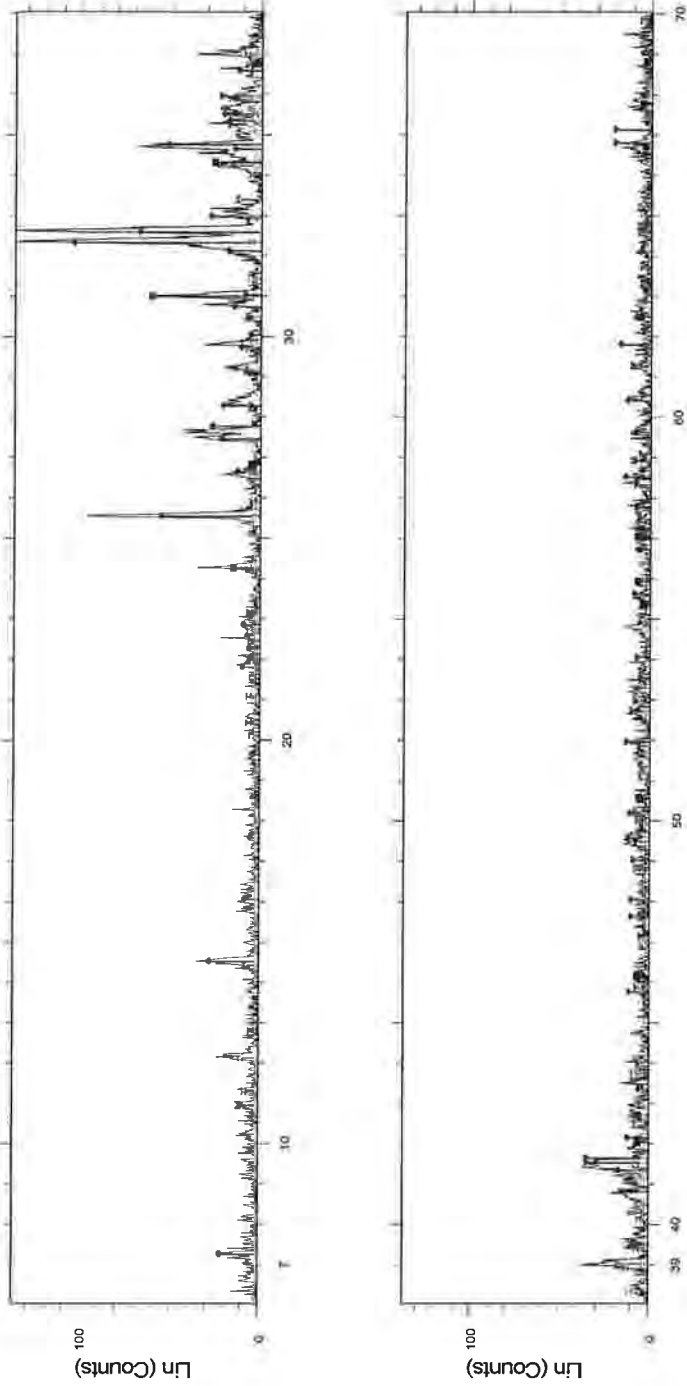
2-Theta - Scale
 Start: 6.000 ° - End: 70.00
 File: Nov6019-3.raw - Type: 2Th/Th locked
 Date: FEBRUARY 2008
 Project: 07-1118-0012 (4000)
 CAD: _____
 CHK: MRGKJDF



XRD RESULTS FOR MAR07-33

FIGURE C4

MAR07-33



- 2-Theta - Scale
- MAR07-33 - File: Nov5019-4.raw - Type: 2Th/Th locked - Start: 5.000 ° - End: 70.00
 - 01-079-1910 (C) - Quartz - SiO2 - I/Ic PDF 3.1 - S-Q 8.9 %
 - 00-020-0548 (D) - Albite, calcian, ordered - (Na,Ca)(Si,A)4O8 - I/Ic PDF 1. - S-Q 3.6 %
 - 01-079-1270 (C) - Chloroite - (Mg2.96Fe1.66Fe.138Al1.276)(Si2.622Al1.376O10) - I/Ic PDF 7.2 - S-Q 0.7 %
 - 01-083-0984 (C) - Chalcophyllite - CuFeS2 - I/Ic PDF 7.2 - S-Q 0.7 %
 - 00-019-0239 (D) - Diopside, syn - CaMg(Fe)SiO3 - I/Ic PDF 1. - S-Q 17.6 %
 - 00-017-0514 (D) - Epidote - Ca2Al2Fe(Al)Si2O7(O,OH)2 - I/Ic PDF 1. - S-Q 5.1 %
 - 00-002-0569 (D) - Talc Steatite Soapstone - 3MgO·4SiO2·H2O - I/Ic PDF 1. - S-Q 3.9
 - 01-073-0267 (C) - Tremolite - Ca2Mg5Si8O22(OH)2 - I/Ic PDF 0.7 - S-Q 4.2 %
 - 00-019-0532 (I) - Microcline, intermediate - KAlSi3O8 - I/Ic PDF 1. - S-Q 1.9 %
 - 01-085-1424 (C) - Ferropargasite chlorous - NaCa2(Fe,Mg)Al(Si6Al2)O22(OH,C)2 - I/Ic PDF 1. - S-Q 3.6 %
 - 00-002-1241 (D) - Pyrrhotite - FeS - I/Ic PDF 1. - S-Q 3.6 %
 - 01-072-1662 (C) - Calcite - CaCO3 - I/Ic PDF 3.2 - S-Q 2.7 %

DATE: FEBRUARY 2008

CAD:

PROJECT: 07-1118-0012 (4000)

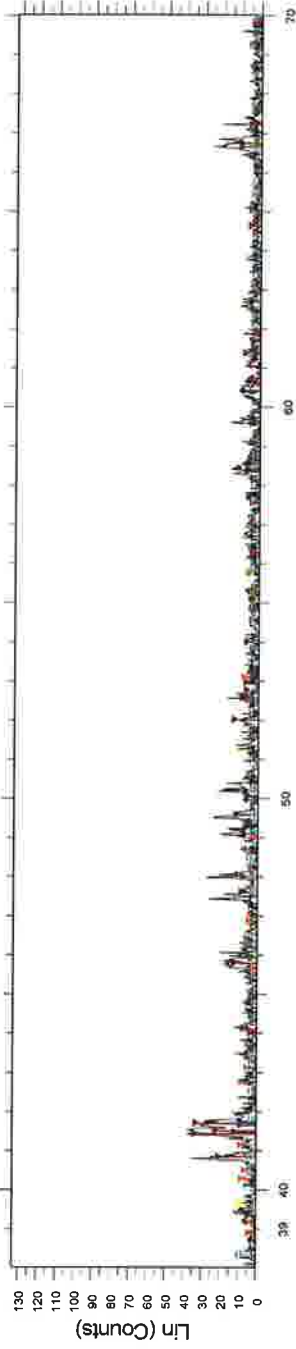
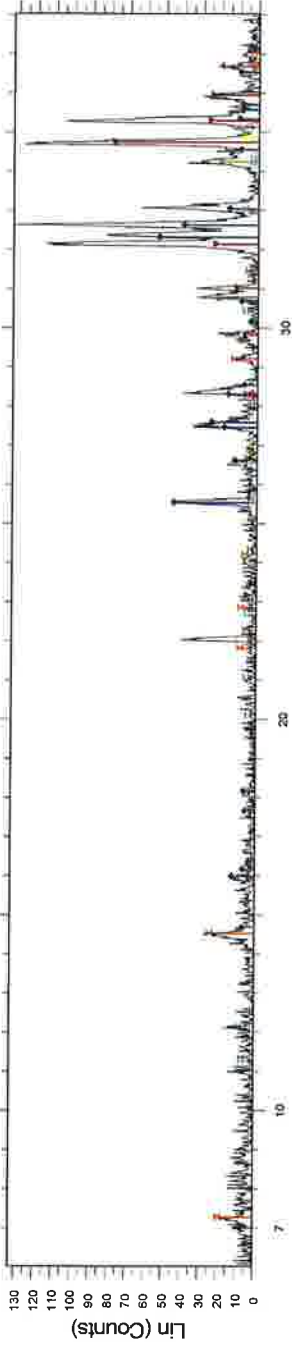
CHK: MRGIKJDF



XRD RESULTS FOR MAR07-49

FIGURE C5

MAR07-49



2-Theta - Scale

Legend:

- 01-071-1151 (C) - Albite high - Na(AlSi3O8)
- 01-083-1752 (C) - Calcite - Ca(CO3)
- 01-079-1345 (C) - Dolomite - CaMg(CO3)2
- 01-081-0487 (C) - Diopside - (Ca0.969Ti0.041)(Mg0.987Al0.013)(Si1.905Al0.095O6)
- 01-079-1270 (C) - Clinoclhire - (Mg2.96Fe1.55Fe1.36Al1.275)(Si2.622Al1.376O10)
- 01-074-1811 (A) - Quartz alpha - SiO2
- 01-073-0257 (C) - Tremolite - Ca2Mg5Si8O22(OH)2
- 01-073-0147 (C) - Talc - Mg3(Si2O5)2(OH)2
- 00-017-0201 (D) - Pyrrhobite - Fe1-xS
- 01-075-0253 (C) - Chalcopyrite - CuFeS2

DATE: FEBRUARY 2008

CAD:

PROJECT: 07-1118-0012 (4000)

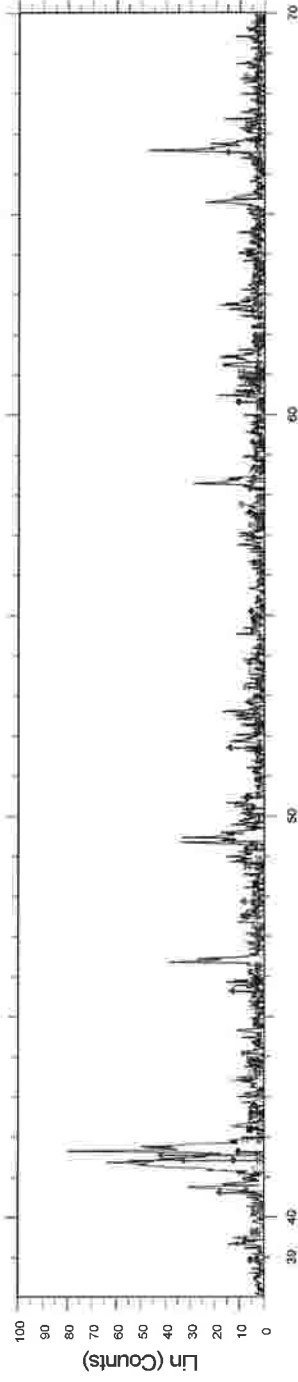
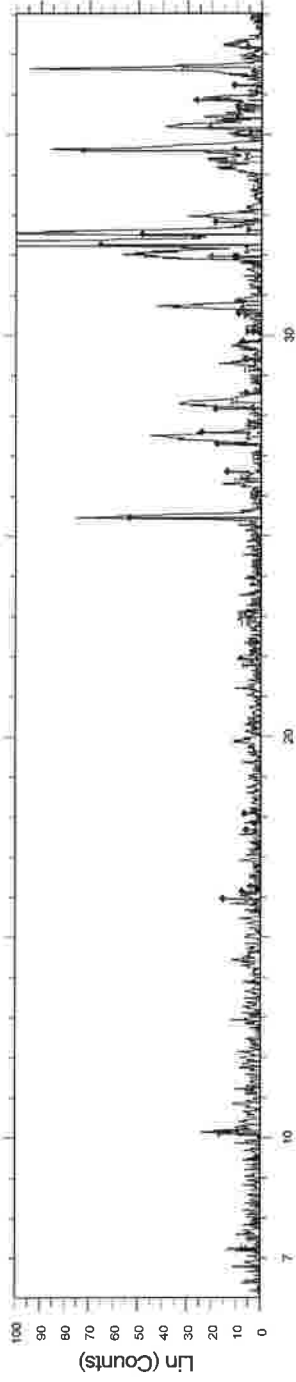
CHK: MRGJKJDF



XRD RESULTS FOR MAR07-80

FIGURE C6

MAR07-80



2-Theta - Scale

- MAR07-80 - File: Nov6019-6.raw - Type: 2Th/Th locked - Start: 6.000 ° - End: 70.00
- 01-071-1162 (C) - Albite high - Na(AlSi3O8)
- 00-026-0288 (D) - Chalcopyrite - CuFeS2
- 01-071-1494 (C) - Diopside - CaMgSi2O6
- 01-088-0709 (C) - Manganese biotite - (Mn,Mg,Al,Fe)1.8(K,Na,Ca)0.91(Si,Al,Ti)4O,
- 01-086-0173 (C) - Rhodochrosite, syn - Mn(CO3)
- 01-080-0743 (C) - Muscovite 2M1 - (K0.82Na0.18)Fe0.03Al1.97(AlSi3)O10(OH)2
- 00-013-0003 (D) - Chlorite - Mg2Al3(Si8Al)O10(O)8
- 00-041-1454 (I) - Zedacite - Ca4MnFe4(PO4)6(OH)4·12H2O
- 00-027-0618 (N) - Schachnerite, syn - Ag1.4Hg0.9
- 01-073-0267 (C) - Tremolite - Ca2Mg5Si8O22(OH)2
- 01-076-0317 (A) - Rutile, syn - TiO2

DATE: FEBRUARY 2008

CAD:

PROJECT: 07-1118-0012 (4000)

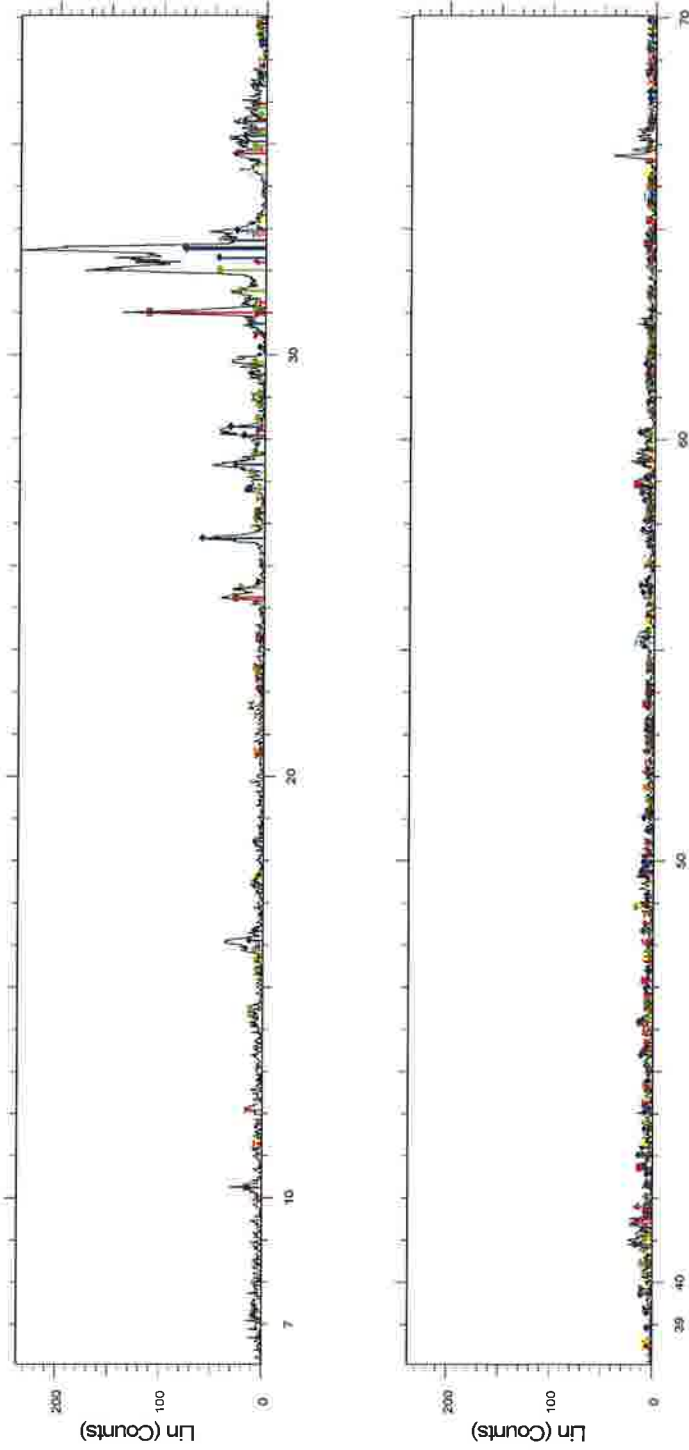
K: MRG/KJDF



XRD RESULTS FOR MAR07-92

FIGURE C7

MAR07-92



DATE: FEBRUARY 2008

CAD:

PROJECT: 07-1118-0012 (4000)

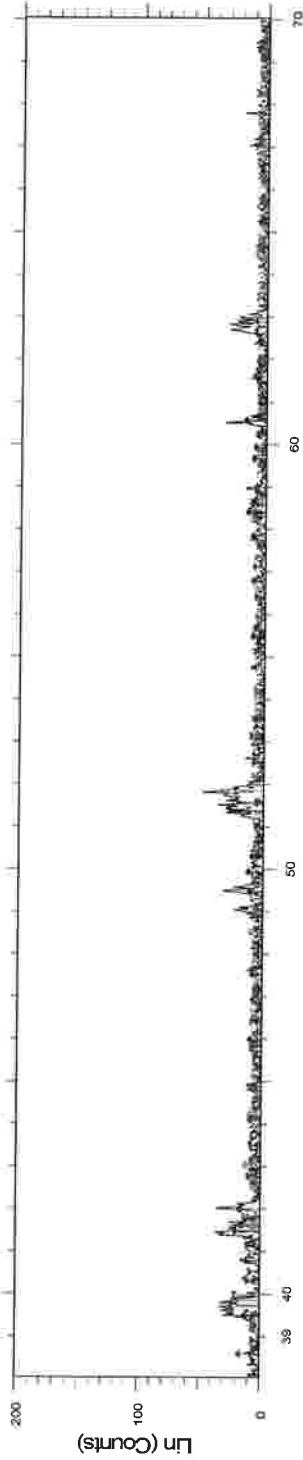
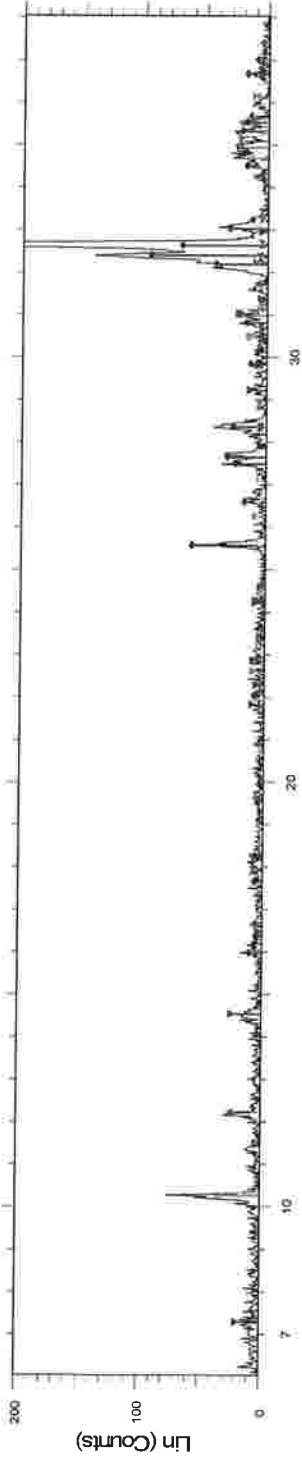
CHK: MRGIKJDF



XRD RESULTS FOR MAR07-96

FIGURE C8

MAR07-96



- 2-Theta - Scale
- 01-MAR07-96 - File: Nov6019-8.raw - Type: 2Th/Th locked - Start: 6.000 ° - End: 70.00
 - 01-078-1910 (C) - Quartz - SiO2
 - 01-083-1938 (C) - Andesine - Na0.622Ca0.368Al1.29Si2.71O8
 - 01-080-1110 (C) - Biotite - KFeMg2(AlSi3O10)(OH)2
 - 01-083-2056 (C) - Hastingsite - Na1.52K0.64Ca1.74(Mg1.17Fe2.96Ti0.39Al0.68)Si6
 - 01-078-1270 (C) - Clinocllore - (Mg2.96Fe1.66Al1.275)Si2.622Al1.376O10(X)
 - 01-078-1677 (C) - Diopside - CaMg(SiO3)2
 - 00-017-0200 (D) - Pyrrhotite 4C - FeS
 - 01-086-2336 (C) - Calcite magnesian - (Mg.129Ca.871)(CO3)
 - 01-073-0266 (C) - Tremolite - Ca2Mg5Si8O22(OH)2
 - 01-080-0742 (C) - Muscovite 2M1 - (K0.82Na0.18)(Fe0.03Al1.97)(AlSi3)O10(OH)2

DATE: FEBRUARY 2008

CAD:

PROJECT: 07-1118-0012 (4000)

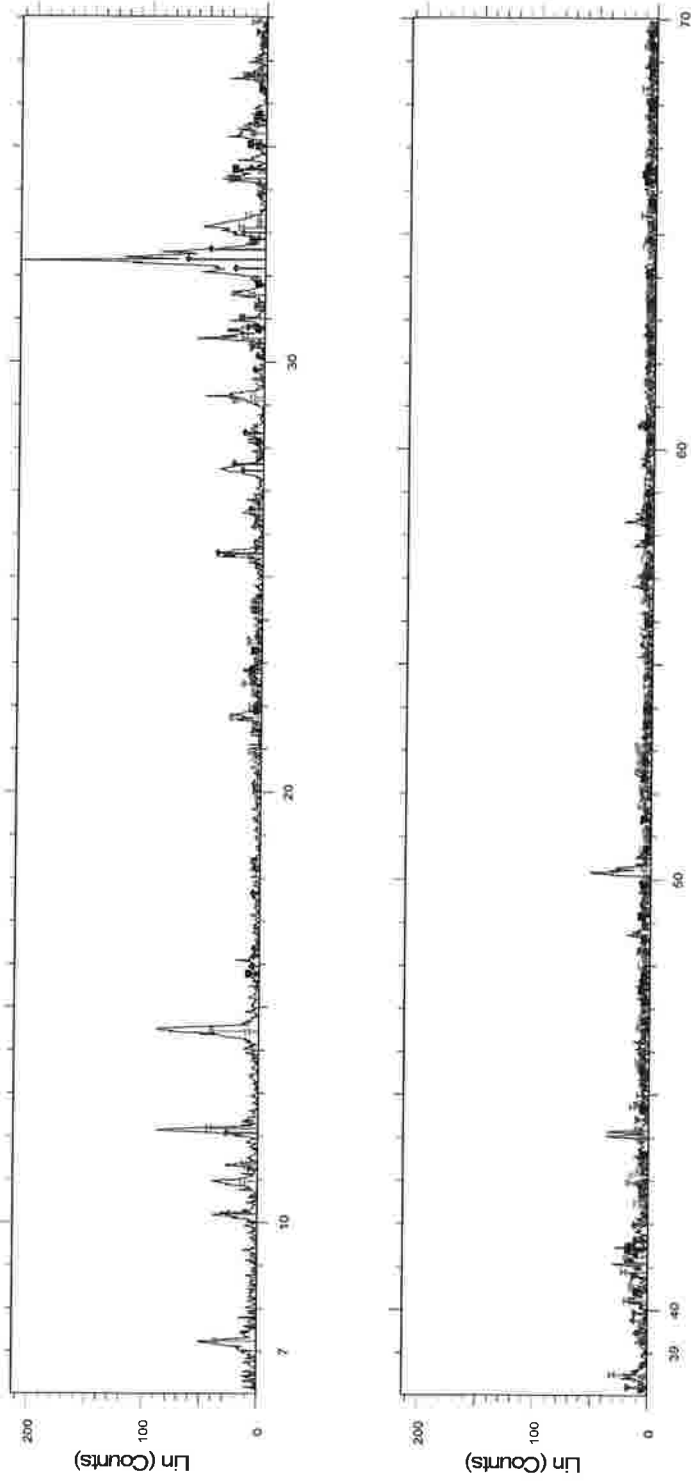
CHK: MRGKJDF



XRD RESULTS FOR MAR07-98

FIGURE C9

MAR07-98



2-Theta - Scale

MAR07-98 - File: Nov5019-9.raw - Type: 2Th/Th locked - Start: 6.000 ° - End: 70.00
 01-079-1910 (C) - Quartz - SiO2
 01-083-1929 (C) - Andesine - Na0.686Ca0.347Al1.46Si2.94O8
 01-080-1119 (C) - Clinocllore - Mg4.54Al0.97Fe0.46Mn0.03(Si2.85Al1.15O10)(OH)8
 01-080-1108 (C) - Biotite - KFeMg2(AlSi3O10)(OH)2
 01-084-2121 (C) - Hastingsite - Na3.96Ca2Mg0.55Fe4.45Al1.65Si6.32O23(OH)
 01-085-1423 (C) - Ferropargasite - NaCa2(Fe,Mg)4(Si6Al2)O22(OH)2
 01-086-2334 (C) - Calcite - Ca(CO3)
 00-002-0669 (D) - Talc Steatite Soapstone - 3MgO·4SiO2·H2O
 01-071-1776 (C) - Alunite - K(Al3(SO4)2(OH)6)
 00-004-0829 (D) - Periclase, syn - MgO
 01-087-0630 (C) - Osbornite, syn - (TiN).88
 01-071-1796 (C) - Diopside - CaMgSi2O6

DATE: FEBRUARY 2008

CAD:

PROJECT: 07-1118-0012 (4000)

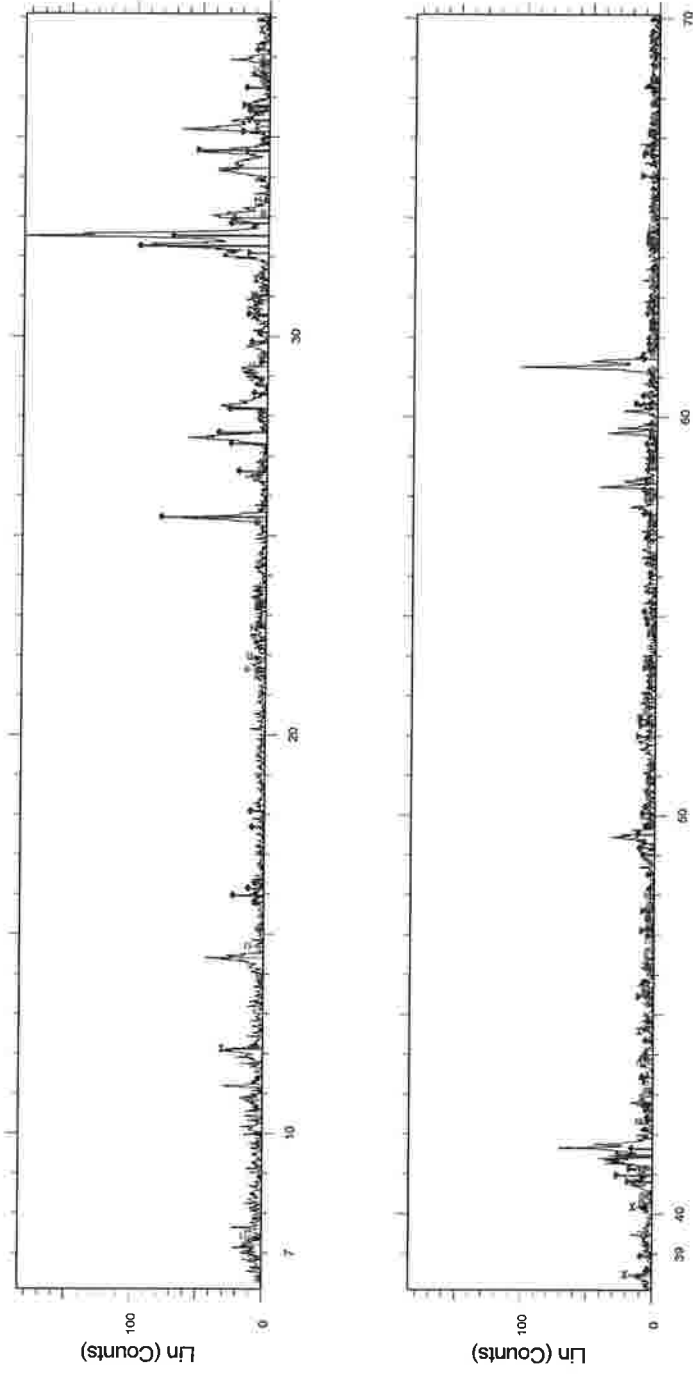
CHK: MRG/KJDF



XRD RESULTS FOR MAR07-99

FIGURE C10

MAR07-99



- 2-Theta - Scale
- ▲ MAR07-99 - File: Nov5019-10.raw - Type: 2ThIth locked - Start: 6.000 ° - End: 70.0
 - 01-079-1910 (C) - Quartz - SiO2
 - 01-071-1162 (C) - Albite high - Na(AlSi3O8)
 - 01-082-0038 (C) - Clinocllore ilb-4 (Cr, Mg-rich) - (Mg0.99Al0.01)6(Al0.67Fe0.33)X
 - ▲ 01-086-2339 (C) - Calcite - Ca(CO3)
 - 00-003-0887 (D) - Tale - Mg3(Si4O10)(OH)2·3MgO·4SiO2·H2O
 - 00-026-1372 (J) - Ferropargasite, syn - NaCa2Fe4AlSi6Al2O22(OH)2
 - ▼ 01-072-1379 (C) - Diopside - (Mg,Fe)2Al2Ca(Si,Al)6O6

DATE: FEBRUARY 2008

CAD:

PROJECT: 07-1118-0012 (4000)

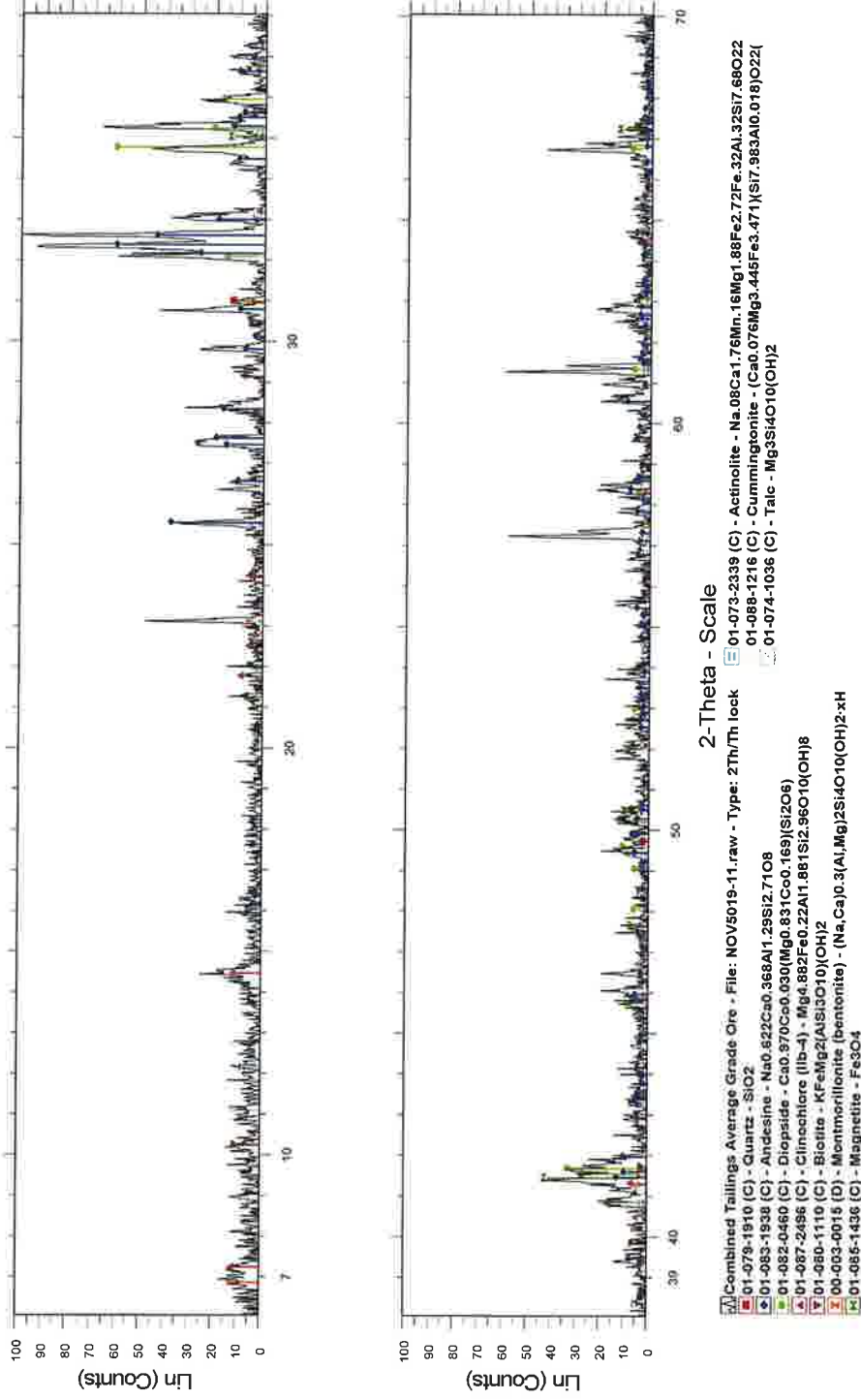


CHK: MRG/KJDF

XRD RESULTS FOR THE COMBINED TAILINGS AVERAGE GRADE ORE

FIGURE C11

Combined Tailings Average Grade Ore



DATE: FEBRUARY 2008

CAD:

PROJECT: 07-1118-0012 (4000)

CHK: MRG/KJDF



APPENDIX D
STATIC TESTING DATA

**TABLE D1
STATISTICAL SUMMARY OF ACID-BASE ACCOUNTING ANALYSIS
MARATHON PGM-Cu PROJECT**

Sample ID	Paste pH	Solid-phase Chemistry					AP (t CaCO ₃ /1000 t)	Neutralization Potentials		Net Potential Ratios	
		Total Sulphur (wt% as S)	Sulphide (wt% as S)	Sulphate (wt% as SO ₄)	Total Carbon (wt% as C)	Carbonate (wt% as CO ₃)		NP (t CaCO ₃ /1000 t)	CaNP (t CaCO ₃ /1000 t)	NP:AP	CaNP:AP
EASTERN GABBRO (n = 57)											
MAR07-01	9.85	0.076	0.080	0.40	0.026	0.039	2.40	31.40	0.650	13.10	0.271
MAR07-03	9.80	0.142	0.100	0.40	0.105	0.231	3.10	27.70	3.853	9.04	1.243
MAR07-04	9.88	0.030	0.030	0.40	0.160	0.366	0.94	25.50	6.104	27.10	6.494
MAR07-05	9.93	0.005	0.010	0.40	0.130	0.258	0.31	14.50	4.303	46.60	13.881
MAR07-06	9.90	0.017	0.010	0.40	0.218	0.546	0.31	25.00	9.107	80.60	29.376
MAR07-07	9.96	0.009	0.010	0.40	0.043	0.132	0.31	14.10	2.202	45.60	7.102
MAR07-08	9.00	0.006	0.010	0.40	0.041	0.005	0.31	42.90	0.083	139.00	0.269
MAR07-101	9.76	1.270	1.160	0.40	0.089	0.131	36.30	15.50	2.185	0.43	0.060
MAR07-112	9.67	0.028	0.010	0.40	0.028	0.075	0.31	9.70	1.251	31.10	4.035
MAR07-113	9.62	0.443	0.150	0.40	0.053	0.145	4.70	46.80	2.418	9.98	0.515
MAR07-114	9.91	0.110	0.010	0.40	0.150	0.449	0.31	40.40	7.489	130.00	24.157
MAR07-12	9.93	0.005	0.010	0.40	0.012	0.005	0.31	44.90	0.083	145.00	0.269
MAR07-16	9.25	4.370	4.020	0.40	0.121	0.161	126.00	18.20	2.685	0.15	0.021
MAR07-18	9.78	0.193	0.090	0.40	0.207	0.539	2.80	38.40	8.990	13.50	3.211
MAR07-23	9.53	0.101	0.060	0.40	0.092	0.214	1.90	30.90	3.569	16.30	1.879
MAR07-24	9.79	0.016	0.010	0.40	0.079	0.201	0.31	21.10	3.352	68.10	10.814
MAR07-25	9.72	0.146	0.090	0.40	0.038	0.045	2.90	22.30	0.751	7.69	0.259
MAR07-27	9.20	0.820	0.540	0.40	0.085	0.169	17.00	21.60	2.819	1.27	0.166
MAR07-32	9.25	0.126	0.050	0.40	0.409	1.100	1.60	43.10	18.347	26.90	11.467
MAR07-36	9.61	0.186	0.080	0.40	0.086	0.119	2.50	23.70	1.985	9.50	0.794
MAR07-37	9.60	0.011	0.010	0.40	0.224	0.391	0.31	13.70	6.521	44.30	21.037
MAR07-38	9.83	0.034	0.010	0.40	0.200	0.381	0.31	34.00	6.355	110.00	20.499
MAR07-39	9.79	0.036	0.010	0.40	0.171	0.330	0.31	30.70	5.504	99.00	17.755
MAR07-42	9.73	0.020	0.020	0.40	0.162	0.249	0.62	40.20	4.153	64.80	6.698
MAR07-43	9.78	0.028	0.020	0.40	0.236	0.800	0.62	30.30	13.343	48.90	21.521
MAR07-44	9.88	0.009	0.010	0.40	0.103	0.151	0.31	13.40	2.519	43.20	8.124
MAR07-45	9.92	0.042	0.020	0.40	0.242	0.554	0.62	26.30	9.240	42.40	14.903
MAR07-46	9.86	0.079	0.040	0.40	0.200	0.517	1.20	33.20	8.623	27.70	7.186
MAR07-48	9.81	0.051	0.020	0.40	0.190	0.328	0.62	27.80	5.471	44.80	8.824
MAR07-50	9.56	0.024	0.020	0.40	0.020	0.005	0.62	33.20	0.083	53.50	0.135
MAR07-51	9.26	0.014	0.010	0.40	0.068	0.100	0.31	27.50	1.668	88.00	5.380
MAR07-53	9.87	0.019	0.010	0.40	0.040	0.046	0.31	19.30	0.767	62.10	2.475
MAR07-57	10.06	0.005	0.010	0.40	0.032	0.049	0.31	26.50	0.817	85.40	2.636
MAR07-60	9.96	0.014	0.010	0.40	0.045	0.071	0.31	36.50	1.184	118.00	3.820
MAR07-61	10.07	0.008	0.010	0.40	0.044	0.053	0.31	34.10	0.884	110.00	2.852
MAR07-62	10.03	0.006	0.010	0.40	0.060	0.055	0.31	60.10	0.917	194.00	2.959
MAR07-70	10.22	0.036	0.010	0.40	0.049	0.237	0.31	49.60	3.953	160.00	12.751
MAR07-71	9.89	0.059	0.010	0.40	0.066	0.221	0.31	21.60	3.686	69.60	11.890
MAR07-72	9.82	0.077	0.020	0.40	0.252	0.761	0.62	32.00	12.693	51.70	20.472
MAR07-78	10.09	0.005	0.010	0.40	0.020	0.024	0.31	6.00	0.400	19.40	1.291
MAR07-82	9.75	0.106	0.030	0.40	0.151	0.330	0.94	42.80	5.504	45.50	5.855
MAR07-83	10.08	0.005	0.010	0.40	0.073	0.104	0.31	39.40	1.735	127.00	5.595
MAR07-85	9.97	0.005	0.010	0.40	0.061	0.051	0.31	44.30	0.851	143.00	2.744
MAR07-87	9.86	0.006	0.010	0.40	0.083	0.061	0.31	46.60	1.017	150.00	3.282
MAR07-89	9.87	0.225	0.110	0.40	0.153	0.211	3.40	40.70	3.519	11.80	1.035
MAR07-91	9.65	0.195	0.090	0.40	0.109	0.193	2.70	40.10	3.219	14.70	1.192
MAR07-95	9.98	0.005	0.010	0.40	0.050	0.113	0.31	8.80	1.885	28.50	6.080
MAR07-97	9.88	0.017	0.010	0.40	0.180	0.497	0.31	65.40	8.289	211.00	26.740
MAR07-99	9.72	0.519	0.360	0.40	0.292	0.760	11.30	39.60	12.676	3.50	1.122
MAR07-10	8.86	0.006	0.010	0.40	0.034	0.005	0.31	44.10	0.083	142.00	0.269
MAR07-55	9.83	0.018	0.010	0.40	0.056	0.082	0.31	20.70	1.368	66.80	4.412
MAR07-56	9.98	0.019	0.010	0.40	0.037	0.048	0.31	34.50	0.801	111.00	2.583

**TABLE D1
STATISTICAL SUMMARY OF ACID-BASE ACCOUNTING ANALYSIS
MARATHON PGM-Cu PROJECT**

Sample ID	Paste pH	Solid-phase Chemistry					AP (t CaCO ₃ /1000 t)	Neutralization Potentials		Net Potential Ratios	
		Total Sulphur (wt% as S)	Sulphide (wt% as S)	Sulphate (wt% as SO ₄)	Total Carbon (wt% as C)	Carbonate (wt% as CO ₃)		NP (t CaCO ₃ /1000 t)	CaNP (t CaCO ₃ /1000 t)	NP:AP	CaNP:AP
MAR07-17	9.54	0.341	0.210	0.40	0.299	0.990	6.60	32.80	16.512	4.98	2.502
MAR07-34	9.85	0.012	0.010	0.40	0.047	0.087	0.31	11.40	1.451	36.80	4.681
MAR07-52	9.73	0.013	0.010	0.40	0.126	0.370	0.31	22.90	6.171	73.90	19.907
MAR07-66	9.09	1.060	0.820	0.40	0.087	0.109	25.60	19.40	1.818	0.76	0.071
MAR07-96	9.48	6.710	6.340	0.40	0.107	0.117	198.00	19.90	1.951	0.10	0.010
MAR07-33	9.00	1.990	1.630	0.40	0.288	0.357	51.00	36.10	5.954	0.71	0.117
MIN	8.94	0.01	0.01	<0.4	0.05	0.07	0.3	11	1	0.08	0.01
MAX	10.08	10	10	<0.4	0.3	1	302	36	17	74	28
AVG	9.33	2	2	<0.4	0.1	0.3	59	23	5	26	6
MED	9.51	0.2	0.1	<0.4	0.1	0.2	4	20	4	13	3
STDEV	0.39	3	3	-	0.09	0.3	105	7	5	30	10
HETEROLITHIC BRECCIA (n = 6)											
MAR07-02	9.75	0.058	0.040	0.40	0.249	0.879	1.10	29.40	14.661	26.20	13.328
MAR07-100	9.54	0.853	0.660	0.40	0.103	0.197	20.60	17.30	3.286	0.84	0.160
MAR07-35	9.82	0.041	0.010	0.40	0.204	0.446	0.31	34.70	7.439	112.00	23.996
MAR07-49	9.52	0.986	0.710	0.40	0.176	0.285	22.10	28.40	4.753	1.28	0.215
MAR07-74	10.15	0.007	0.010	0.40	0.189	0.620	0.31	75.60	10.341	244.00	33.358
MAR07-81	9.70	0.323	0.180	0.40	0.148	0.470	5.60	56.20	7.839	9.99	1.400
MIN	9.52	0.01	0.01	<0.4	0.1	0.2	0.3	17	3	0.8	0.2
MAX	10.15	1	0.7	<0.4	0.2	0.9	22	76	15	244	33
AVG	9.70	0.4	0.3	<0.4	0.2	0.5	8	40	8	66	12
MED	9.72	0.2	0.1	<0.4	0.2	0.5	3	32	8	18	7
STDEV	0.23	0.4	0.3	-	0.05	0.2	10	22	4	97	14
SYENITE (n = 7)											
MAR07-13	9.46	0.129	0.090	0.40	0.427	1.120	2.80	33.20	12.709	11.70	6.672
MAR07-20	9.26	0.099	0.030	0.40	0.402	1.230	0.94	38.20	35.641	40.70	21.825
MAR07-26	9.60	0.022	0.010	0.40	0.579	0.819	0.31	26.30	155.656	84.70	44.065
MAR07-40	9.51	0.005	0.010	0.40	0.431	1.630	0.31	41.50	115.868	134.00	87.699
MAR07-73	9.19	0.026	0.010	0.40	0.433	1.520	0.31	36.50	116.406	118.00	81.780
MAR07-75	9.23	0.369	0.140	0.40	0.858	2.900	4.50	65.60	15.890	14.60	10.749
MAR07-92	9.44	0.005	0.010	0.40	0.183	0.647	0.31	19.50	49.197	63.00	34.810
MIN	9.19	0.01	0.01	<0.4	0.2	0.6	0.3	20	13	12	7
MAX	9.60	0.4	0.1	<0.4	0.9	3	5	66	156	134	88
AVG	9.36	0.09	0.04	<0.4	0.5	1	1	37	72	67	41
MED	9.44	0.03	0.01	<0.4	0.4	1	0.3	37	49	63	35
STDEV	0.16	0.1	0.05	-	0.2	0.7	2	15	57	48	33
SERPENTINITE (n = 2)											
MAR07-103	9.86	0.228	0.090	0.40	0.197	0.632	2.80	48.00	10.541	17.20	3.765
MAR07-104	9.95	0.115	0.010	0.40	0.473	1.750	0.31	71.30	29.188	230.00	94.155
MIN	9.86	0.1	0.01	<0.4	0.2	0.6	0.3	48	11	17	4
MAX	9.95	0.2	0.09	<0.4	0.5	2	3	71	29	230	94
AVG	9.90	0.2	0.05	<0.4	0.3	1	2	60	20	124	49
MED	9.90	0.2	0.05	<0.4	0.3	1	2	60	20	124	49
STDEV	0.06	0.08	0.06	-	0.2	0.8	2	16	13	150	64
TAILINGS -COMBINED (n = 1)											
Average Grade Ore	8.82	0.181	0.100	< 0.4	0.105	0.319	3.1	24.0	5.321	7.7	

**TABLE D2
RESULTS OF WHOLE ROCK ANALYSIS
MARATHON PGM-Cu PROJECT**

SAMPLE ID	WHOLE ROCK ANALYSIS													
	SiO ₂ (%)	Al ₂ O ₃ (%)	Fe ₂ O ₃ (%)	MgO (%)	CaO (%)	Na ₂ O (%)	K ₂ O (%)	TiO ₂ (%)	P ₂ O ₅ (%)	MnO (%)	Cr ₂ O ₃ (%)	V ₂ O ₅ (%)	LOI (%)	Sum (%)
EASTERN GABBRO (n = 57)														
MAR07-01	42.4	11.6	22.3	11.8	8.0	2.2	0.4	2	0.2	0.3	0.05	0.1	-0.4	100
MAR07-04	45.7	14.2	16.2	7.7	11.2	2.6	0.5	1	0.2	0.2	0.07	0.09	0.4	101
MAR07-05	50.7	15.4	12.4	8.7	11.0	3.0	0.5	1	0.08	0.2	0.03	0.05	0.4	102
MAR07-07	50.3	15.8	11.6	7.2	11.1	2.9	0.3	2	0.08	0.2	0.08	0.05	-0.09	101
MAR07-08	35.0	10.6	33.6	12.9	4.3	1.7	0.2	3	0.1	0.4	0.02	0.3	-1	101
MAR07-10	38.7	8.8	27.7	17.0	4.7	1.4	0.2	1	0.1	0.4	0.03	0.08	-0.5	100
MAR07-101	50.7	16.7	10.7	5.6	8.8	3.9	0.8	0.4	0.2	0.2	0.05	0.03	2	100
MAR07-112	50.3	14.9	14.5	6.3	10.0	2.8	0.7	1	0.2	0.2	0.02	0.06	-0.5	101
MAR07-12	45.8	15.1	16.2	12.1	7.1	2.7	0.7	0.3	0.2	0.3	0.01	0.01	-0.5	100
MAR07-16	52.1	13.7	13.5	3.9	8.9	3.3	0.8	0.6	0.3	0.2	0.02	0.02	2	100
MAR07-18	39.0	10.5	22.8	4.9	11.6	2.5	0.9	4	3	0.3	0.09	0.08	0.5	99
MAR07-27	52.8	17.8	8.9	5.7	8.9	4.1	0.3	0.4	0.2	0.2	0.05	0.02	2	101
MAR07-32	55.0	17.5	7.6	2.4	8.1	4.5	2	0.6	0.3	0.1	0.04	0.03	3	101
MAR07-37	47.0	14.2	15.9	6.3	11.8	2.6	0.3	2	0.05	0.2	0.03	0.09	0.8	101
MAR07-38	45.9	15.3	16.1	7.9	10.2	2.8	0.5	1	0.2	0.2	0.08	0.08	0.4	101
MAR07-39	45.2	14.1	18.0	8.6	9.2	2.7	0.4	1	0.2	0.2	0.04	0.08	0.6	101
MAR07-42	45.6	12.1	17.4	11.9	11.1	1.8	0.3	0.9	0.2	0.3	0.1	0.06	-0.2	102
MAR07-43	49.0	14.6	13.9	7.7	9.8	2.7	0.7	0.8	0.4	0.2	0.04	0.05	1	101
MAR07-44	47.3	15.3	14.3	8.4	11.3	2.7	0.4	0.9	0.3	0.2	0.04	0.06	-0.1	101
MAR07-46	45.8	13.1	16.3	10.5	10.5	2.4	0.5	0.8	0.4	0.3	0.05	0.05	0.4	101
MAR07-51	42.5	7.7	19.9	15.4	9.8	1.3	0.3	1	0.5	0.3	0.1	0.05	2	102
MAR07-53	48.6	14.5	12.3	7.9	13.0	2.5	0.3	0.9	0.2	0.2	0.04	0.06	0.8	101
MAR07-55	48.2	14.0	14.9	7.7	11.1	2.6	0.5	1	0.2	0.2	0.05	0.07	0.6	102
MAR07-56	47.8	13.8	13.3	9.1	11.4	2.5	0.4	1	0.09	0.2	0.07	0.05	0.4	100
MAR07-57	48.8	14.2	13.7	8.3	10.6	2.7	0.4	1	0.1	0.2	0.07	0.05	0.1	101
MAR07-59	39.5	7.8	28.2	17.0	4.2	1.3	0.4	0.8	0.3	0.4	0.01	0.06	0.1	100
MAR07-61	46.3	15.7	15.1	10.0	10.6	2.3	0.5	0.7	0.3	0.2	0.03	0.04	-0.5	101
MAR07-65	41.7	6.1	16.5	21.2	8.2	0.9	0.1	1	0.2	0.2	0.3	0.04	3	100
MAR07-70	44.5	12.7	17.8	10.4	10.1	2.3	0.4	2	0.3	0.2	0.10	0.07	0.5	101
MAR07-71	45.4	13.2	17.3	8.0	11.0	2.7	0.5	2	0.3	0.2	0.06	0.08	0.6	101
MAR07-78	50.7	14.9	12.5	7.5	9.4	2.8	1	0.6	0.4	0.2	0.02	0.04	0.1	101
MAR07-91	30.8	10.8	36.2	7.6	6.3	1.7	0.3	5	0.3	0.3	0.06	0.3	-0.2	100
MAR07-95	49.6	15.7	12.0	6.6	11.2	2.9	0.3	0.9	0.02	0.2	0.04	0.05	0.4	100
MAR07-50	37.3	12.3	28.4	10.8	6.1	2.0	0.2	3	0.08	0.3	< 0.01	0.2	-0.4	100
MAR07-87	39.6	6.7	30.4	18.4	4.2	1.2	0.3	0.7	0.2	0.5	0.02	0.05	-2	100
MAR07-82	45.7	17.4	14.2	10.8	9.0	2.4	0.4	0.2	0.1	0.2	0.01	0.01	-0.6	100
MAR07-83	49.1	18.3	11.9	8.5	9.2	2.9	0.8	0.3	0.1	0.2	0.02	0.02	-0.03	101
MAR07-85	45.3	16.5	15.8	12.2	8.4	2.3	0.3	0.2	0.09	0.3	0.02	< 0.01	-0.8	101
MAR07-03	42.1	13.2	22.6	7.6	9.0	2.4	0.5	2	0.1	0.2	0.1	0.1	-0.1	100
MAR07-06	47.7	15.1	13.2	7.4	10.7	2.8	0.3	2	0.07	0.2	0.1	0.08	0.5	100
MAR07-23	36.0	12.7	22.9	5.1	12.5	2.6	0.7	3	5	0.3	0.01	0.1	0.1	101
MAR07-24	47.3	14.7	15.9	7.4	11.7	2.5	0.3	1	0.05	0.2	0.03	0.09	-0.09	102
MAR07-25	42.2	13.5	21.2	7.4	11.2	2.2	0.3	2	0.2	0.2	0.05	0.2	-0.4	101
MAR07-48	46.4	12.2	14.9	10.4	12.4	1.9	0.3	0.9	0.2	0.2	0.1	0.06	0.2	100
MAR07-54	47.3	15.7	13.2	7.2	11.7	2.7	0.5	1	0.3	0.2	0.03	0.06	0.6	100
MAR07-58	46.1	12.3	18.0	8.4	9.9	2.4	0.6	2	0.4	0.3	0.05	0.08	0.2	101
MAR07-84	46.7	13.6	12.4	7.6	14.8	2.1	0.4	0.9	0.6	0.2	0.02	0.05	1	101
MAR07-89	46.1	12.9	15.3	11.1	11.4	2.1	0.3	1	0.2	0.2	0.09	0.05	0.3	101
MAR07-99	47.3	16.8	9.0	6.9	13.3	2.5	0.5	0.4	0.09	0.1	0.04	0.03	1	99
MAR07-113	18.0	3.6	44.9	7.8	11.8	0.4	0.1	7	7	0.4	0.04	0.3	-2	99
MAR07-60	45.3	15.2	16.6	9.9	8.8	2.4	0.5	0.5	0.4	0.3	0.02	0.04	-0.3	100
MAR07-82	40.5	11.3	24.1	8.6	8.9	2.3	0.8	2	2	0.4	0.01	0.04	0.07	101
MAR07-114	42.8	7.6	19.9	8.2	14.1	1.8	0.7	2	3	0.4	0.02	0.07	0.3	100
MAR07-36	37.9	11.6	25.3	4.3	11.0	2.6	1.0	4	3	0.4	< 0.01	0.07	-0.84	101
MAR07-45	42.6	13.2	18.3	7.3	12.2	2.3	0.4	2	2	0.2	0.02	0.1	1	101
MAR07-72	48.3	10.7	17.7	5.0	11.0	3.3	1	1	0.4	0.4	0.04	0.03	1	101
MAR07-97	52.9	17.7	10.2	7.1	6.9	3.5	1	0.2	0.09	0.2	0.03	< 0.01	0.8	101
MIN	18.0	3.6	7.6	2.4	4.2	0.4	0.1	0.2	0.02	0.1	0.01	0.01	-2	99
MAX	55.0	18.3	44.9	21.2	14.8	4.5	2	7	7	0.5	0.3	0.3	3	102
MED	45.9	13.8	16.1	7.9	10.5	2.5	0	1	0	0	0	0	0	101
AVG	44.9	13.3	17.8	8.9	9.9	2.4	0.5	1	0.6	0.3	0.05	0.08	0.3	101
STDEV	6.0	3.1	7.1	3.6	2.3	0.7	0.3	1	1	0.08	0.04	0.07	1	1
TWO DUCK LAKE GABBRO (n = 32)														
MAR07-09	39.7	9.4	28.1	15.3	4.8	1.8	0.5	1	0.6	0.4	0.04	0.07	-2	100
MAR07-11	48.5	21.0	10.1	5.1	10.6	3.5	0.7	0.6	0.4	0.2	0.01	0.03	-0.2	101
MAR07-19	28.7	6.3	34.5	9.1	9.9	1.3	0.4	5	4	0.4	0.08	0.2	-0.2	99
MAR07-41	49.7	17.9	9.9	6.2	12.1	3.1	0.6	0.6	0.3	0.2	0.05	0.03	0.4	101
MAR07-47	46.8	15.4	13.6	9.1	11.1	2.3	0.5	0.7	0.1	0.2	0.03	0.06	0.2	100
MAR07-67	45.2	15.8	14.2	7.0	12.1	2.3	0.4	1	0.2	0.2	0.02	0.1	0.9	100
MAR07-68	45.5	15.0	14.7	7.4	12.9	2.3	0.3	1	0.1	0.2	0.02	0.13	0.4	100
MAR07-69	44.9	14.5	12.4	6.8	12.9	2.1	0.4	1	0.1	0.2	0.02	0.08	5	101
MAR07-84	47.0	16.9	12.8	9.0	10.5	2.6	0.5	0.4	0.2	0.2	0.03	0.03	-0.2	100
MAR07-86	47.1	16.1	14.2	9.9	10.7	2.5	0.5	0.5	0.3	0.2	0.03	0.02	-0.3	102
MAR07-106	48.2	18.0	8.6	6.4	12.7	2.7	0.5	0.5	0.2	0.1	0.04	0.03	1	99
MAR07-107	44.7	12.2	16.8	11.1	10.9	1.9	0.4	0.8	0.2	0.2	0.1	0.05	0.1	100
MAR07-108	48.2	18.9	8.8	4.4	13.0	3.0	0.6	0.8	0.2	0.1	0.04	0.04	2	100
MAR07-109	48.3	18.8	8.0	4.2	12.6	3.3	0.5	0.8	0.3	0.1	0.02	0.05	3	100
MAR07-14	46.7	15.1	12.2	5.4	11.5	3.3	0.9	1	0.5	0.2	0.03	0.06	3	100
MAR07-15	43.2	13.1	19.5	5.1	11.4	2.3	0.4	1	0.2	0.2	0.02	0.08	3	99
MAR07-21	38.2	5.5	29.5	8.3	11.1	1.4	0.7	4	0.8	0.4	0.03	0.1	0.4	100

**TABLE D2
RESULTS OF WHOLE ROCK ANALYSIS
MARATHON PGM-Cu PROJECT**

SAMPLE ID	WHOLE ROCK ANALYSIS														Sum (%)
	SiO ₂ (%)	Al ₂ O ₃ (%)	Fe ₂ O ₃ (%)	MgO (%)	CaO (%)	Na ₂ O (%)	K ₂ O (%)	TiO ₂ (%)	P ₂ O ₅ (%)	MnO (%)	Cr ₂ O ₃ (%)	V ₂ O ₅ (%)	LOI (%)		
MAR07-28	42.0	9.3	24.5	15.0	5.8	1.8	0.5	0.8	0.4	0.4	0.03	0.04	0.3	101	
MAR07-29	46.9	16.6	13.6	9.0	9.1	2.9	0.6	0.4	0.5	0.2	0.02	0.02	0.7	101	
MAR07-30	47.7	14.0	13.1	8.3	10.7	2.4	0.9	0.5	0.1	0.2	0.04	0.04	2	100	
MAR07-31	49.0	16.3	8.8	5.9	13.3	2.9	0.6	0.6	0.5	0.2	0.03	0.04	2	101	
MAR07-63	47.5	16.5	9.5	5.8	13.9	2.6	0.5	0.8	0.3	0.1	0.03	0.05	2	100	
MAR07-79	45.1	14.1	15.4	9.8	11.3	2.0	0.5	0.7	0.2	0.2	0.03	0.04	1	100	
MAR07-80	46.6	17.3	12.7	6.7	12.1	2.6	0.4	0.8	0.1	0.2	0.03	0.06	0.8	100	
MAR07-88	47.7	18.2	13.6	6.9	9.9	3.1	0.6	0.6	0.5	0.2	0.02	0.03	-0.1	101	
MAR07-90	48.4	16.1	11.7	7.8	12.1	2.6	0.4	0.8	0.2	0.2	0.03	0.04	0.9	101	
MAR07-93	47.7	15.5	9.7	6.6	14.3	2.5	0.5	0.9	0.6	0.2	0.04	0.06	2	100	
MAR07-94	49.3	17.9	7.5	4.9	13.6	3.2	0.7	0.7	0.4	0.1	0.03	0.04	2	100	
MAR07-98	46.8	16.2	11.4	7.5	9.9	2.8	0.8	0.3	0.1	0.2	0.03	0.02	4	100	
MAR07-22	47.1	17.7	11.9	3.7	11.3	3.8	0.9	1	1	0.2	0.02	0.05	2	101	
MAR07-76	41.3	14.4	19.9	4.3	10.4	3.0	0.9	4	2	0.3	< 0.01	0.04	0.08	100	
MAR07-77	44.5	15.8	15.0	3.8	10.1	3.4	1	3	2	0.2	< 0.01	0.02	2	100	
MIN	28.7	5.5	7.5	3.7	4.8	1.3	0.3	0.3	0.1	0.1	0.01	0.02	-2	99	
MAX	49.7	21.0	34.5	15.3	14.3	3.8	1	5	4	0.4	0.1	0.2	5	102	
MED	46.9	16.0	13.0	6.9	11.3	2.6	1	1	0	0	0	0	1	100	
AVG	45.6	15.2	14.6	7.4	11.2	2.6	0.6	1	0.6	0.2	0.03	0.05	1	100	
STDEV	4.1	3.5	6.5	2.8	2.0	0.6	0.2	1	0.7	0.08	0.02	0.04	1	1	
VOLCANIC (n = 10)															
MAR07-102	51.2	15.1	11.8	6.2	9.6	3.5	0.6	2	0.1	0.2	0.07	0.05	0.5	100	
MAR07-105	64.2	15.5	5.1	2.5	5.5	4.0	2	0.6	0.3	0.1	0.04	0.02	1	101	
MAR07-111	60.0	14.7	7.2	3.5	5.5	5.0	1.54	0.9	0.2	0.1	0.04	0.02	1	100	
MAR07-110	38.4	11.4	26.9	4.0	9.4	2.1	0.5	0.5	0.4	0.2	0.03	0.03	4	98	
MAR07-17	64.2	14.2	4.7	1.9	7.0	3.7	1	0.6	0.3	0.1	0.05	0.01	2	100	
MAR07-33	48.7	14.8	12.5	3.8	12.7	2.4	0.3	0.4	0.4	0.4	0.03	0.02	2	99	
MAR07-52	58.6	15.6	6.8	4.1	8.5	3.0	2	1	0.3	0.1	0.04	0.02	1	101	
MAR07-66	60.0	14.4	8.9	2.9	7.2	3.0	0.7	0.6	0.3	0.2	0.03	0.02	1	100	
MAR07-96	43.8	14.5	19.1	4.6	8.3	3.7	0.8	0.3	0.3	0.2	0.03	0.01	3	99	
MAR07-34	51.3	14.3	13.5	5.9	10.5	3.3	0.6	1	0.2	0.2	0.03	0.06	0.2	102	
MIN	38.4	11.4	4.7	1.9	5.5	2.1	0.3	0.3	0.1	0.1	0.03	0.01	0.2	98	
MAX	64.2	15.6	26.9	6.2	12.7	5.0	2	2	0.4	0.4	0.07	0.06	4	102	
MED	54.9	14.6	10.4	3.9	8.4	3.4	1	1	0	0	0	0	1	100	
AVG	54.0	14.5	11.7	3.9	8.4	3.4	1.0	0.8	0.3	0.2	0.04	0.03	2	100	
STDEV	8.8	1.2	6.9	1.4	2.2	0.8	0.5	0.4	0.09	0.08	0.01	0.02	1	1	
HERCULITE BRECCIA (n = 8)															
MAR07-02	48.8	16.3	11.5	4.6	11.2	3.5	0.8	1	0.3	0.2	0.02	0.1	1	100	
MAR07-100	47.9	16.8	12.3	5.2	11.6	3.1	0.5	0.8	0.3	0.2	0.03	0.06	1	100	
MAR07-35	45.1	13.5	15.7	9.6	12.6	2.0	0.4	1	0.7	0.3	0.04	0.04	0.6	102	
MAR07-49	48.0	14.6	10.8	6.8	14.0	2.2	0.3	0.6	0.1	0.2	0.06	0.04	2	99	
MAR07-74	35.3	5.2	33.7	16.7	4.3	0.8	0.2	2	0.5	0.5	0.04	0.1	1	100	
MAR07-81	46.7	16.3	11.2	8.4	13.2	2.1	0.4	0.5	0.2	0.2	0.04	0.04	1	101	
MIN	35.3	5.2	10.8	4.6	4.3	0.8	0.2	0.5	0.1	0.2	0.02	0.04	0.8	99	
MAX	48.8	16.8	33.7	16.7	14.0	3.5	0.8	2	0.7	0.5	0.06	0.1	2	102	
MED	47.3	15.4	12.0	7.6	12.1	2.2	0	1	0	0	0	0	1	100	
AVG	45.3	13.8	15.9	8.6	11.2	2.3	0.4	1	0.3	0.2	0.04	0.07	1	100	
STDEV	5.1	4.4	8.9	4.4	3.5	1.0	0.2	0.4	0.2	0.1	0.01	0.04	0.4	1	
SYENITE (n = 7)															
MAR07-20	54.3	10.5	16.5	1.0	5.8	3.5	4	2	0.6	0.3	0.02	0.01	1	99	
MAR07-26	60.0	14.7	7.4	0.3	2.9	5.7	5	0.4	0.05	0.2	0.02	< 0.01	2	99	
MAR07-40	66.7	12.8	4.6	2.0	2.4	3.3	4	0.4	0.04	0.07	0.03	< 0.01	3	99	
MAR07-73	56.7	16.0	9.1	0.6	4.1	5.4	4	0.6	0.2	0.2	0.01	< 0.01	3	100	
MAR07-75	60.5	14.3	5.4	0.9	5.5	4.1	4	0.3	0.09	0.2	0.03	< 0.01	4	99	
MAR07-92	60.8	14.9	6.6	2.1	4.3	5.3	4	0.4	0.2	0.1	0.04	0.01	2	101	
MAR07-13	54.6	11.0	14.1	1.2	6.6	4.6	3	0.5	0.1	0.4	< 0.01	< 0.01	2	98	
MIN	54.3	10.5	4.6	0.3	2.4	3.3	3	0.3	0.04	0.07	0.01	0.01	1	98	
MAX	66.7	16.0	16.5	2.1	6.6	5.7	5	2	0.6	0.4	0.04	0.01	4	101	
MED	60.0	14.3	7.4	1.0	4.3	4.6	4	0	0	0	0	0	2	99	
AVG	59.1	13.5	9.1	1.2	4.5	4.5	4	0.7	0.2	0.2	0.02	0.01	2	99	
STDEV	4.3	2.1	4.5	0.7	1.5	1.0	0.5	0.6	0.2	0.1	0.01	0.00	1	1	
SERPENTINITE (n = 2)															
MAR07-103	53.7	14.0	9.7	6.1	7.5	3.6	1	1	0.4	0.2	0.06	0.04	3	100	
MAR07-104	56.7	14.8	5.3	2.8	9.0	5.1	1	0.6	0.2	0.1	0.03	0.02	5	100	
MIN	53.7	14.0	5.3	2.8	7.5	3.6	1	0.6	0.2	0.1	0.03	0.02	3	100	
MAX	56.7	14.8	9.7	6.1	9.0	5.1	1	1	0.4	0.2	0.06	0.04	5	100	
MED	55.2	14.4	7.5	4.4	8.3	4.4	1	1	0	0	0	0	4	100	
AVG	55.2	14.4	7.5	4.4	8.3	4.4	1	0.8	0.3	0.1	0.04	0.03	4	100	
STDEV	2.1	0.6	3.1	2.3	1.0	1.0	0.06	0.3	0.2	0.04	0.02	0.01	1	0	
TAILINGS - COMBINED (n = 1)															
Average Grade Ore	46.9	15.5	12.7	7.4	12.5	2.4	0.5	1	0.3	0.2	0.06	0.06	1	100	

**TABLE D3
RESULTS OF BULK METAL ANALYSIS
MARATHON PGM-Cu PROJECT**

SAMPLE ID	BULK METAL ANALYSIS																												
	Ag (mg/kg)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Be (mg/kg)	Bi (mg/kg)	Ca (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	K (mg/kg)	Li (mg/kg)	Mg (mg/kg)	Mn (mg/kg)	Mo (mg/kg)	Ni (mg/kg)	Pb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Sn (mg/kg)	Sr (mg/kg)	Ti (mg/kg)	Ti (mg/kg)	U (mg/kg)	V (mg/kg)	Y (mg/kg)	Zn (mg/kg)
EASTERN GABBRO (n = 57)																													
MAR07-01	0.28	62000	13	270	0.3	0.06	51000	0.17	100	290	400	160000	3700	2.5	70000	1900	1.5	230	3.5	4	0.5	0.9	390	6100	0.05	0.33	460	8.2	160
MAR07-04	0.26	78000	1	320	0.4	0.08	74000	0.32	58	350	200	120000	4800	2.5	45000	1300	0.81	140	3	0.8	0.5	1.7	420	5400	0.05	0.57	390	11	98
MAR07-05	0.18	79000	1	340	0.4	0.03	67000	0.33	38	140	42	73000	5000	2.5	30000	970	0.48	63	4.6	0.4	0.5	1.3	290	3000	0.05	0.3	230	13	73
MAR07-07	0.1	86000	1	180	0.3	0.01	76000	0.14	42	420	42	80000	3100	2.5	43000	1000	0.48	140	2.2	0.2	0.5	0.5	390	5200	0.05	0.11	260	11	81
MAR07-08	0.07	56000	1	210	0.2	0.01	30000	0.07	150	130	34	250000	2300	6	81000	2500	7	290	1.4	0.2	0.5	0.6	390	14000	0.05	0.08	1400	2.4	200
MAR07-10	0.09	48000	1	210	0.2	0.02	32000	0.08	140	170	31	210000	2400	7	110000	2700	0.55	330	2.4	0.2	0.5	0.4	350	5000	0.05	0.19	420	4.2	180
MAR07-101	0.66	80000	1	260	1.5	0.16	55000	0.26	66	160	880	70000	7400	14	32000	1100	1.1	180	7.7	0.05	1	1.1	600	2000	0.05	1.7	130	20	100
MAR07-112	0.13	70000	1	270	0.6	0.09	60000	0.16	52	93	160	92000	6500	2.5	35000	1300	0.84	110	6	0.05	0.5	0.8	220	5500	0.05	0.56	280	24	110
MAR07-12	0.1	83000	1	390	0.8	0.03	50000	0.08	87	75	38	120000	7100	19	76000	1800	0.91	230	4.5	0.3	0.5	0.9	550	1300	0.05	0.88	67	13	110
MAR07-16	1	72000	1	310	0.6	0.2	60000	0.45	81	140	5700	97000	7900	9	23000	1100	1.7	390	9.2	0.1	2	0.8	420	1700	0.05	0.32	130	15	86
MAR07-18	0.2	55000	1	780	0.9	0.14	80000	0.26	56	99	370	160000	8700	2.5	30000	1800	2.5	59	8.8	0.7	1	1.3	440	15000	0.2	1.5	340	48	170
MAR07-27	1	84000	14	350	0.7	0.48	53000	0.3	40	220	1200	59000	3000	6	31000	820	0.89	110	11	0.2	2	0.6	760	1100	0.05	0.15	97	8	79
MAR07-32	0.28	74000	1	370	4.4	0.08	48000	0.14	19	160	260	51000	14000	11	13000	800	2.1	41	14	0.05	1	2.1	370	1500	0.1	7.7	140	62	66
MAR07-37	0.09	73000	1	190	0.3	0.04	77000	0.2	53	150	160	110000	3000	2.5	38000	1300	0.76	79	1.5	0.2	0.5	1.2	260	6500	0.2	0.1	390	12	100
MAR07-38	0.25	74000	1	350	0.4	0.03	63000	0.11	69	490	340	110000	5000	2.5	45000	1400	0.52	150	1.7	0.1	1	2.3	420	5700	0.2	0.36	410	8	100
MAR07-39	0.24	70000	1	330	0.4	0.07	58000	0.12	78	270	360	120000	4500	2.5	50000	1500	0.63	160	3.1	0.4	0.5	0.9	380	6300	0.2	0.23	400	9.2	120
MAR07-42	0.25	69000	1	330	0.3	0.02	70000	0.13	87	490	240	120000	3100	2.5	70000	1600	0.46	300	13	0.1	0.5	0.5	410	4400	0.05	0.27	300	10	110
MAR07-43	0.22	71000	1	330	0.6	0.04	61000	0.11	60	180	280	93000	7200	2.5	44000	1300	0.54	120	3	0.05	0.5	0.7	460	3800	0.1	0.91	220	13	94
MAR07-44	0.11	79000	1	350	0.4	0.01	74000	0.11	62	280	100	100000	3900	2.5	50000	1400	0.48	130	1.3	0.1	0.5	0.8	470	4500	0.05	0.21	260	9.9	94
MAR07-46	0.37	86000	1	360	0.4	0.03	68000	0.14	79	290	660	110000	4800	2.5	63000	1600	0.47	200	2.9	0.05	0.5	0.5	470	3700	0.05	0.46	220	13	110
MAR07-51	0.25	38000	4	290	1.9	0.07	60000	0.16	34	140	54	130000	3100	13	90000	820	1.1	360	7	0.6	2	1.7	260	4800	0.2	2.2	120	17	91
MAR07-53	0.07	72000	1	320	0.6	0.005	83000	0.1	54	140	95	84000	3400	2.5	46000	1200	0.32	92	1.9	0.05	1	0.6	490	5000	0.05	0.52	310	11	84
MAR07-55	0.08	72000	1	340	0.4	0.02	73000	0.16	55	420	110	100000	5100	2.5	46000	1200	0.32	190	1.8	0.05	1	0.7	350	5200	0.05	0.19	240	12	90
MAR07-56	0.05	67000	1	280	0.4	0.005	72000	0.15	55	390	71	89000	4000	2.5	52000	1300	1.7	180	1.8	0.05	0.5	0.7	400	6500	0.05	0.18	290	13	100
MAR07-57	0.27	72000	1	260	0.5	0.06	69000	0.15	63	230	290	94000	4500	2.5	49000	1500	1	140	3.4	3.2	0.5	2	380	9000	0.3	0.64	400	16	120
MAR07-59	0.09	40000	1	220	0.5	0.01	28000	0.09	160	78	72	200000	4300	11	100000	3100	0.96	320	1.6	0.4	1	1	280	4400	0.2	0.51	280	8.7	200
MAR07-61	0.07	79000	1	430	0.4	0.005	69000	0.1	71	150	67	100000	5000	2.5	59000	1600	0.48	160	1.5	0.1	0.5	0.5	620	3400	0.05	0.36	190	9.8	100
MAR07-65	0.19	29000	1	140	0.3	0.03	52000	0.11	100	1150	270	110000	1600	2.5	120000	1500	0.45	1050	1.5	0.1	0.5	0.8	200	5000	0.05	0.2	170	12	120
MAR07-70	0.47	64000	1	350	0.5	0.07	65000	0.12	73	550	460	120000	4700	2.5	62000	1600	1.7	300	2.2	0.7	0.5	7.7	430	7600	0.05	0.45	380	13	120
MAR07-71	0.24	67000	1	290	0.6	0.12	72000	0.15	62	370	450	120000	4900	8	48000	1400	0.59	140	2.8	0.05	0.5	1.1	410	8700	0.05	0.69	430	17	110
MAR07-78	0.2	68000	1	380	2	0.02	55000	3.6	58	62	70	78000	12000	9	40000	1300	4.1	100	7.9	0.05	0.5	2.4	470	3300	0.05	3.3	190	21	95
MAR07-91	1.1	49000	1	260	0.3	0.17	39000	0.65	120	340	1900	230000	3300	2.5	41000	2000	0.65	250	4.7	0.05	1	1.1	330	25000	0.05	0.51	1600	8.7	230
MAR07-95	0.14	89000	1	440	0.5	0.09	87000	0.11	27	120	99	50000	6900	5	29000	850	0.98	54	2.1	0.05	0.5	0.4	660	2800	0.05	0.42	210	14	58
MAR07-50	0.18	59000	1	240	0.3	0.03	38000	0.16	99	520	130	190000	2300	2.5	61000	1900	0.37	490	1.5	0.4	2	0.6	450	5700	0.05	0.3	230	17	140
MAR07-97	0.09	31000	1	210	0.3	0.02	25000	0.5	170	95	68	200000	2900	7	100000	3000	0.4	300	1.9	0.05	0.5	0.3	250	3100	0.05	0.55	250	6.4	200
MAR07-62	0.05	95000	1	330	0.4	0.005	62000	0.08	81	91	37	110000	3900	2.5	69000	1600	0.31	210	1.2	0.1	0.5	0.4	640	1300	0.05	0.31	63	4.9	89
MAR07-83	0.12	86000	1	400	0.5	0.02	55000	0.48	65	56	62	78000	7800	2.5	47000	1200	0.92	160	2.4	0.05	0.5	0.5	640	1500	0.05	0.42	83	5.8	79
MAR07-85	0.06	79000	1	270	0.3	0.02	51000	0.48	97	78	29	100000	3000	2.5	71000	1700	0.22	250	1.1	0.05	0.5	0.2	570	940	0.05	0.17	56	3.2	100
MAR07-03	0.46	69000	1	290	0.5	0.11	60000	0.23	83	540	750	160000	4900	2.5	45000	1500	1.2	190	5	0.8	0.5	1.1	320	9000	0.05	0.45	640	10	140
MAR07-06	1.6	79000	1	230	0.4	0.03	72000	0.11	49	560	130	90000	3400	2.5	44000	1100	0.54	160	2.8	0.3	0.5	0.5	370	4700	0.05	0.16	340	9.2	97
MAR07-23	0.28	66000	1	630	0.9	0.05	83000	0.17	68	56	530	160000	7000																

**TABLE D3
RESULTS OF BULK METAL ANALYSIS
MARATHON PGM-Cu PROJECT**

SAMPLE ID	BULK METAL ANALYSIS																												
	Ag (mg/kg)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Be (mg/kg)	Bi (mg/kg)	Ca (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	K (mg/kg)	Li (mg/kg)	Mg (mg/kg)	Mn (mg/kg)	Mo (mg/kg)	Ni (mg/kg)	Pb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Sn (mg/kg)	Sr (mg/kg)	Ti (mg/kg)	Ti (mg/kg)	U (mg/kg)	V (mg/kg)	Y (mg/kg)	Zn (mg/kg)
MAR07-28	0.12	47000	1	300	0.5	0.02	34000	0.11	130	130	140	170000	5400	11	90000	2500	0.9	290	4.8	0.05	1	0.7	260	2300	0.05	0.67	170	11	160
MAR07-29	0.15	89000	1	410	0.6	0.03	62000	0.09	73	110	80	99000	6300	11	56000	1600	1.1	160	4.7	0.05	0.5	0.6	610	1400	0.1	0.64	87	14	94
MAR07-30	0.17	67000	1	310	1.9	0.01	85000	0.13	58	220	45	85000	8500	11	46000	1500	0.76	130	4.1	0.2	0.5	0.8	450	1900	0.05	1.8	160	26	93
MAR07-31	0.2	86000	1	420	0.4	0.02	91000	0.09	37	160	300	63000	5800	2.5	37000	910	0.53	78	2	0.2	0.5	0.5	620	2200	0.05	0.36	220	14	51
MAR07-63	1.6	85000	1	410	0.5	0.26	92000	0.42	45	130	2700	66000	5400	2.5	35000	910	0.6	240	4.5	0.05	3	1	620	3700	0.1	0.45	230	14	75
MAR07-79	0.84	44000	1	220	0.3	0.21	46000	0.64	57	95	1400	67000	3000	2.5	37000	1100	0.52	190	1.9	0.05	1	0.5	340	2400	0.05	0.32	160	7.7	78
MAR07-80	1.5	74000	1	300	0.3	0.23	67000	0.85	61	100	3100	74000	3800	2.5	34000	1100	0.63	200	5.5	0.05	2	0.6	630	3300	0.05	0.33	300	7.9	120
MAR07-88	0.1	87000	1	470	0.5	0.03	60000	0.47	60	78	61	86000	5500	6	39000	1400	0.54	110	3.1	0.05	0.5	0.5	680	2200	0.05	0.47	180	10	93
MAR07-90	0.12	79000	1	340	0.5	0.01	77000	0.52	52	150	120	78000	4300	2.5	46000	1100	0.47	120	2	0.05	0.5	0.5	530	3300	0.05	0.47	210	12	81
MAR07-93	0.83	73000	1	360	0.6	0.07	89000	0.17	39	130	1200	62000	5400	2.5	37000	1000	0.65	98	2.8	0.05	1	0.6	530	3000	0.05	0.67	260	18	76
MAR07-94	0.11	86000	1	440	0.6	0.11	85000	0.1	27	110	100	49000	7100	6	29000	860	0.51	54	1.9	0.05	0.5	0.4	670	3000	0.05	0.45	210	14	57
MAR07-98	0.14	78000	3	340	1.7	0.04	61000	0.12	56	110	43	75000	8100	9	44000	1300	1.7	130	8.1	0.1	0.5	1.6	530	1700	0.2	1.5	120	15	98
MAR07-22	0.23	92000	1	830	1	0.06	75000	0.16	37	100	320	82000	8700	10	22000	1100	1.4	32	6.2	0.1	1	0.9	820	5000	0.1	0.93	240	25	93
MAR07-76	0.05	72000	1	2800	0.5	0.01	66000	0.12	52	54	82	140000	8400	2.5	25000	1900	1.5	7.2	2.3	0.05	2	0.6	1300	9900	0.05	0.67	160	23	150
MAR07-77	0.48	80000	1	2800	0.9	0.03	65000	0.0015	38	52	43	100000	12000	7	20000	1700	1.4	3.6	3.5	0.2	0.5	0.7	1120	12000	0.05	1.2	72	25	120
MIN	0.05	30000	1	220	0.3	0.005	34000	0.00	27	62	43	49000	3000	2.5	20000	800	0.31	4	1.4	0.05	0.5	0.4	230	1400	0.05	0.32	72	7.7	61
MAX	2.50	110000	3	2800	1.9	0.610	92000	0.73	140	460	7300	240000	12000	23.0	96000	2800	2.90	490	18.0	0.30	3.0	1.8	1300	18000	0.20	1.80	780	46.0	230
MED	0.21	78000.00	1.00	390.00	0.50	0.04	73000.00	0.14	56.50	115.00	285.00	85500.00	5450.00	2.50	38000.00	1200.00	0.89	126.00	3.50	0.05	0.75	0.70	585.00	3300.00	0.05	0.56	215.00	13.00	92.00
AVG	0.51	74969	1	541	0.7	0.097	71000.0	0.25	61.3	142.6	884.81	98856.25	5918.8	5.8	42781	1373	0.98	150	4.3	0.10	1.0	0.8	699	4638	0.06	0.68	262	15.8	101
STDEV	0.66	17891	0	603	0.4	0.128	14018.4	0.20	28.5	90.33	1645.94	47664.56	1857	5.0	17123	518	0.64	110	3.2	0.08	0.7	0.3	222	3955	0.03	0.37	165	8.5	47
VOLCANIC (n = 10)																													
MAR07-102	0.15	73000	1	280	0.5	0.07	59000	0.13	46	220	180	76000	6100	2.5	35000	1100	0.6	140	2.8	0.05	0.5	0.6	430	7300	0.05	0.25	250	12	100
MAR07-105	0.17	76000	1	570	1.4	0.14	35000	0.12	19	75	68	34000	16000	6	15000	720	3.4	42	7.5	0.2	0.5	1.2	530	3100	0.05	0.95	93	16	84
MAR07-111	0.33	69000	2	380	1.1	0.1	34000	0.08	26	89	100	47000	15000	2.5	20000	820	1.3	74	8.4	0.05	0.5	1.6	420	4600	0.05	1.4	140	18	67
MAR07-110	1.8	53000	3	120	0.7	0.4	51000	0.53	180	150	5700	180000	5100	7	23000	1100	5.4	580	8.6	0.2	4	6.4	380	2000	0.05	0.74	130	13	96
MAR07-17	0.78	77000	1	440	0.9	0.18	49000	0.19	16	190	380	34000	13000	15	12000	770	2	50	8.9	1.2	0.5	1.5	400	2100	0.4	1	74	12	60
MAR07-33	2.8	80000	4	220	1.6	0.47	89000	0.89	56	160	3300	94000	3300	10	24000	2500	1.1	220	11	0.2	2	2	580	1600	0.1	2.3	110	29	210
MAR07-52	0.18	76000	1	380	0.3	0.005	54000	0.12	50	180	190	46000	14000	2.5	24000	1300	0.32	72	1.7	0.05	0.5	0.6	390	4600	0.05	0.12	280	12	80
MAR07-66	0.29	71000	1	360	1.1	0.13	46000	0.18	26	170	580	60000	7000	7	17000	1700	1.8	66	4.2	0.3	0.5	1.1	440	2800	0.1	0.64	92	13	77
MAR07-96	0.07	77000	1	200	0.4	0.01	71000	0.14	47	140	33	79000	3100	2.5	37000	1200	0.51	91	2.3	0.4	0.5	0.5	290	3800	0.05	0.05	250	11	87
MAR07-34	0.18	74000	1	310	0.7	0.04	66000	0.13	41	160	120	82000	6400	7	30000	1100	0.79	58	4.5	0.05	0.5	0.9	250	4100	0.05	0.61	260	23	84
MIN	0.07	53000	1	120	0.3	0.005	34000	0.08	16	75	33	34000	3100	2.5	12000	720	0.32	42	1.7	0.05	0.5	0.6	250	1600	0.05	0.05	74	11.0	60
MAX	2.80	80000	4	570	1.6	0.470	89000	0.89	180	220	5700	180000	16000	18.0	37000	2500	5.40	580	11.0	1.20	4.0	6.4	580	7300	0.40	2.30	280	29.0	210
MED	0.23	75000.00	1.00	335.00	0.80	0.11	52500.00	0.13	43.50	160.00	185.00	68000.00	6700.00	6.50	23500.00	1100.00	1.20	73.00	6.00	0.20	0.50	1.15	410.00	3450.00	0.05	0.69	135.00	13.00	84.00
AVG	0.67	72600	2	324	0.9	0.155	55400.0	0.25	50.7	153.4	1065.10	73200.00	8900.0	6.2	23700	1231	1.72	139	6.0	0.27	1.0	1.6	411	3600	0.10	0.81	168	15.9	95
STDEV	0.91	7689	1	129	0.4	0.159	16741.2	0.26	47.5	43.88	1903.65	42987.85	5029	4.1	8274	530	1.58	164	3.3	0.35	1.2	1.7	98	1689	0.11	0.67	82	5.9	42
HETEROLITHIC BRECCIA (n = 6)																													
MAR07-02	0.52	85000	7	380	1.8	0.2	72000	0.16	37	100	560	77000	8400	6	26000	880	2.5	92	11	1.2	1	1	570	3700	0.1	1.8	450	19	92
MAR07-100	0.88	78000	1	370	0.5	0.41	70000	0.46	62	110	1300	78000	5100	2.5	29000	1100	0.47	140	10	0.05	2	0.8	610	3200	0.05	0.79	290	12	80
MAR07-35	0.19	72000	1	360	0.5	0.07	85000	0.13	66	190	230	110000	3800	2.5	59000	1600	0.86	140	2.5	0.05	1	0.5	540	2800	0.05	0.39	200	18	95
MAR07-49	1.6	72000	1	280	0.3	0.26	88000	0.41	63	290	3500	72000	3600	2.5	40000	920	0.46	300	8.3	0.1	2	0.9	510	2800	0.05	0.29	200	11	66
MAR07-74	0.07	26000	1	150	0.4	0.02	28000	0.09	160	210	79	230000	2400	13	99000	3300	1	300	1.3	0.1	0.5	1	190	6900	0.05	0.42	650	8.8	220
MAR07-81	4.4	77000	1	280	0.4	0.17	80000	0.65	65	110	2890	71000	4000	2.5	47000	1100	0.38	310	3.5	0.05	2	0.4	550	2200	0.05	0.36	170	9.9	76
MIN	0.07	26000	1	150	0.3	0.020	28000	0.09	37	100	79	71000	2400	2.5	28000	880	0.38	92	1.3	0.05	0.5	0.4	190	2200	0.05	0.29	170	8.8	66
MAX	4.40	85000	7	380	1.8	0.410	88000	0.65	160	290	3500	230000	8400	13.0	99000	3300	2.50	310	11.0	1.20	2.0	1.0	610	6900	0.10	1.80	650	19.0	220
MED	0.70	74500.00	1.00	320.00	0.45	0.19	76000.00	0.28	64.00	150.00	930.00	77500.00	3900.00	2.50	43500.00	1100.00	0.67	220.00	5.90	0.08	1.50	0.85	545.00	3000.00	0.05	0.40	245.00	11.50	86.00
AVG	1.31	68333	2	300	0.6	0.188	70500.0	0.32	75.5	168.3	1428.17	106333	4550.0	4.8	50000	1483	0.95	214	6.1										

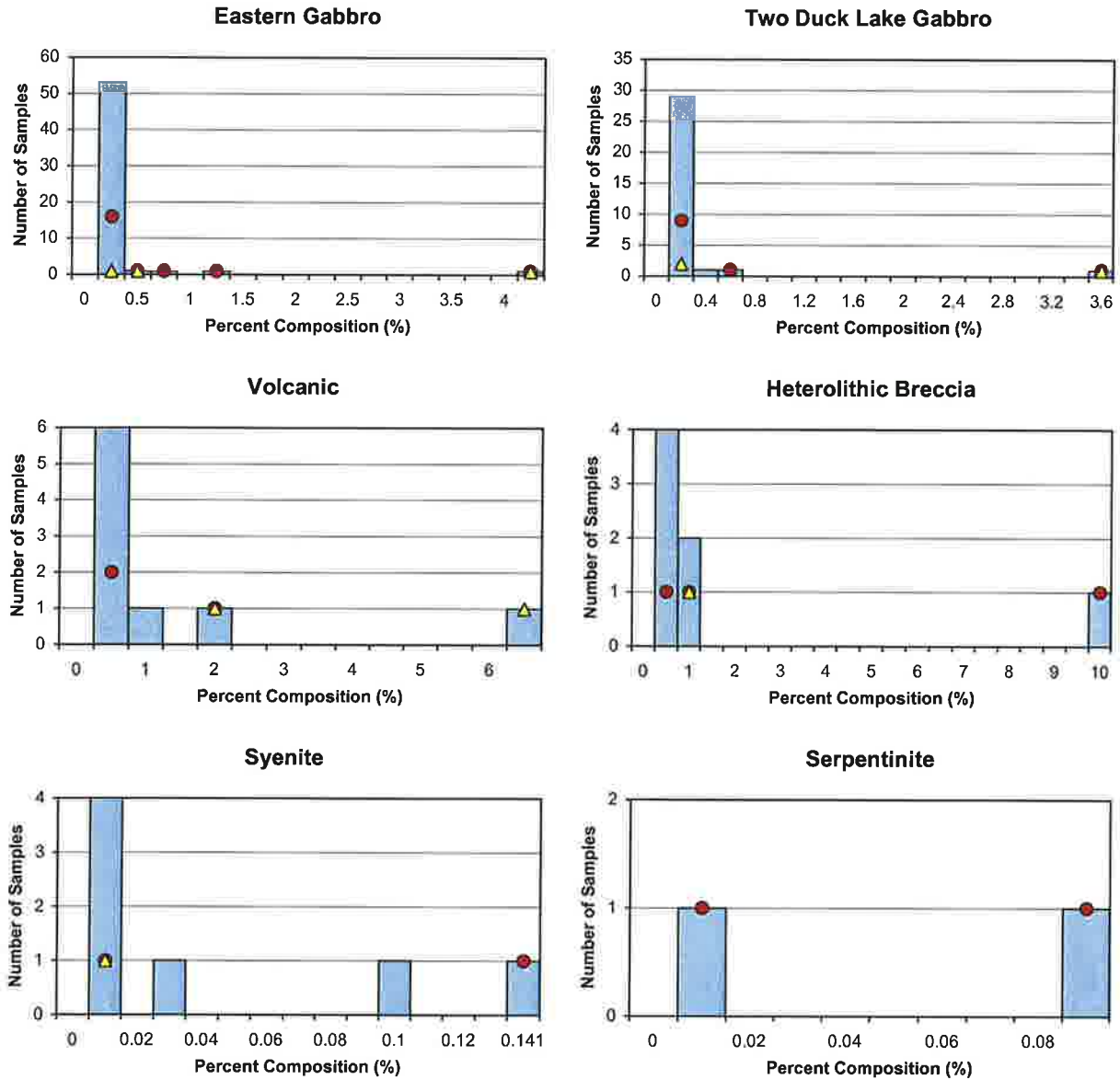
TABLE D4
RESULTS OF SHORT-TERM LEACH TESTS
MARATHON PGM-Cu PROJECT

Sample ID	SPLP Analysis																																
	Hg mg/L	Al mg/L	As mg/L	Ag mg/L	Ba mg/L	Be mg/L	B mg/L	Bl mg/L	Ca mg/L	Cd mg/L	Co mg/L	Cr mg/L	Cu mg/L	Fe mg/L	K mg/L	Li mg/L	Mg mg/L	Mn mg/L	Mo mg/L	Na mg/L	Ni mg/L	Pb mg/L	Sb mg/L	Se mg/L	Sn mg/L	Sr mg/L	Ti mg/L	Ti mg/L	U mg/L	V mg/L	W mg/L	Y mg/L	Zn mg/L
EASTERN GABBRU (n = 20)																																	
MAR07-01	0.0005	0.650	0.0015	0.0005	0.322	0.002	0.090	0.0001	2.42	0.0003	0.00142	0.00050	0.0066	1.56	1.52	0.001	1.16	0.021	0.018	17.20	0.0028	0.0019	0.0046	0.0005	0.0015	0.02	0.023	0.00020	0.0001	0.032	0.0012	0.00033	0.009
MAR07-08	0.0005	0.020	0.0008	0.0005	0.351	0.002	0.016	0.0001	15.60	0.0003	0.00008	0.00015	0.0005	0.01	1.54	0.001	16.90	0.004	0.050	4.82	0.0008	0.0019	0.0013	0.0005	0.0008	0.11	0.000	0.00005	0.0001	0.011	0.0010	0.00002	0.003
MAR07-10	0.0005	0.005	0.0008	0.0005	0.372	0.002	0.040	0.0001	18.00	0.0008	0.00018	0.00015	0.0004	0.01	4.08	0.001	19.60	0.151	0.003	5.38	0.0013	0.0313	0.0010	0.0005	0.0008	0.12	0.000	0.00005	0.0001	0.00003	0.0003	0.0001	0.007
MAR07-16	0.0005	0.070	0.0005	0.0005	0.180	0.002	0.062	0.0001	11.50	0.0003	0.00005	0.00015	0.0016	0.01	1.18	0.001	0.59	0.004	0.005	11.90	0.0004	0.0014	0.0013	0.0005	0.0008	0.10	0.001	0.00005	0.0001	0.003	0.0003	0.0001	0.018
MAR07-18	0.0005	0.120	0.0018	0.0005	0.259	0.002	0.058	0.0001	3.42	0.0003	0.00009	0.00015	0.0010	0.09	6.22	0.001	0.64	0.002	0.005	10.20	0.0004	0.0011	0.0011	0.0005	0.0002	0.03	0.001	0.00005	0.0001	0.008	0.0007	0.0001	0.022
MAR07-27	0.0005	0.280	0.0003	0.0005	0.196	0.002	0.055	0.0001	4.11	0.0003	0.00009	0.00015	0.0058	0.14	0.45	0.001	0.25	0.002	0.004	18.10	0.0004	0.0018	0.0009	0.0005	0.0004	0.05	0.003	0.00005	0.0001	0.011	0.0003	0.00002	0.005
MAR07-46	0.0005	0.270	0.0020	0.0005	0.295	0.002	0.030	0.0001	2.44	0.0003	0.00010	0.00015	0.0017	0.14	3.76	0.001	0.73	0.002	0.009	13.60	0.0004	0.0285	0.0011	0.0005	0.0016	0.03	0.002	0.00005	0.0001	0.015	0.0009	0.0001	0.007
MAR07-50	0.0005	0.180	0.0001	0.0005	0.377	0.002	0.052	0.0001	4.13	0.0003	0.00025	0.00015	0.0009	0.26	1.16	0.001	1.92	0.004	0.004	6.74	0.0004	0.0010	0.0008	0.0005	0.0007	0.04	0.005	0.00005	0.0001	0.012	0.0002	0.0001	0.011
MAR07-51	0.0005	0.020	0.0004	0.0005	0.278	0.002	0.076	0.0001	4.22	0.0003	0.00006	0.00015	0.0005	0.01	13.00	0.001	2.03	0.001	0.003	10.90	0.0008	0.0269	0.0009	0.0005	0.0002	0.03	0.000	0.00005	0.0001	0.003	0.0003	0.0001	0.043
MAR07-59	0.0005	0.160	0.0017	0.0005	0.287	0.002	0.049	0.0001	1.30	0.0003	0.00029	0.00015	0.0007	0.42	2.07	0.001	0.31	0.008	0.003	18.80	0.0011	0.0011	0.0008	0.0005	0.0005	0.02	0.002	0.00005	0.0001	0.004	0.0005	0.00002	0.007
MAR07-62	0.0005	0.340	0.0003	0.0005	0.303	0.002	0.035	0.0001	4.03	0.0003	0.00009	0.00015	0.0005	0.08	0.77	0.001	0.54	0.001	0.003	8.06	0.0004	0.0016	0.0007	0.0005	0.0006	0.03	0.001	0.00005	0.0001	0.004	0.0005	0.0001	0.006
MAR07-65	0.0005	0.005	0.0003	0.0005	0.248	0.002	0.036	0.0001	6.53	0.0010	0.00005	0.00015	0.0005	0.01	1.36	0.001	0.92	0.001	0.001	15.50	0.0008	0.0521	0.0006	0.0005	0.0005	0.06	0.000	0.00005	0.0001	0.000	0.0005	0.0001	0.004
MAR07-70	0.0005	0.500	0.0006	0.0005	0.297	0.002	0.060	0.00048	2.22	0.0003	0.00028	0.00050	0.0034	0.38	0.77	0.001	0.39	0.006	0.004	14.20	0.0012	0.0285	0.0010	0.0005	0.0004	0.02	0.008	0.00005	0.0001	0.012	0.0003	0.00003	0.010
MAR07-78	0.0005	0.300	0.0012	0.0005	0.309	0.002	0.031	0.00007	4.14	0.0003	0.00010	0.00015	0.0007	0.12	1.25	0.001	0.50	0.003	0.010	5.71	0.0004	0.0011	0.0008	0.0005	0.0005	0.03	0.003	0.00005	0.0001	0.004	0.0005	0.00016	0.005
MAR07-91	0.0005	0.070	0.0004	0.0005	0.208	0.002	0.024	0.00004	5.83	0.0003	0.00006	0.00015	0.0013	0.02	3.60	0.001	1.92	0.001	0.002	5.98	0.0004	0.0059	0.0007	0.0005	0.0007	0.05	0.001	0.00005	0.0001	0.003	0.0002	0.0001	0.004
MAR07-95	0.0005	0.640	0.0001	0.0005	0.298	0.002	0.030	0.00003	2.01	0.0003	0.00031	0.00040	0.0004	0.28	0.68	0.001	0.18	0.003	0.004	15.50	0.0004	0.0012	0.0012	0.0005	0.0003	0.02	0.012	0.00005	0.0001	0.023	0.0006	0.00003	0.008
MAR07-99	0.0005	0.300	0.0222	0.0005	0.236	0.002	0.044	0.00003	4.05	0.0003	0.00012	0.00015	0.0017	0.17	3.75	0.001	0.41	0.002	0.003	20.40	0.0013	0.0244	0.0009	0.0006	0.0004	0.05	0.003	0.00005	0.0001	0.012	0.0016	0.0001	0.003
MAR07-101	0.0005	0.250	0.0006	0.0005	0.296	0.002	0.069	0.00003	7.26	0.0003	0.00033	0.00070	0.0043	0.29	4.84	0.001	0.63	0.004	0.004	17.80	0.0015	0.0019	0.0009	0.0005	0.0006	0.07	0.005	0.00005	0.0001	0.005	0.0010	0.00014	0.007
MAR07-112	0.0005	1.420	0.0005	0.0005	0.417	0.002	0.080	0.00002	6.82	0.0003	0.00126	0.00200	0.0035	1.31	0.80	0.001	1.12	0.011	0.006	5.45	0.0023	0.0026	0.0025	0.0005	0.0013	0.05	0.116	0.00005	0.0001	0.050	0.0012	0.00019	0.007
MAR07-113	0.0005	0.070	0.0005	0.0005	0.198	0.002	0.034	0.00001	5.15	0.0003	0.00005	0.00015	0.0011	0.01	13.80	0.001	2.26	0.001	0.003	5.44	0.0004	0.0007	0.0007	0.0005	0.0007	0.04	0.002	0.00005	0.0001	0.014	0.0003	0.0001	0.006
MIN	0.0005	0.005	0.0001	0.0005	0.180	0.002	0.016	0.00001	1.30	0.0003	0.00005	0.00015	0.0004	0.01	0.45	0.001	0.18	0.001	0.001	4.82	0.0004	0.0007	0.0006	0.0005	0.0002	0.02	0.000	0.00005	0.0001	0.000	0.0002	0.0001	0.003
MAX	0.0005	1.420	0.0222	0.0005	0.417	0.002	0.090	0.00048	18.00	0.0010	0.00142	0.00200	0.0147	1.55	13.80	0.001	19.80	0.151	0.060	20.40	0.0028	0.0521	0.0046	0.0060	0.0016	0.12	0.116	0.00020	0.0001	0.050	0.0016	0.00033	0.043
MED	0.0005	0.215	0.0006	0.0005	0.295	0.002	0.046	0.00001	4.13	0.0003	0.00010	0.00015	0.0011	0.13	1.63	0.001	0.78	0.003	0.004	11.40	0.0006	0.0019	0.0009	0.0006	0.0006	0.04	0.002	0.00005	0.0001	0.010	0.0005	0.0001	0.007
AVG	0.0005	0.282	0.0018	0.0005	0.286	0.002	0.046	0.00004	6.76	0.0004	0.00026	0.00032	0.0025	0.26	3.32	0.001	2.68	0.011	0.008	11.58	0.0009	0.0107	0.0012	0.0008	0.0007	0.05	0.009	0.00006	0.00005	0.011	0.0006	0.00005	0.010
STDEV	-	0.332	0.0048	-	0.064	-	0.019	0.00010	4.44	0.00002	0.00038	0.00043	0.0034	0.42	3.81	-	5.39	0.033	0.013	5.37	0.0007	0.0160	0.0009	0.0012	0.0004	0.03	0.026	0.00003	0.00009	0.012	0.0004	0.00009	0.009
TWO DUCK LAKE (n = 10)																																	
MAR07-15	0.0005	0.060	0.0002	0.0005	0.155	0.002	0.036	0.00001	19.40	0.0003	0.00008	0.00015	0.0013	0.01	2.21	0.001	1.76	0.005	0.004	10.20	0.0009	0.0013	0.0013	0.0005	0.0005	0.20	0.001	0.00005	0.0001	0.001	0.0003	0.0001	0.013
MAR07-19	0.0005	0.120	0.0017	0.0005	0.263	0.002	0.055	0.00001	3.51	0.0003	0.00021	0.00015	0.0039	0.23	15.00	0.001	1.02	0.003	0.005	11.20	0.0009	0.0017	0.0009	0.0005	0.0012	0.03	0.008	0.00005	0.0001	0.022	0.0005	0.00002	0.005
MAR07-22	0.0005	0.130	0.0005	0.0005	0.267	0.002	0.034	0.00001	6.61	0.0003	0.00004	0.00015	0.0006	0.02	2.92	0.001	1.02	0.002	0.003	4.55	0.0004	0.0011	0.0007	0.0005	0.0012	0.05	0.001	0.00005	0.0001	0.006	0.0004	0.0001	0.003
MAR07-28	0.0005	0.050	0.0010	0.0005	0.258	0.002	0.036	0.00001	1.68	0.0003	0.00005	0.00015	0.0005	0.03	6.15	0.001	0.36	0.001	0.002	10.50	0.0009	0.0011	0.0006	0.0005	0.0003	0.02	0.000	0.00005	0.0001	0.002	0.0007	0.0001	0.003
MAR07-31	0.0005	0.780	0.0005	0.0005	0.348	0.002	0.063	0.00001	2.55	0.0003	0.00032	0.00015	0.0020	0.48	1.26	0.001	0.38	0.005															

APPENDIX E
HISTOGRAMS OF BULK ELEMENTAL ANALYSIS

**FIGURE E1
HISTOGRAMS OF WASTE ROCK CHEMISTRY
MARATHON PGM**

SULPHIDE CONTENT



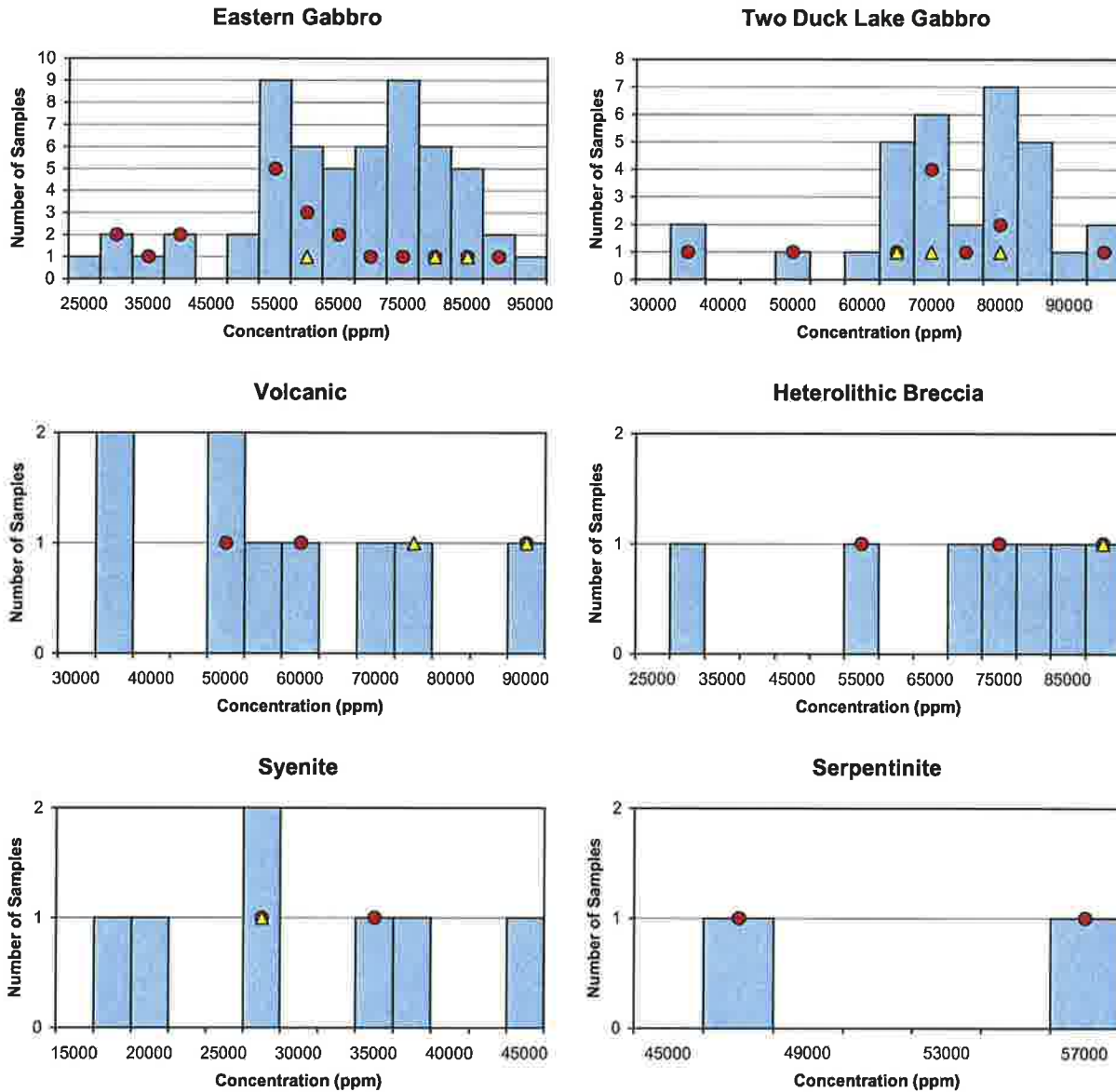
Note:

The blue bars represent solid-phase concentrations. The red dots and the yellow triangles represent the samples selected for short-term leach and kinetic testing, respectively, for the corresponding concentration interval.

- Solid-phase Concentrations
- Samples Selected for Leach Testing
- ▲ Samples Selected for Kinetic Testing

**FIGURE E2
HISTOGRAMS OF WASTE ROCK CHEMISTRY
MARATHON PGM**

CALCIUM

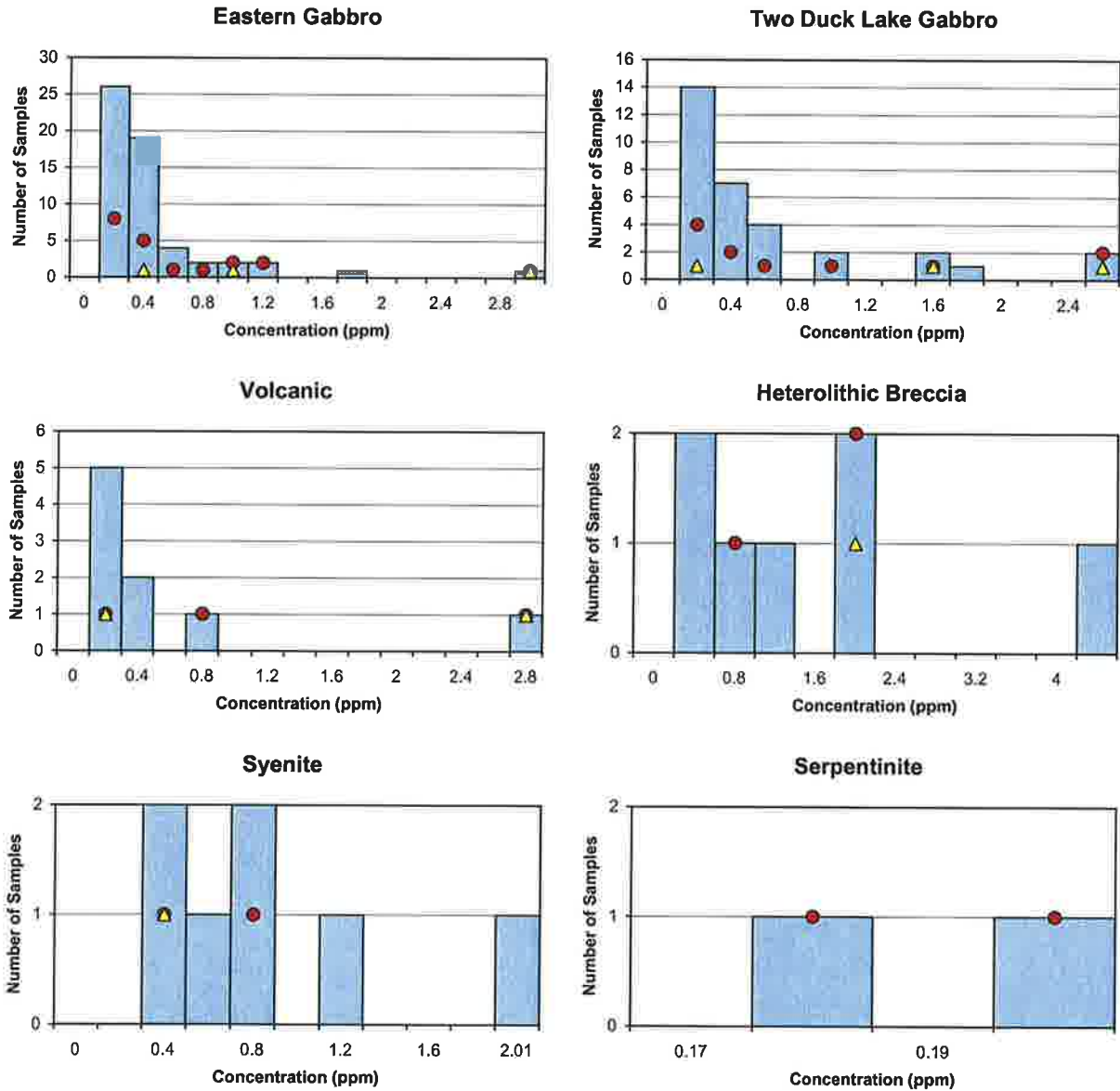


Note:
The blue bars represent solid-phase concentrations. The red dots and the yellow triangles represent the samples selected for short-term leach and kinetic testing, respectively, for the corresponding concentration interval.

- Solid-phase Concentrations
- Samples Selected for Leach Testing
- ▲ Samples Selected for Kinetic Testing

**FIGURE E3
HISTOGRAMS OF WASTE ROCK CHEMISTRY
MARATHON PGM**

SILVER

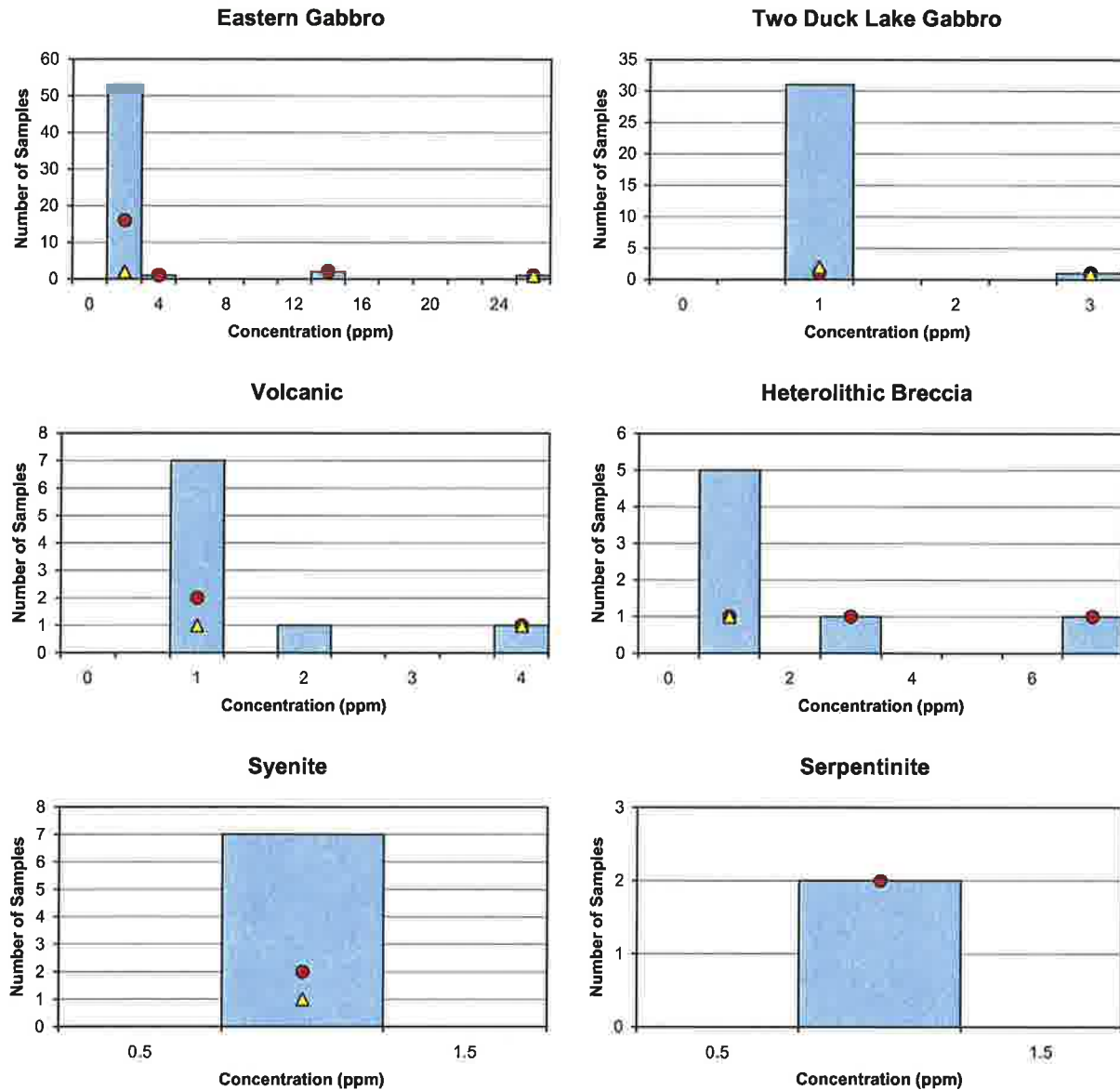


Note:
The blue bars represent solid-phase concentrations. The red dots and the yellow triangles represent the samples selected for short-term leach and kinetic testing, respectively, for the corresponding concentration interval.

- Solid-phase Concentrations
- Samples Selected for Leach Testing
- ▲ Samples Selected for Kinetic Testing

**FIGURE E4
HISTOGRAMS OF WASTE ROCK CHEMISTRY
MARATHON PGM**

ARSENIC



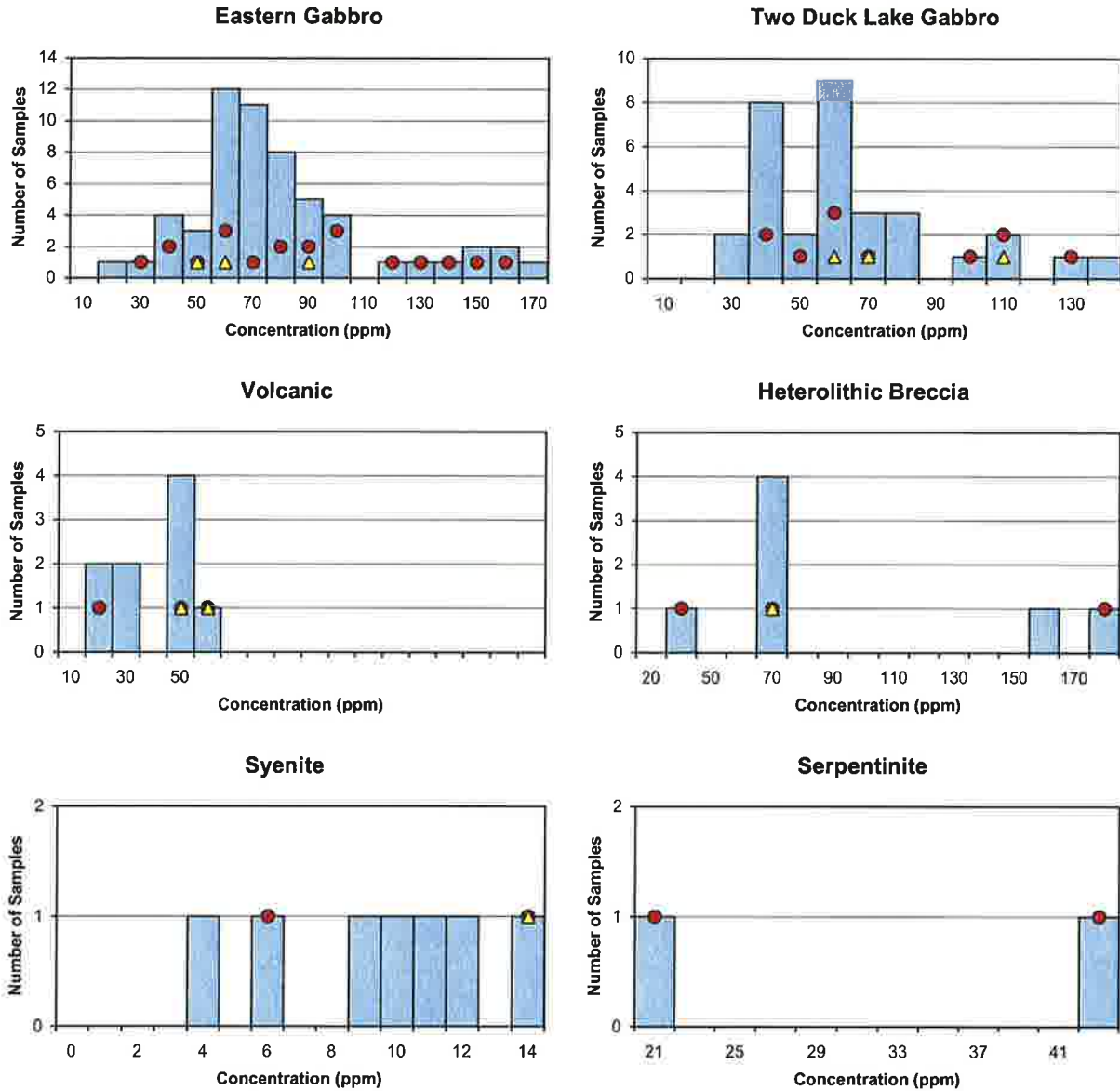
Note:

The blue bars represent solid-phase concentrations. The red dots and the yellow triangles represent the samples selected for short-term leach and kinetic testing, respectively, for the corresponding concentration interval.

- Solid-phase Concentrations
- Samples Selected for Leach Testing
- ▲ Samples Selected for Kinetic Testing

**FIGURE E6
HISTOGRAMS OF WASTE ROCK CHEMISTRY
MARATHON PGM**

COBALT



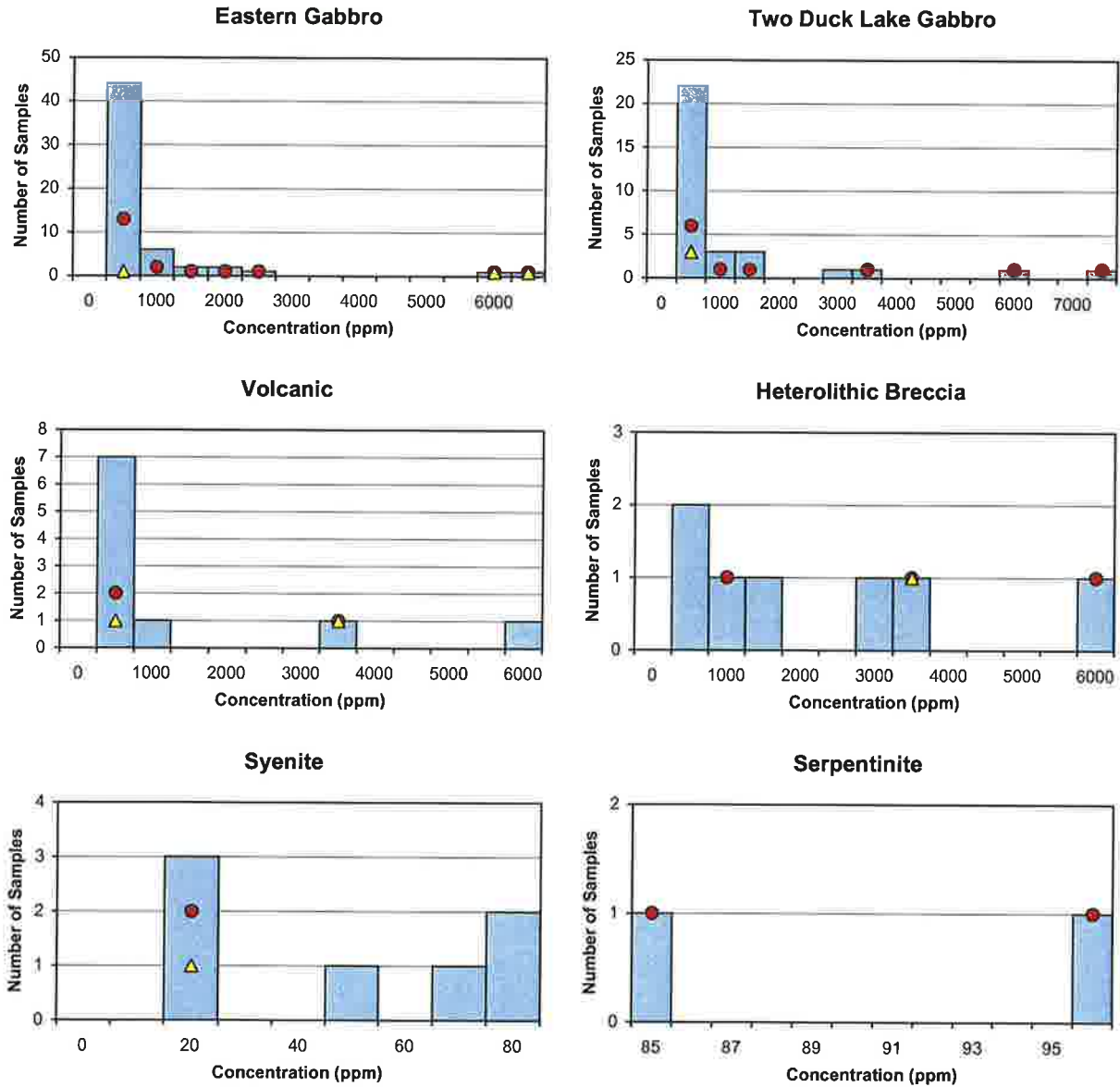
Note:

The blue bars represent solid-phase concentrations. The red dots and the yellow triangles represent the samples selected for short-term leach and kinetic testing, respectively, for the corresponding concentration interval.

- ▣ Solid-phase Concentrations
- Samples Selected for Leach Testing
- △ Samples Selected for Kinetic Testing

**FIGURE E8
HISTOGRAMS OF WASTE ROCK CHEMISTRY
MARATHON PGM**

COPPER

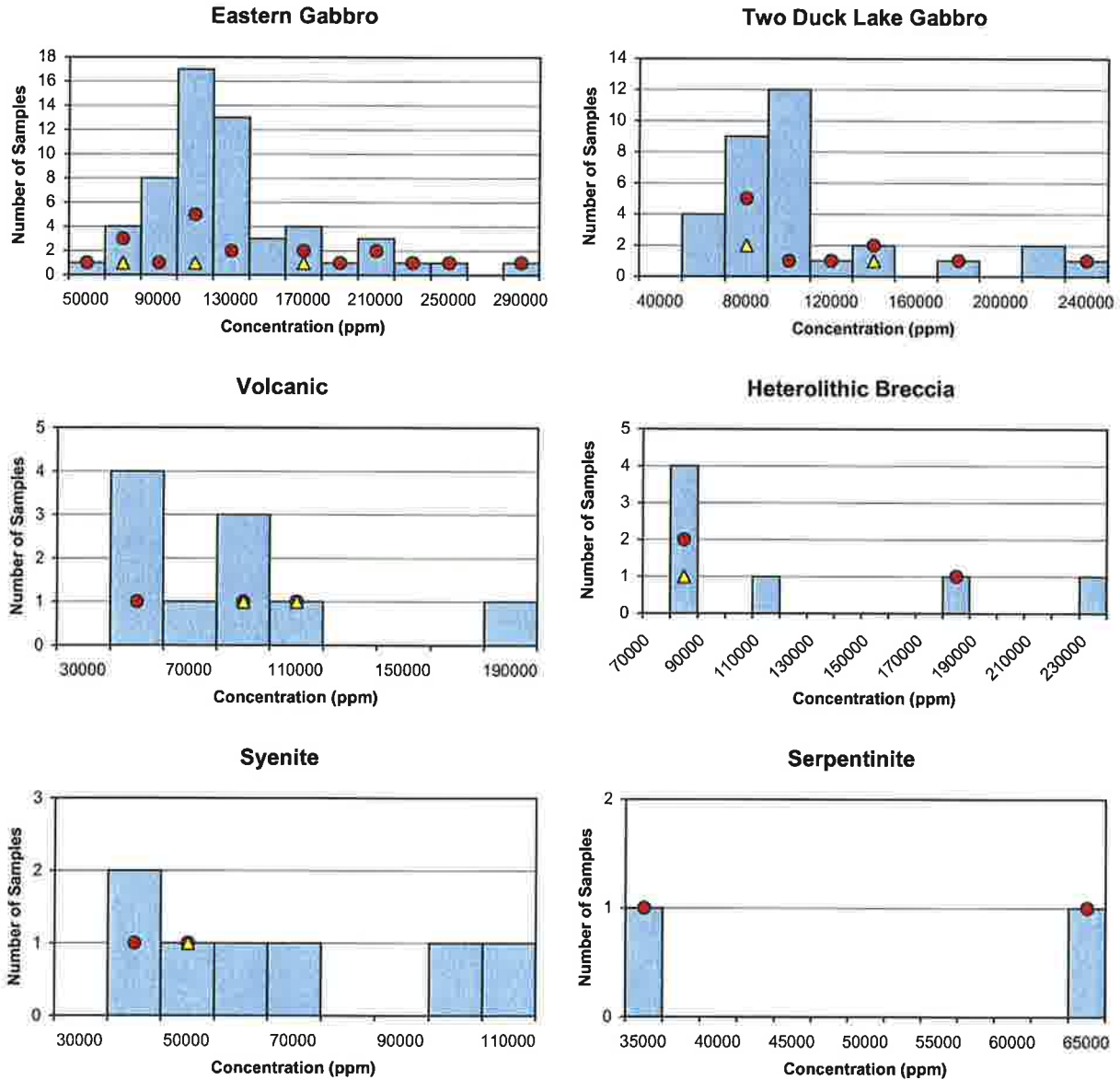


Note:
The blue bars represent solid-phase concentrations. The red dots and the yellow triangles represent the samples selected for short-term leach and kinetic testing, respectively, for the corresponding concentration interval.

- ▣ Solid-phase Concentrations
- Samples Selected for Leach Testing
- △ Samples Selected for Kinetic Testing

**FIGURE E9
HISTOGRAMS OF WASTE ROCK CHEMISTRY
MARATHON PGM**

IRON



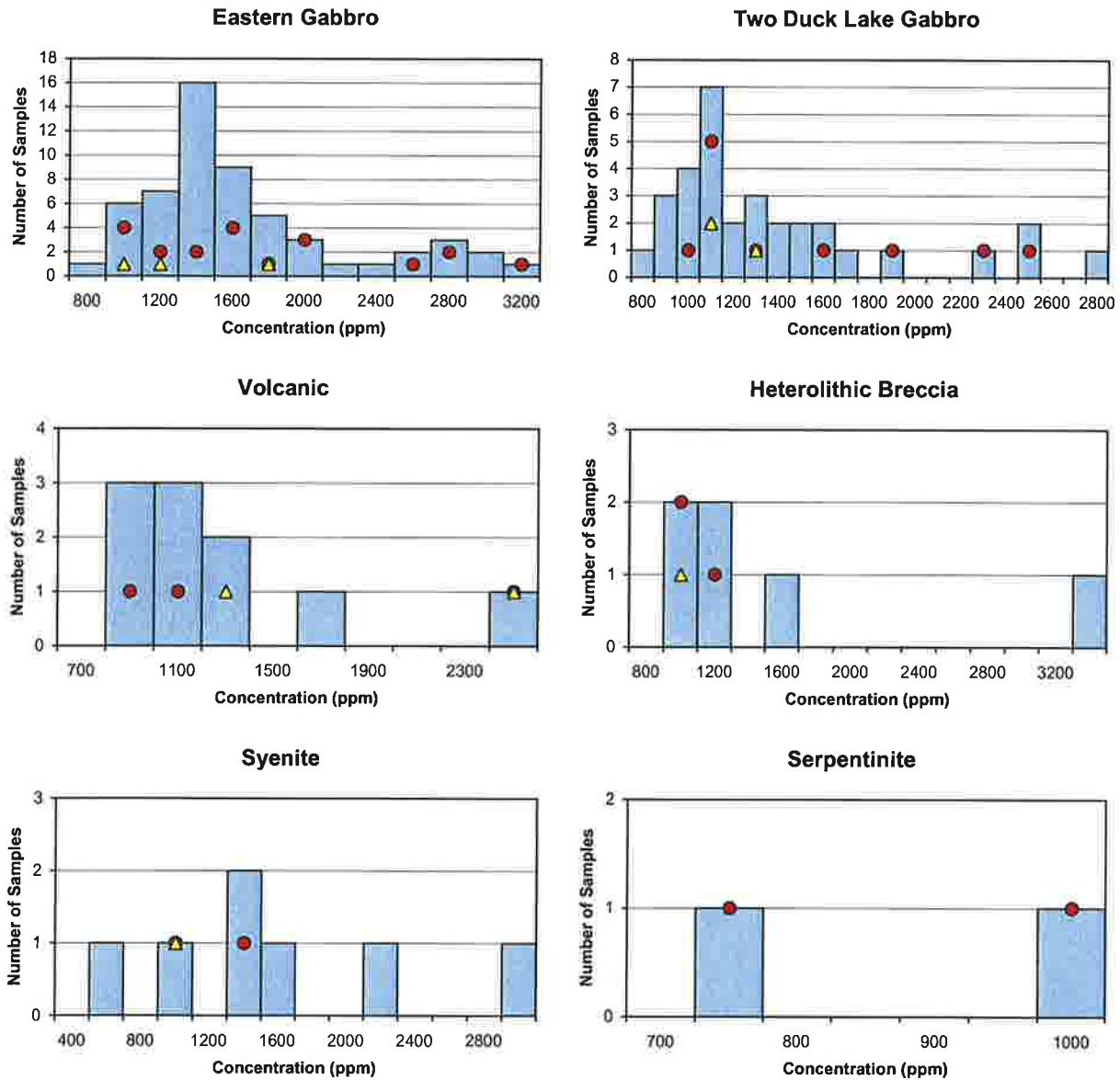
Note:

The blue bars represent solid-phase concentrations. The red dots and the yellow triangles represent the samples selected for short-term leach and kinetic testing, respectively, for the corresponding concentration interval.

- ▣ Solid-phase Concentrations
- Samples Selected for Leach Testing
- △ Samples Selected for Kinetic Testing

**FIGURE E10
HISTOGRAMS OF WASTE ROCK CHEMISTRY
MARATHON PGM**

MANGANESE



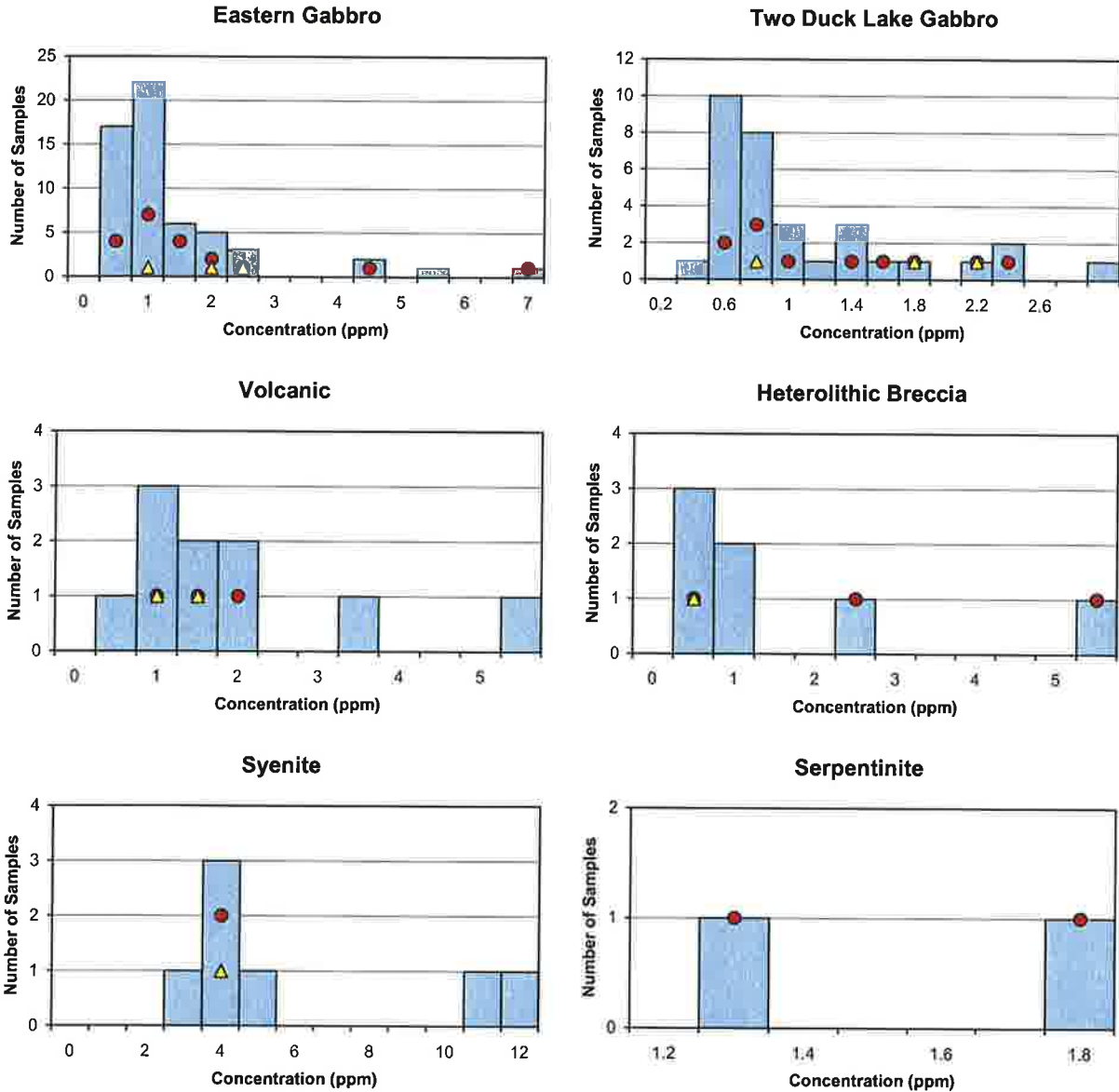
Note:

The blue bars represent solid-phase concentrations. The red dots and the yellow triangles represent the samples selected for short-term leach and kinetic testing, respectively, for the corresponding concentration interval.

- ▣ Solid-phase Concentrations
- Samples Selected for Leach Testing
- △ Samples Selected for Kinetic Testing

**FIGURE E11
HISTOGRAMS OF WASTE ROCK CHEMISTRY
MARATHON PGM**

MOLYBDENUM



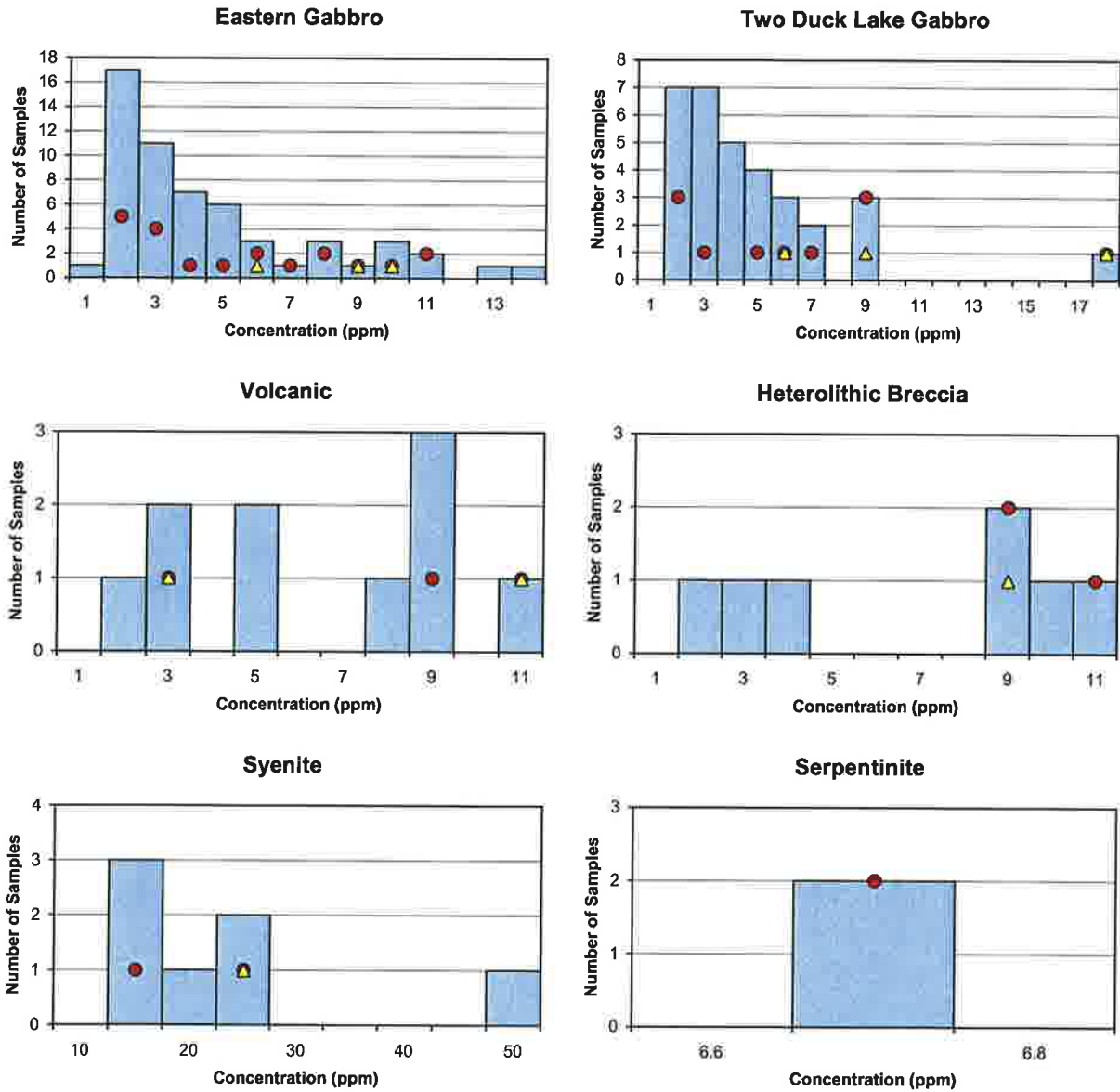
Note:

The blue bars represent solid-phase concentrations. The red dots and the yellow triangles represent the samples selected for short-term leach and kinetic testing, respectively, for the corresponding concentration interval.

- Solid-phase Concentrations
- Samples Selected for Leach Testing
- ▲ Samples Selected for Kinetic Testing

**FIGURE E13
HISTOGRAMS OF WASTE ROCK CHEMISTRY
MARATHON PGM**

LEAD



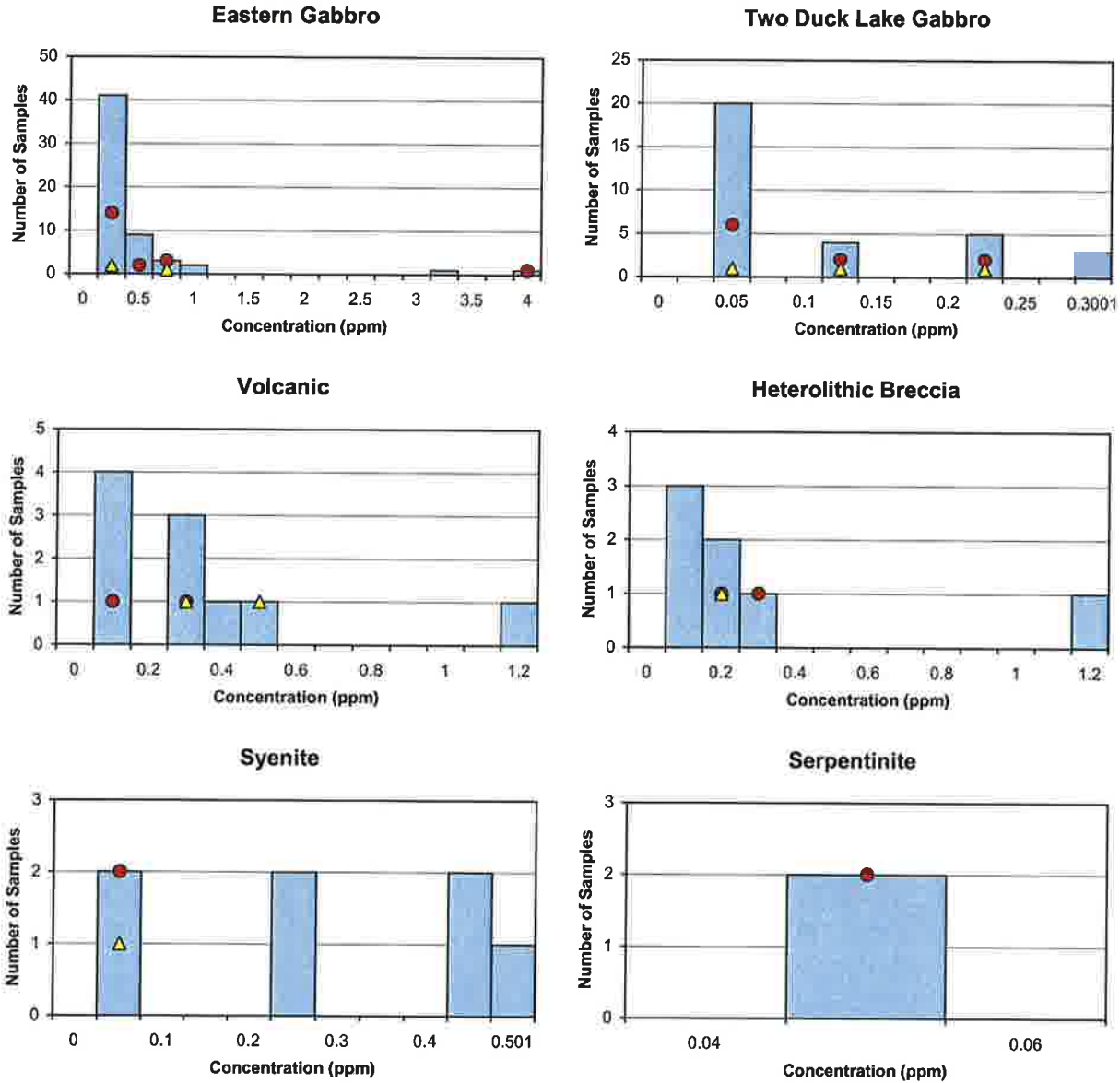
Note:

The blue bars represent solid-phase concentrations. The red dots and the yellow triangles represent the samples selected for short-term leach and kinetic testing, respectively, for the corresponding concentration interval.

- Solid-phase Concentrations
- Samples Selected for Leach Testing
- ▲ Samples Selected for Kinetic Testing

**FIGURE E14
HISTOGRAMS OF WASTE ROCK CHEMISTRY
MARATHON PGM**

ANTIMONY

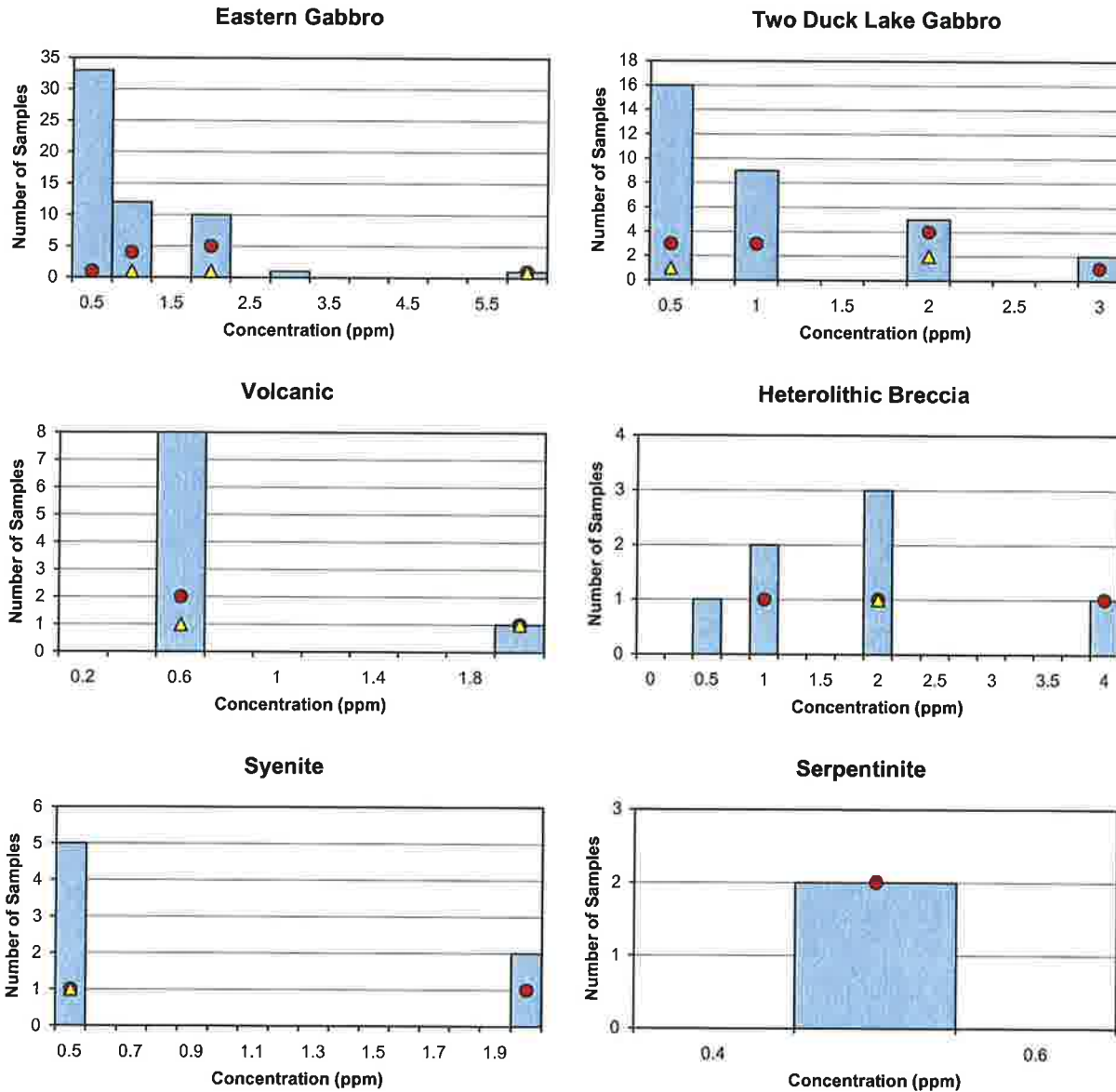


Note:
The blue bars represent solid-phase concentrations. The red dots and the yellow triangles represent the samples selected for short-term leach and kinetic testing, respectively, for the corresponding concentration interval.

- Solid-phase Concentrations
- Samples Selected for Leach Testing
- ▲ Samples Selected for Kinetic Testing

**FIGURE E15
HISTOGRAMS OF WASTE ROCK CHEMISTRY
MARATHON PGM**

SELENIUM

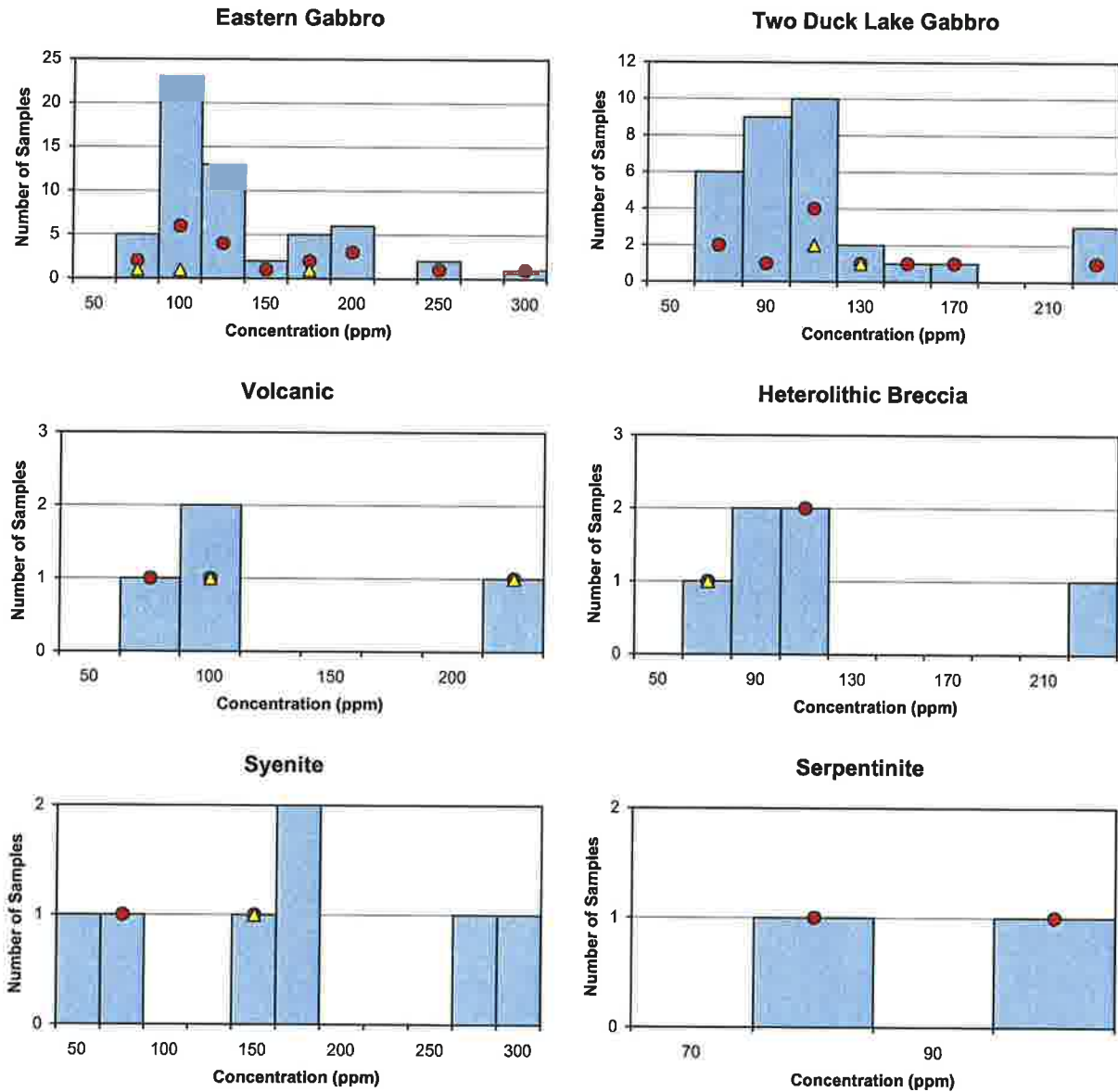


Note:
The blue bars represent solid-phase concentrations. The red dots and the yellow triangles represent the samples selected for short-term leach and kinetic testing, respectively, for the corresponding concentration interval.

- Solid-phase Concentrations
- Samples Selected for Leach Testing
- △ Samples Selected for Kinetic Testing

**FIGURE E16
HISTOGRAMS OF WASTE ROCK CHEMISTRY
MARATHON PGM**

ZINC



Note:
The blue bars represent solid-phase concentrations. The red dots and the yellow triangles represent the samples selected for short-term leach and kinetic testing, respectively, for the corresponding concentration interval.

- Solid-phase Concentrations
- Samples Selected for Leach Testing
- ▲ Samples Selected for Kinetic Testing

APPENDIX F

**PROVINCIAL WATER QUALITY OBJECTIVES
AND
MUNICIPAL/INDUSTRIAL STRATEGY FOR
ABATEMENT DISCHARGE LIMITS**

TABLE F1
PROVINCIAL WATER QUALITY OBJECTIVES AND MISA EFFLUENT DISCHARGE LIMITS
MARATHON PGM-Cu

Parameter	Units	Provincial Water Quality Objectives ⁽¹⁾	MISA Effluent Discharge Limits ⁽²⁾
pH	units	6.5 – 8.5	-
Ag	mg/L	0.0001	-
Al	mg/L	0.015 – 0.075 ⁽³⁾	-
As	mg/L	0.005	0.5
B	mg/L	0.2	-
Ba	mg/L	-	-
Be	mg/L	0.011 – 1.1 ⁽⁴⁾	-
Bi	mg/L	-	-
Cd	mg/L	0.0001 – 0.0005 ⁽⁵⁾	-
Co	mg/L	0.0009	-
Cr	mg/L	0.001 ⁽⁶⁾	-
Cu	mg/L	0.001 – 0.005 ⁽⁷⁾	0.3
Fe	mg/L	0.3	-
Hg	mg/L	0.0002	-
Li	mg/L	-	-
Mn	mg/L	-	-
Mo	mg/L	0.04	-
Ni	mg/L	0.025	0.5
Pb	mg/L	0.001 – 0.005 ⁽⁸⁾	0.2
Sb	mg/L	0.02	-
Se	mg/L	0.1	-
Sn	mg/L	-	-
Sr	mg/L	-	-
Ti	mg/L	-	-
Tl	mg/L	0.0003	-
U	mg/L	0.005	-
V	mg/L	0.006	-
Zn	mg/L	0.02	0.5

Notes:

(1) MOEE [Ontario Ministry of Environment and Energy], 1994. Policies Guidelines Provincial Water Quality Objectives. Reprinted 1999.

(2) MISA [Municipal/Industrial Strategy for Abatement] (1994). Ontario Regulation 560/94, Effluent Monitoring and Effluent Limits – Metal Mining Sector.

(3) PWQO for Al depends on pH as follows: pH = 4.5–5.5, PWQO = 0.015 mg/L; pH >5.5–6.5, PWQO = 10% of background concentration; pH >6.5–9.0, PWQO = 0.075 mg/L.

(4) PWQO for Be depends on hardness as follows: hardness <75 mg/L as CaCO₃, PWQO = 0.011 mg/L; hardness >75 mg/L as CaCO₃, PWQO = 1.1 mg/L.

(5) PWQO for Cd depends on hardness as follows: hardness 0–100 mg/L as CaCO₃, PWQO = 0.0001 mg/L; hardness >100 mg/L as CaCO₃, PWQO = 0.0005 mg/L.

(6) PWQO for Cr is based on either: hexavalent chromium [Cr (VI)], PWQO = 0.001 mg/L; or trivalent chromium [Cr (III)], PWQO = 0.0089 mg/L. Conservatively, it is assumed that all Cr is present as Cr (VI).

(7) PWQO for Cu depends on hardness as follows: hardness 0–20 mg/L as CaCO₃, PWQO = 0.001 mg/L; hardness >20 mg/L as CaCO₃, PWQO = 0.005 mg/L.

(8) PWQO for Pb depends on hardness as follows: hardness <30 mg/L as CaCO₃, PWQO = 0.001 mg/L; hardness = 30–80 mg/L as CaCO₃, PWQO = 0.003 mg/L; hardness >80 mg/L as CaCO₃, PWQO = 0.005 mg/L.

Golder Associates