## TECHNICAL MEMORANDUM

## Mount Polley 2012 Biosolids Reclamation Program

Presented to: Tania Gheseger, Metro Vancouver

Presentation date: June 27, 2012

## BACKGROUND

Mount Polley Mining Corporation (Mount Polley) is an active metal mine located near Likely, BC. Metro Vancouver has retained SYLVIS Environmental to provide qualified professional services regarding the biosolids reclamation program at Mount Polley. Mount Polley has identified three areas for reclamation in 2012 at the North Bell Dump; Phase 1, Phase 2 and Phase 3 (Figure 1, Appendix Two).

This technical memorandum summarizes the overburden monitoring data collected on June 14, 2012 as well as the reclamation prescriptions for 2012. Analysis and calculations provided within are related to trace element concentrations as fertility and detailed application rate calculations were previously completed.

## **OVERBURDEN**

On June 14, 2012, Ashley Ahrens of SYLVIS collected overburden samples at the Mount Polley Mine. One sample of overburden was collected from the overburden stockpiles planned for each Phase of reclamation in 2012 (three samples in total). The results are summarized in Table 1, Appendix One.

In 1999 Permit PE 15968 ("the Permit") was issued to Mount Polley which authorizes the use of municipal biosolids to land for the purposes of mine site reclamation. The Permit authorizes the application of biosolids that are managed by the Greater Vancouver Regional District, now Metro Vancouver. The Permit requires that the biosolids quality must be equivalent or better than Agricultural Low Grade Biosolids, as specified in the "Guidelines for Disposal of Domestic Sludge under the Waste Management Act". This guideline has subsequently been replaced by the Organic Matter Recycling Regulation (OMRR). The biosolids used at Mount Polley Mine are Class A under OMRR and therefore meet the Permit requirements.

The Permit does not specify final trace element concentrations for soil. The OMRR limits for agricultural land have been included in Tables 1 and 2 of Appendix One for a reference point only for final trace element soil concentrations. The OMRR specifies limits for agricultural, urban park, residential, commercial and industrial land. The agricultural land limits were included in Tables 1 and 2 of Appendix One because these are the most stringent limits and thus the most conservative (compared to the limits included in OMRR for urban park, residential, commercial and industrial land). The industrial land limits were included in Table 2,



Appendix One, for comparative purposes only. As the agricultural standards are more conservative than industrial standards by meeting the agricultural standards means de facto the industrial standard is also met. The most restrictive limit of the site specific factors: intake of contaminated soil, toxicity to soil invertebrates and plants, livestock ingesting soil and fodder and major microbial functional impairment was included in the limits in Table 1, Appendix One.

The mix ratio of biosolids:overburden has been determined based on overburden and biosolids trace element concentrations. Using a mathematical model which accounts for the bulk density, total solids concentration, mix ratio percentage and the trace element concentrations from biosolids (biosolids data provided by Metro Vancouver), predicted reclamation mix trace element concentrations are calculated (Table 2, Appendix One). For the North Bell, the recommended mix is 1 part Annacis biosolids to 3 parts overburden by volume (v/v). The predicted trace element concentrations using the North Bell overburden average data and Metro Vancouver biosolids data is provided in Table 2, Appendix One. The North Bell pre-application substrate analysis has also been included in Table 2, Appendix One. All predicted trace element concentrations except for copper and chromium are within the agricultural (and thus the industrial) trace element limits specified in OMRR for the site specific factors: intake of contaminated soil, toxicity to soil invertebrates and plants, livestock ingesting soil and fodder and major microbial functional impairment.

Table 2, Appendix One, include the predicted and results for the mix ratio of 1:3 biosolids: overburden. The predicted Cr concentration of 59  $\mu$ g/g exceeds the agricultural limit of 50  $\mu$ g/g (for the site specific factor of major microbial functional impairment). This exceeds the agricultural limit for major microbial functional impairment of 50  $\mu$ g/g but is within the agricultural limit for human intake of contaminated soil of 100  $\mu$ g/g. The predicted Cr concentration is below the OMRR limit of 700  $\mu$ g/g for Cr for industrial land. The overburden is higher in Cr concentration than the biosolids. The overburden consists of surface soil removed from areas within the Mount Polley mine. Naturally occurring elevated background concentrations of Cr are common in the Interior of BC and above mine sites in particular resulting from parent material from which the soil and subsoil has developed.

The predicted copper concentration also exceeds the agricultural and industrial trace element limits specified in OMRR for the site specific factors: intake of contaminated soil, toxicity to soil invertebrates and plants, livestock ingesting soil and fodder and major microbial functional impairment. Mount Polley is a copper mine therefore copper is expected to be present in the soil at elevated concentrations and the predicted soil copper concentration (691  $\mu$ g/g) is lower than the pre-application copper concentration (1,103  $\mu$ g/g). The biosolids and overburden reclamation mix will result in a reduction of the final soil copper concentration. Naturally occurring elevated background concentrations of Cu are common in the Interior of BC and above mine sites in particular resulting from parent material from which the soil and subsoil has developed.



## **RECLAMATION PRESCRIPTIONS**

Mount Polley is currently working on delineating 1 ha parcels of Phase 1, Phase 2 and Phase 3 (Figure 1, Appendix Two) for 2012 reclamation. Once the parcels have been identified, the parcels will be entered into the Biosolids Application Tracking Sheet which will summarize the prescribed biosolids application rates, biosolids applied, actual volume of reclamation mix applied and percent complete.

On June 28, 2012, SYLVIS and Metro Vancouver will be present at Mount Polley to review biosolids and overburden mixing methodology and to ensure regulatory compliance. For the review of overburden mixing methodology a 1 ha parcel will be used. For a 1 ha parcel 500 m<sup>3</sup> of biosolids and 1,500 m<sup>3</sup> of overburden are required. This is based on a mix ratio of 1:3 biosolids: overburden. The *Mount Polley – Progressive Biosolids Reclamation Options* document (SYLVIS document # 855R-10) prepared for Metro Vancouver in 2011 describes the biosolids application rate determination based on permit specified application rates, trace elements and nutrients. Table 3, Appendix One is the application prescription for a 1 ha parcel of land at the North Bell Dump.



## **APPENDIX ONE – TABLES**

Constituent <sup>a</sup>	North Bell OB Phase 1	North Bell OB Phase 2	North Bell OB Phase 3	Overburden Average <sup>b</sup>	OMRR Limits – Agricultural	Units
	14-June-12	14-June-12	14-June-12		Lanu	
Available Nutrients						
Nitrate	< 2	< 2	< 2	2	-	mg/kg
Phosphorus	17	10	10	12	-	mg/kg
Potassium	117	125	99	110	-	mg/kg
Sulfate	9	4	10	8	-	mg/kg
Copper	55.4	43.8	39.0	46.1	-	mg/kg
Iron	53.6	37.7	35.4	42.2	-	mg/kg
Manganese	26.6	24.7	26.8	26.0	-	mg/kg
Zinc	1.0	1.2	1.3	1.2	-	mg/kg
Ammonium	< 0.3	< 0.3	0.4	0.3	-	mg/kg
Total Kieldahl Nitrogen	0.01	< 0.01	< 0.01	0.01	_	%
Classification						
Cation Exchange Capacity	10	10	10	10	_	meg/100 g
Organic Matter	0.66	0.10	0.18	0.31	_	% dry weight
Total Organic Carbon	0.33	0.05	0.09	0.2	_	% dry weight
Hot Water Soluble	0.00			•		ye ally height
Boron – water soluble	0.2	< 0.2	0.3	0.2	-	ua/a
Strong Acid Leachable Metals	-	-				F 5 5
Antimony	< 0.2	< 0.2	< 0.2	0.2	-	ua/a
Arsenic	12.9	14.3	17.2	14.8	25	µg/q
Barium	151	208	197	185	-	µg/g
Beryllium	0.5	0.6	0.5	0.5	-	µg/g
Cadmium	0.38	0.46	0.46	0.43	3 or 35, 9 <sup>d</sup>	µg/g
Chromium	69.8	46.2	53.0	56.3	50	µg/g
Cobalt	17.5	19.8	21.2	19.5	40	µg/g
Copper	670	780	580	680	150	µg/g
Lead	10.6	12.6	12.7	12.0	350	µg/g
Lithium	15	17	20	20	-	µg/g
Mercury	0.08	0.12	0.26	0.2	0.6	µg/g
Molybdenum	4	4	5	4	5	µg/g
Nickel	45.4	31.7	64.9	47.3	150	µg/g
Selenium	1.7	1.3	1.4	1.5	2	µg/g
Silver	0.4	0.4	0.4	0.4	-	µg/g
Strontium	130	137	160	140	-	µg/g
	0.06	0.06	0.06	0.06	-	µg/g
l in	< 1	< 1	< 1	1	-	µg/g
	90.9	103	104	99.3	-	µg/g
Zilic Developing Aggregate Property		120	119	100	200	µg/g
Mointure		10.6	10.4	10.2		0/
Rulk dopsity	10.0	10.0	2.02	10.3	-	% kg/l
Wet bulk density	2.13	2.03	2.02	2.22	_	kg/L
Texture	Sandy Loam	Sandy Loam	Sandy Loam			
Sand (% by weight)	57.0	58.0	55.6	56.9	_	50µm -2mm
Silt (% by weight)	29.0	25.0	29.4	27.8	_	2um -50um
Clay (% by weight)	14.0	17.0	15.0	15.3	-	<2µm
Soil Acidity						-p
pH	8.1	8.4	8.5	8.3	-	рН
EC (sat. paste equiv based on	0.1	0.1	0.00	0.0		
1:2)	0.29	0.26	0.29	0.28	-	as/m@25C
EC (1:2 Soil:Water)	0.14	0.13	0.14	0.14	-	dS/m @ 25C

Table 1: 2012 reclamation program Mount Polley overburden analysis.

<sup>a</sup> Each sample is a composite sample of 8 sub-samples collected from each Phase (Figure 1, Appendix Two) on June 14, 2012.

<sup>b</sup> The overburden average represents the average overburden concentrations for each parameter. If the result was < the detection limit, the detection limit was used for the purpose of calculating the average

<sup>c</sup> The results are compared to Organic Matter Recycling Regulation (OMRR). The site specific factors used were: intake of contaminated soil, toxicity to soil invertebrates and plants, livestock ingesting soil and fodder and major microbial functional impairment. These criteria are the most stringent criteria for agricultural land.

<sup>d</sup> The criteria is 3 μg/g if the crops are grown for human consumption, otherwise the criteria is 35 μg/g for the site specific factor of *intake of contaminated soil*. The criteria is 9 μg/g for the site specific factor *livestock ingesting soil and fodder*.



Constituent <sup>a</sup>	North Bell pre- application substrate analysis <sup>b</sup>	Average Overburden Quality	1 Annacis: 3 Overburden <sup>c</sup>	OMRR Limits – Agricultural Land <sup>d</sup>	OMRR Limits – Industrial Land <sup>d</sup>	Units
Arsenic	7.0	14.8	14.4	25	100	µg/g
Cadmium	0.3	0.43	0.5	3 or 35, 9 <sup>e</sup>	500	µg/g
Chromium	21.3	56.3	59	50	700	µg/g
Cobalt	15.0	19.5	19	40	300	µg/g
Copper	1,103	680	691	150	250	µg/g
Lead	8.4	12.0	16	350	2,000	µg/g
Mercury	0.096	0.2	0.27	0.6	150	µg/g
Molybdenum	0.97	4	4.72	5	40	µg/g
Nickel	15.1	47.3	47	150	500	µg/g
Selenium	0.3	1.5	1.8	2	10	µg/g
Zinc	74.9	100	171	200	600	µg/g

**Table 2:** North Bell predicted trace element concentrations.

<sup>a</sup> Each sample is a composite sample of 8 sub-samples collected from each site (Figure 1, Appendix Two) on November 10, 2010 (pre-application substrate) or June 14, 2012 (North Bell overburden).

<sup>b</sup> The North Bell pre-application substrate analysis is included to compare initial soil trace element concentrations versus predicted final reclamation mix trace element concentrations.

<sup>c</sup> The highest trace element values for each parameter for 2012 Annacis Island biosolids (up to June 26, 2012, provided by Metro Vancouver) were used in the calculations. If the result was < the detection limit, the detection limit was used for the purpose of calculating the average. These are predicted concentrations – not obtained from actual mixes.

<sup>d</sup> The results are compared to Organic Matter Recycling Regulation (OMRR). The site specific factors used were: intake of contaminated soil, toxicity to soil invertebrates and plants, livestock ingesting soil and fodder and major microbial functional impairment. These criteria are the most stringent criteria for agricultural land.

<sup>e</sup> The criteria is 3 μg/g if the crops are grown for human consumption, otherwise the criteria is 35 μg/g for the site specific factor of intake of contaminated soil. The criteria is 9 μg/g for the site specific factor livestock ingesting soil and fodder.



Area	Application Method (direct, rec mix or top dress) <sup>a</sup>	Biosolids application rate (dt/ha)	Mix ratio by volume (biosolids: overburden)	Biosolids type	Biosolids bulk density (wet t/m³)	Area (ha)	Biosolids volume required (m³)	Overburden volume required (m³)	Total rec. mix volume required	Soil depth (cm)
North Bell	Rec. mix	131.0	1:3	Annacis	0.9	1	500	1,500	2,000	20

**Table 3:** Reclamation prescriptions by area at Mount Polley for 1 ha at the North Bell Dump.

<sup>a</sup> Rec. mix refers to reclamation mix.



## **APPENDIX TWO – FIGURES**



Figure 1: Mount Polley 2012 Biosolids Application Phases.





November 27<sup>th</sup>, 2012

Ms. Tania Gheseger Metro Vancouver 10<sup>th</sup> floor, 4330 Kingsway Burnaby, BC V5H 4G8

#### Re: Mount Polley Biosolids Reclamation Program - Certification of Compliance

Dear Ms. Gheseger:

This letter is a qualified professional certification of compliance that designated biosolids transported in 2012 were applied at Mount Polley Mine in compliance with Ministry of Environment Permit PE 15968 (the Permit).

#### 2012 Review

SYLVIS was retained by Metro Vancouver to provide qualified professional expertise and recommendations on the biosolids mine reclamation program at the Mount Polley Mine as required by the Permit.

In June 2012 SYLVIS collected samples of the overburden which had been identified by Mount Polley for use in the 2012 reclamation program. SYLVIS analyzed the overburden and prepared a Technical Memorandum (dated June 27, 2012) which summarized the background, overburden quality and reclamation prescriptions. The recommended mix ratio of biosolids to overburden was 1:3 on a volume basis.

In conjunction with Mount Polley and Metro Vancouver, SYLVIS identified reclamation areas for 2012 which included Phase 1 and Phase 2 (Figure 1, enclosed). Phase 1 and 2 were sub-divided into one hectare parcels. Parcels 11 to 16 are in Phase 1 and parcels 17 to 22 are in Phase 2 (Figure 1, enclosed).

From May to July 2012, Organic Matter Recycling Regulation (OMRR) compliant Class A biosolids from Metro Vancouver's Annacis Island Wastewater Treatment Plant were transported to the Mount Polley Mine. Phase 1 (Staging Area 2) received 1,060 tonnes between May 30 – June 17<sup>th</sup> and Phase 2 (Staging Area 1) received 1,482 tonnes between June 18 – July 31<sup>st</sup> as reported by Metro Vancouver. The biosolids transportation trucks are scaled and as such the tonnages are deemed accurate. Metro Vancouver and Mount Polley Mine worked together to ensure the appropriate amount of biosolids were delivered to

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each Staging Area. SYLVIS was not involved in the hauling coordination and as such these tonnages have been verified by Metro Vancouver.

On June 28, 2012 Ashley Ahrens of SYLVIS and Tania Gheseger of Metro Vancouver conducted operational training and supervision on site at Mount Polley. The purpose was to provide guidance and training to Mount Polley equipment operators on biosolids mixing and application techniques and record keeping, to set a standard for mixing consistency, and to ensure Mount Polley reclamation staff (Gabriel Holmes) was informed of all requirements specified by SYLVIS and Metro Vancouver. Following this training day, Mount Polley proceeded with operational mixing of the biosolids reclamation mix and its subsequent placement, which concluded on October 20<sup>th</sup>, 2012.

On October 24<sup>th</sup> Ashley Ahrens returned to Mount Polley to conduct a post-application site assessment.

#### Permit Requirements

Under contract by Metro Vancouver SYLVIS is responsible to provide technical recommendations and guidance to Mount Polley for the operational aspects of the reclamation program which are undertaken by Mount Polley. Specifically, SYLVIS works with Mount Polley to conduct soil monitoring prior to reclamation activities and to ensure the biosolids application rates are in accordance with the Permit application rate criteria (maximum of 150 dt/ha).

Metro Vancouver is responsible for ensuring biosolids meet regulatory and Permit specified quality standards and providing biosolids analysis results (Section 3.1 of the Permit).

#### Application Rates and Soil Mixing

The soil mixing method recommended by SYLVIS is excavator bucket mixing. In this method the excavator combines one bucket of biosolids with three buckets of overburden, lifting and dropping the mixed pile until it is appropriately mixed. One batch of material refers to one cycle of mixing which is one bucket of biosolids combined with three bucket of overburden. The operator records each bucket of each batch on the log tracking sheets and this information is compiled in a tracking spreadsheet. This method records biosolids mixed on a volume basis. The method relies on bulk volume measurements thus there is a margin of error associated with tracking actual biosolids mixed.

The specified application rate for 2012 was 131 dt/ha which was intentionally less than the Permit maximum application rate in order to allow for a margin of error attributed to operational logistics while remaining compliant with the Permit specified application rate maximum.

To ensure accurate application rates, each reclamation site is delineated into one hectare parcels. Once the appropriate volume of reclamation mix is fabricated for a one hectare parcel, it is set aside and labeled with spray paint with the parcel number where it will be placed. Once the mixing is complete each pile is placed within the appropriate parcel. This method enables the operator to evenly place reclamation mix within each one hectare parcel. Each parcel is delineated with stakes and the mix is placed at the top of the parcel in a windrow. The dozer then evenly spreads the windrow from the top of the slope to the bottom.



#### **Biosolids Application**

The biosolids were mixed from June 28<sup>th</sup> to October 3<sup>rd</sup> and applied to the mine site from September 7<sup>th</sup> to October 20<sup>th</sup> using a bulldozer. The areas reclaimed in 2012 at the Mount Polley site total 5.1 ha. The Technical Memorandum specified an application rate of 131 dry tonnes per hectare for the North Bell reclamation areas (Phases 1 and 2). The actual application rates by area are provided in Table 2, below.

Phase	Estimated Biosolids Applied (dt)	Area (ha)	Specified Application Rate (dt/ha)	Actual Application Rate (dt/ha)	Permit Application Rate Limit
Phase 1 (Staging Area 2)	308	2.1	131	146.7	150
Phase 2 (Staging Area 1)	433	3.0	131	144.4	150

Table 1	1:	Biosolids	application	rates.
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The previously specified biosolids bulk density was 0.9 t/m<sup>3</sup>. Based on the biosolids mixing and application tracking this bulk density has been proven to be low. The actual bulk density calculated based on biosolids delivered versus biosolids mixed (according to the biosolids mixing and application tracking) is 0.96 t/m<sup>3</sup>. This bulk density value is more accurate since the biosolids deliveries were scaled so the delivered tonnage is known. The bulk density of 0.96 t/m<sup>3</sup> was used in calculating the actual application rate in Table 1.

The actual application rates are slightly higher than prescribed rates, as the final surveys of the reclamation mix placement areas were slightly smaller than the planned areas (Figure 2, enclosed) and the bulk density values were updated. The final application rates remain within the Permit limits.

#### Site Inspection

The 2012 biosolids reclamation areas were inspected on October 24<sup>th</sup>. A thin layer of snow had fallen on the site. Holes were dug to clear the snow and to assess reclamation mix distribution and depth throughout both reclamation areas. Photographs from this site inspection are included in Photographs 1 through 9, enclosed.

#### Phase 1

The reclamation mix mixing, record keeping, and methodology for the biosolids mix placement for Phase 1 was completed in accordance with recommendations provided by SYLVIS and the requirements of the Permit. The reclamation mix placement area deviated slightly from SYLVIS' recommendations. SYLVIS recommended the reclamation mix be distributed uniformly over Phase 1. Based on the final surveys provided by Mount Polley, the reclamation mix was placed over 2.1 ha instead of the previously identified 2.2 ha. The bulk density was also recalculated to 0.96 t/m<sup>3</sup>. The reduced area and recalculated bulk density resulted in a slightly higher application rate than was originally specified. The reclamation mix was evenly distributed on the 2.1 ha portion of slope and the application rate (146.7 dt/ha) is in compliance with the Permit



limit. The reclamation mix was uniformly mixed and homogenous. The reclamation mix was placed within Phase 1 from top to bottom.

#### Phase 2

The reclamation mix mixing and record keeping for Phase 2 was completed in accordance with recommendations provided by SYLVIS and the requirements of the Permit. The reclamation

mix placement area deviated slightly from SYLVIS' recommendations. SYLVIS recommended the reclamation mix be distributed uniformly over Phase 1. Based on the final surveys provided by Mount Polley, the reclamation mix was placed over 3.0 ha instead of the previously identified 3.1 ha. The bulk density was also recalculated to 0.96 t/m<sup>3</sup>. The reduced area and recalculated bulk density resulted in a slightly higher application rate than was originally specified. The reclamation mix was evenly distributed on the 3.0 ha portion of slope and the application rate (144.4 dt/ha) is in compliance with the Permit limit. The reclamation mix was uniformly mixed and homogenous. Phase 2 was contoured from top to bottom and the reclamation mix was placed on the slope using a dozer. The reclamation mix was then horizontally windrowed (Photograph 9, enclosed).

Horizontal windrowing refers to the placement of reclamation mix using a dozer. The reclamation mix was placed on the northern boundary of each parcel. Beginning at the bottom of the slope, the reclamation mix was pushed horizontally across the slope such that a portion of the reclamation mix was allowed to slough off the downhill side of the dozer blade. This created horizontal windrows along the slope. The result of this operation is a rough, mounded surface with minimal compaction. Horizontal windrowing enhances soil-relief, minimizes the potential for erosion, provides micro-sites for vegetation establishment, increases diversity of the site and increases soil water holding capacity.

#### Closure

The 2012 biosolids applications at Mount Polley Mine were completed in accordance with the recommendations provided by SYLVIS and the application rate requirements of the Permit. If you or your associates have any questions concerning the contents of this Certification of Compliance letter, please contact me at your convenience.

Yours truly,

Ashley Ahrens, BSc, RPBio Project Manager - Residuals Encl: Notice of Limitations Figures Photographs



#### **Certification of Compliance**

I, Ashley Ahrens confirm by signature and seal below that to the best of my knowledge the biosolids were land applied according to the recommendations provided by SYLVIS. These applications are considered a beneficial use of the resource and to the best of my knowledge comply with Ministry of Environment Permit 15968.

This certification is valid only if it bears the original signature and seal of the author.

**Professional Seal** 

Signature:

Date:

Nou. 2 2



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#### Mount Polley Certification of Compliance

#### Notice of Limitations

SYLVIS has been contracted to conduct biosolids processing and application oversight and to prepare a Technical Memorandum and Certification of Compliance (herein referred to as "the documents") for the purpose of a biosolids application to soil. The documents are limited to the specific site, development and design objectives for reclamation of land at Mount Polley in Likely, BC.

The documents are intended for use by persons or companies familiar with biosolids and their management, real property such as the subject property, and persons or companies that are familiar with land use terminology, methodology, and reporting. Any questions about the documents, their use, terms, scope, research or the analytical methodology used should be directed to SYLVIS.

The documents must not be used partially but only in the context in which it are presented. SYLVIS cannot monitor changes to the documents once they leave their office, nor can they prevent changes, additions or deletions in copies of their documents. SYLVIS recommends that people intending to rely on their report do so only after reading all applicable documents pertaining to the reclamation program in their entirety.

The client (Metro Vancouver) is the only parties who may rely on the opinions expressed in the reports. As the documents were prepared exclusively for Metro Vancouver, the documents are to be used only for the intended use stated herein. No one else may rely on the documents without the written consent of the author, which SYLVIS may not provide retroactively. SYLVIS expressly denies any legal liability for unauthorized reliance and for any other use.

Possessions of the documents, or copies of the documents, do not carry with them the right to reproduction or publication, in full or in part. No one other than Metro Vancouver may use the documents for any purpose without the written consent of SYLVIS. Exceptions exist when required by due process of law, or if subject to confidential review by the British Columbia Ministry of Environment.

The information contained in the documents and the basis for the opinions and estimates may rely upon written and verbal information obtained from a variety of sources that SYLVIS considers reliable. The documents are not prepared for court purposes or for arbitration, as such some of the information set out in the documents may not be fully documented or confirmed by reference to primary sources. Information provided by Metro Vancouver or Mount Polley may not be verified with other parties unless so indicated in the documents. Any information provided to SYLVIS by Metro Vancouver or Mount Polley is believed to be correct and reliable. General market and environmental information is derived from various public sources, as well as from various individuals believed to be knowledgeable in these matters. Information from others is believed to be correct, but accuracy cannot be guaranteed. The veracity of information provided to SYLVIS by others will be accepted unless SYLVIS has specific reason for doubt, in which case further confirmation is usually sought. Soil quality predictions are predicated upon laboratory analysis of the soil and biosolids, and SYLVIS cannot assume responsibility for the accuracy of such analyses where the basis is third party sources. SYLVIS has included plans and sketches for visual reference only and SYLVIS cannot assume responsibility for the accuracy of such analyses.

SYLVIS has not and will not complete technical investigations such as:

- · Contaminated Site Assessments,
- · Biosolids Analysis,
- Biosolids Transportation Records,
- · Biosolids Application Audit,
- · Biosolids Record Keeping Audit,
- Hydrogeological Assessments, and
- Terrain Stability Assessments,

SYLVIS has been retained to provide Qualified Professional expertise in the preparation of the documents and all previous biosolids actions on the Mount Polley mine site, including research and demonstration trials, previous and ongoing biosolids stockpiles and previous biosolids applications are outside of SYLVIS responsibility and scope.



SYLVIS will undertake no investigation with the British Columbia Ministry of Environment or any other government regulatory agency except as expressly described in the documents. The subject property must comply with such government regulations. Any non-compliance may affect the documents. Confirming compliance could require further investigations.

Unless otherwise stated in this document, the existence of any contaminants or hazardous materials, which may or may not be present on the property, is not assessed. SYLVIS will neither source hazardous materials or contaminated land studies nor commission such a study. SYLVIS has no knowledge of the existence of such materials on or in the property. SYLVIS is not retained to detect such substances, the presence of which may materially affect the value of the property. No responsibility is assumed by SYLVIS for any such conditions, or for any specialized expertise or engineering knowledge required to discover them or to remove or eliminate them.

Attendance at any legal proceedings with respect to the documents, and any fees and expenses for preparation and attendance, are to be agreed upon in advance. However, neither this nor any other of these limiting conditions is an attempt to limit the use that might be made of the documents should it properly become evidence in a judicial proceeding. In such a case, it is the judicial body that will decide the use of the documents that best serves the administration of justice.





**Figure 1:** Aerial photograph of the North Bell sites at the Mount Polley mine site showing planned staging areas, reclamation phases and overburden stockpiles.





**Figure 2:** Aerial photograph of the North Bell sites at the Mount Polley mine site showing final 2012 reclamation areas.





**Photograph 1:** Soil pits were dug to reveal the reclamation mix in Phase 1. (October 2012)



Photograph 2: Phase 1 was applied and contoured parallel to the slope similar to the 2011 reclamation program. (October 2012)



Photograph 3: The visible reclamation mix was uniformly mixed and evenly distributed over Phase 1. (October 2012)





**Photograph 4:** A close up of the placed reclamation mix in Phase 1. (October 2012)



Photograph 5: Phase 2 was contoured parallel to the slope as with Phase 1. The reclamation mix was then applied in windrows perpendicular to the slope. (October 2012)



Photograph 6: The reclamation mix was uniformly mixed and evenly distributed over Phase 2. (October 2012)





Photograph 7: Looking south across the Phase 2 area from the north end of Phase 2. (October 2012)



Photograph 8: The reclamation mix was uniformly mixed and distributed in Phase 2. (October 2012)



Photograph 9: Looking west across Phase 2 from the east side of Phase 2. (October 2012)



#### **Report Transmission Cover Page**



Bill To:	Sylvis Environmental	Project:		Lot ID:	876213
Report To:	Sylvis Environmental	ID:		Control Number:	6781
	427 Seventh Street	Name:	OB Monitoring	Date Received:	Jun 15. 2012
	New Westminster, BC, Canada	Location:	MT Polley	Date Reported:	Jun 26, 2012
	V3M 3L2	LSD:		Report Number:	1744599
Attn:	Vanessa Menunzio	P.O.:			
Sampled By:	AA	Acct code:			
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Contact & Affiliation	Address	Delivery Commitments
Ashley Ahrens Sylvis Environmental	427 Seventh Street New Westminster, British Columbia V3M 3L2 Phone: (604) 777-9788 Fax: (604) 777-9791 Email: aahrens@sylvis.com	On [Report Approval] send (Test Report) by Email - Single Report
Results Sylvis Environmental	427 Seventh Street New Westminster, British Columbia V3M 3L2 Phone: (604) 777-9788 Fax: (604) 777-9791 Email: datamanager@sylvis.com	On [Lot Verification] send (COA) by Email - Single Report On [Report Approval] send (COC, Test Report) by Email - Merge Reports On [Lot Approval and Final Test Report Approval] send (Invoice) by Email - Single Report

#### Notes To Clients:

• TKN analysis was performed by a subcontract laboratory. See attached4 page certificate of analysis 1212303.

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#### Sample Custody



Bill To: Report To:	Sylvis Environmental Sylvis Environmental 427 Seventh Street New Westminster, BC, Canada V3M 3L2	Project: ID: Name: Location: LSD:	OB Monitoring MT Polley	Lot ID: Control Number: Date Received: Date Reported: Report Number:	876213 6781 Jun 15, 2012 Jun 26, 2012 1744599
Attn:	Vanessa Menunzio	P.O.:			
Sampled By:	AA	Acct code:			
Company:					

## Sample Disposal Date: July 26, 2012

All samples will be stored until this date unless other instructions are received. Please indicate other requirements below and return this form to the address or fax number on the top of this page.

Extend Sample Storage Until(MM/DD/YY)The following charges apply to extended sample storage:<br/>Storage for an additional 30 days\$ 2.50 per sample<br/>\$ 5.00 per sample<br/>\$ 5.00 per sample<br/>\$ 7.50 per sampleStorage for an additional 90 days\$ 7.50 per sample

Return Sample, collect	xt, to the address below via:		
Greyhound			
Purolator			
Other (specify)			_
		Name	
		Company	
		Address	

Phone Fax

Signature

Terms and Conditions: www.exova.ca/terms&conditions

### **Analytical Report**



Bill To: Report To:	Sylvis Environmental Sylvis Environmental 427 Seventh Street New Westminster, BC, Canada V3M 3L2	Project: ID: Name: Location: LSD:	OB Monitoring MT Polley	Lot ID: Control Number: Date Received: Date Reported: Report Number:	<b>876213</b> 6781 Jun 15, 2012 Jun 26, 2012
Attn:	Vanessa Menunzio	P.O.:		Report Number.	11 44000
Sampled By:	AA	Acct code:			
Company:					

		<b>Reference Number</b>	876213-1	876213-2	876213-3	
		Sample Date	Jun 14, 2012	Jun 14, 2012	Jun 14, 2012	
		Sample Time	13:00	13:15	13:30	
		Sample Location				
	:	Sample Description	North Bellob Sample	North Bellob Sample	North Bellob Sample	
		Matrix	Soil	2 Soil	3 Soil	
Analyte		Units	Results	Results	Results	Nominal Detection
Available Nutrients						Linit
Nitrate - N	Available	ug/g	<2	<2	<2	2
Phosphorus	Available	ug/g	17	10	10	5
Potassium	Available	ug/g	117	125	99	25
Sulfate-S	Available	mg/kg	9	4	10	1
Copper	Available	mg/kg	55.4	43.8	39.0	0.1
Iron	Available	mg/kg	53.6	37.7	35.4	2
Manganese	Available	mg/kg	26.6	24.7	26.8	0.1
Zinc	Available	mg/kg	1.0	1.2	1.3	0.5
Ammonium - N	Available-dry basis	ug/g	<0.3	<0.3	0.4	0.3
Classification						
Cation Exchange Capacity		meq/100g	10	10	10	4
Organic Matter	Calculated Value	%	0.66	0.10	0.18	0.04
Carbon	Total Organic	%	0.33	0.05	0.09	0.04
Hot Water Soluble						
Boron	Hot Water Soluble	mg/kg	0.2	<0.2	0.3	0.2
Metals Strong Acid Digesti	ion					
Mercury	Strong Acid Extractal	ble mg/kg	0.08	0.12	0.26	0.01
Strong Acid Leachable Me	tals					
Antimony	Strong Acid Extractal	ble ug/g	<0.2	<0.2	<0.2	0.2
Arsenic	Strong Acid Extractal	ble ug/g	12.9	14.3	17.2	0.2
Barium	Strong Acid Extractal	ble ug/g	151	208	197	1
Beryllium	Strong Acid Extractal	ble ug/g	0.5	0.6	0.5	0.1
Cadmium	Strong Acid Extractal	ble ug/g	0.38	0.46	0.46	0.01
Chromium	Strong Acid Extractal	ble ug/g	69.8	46.2	53.0	0.5
Cobalt	Strong Acid Extractal	ble ug/g	17.5	19.8	21.2	0.1
Copper	Strong Acid Extractal	ble ug/g	670	780	580	1
Lead	Strong Acid Extractal	ble ug/g	10.6	12.6	12.7	0.1
Lithium	Strong Acid Extractal	ble ug/g	15	17	20	1
Molybdenum	Strong Acid Extractal	ble ug/g	4	4	5	1
Nickel	Strong Acid Extractal	ble ug/g	45.4	31.7	64.9	0.5
Selenium	Strong Acid Extractal	ble ug/g	1.7	1.3	1.4	0.3
Silver	Strong Acid Extractal	ble ug/g	0.4	0.4	0.4	0.1
Strontium	Strong Acid Extractal	ble ug/g	130	137	160	1
Thallium	Strong Acid Extractal	ble ug/g	0.06	0.06	0.06	0.05

<1

0.5

ug/g

ug/g

<1

0.5

<1

0.6

1

0.5

Terms and Conditions: www.exova.ca/terms&conditions

Strong Acid Extractable

Strong Acid Extractable

Tin

Uranium

#### **Analytical Report**



Report To:       Sylvis Environmental       ID:         427 Seventh Street       Name:       OB Monitoring         New Westminster, BC, Canada       Location:       MT Polley         V3M 3L2       LSD:         Attn:       Vanessa Menunzio       P.O.:         Sampled By:       AA       Acct code:	Control Number: Date Received: Date Reported: Report Number:	6781 Jun 15, 2012 Jun 26, 2012 1744599	
--	---	---	--

Company:

	Ref	erence Number	876213-1	876213-2	876213-3	
		Sample Date	Jun 14, 2012	Jun 14, 2012	Jun 14, 2012	
		Sample Time	13:00	13:15	13:30	
	S	ample Location				
	Sam	ple Description	North Bellob Sample	North Bellob Sample	North Bellob Sample	
			1	2	3	
		Matrix	Soil	Soil	Soil	
Analyte		Units	Results	Results	Results	Nominal Detection Limit
Strong Acid Leachable M	letals - Continued					
Vanadium	Strong Acid Extractable	ug/g	90.9	103	104	0.1
Zinc	Strong Acid Extractable	ug/g	100	120	119	1
Physical and Aggregate	Properties					
Moisture	Wet Weight @ 105°C	%	10.0	10.6	10.4	0.1
Texture			Sandy Loam	Sandy Loam	Sandy Loam	
Sand	50 µm - 2 mm	% by weight	57.0	58.0	55.6	0.1
Silt	2 µm - 50 µm	% by weight	29.0	25.0	29.4	0.1
Clay	<2 µm	% by weight	14.0	17.0	15.0	0.1
Bulk Density	Apparent	kg/L	2.13	1.82	2.02	
Wet Bulk Density	Apparent	kg/L	2.37	2.03	2.25	
Soil Acidity						
рН	1:2 Soil:Water	pН	8.1	8.4	8.5	
Electrical Conductivity	Sat. Paste equiv based on 1:2	dS/m at 25 C	0.29	0.26	0.29	0.02
Electrical Conductivity	1:2 Soil:Water	dS/m at 25 C	0.14	0.13	0.14	0.01

Mathier So nnea Approved by:

Mathieu Simoneau Operations Manager

#### **Methodology and Notes**



Bill To:	Sylvis Environmental	Project:		Lot ID:	876213
Report To:	Sylvis Environmental	ID:		Control Number:	6781
	427 Seventh Street	Name:	OB Monitoring	Date Received:	Jun 15, 2012
	New Westminster, BC, Canada	Location:	MT Polley	Date Reported:	Jun 26, 2012
	V3M 3L2	LSD:		Report Number:	1744599
Attn:	Vanessa Menunzio	P.O.:			
Sampled By:	AA	Acct code:			
Company:					

#### Method of Analysis

Method Name	Reference		Method	Date Analysis Started	Location
Ammonium-N (Extractable) in Soil	Carter	*	Extraction of NO3-N and NH4-N with 2.0 M KCl, 6.2	18-Jun-12	Exova Edmonton
Boron in general soil	McKeague	*	Hot Water Soluble Boron - Azomethine -H Method, 4.61	18-Jun-12	Exova Edmonton
Bulk Density of soil	Agronomy No 9, Part 1	*	Core Method, 13-2	18-Jun-12	Exova Edmonton
Cation Exchange Capacity (CEC) - Ammonium	McKeague	*	CEC and Exchangeable Cations by NH4OAc at pH 7, 3.32	18-Jun-12	Exova Edmonton
Mercury (Hot Block) in Soil	US EPA	*	Determination of Hg in Sediment by Cold Vapor Atomic Absorption Spec, 245.5	18-Jun-12	Exova Edmonton
Metals ICP-MS (BCMOE SALM) in soil	B.C.M.O.E	*	Strong Acid Leachable Metals (SALM) in Soil, V 1.0, SALM	18-Jun-12	Exova Edmonton
Micronutrients in General Soil	McKeague	*	DTPA-TEA Extractable Elements, 4.65	18-Jun-12	Exova Edmonton
Moisture	Carter	*	Gravimetric Method with Oven Drying, 51.2	18-Jun-12	Exova Edmonton
Nutrients in General Soil	Comm. Soil Sci. Pl. Anal.	*	Modified Kelowna Soil Test, Vol 26, 1995	18-Jun-12	Exova Edmonton
Particle Size Analysis - GS	Carter	*	Hydrometer Method, 55.3	18-Jun-12	Exova Edmonton
pH and Conductivity in general soil 1:2	McKeague	*	1:2 Soil:Water Ratio, 4.12	18-Jun-12	Exova Edmonton
Sulfate in General Soil	McKeague	*	Sulfate Extractable by 0.1M CaCl2, 4.47	18-Jun-12	Exova Edmonton
Total Carbon, Nitrogen & Sulfur by Leco Combustion	SSSA Book Series 5	*	Total Carbon, Organic Carbon, and Organic Matter, Ch 34	20-Jun-12	Exova Surrey
		*	Reference Method Modified		

#### References

McKeague	Manual on Soil Sampling and Methods of Analysis
Carter	Soil Sampling and Methods of Analysis.
Comm. Soil Sci. Pl.	Communications in Soil Science and Plant Analysis
B.C.M.O.E	B.C. Ministry of Environment
US EPA	US Environmental Protection Agency Test Methods
Agronomy No 9, Part	Methods of Soil Analysis, Part 1

#### Comments:

• TKN analysis was performed by a subcontract laboratory. See attached4 page certificate of analysis 1212303.

#### **Methodology and Notes**



Bill To:	Sylvis Environmental	Project:		Lot ID:	876213
Report To:	Sylvis Environmental	ID:		Control Number:	6781
	427 Seventh Street	Name:	OB Monitoring	Date Received:	Jun 15. 2012
	New Westminster, BC, Canada	Location:	MT Polley	Date Reported:	Jun 26. 2012
	V3M 3L2	LSD:		Report Number:	1744599
Attn:	Vanessa Menunzio	P.O.:			
Sampled By:	AA	Acct code:			
Company:					

Please direct any inquiries regarding this report to our Client Services group. Results relate only to samples as submitted. The test report shall not be reproduced except in full, without the written approval of the laboratory.



Client:	Exova Canada Inc. (Surrey)			
	#104, 19575 - 55A Avenue		Report Number:	1212303
	Surrey, BC		Date Submitted:	2012-06-19
	V3S 8P8		Date Reported:	2012-06-26
Attention:	Exova Surrey		Project:	876213
PO#:	512949		COC #:	753866
Invoice to:	Exova Canada Inc. (Surrey)	Page 1 of 4		

#### Dear Exova Surrey:

Please find attached the analytical results for your samples. If you have any questions regarding this report, please do not hesitate to call (613-727-5692).

**Report Comments:** 

APPROVAL:

Lorna Wilson Inorganic Laboratory Supervisor

Exova (Ottawa) is certified and accredited for specific parameters by:

CALA, Canadian Association for Laboratory Accreditation (to ISO 17025), OMAF, Ontario Ministry of Agriculture, Food and Rural Affairs (for farm soils), Licensed by Ontario MOE for specific tests in drinking water.

Please note: Field data, where presented on the report, has been provided by the client and is presented for informational purposes only.



## **EXOVA** OTTAWA

Client:	Exova Canada Inc. (Surrey) #104, 19575 - 55A Avenue
	Surrey, BC
	V3S 8P8
Attention:	Exova Surrey
PO#:	512949
Invoice to:	Exova Canada Inc. (Surrey)

Report Number:	1212303
Date Submitted:	2012-06-19
Date Reported:	2012-06-26
Project:	876213
COC #:	753866

Group	Analyte	MRL	Units	Lab I.D. Sample Matrix Sample Type Sampling Date Sample I.D. <b>Guideline</b>	965035 Soil 2012-06-14 876213-1
Nutrients	Total Kjeldahl Nitrogen	0.01	%		0.01

				Lab I.D. Sample Matrix Sample Type Sampling Date Sample I.D.	965036 Soil 2012-06-14 876213-2	965037 Soil 2012-06-14 876213-3
Group	Analyte	MRL	Units	Guideline		
Nutrients	Total Kjeldahl Nitrogen	0.01	%		<0.01	<0.01

Guideline =

\* = Guideline Exceedence

Results relate only to the parameters tested on the samples submitted. Methods references and/or additional QA/QC information available on request.





Exova Canada Inc. (Surrey)
#104, 19575 - 55A Avenue
Surrey, BC
V3S 8P8
Exova Surrey
512949
Exova Canada Inc. (Surrey)

Report Number:	1212303
Date Submitted:	2012-06-19
Date Reported:	2012-06-26
Project:	876213
COC #:	753866

#### QC Summary

Analyte				Blank		QC % Rec	QC Limits
Run No 234002	Analysis Date	2012-0	)6-25	Method	C	SM4500-Norg-B	
Total Kjeldahl Nitrogen				<0.01 %		98	95-105

Guideline =

\* = Guideline Exceedence

Results relate only to the parameters tested on the samples submitted. Methods references and/or additional QA/QC information available on request. MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective.



Client:Exova Canada Inc. (Surrey)<br/>#104, 19575 - 55A Avenue<br/>Surrey, BC<br/>V3S 8P8Attention:Exova SurreyPO#:512949Invoice to:Exova Canada Inc. (Surrey)

 Report Number:
 1212303

 Date Submitted:
 2012-06-19

 Date Reported:
 2012-06-26

 Project:
 876213

 COC #:
 753866

#### Sample Comment Summary

Sample ID: 965035 876213-1 Samples were analysed as received and reported on dried sample basis.

Guideline =

\* = Guideline Exceedence

Results relate only to the parameters tested on the samples submitted. Methods references and/or additional QA/QC information available on request. MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective.



MOUNT POLLEY MINING CORP. ATTN: Ron Martel PO Box 12 Likely BC V0L 1N0

Date Received: 08-JUN-12 Report Date: 28-JUN-12 15:49 (MT) Version: FINAL

Client Phone: 250-790-2215

# **Certificate of Analysis**

L1159533 Lab Work Order #:

NOT SUBMITTED

Job Reference: C of C Numbers: Legal Site Desc:

Project P.O. #:

Can Dang Senior Account Manager

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## ALS ENVIRONMENTAL ANALYTICAL REPORT

L1159533 CONTD.... PAGE 2 of 4 28-JUN-12 15:49 (MT) Version: FINAL

	Sample ID Description Sampled Date Sampled Time Client ID	L1159533-1 OTHER 07-JUN-12 10:00 COMPOSITE BIOSOLIDS SAMPLE		
Grouping	Analyte			
SOIL				
Leachable Anions & Nutrients	Total Kjeldahl Nitrogen (%)	0.511		
Plant Available Nutrients	Available Ammonium-N (mg/kg)	425 DLM		
	Available Nitrate-N (mg/kg)	7.8 DLM		
	Available Nitrite-N (mg/kg)	DLM <0.80		
	Available Phosphate-P (mg/kg)	292		
	Available Sulfate-S (mg/kg)	105		
Bacteriological Tests	Coliform Bacteria - Fecal (MPN/g)	<2		
	Salmonella	Presumptive Positive		
	Salmonella Confirm	Not Isolated		

\* Please refer to the Reference Information section for an explanation of any qualifiers detected.

# MPMC Biosolids Application - 2012 Update

