APPENDIX C SURFACE WATER

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1.0 OVERVIEW AND OBJECTIVE

The hydrology of the CGC Inc. – Windsor Plant property (Site), located in Hants County, Nova Scotia, has been studied using state-of-the art computer modeling as described in this Appendix. This hydrologic project had the objective of determining the potential effect of the creation of a surface mine on the total quantity of surface water runoff within the study area.

A hydrologic model was assembled and used to complete this preliminary estimate of total runoff from the Site and adjacent areas. Although the model calculates peak discharge in each watershed within the study area, under a range of possible conditions, the emphasis of this report is on the total volume of runoff generated by the various watersheds that make up the Site.

The following sections of this appendix describe the methodology, rationale, and details of the hydrological study, including the model used, input data and assumptions, resulting calculations and outputs and comparison to existing measured discharge data. Should the model tool be used in the future for more detailed analyses, recommendations for additional field work and modeling are also are included.

1.1 HYDROLOGIC CONTEXT - SITE DESCRIPTION

The Site is located on a peninsula which is bounded on the north by the Kennetcook River and on the south by the St. Croix River, both of which flow into the Avon River which forms the western boundary of the peninsula. The eastern limit of the hydrologic study area was taken as a height-of-land, which forms a drainage divide east of the existing mine. From south to north the peninsula and hydrologic study area is about five km and east-to-west the hydrologic study area on this peninsula is about 10 km.

The hydrologic study area is extensive, covering an area many times the Site proper, extending to shorelines on the north, east and south and to a height of land some distance to the east of the existing mine. The hydrologic study area is consistent with the groundwater study area.

This peninsula is hydrologically complex in that the area is topographically rough and encompasses six independent watershed areas consisting of a total of 41 sub-watersheds. The area could be even further sub-divided into more identifiable runoff catchments, but 41 sub-watersheds was considered a sufficient level of precision consistent with the level of known detail and for the purpose of estimating total runoff volumes. Each of the 41 sub-watersheds corresponds to a single creek or a major branch of a creek.

In summary, the topography of the peninsula consists of an area of higher elevation in the middle surrounded by low lying lands, with creeks running from the middle portion of the peninsula out to the three surrounding rivers, as shown on Figure C.1. The creeks are mostly ephemeral, flowing in immediate response to rain events or snow melt. The Site proper is described elsewhere in detail, but in a hydrological context the Site is proposed to include an area approximately in the middle of the peninsula running east-west just over one km and north-south about 3.5 to 2 km. The proposed Site is in an area with few streams, intersecting the headwaters of only four of the 41 watersheds, of which three of those four are ephemeral.

The proposed Site is predominantly forested land in various stages of regeneration from historical timber harvesting activities (Figure C.2). Some wetlands are present within the proposed site and are described in Section 4.4 of the Focus Report. No agricultural lands or developed areas are present in the proposed Site. The remaining portion of the hydrologic study area consists primarily of agricultural areas, various water features (*e.g.*, wetlands, watercourses and ponds), developed areas (*e.g.*, residential and industrial), the existing Miller's Creek mine and roads (Figure C.2). Each land use type is reflected in the model input parameters as discussed below.

2.0 HYDROLOGIC COMPUTER MODEL PROGRAM

The computer model HEC-HMS (Hydrologic Engineering Center - Hydrologic Modeling System) was selected to generate runoff hydrographs for the Site because of its particular applicability to rural design settings and potential interactions with groundwater. HEC-HMS is a computer program developed by the Hydrologic Engineering Center of the U.S. Army Corp of Engineers. The program simulates how precipitation generates runoff and how the resulting runoff as overland flow and in-stream discharge is routed through the watershed and down stream networks and eventually off site.

HMS uses recognized hydrologic and hydraulic methods to calculate and route runoff hydrographs. The model requires input of a hyetograph, topographic features (catchment area, slope, roughness), soil parameters (rainfall, moisture condition, infiltration capacity), ground cover conditions and drainage paths.

In order to streamline HMS modeling, HEC-GeoHMS (Geospatial Hydrologic Modeling) model extension was used with ArcView Geographic Information System. HEC-GeoHMS uses ArcView and Spatial Analyst to develop hydrologic modelling inputs. By analyzing digital terrain information, HEC-GeoHMS recognizes drainage paths and watershed boundaries and converts that information into a hydrologic data structure including the HEC-HMS basin model, physical watershed and stream characteristics, and a background map file. This represents the watershed response to precipitation.

The data inputs include a stream network and Digital Elevation Map (DEM). For this study a two-meter DEM (source: LaserMap Image Plus, LIDAR April 2006) was used for HEC-GeoHMS model to generate stream network and subcatchments. A 5 metre contour map and the river network (source: Service Nova Scotia & Municipal Relations, Nova Scotia Topographic Database, 5-m contour map) were used as reference to verify the HEC-GeoHMS- generated stream network and the subcatchment delineation.

As automatically generated, the Site was delineated into a stream network consisting of six watersheds with 41 subcatchments, 14 reaches, 17 junctions and 16 outlets. The watershed and subcatchment delineation is presented in Figure C.3.

It should be noted that these watershed catchments are different from catchments previously defined in the EARD. The EARD watershed catchment map boundary had been arbitrarily based on the surrounding roads (Belmont Road, Avondale Road and the Ferry Road loop) whereas this hydrologic area study boundary was based on the hydrologic boundary of the three rivers and the height-of-land to the east.

As well, this hydrologic study examined the staged development of the mine and associated stockpiles, therefore additional sets of sub-catchments were delineated.

The comparison between the catchments based on the aerial disturbance analysis and the watersheds and sub-catchments used in this hydrologic study is illustrated in Figure C.4.

The hydrologic geographic delineation from HEC-GeoHMS was then imported into the Hydrologic Modelling System, HEC-HMS.

2.1 HYDROLOGIC MODEL DATA INPUTS

Hydrologic modeling requires input parameters including areas, slopes, length of flow path, estimates of abstraction and infiltration and pervious/impervious areas for each sub-catchment. Precipitation information, either as data for actual historical storm events or in the form of synthetic event estimates, is also used.

Precipitation

The precipitation information used in this hydrologic study was from both single-event storms and historical precipitation data.

To show response to design-return-period events, single-event synthetic design storm events were used in this study. The synthetic design storms were developed by applying the Soil Conservation Service (SCS) Type II rainfall distribution to known rainfall depths for the 24-hour duration 2-year, 5-year, 10-year, 25-year, 50-year and 100-year return periods (Rainfall Frequency Atlas of Canada). A 5-minute time step was used. The synthetic design storms parameters used in the model are listed in Table C.1.

The historical data was applied to a continuous model. Two local weather gauge stations were available to provide the historical precipitation data (Environment Canada, July 2009). The closest gauge station to the Site is Avondale gauge station, which is located in the project area. Daily precipitation data exists from May 1st 1993 to February 28th 2006. Another close gauge station is the Kentville gauge station, located about 30 km from the project area, which has daily precipitation data from 1993 to 2009. In order to compare with the measured flow data, which was measured from 2005 to 2009, the Kentville precipitation data from January 1, 2005 to July 8, 2009 was used as input data to the HEC-HMS model continuous simulation. The simulation time step was set to one day in this model simulation.

Watersheds and Sub-catchments

As described above, the hydrologic study area was divided into six watersheds with a total 41 sub-catchments. Six watersheds were identified as they individually drain into the surrounding rivers and eventually to the Bay of Fundy.

To more accurately define the hydrology of the area and the Site, the six watersheds were further sub-divided into sub-catchments. Forty-one sub-catchments were delineated, although the rough topography of the area could have resulted in many more sub-catchments. However, both the study objective and the level of detail available do not support further delineation.

Sub-catchment parameters

Some parameters were derived directly from the geography of the hydrologic study area from HEC-GeoHMS. Sub-catchment area, longest flow path, and average slope of the catchments were calculated results.

Land use maps were used to calculate the relative percentage of impervious area, which was derived by clipping subcatchment polygons, derived from HEC-GeoHMS using ArcView tools. The impervious area in this study is roads and developed areas as shown on Figure C.2.

Infiltration and abstraction typically are parameters that are used to calibrate a hydrologic model. Typical values can be assumed from previously calibrated models in similar areas (soils, land-disturbance filling and/or excavation, etc.) Infiltration and abstraction, typically, are considered as "losses" to the surface water system, especially if modeling single-event short durations (e.g. 24 hours). In this case, recovery of groundwater infiltration, as contributing to total stream flow volumes, was considered as potentially important. Also, because the Site was known anecdotally as being a "flashy runoff" site, the "filling" of the initial infiltration would be significant. As such, infiltration and abstraction were modeled using a deficit-and-constant-loss approach in computing runoff volumes and the cumulative losses. The deficit-and-constant-loss approach assumes initial loss capability which can "recover" after a period of no rainfall. The initial loss specifies the quantity of precipitation that will infiltrate or be stored in the sub-catchment before surface runoff begins. To use this model the initial loss, a constant infiltration rate and a recovery rate are input. In absence of specific site data, these parameters were estimated based on suggested values for specific soil types from the HEC-HMS User Manual (USACE, 2000).

Summaries of the sub-catchment parameters, for existing conditions, are listed in Table C.2a to Table C.2f, for Watersheds One to Six.

It should be noted that the proposed Site and surrounding area is hydrologically, somewhat unusually flashy for a rural location, which is indicative of a very low permeable soil very close to the surface. Therefore, the model assumes low infiltration.

Methodology

The Clark Unit Hydrograph model was utilized in the hydrology study. Clark's model derives the watershed unit hydrograph by using translation and attenuation in the transformation of excess precipitation to runoff. This method is intended primarily for continuous simulation, where recorded data is used for calibration purposes. However, the method is valid for modeling single (event-based) storm events. This method utilizes the time of concentration and storage unit coefficient.

The recession baseflow method was used in the hydrologic model to approximate the "base flow" recession in the watersheds when channel flow recedes exponentially after an event. This method is intended primarily for event simulation, however, within HMS recession can be automatically reset after each storm event and can be used for continuous simulation.

Routing, as a hydrology term, means how the runoff from each catchment contributes to the total flows along the connecting channels of a watershed, calculating travel time within each sub-catchment and within each channel. This is especially important where peak discharge is required as each catchment will contribute its peak flow with a different response time within an event. For more precise estimates of routing other models may be used in parallel with HMS. For this study, routing in the HMS model was based on the Lag method, where the outflow hydrograph is the same as the inflow hydrograph but lagged in time by a specific duration. The lag duration is calculated based on flow length, average slope and land use.

3.0 HYDROLOGIC MODEL SCENARIOS

Four general scenarios were examined using this HMS model:

1. existing conditions – the hydrologic study area as it is presently;
2. the proposed mine pit and stockpiles in 20 years;
3. the proposed mine pit and stockpiles in 40 years; and,
4. the proposed mine pit and stockpiles in 70 years.

The sub-catchments were incrementally adjusted to account for the mine pit and stockpiles as shown in Figures C.5 (End of 20 Years), Figure C.6 (End of 40 Years) and Figure C.7 (End of 70 Years).

The proposed mine footprint, at each increment in time, did not match with the existing hydrologic sub-catchments, therefore a new "mine footprint" (M) sub-catchment was created within each of the existing conditions sub-catchments leaving the remainder of the previous existing sub-catchment. As well, there were isolated 'left-over' smaller pieces, slivers, of sub-catchment, which although not within the proposed mine footprint, nevertheless would drain to the mine. These remaining slivers, in the model, were made part of the mine-footprint sub-catchment. Therefore the areas of the mine-footprint sub-catchments herein are not the same as listed elsewhere for the mine. The same situation existed for the proposed stockpiles areas and sub-catchments for all increments in time; the stockpile sub-catchments also are larger than the stockpile footprints listed elsewhere.

In Figure C.5 mine sub-catchments MA and MB have been sub-divided from sub-catchments 33 and 61 and Stockpile sub-catchments S1A, S1B, S1C and S2A and S2B have been sub-divided from sub-catchments 33, 35, 37 and 61.

Sub-catchments parameters and flow links were adjusted to model all of the runoff 'remaining' in the mine and 'remaining' at the stockpile location, where 'remaining' means the discharge will be "accumulated and perhaps pumped, but is otherwise removed from within the model from the watershed stream network".

- Modified sub-catchments parameters, for the new sub-catchments that represent the mine and stockpiles at the 20-year mine development point are shown in Table C.3a, 40-year mine development in Table C.4a and 70-year mine development in Table C.5a;
- Modified sub-catchments parameters, for the other, unaffected sub-catchments, are shown in Tables C.3b to C.3g (20-year mine development), Tables C.4b to C.4g (40-year mine development) and Tables C.5b to C.5g (70-year mine development) for watersheds one through six.

Figures C.6 and C.7 show how the hydrologic model sub-catchments were adjusted to account for the projected mine and stockpile growth westwards over time.

3.1 HYDROLOGIC MODEL SCENARIO RESULTS

Sub-catchment peak discharge and total volumes

The primary results of the model projections of each of the various model scenarios are shown in Tables C.6a to C.6f (Existing Conditions), Tables C.7a to C.7f (20 Years), Tables C.8a to C.8f (40 Years) and Tables C.9a to C.9f (70 Years). The tables show projected peak discharge (m^3/sec) and Total Runoff volume for each sub-catchment within each watershed for the 24-hour-duration 2-year, 5-year, 10-year, 25-year, 50-year and 100-year events.

Tables C.10, C.11, and C.12 similarly summarize the projected peak discharge (m^3/sec) and total runoff volume for the mine and stockpiles, at the 20-year, 40-year and 70-year projected development.

Watershed Outlet Volumes

Table C.13 summarizes the total runoff volumes, at the sixteen watershed outlets, for existing conditions and for the 70-year projected development, for each of the design events. The locations of the sixteen outlets are shown on Figure C.3.

Nine of the outlets are not impacted by the mine development.

Seven of the outlets are projected to be impacted, if nothing is done to compensate. Outlet 03-1 under existing conditions (EX) is projected to have a total flow volume of 127,000 m^3 under the 10-year event and at the end of mine life (EQL) or 70 years, a total flow volume of 116,000 m^3, a difference of 11,000 m^3 or about 9%. Similarly, under the 10-year event, with no compensation:

- outlet 03-2 shows a difference of 39,000 m^3 or about 15%;
- outlet 05-1 shows a difference of 7,000 m^3 or about 9%;
- outlet 05-2 shows a difference of 4,000 m^3 or about 6%;
- outlet 05-3 shows a difference of 32,000 m^3 or about 24%;
- outlet 06-1 shows a difference of 31,000 m^3 or about 13%; and
- outlet 06-2 shows a difference of 39,000 m^3 or about 45%.

Figure C.20 shows that the intercepted volume is linear (log plot) with return period, so the implication is that the difference (percent of the volume intercepted) does not vary with return period. For example, Outlet O6-2, which has the largest percent volume intercepted, shows interception percentages of 9.5%, 9.7,%, 9.8%, 9.9%, 9.9% and 9.9% at the level of the 2-, 5-, 10-, 25-, 50- and 100-yr return periods) for the 20-year development extent, i.e. 10%. For the 40-year development, the percentage volume intercepted at O6-2 is about 26% and at the 70-year development about 45%. Therefore, the 10-year return period is representative of the percent volume intercepted, at a point of development.

Development over time may not impact a watershed to the same degree. For example, O3-1 is affected at the 20-year point, to about 9% and is not affected any greater amount by later developments. Outlet 03-2 is affected to an interception volume of about 14% to 15% at the 20-year to 70-year developments. Outlet O5-1 and O5-2 are affected to about 9% and 6%. Outlet O5-3 is affected to 8% at the 40-year point and to 25% at the 70-year point. Outlet O61- is affected to about 13% at the 40-year point-of-development.

Therefore, it is to be expected that planning for any compensating measures will be done on a watershed-by-watershed basis and with time as the development proceeds.

3.2 CONTINUOUS HYDROLOGIC MODEL RESULTS

In addition to the event-based modeling, the HMS model was used in a continuous mode to place spot discharge measures in context.

Continuous modeling runs the model over a longer period of time, from a duration of many days to that of many years. Continuous modeling allows the modeling of the effects of interactions between events and the modeling of the effect of groundwater re-capture into the surface water flow. Single events may actually overlap in time which would increase the runoff as compared to a single discrete event. Individual event modeling, through the effects of infiltration, shows a loss of rain to the runoff, whereas in reality that apparent loss may be recovered later as the groundwater seeps into the surface water channels.

For this hydrologic study, the continuous model was run with historical rainfall data, from April 2005 to March 2009. Within that timeframe, periodic spot measurements of discharge within 11 streams were made. The spot measurements necessarily do not indicate where the measured flow is on the hydrograph of that stream at that time. The spot measurement can not, and should not, be taken as a maximum or a minimum discharge. As well, no evaluation of the total volume of runoff can be made on the basis of these spot measurements.

The only comparison that can be made is of discharge at that moment in time.

A comparison of the spot measurements of discharge with the continuous modeling is shown on Figures C.9 through Figure C.19, with each plot corresponding to one of the outlets discussed earlier. The measured historical rainfall is shown along the top of each figure and the resulting continuous hydrograph is shown along the bottom of each plot. The spot measurements are shown as green dots at the day and discharge when taken.

Figure C.13, for outlet 05-2, which has a larger discharge, most clearly shows the effects noted above. For example, the multiple events of November 2005 overlap the declining limb of the hydrograph, with the declining limb being the result of groundwater recovery into the surface water channel. The spot measurements roughly agree with the modeling predictions, although none of the apparent discharge peaks were captured by the spot measurements.

The remaining figures show some agreement and a considerable lack of agreement between measured and predicted discharges. For a number of the measurements, the measured discharge is an order of magnitude larger the coincident predicted discharge, and on Figures C.9, C.10, C.17 and C.18 there the spot measurements are about 15 times larger. Three of those four points are for the same June 2006 event.

Numerous interpretations could be made of the disagreement in peak discharge, both within the modeling and within the spot measurements. The model was run with very low infiltration, with the result that almost all the rainfall became runoff. The main remaining feature of the model contributing to peak discharge is the method of routing. Routing determines the speed with runoff occurs and thus how hydrographs "add up". It may be that the lag chosen for the modeling was too large and the hydrograph too "spread out". However this does not effect the essential point, for this hydrologic study, which is the total volume of runoff.

Infiltration, largely, controls total runoff volume, and as discussed earlier, this hydrologic study used a low value of infiltration which maximizes runoff volumes.

4.0 PROVISIONS AND RECOMMENDATIONS

The accuracy and precision of the hydrologic modeling depends in part on the accuracy and precision of the values of the input parameters. The results presented here should be interpreted in light of the input data and the general accuracy of the modeling.

Some of the modeling input parameters are well understood and can be assumed to be accurate, such as rainfall and the watershed and sub-catchments areas and impervious areas. Other input parameters are likely close approximations and would not affect the essential outcome or projections of the hydrological study, such as flow path lengths and slopes.

However, other parameters are assumptions based on photographs of the site, and may affect the value of the total volumes projected to be affected. Photographs show a low relief with small swamps and vernal ponds, which would affect assumed abstraction greatly and provide locations for more protracted infiltration than assumed by the model. The presence of the swamps and ponds also affect the assumed flow path links and the flow path slopes.

However it should be noted that the projections for total flow volumes for both existing conditions and the various mine development points are based on the same values of all the parameters. A variation in parameters would affect both projections to the same magnitude.

However, it would be useful to collect data:

1. for continuous discharge, or stream water level elevations that could be converted to discharge, for all of the outlets projected to be affected by the proposed development;
2. for continuous discharge, or stream water level elevations that could be converted to discharge, for outlets projected to be *not* affected by the proposed development, as a check on the data above;
3. detailed surveys of the slopes of the creeks
4. field verification of the flow linkages derived from the DEM, which themselves are a derived product;
5. soil borings as a check on the assumed soils and infiltration values.

In addition, sites this small are subject to wide variations in the extent and intensity of localized storm events that often fall outside expected wide-area averages. It would be useful to install continuously recording rain gages, as part of the continuous stream data recording. As well, such on-site gages would allow determining the timing of the rain events and the timing of the sub-catchment response, which would further improve the calibration and predictive capability of this Site modeling tool that has been assembled.

5.0 REFERENCES

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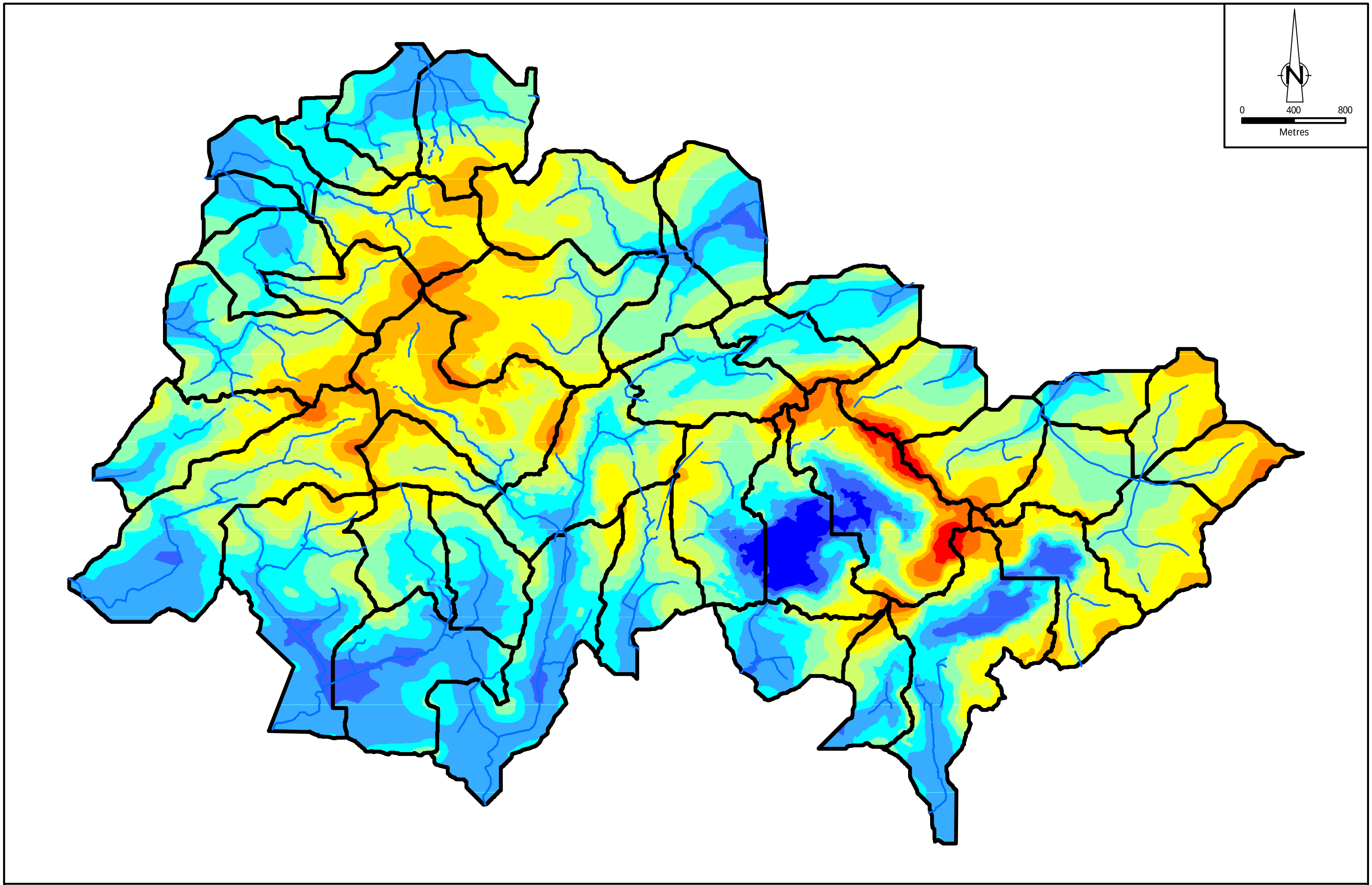


Source: 2 Meter DEM

Elevation (m)

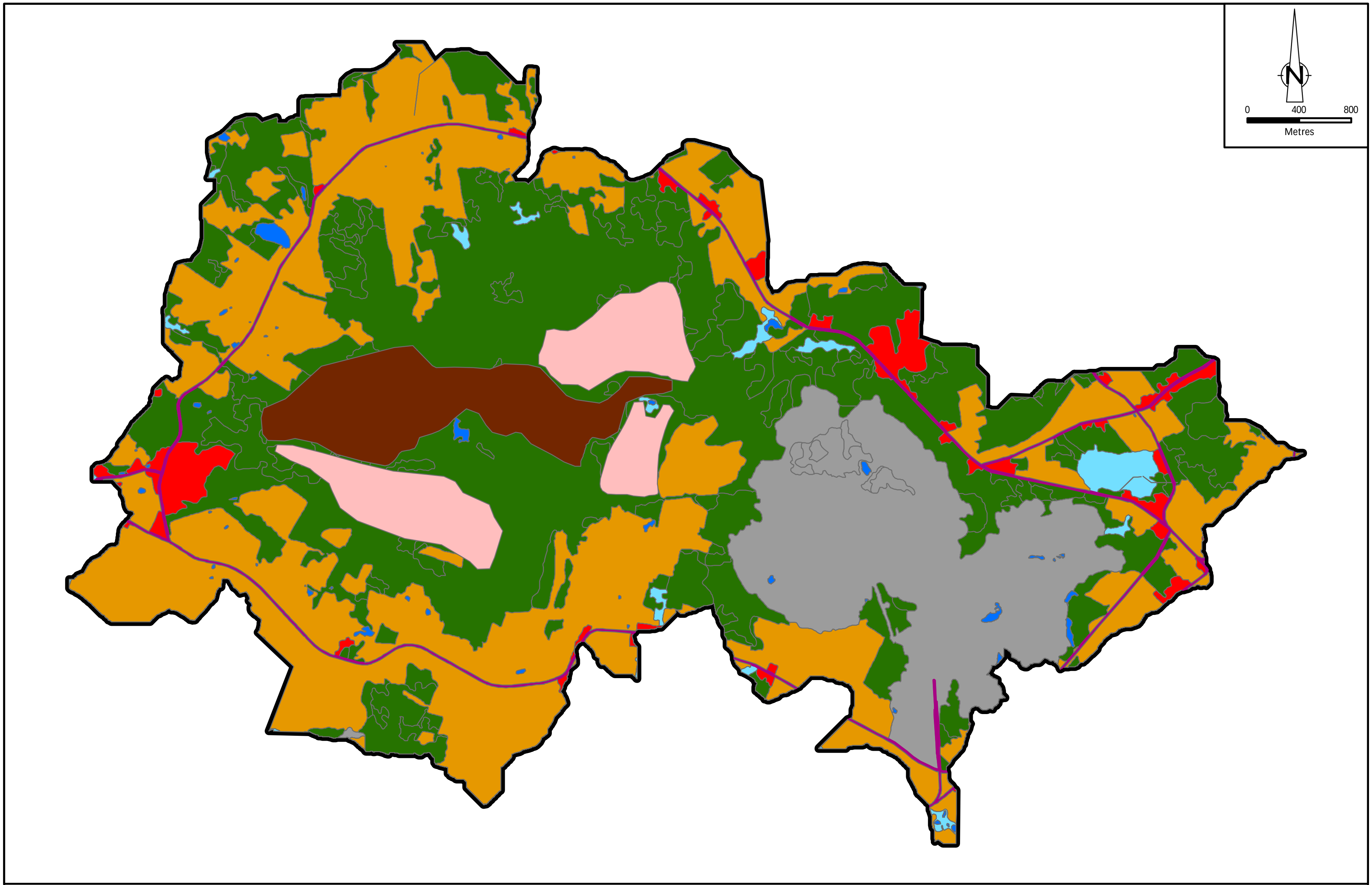
80 - 89	50 - 59	10 - 19
70 - 79	40 - 49	0 - 9
60 - 69	30 - 39	-27 - -1
	20 - 29	River

Subcatchments Boundary

Figure C.1

Topographic Map
Miller's Creek Mine Extension Project
CGC Inc. - Windsor Plant
Hants County, Nova Scotia

Figure-1.mxd August 12, 2009



Source: Land Use Map

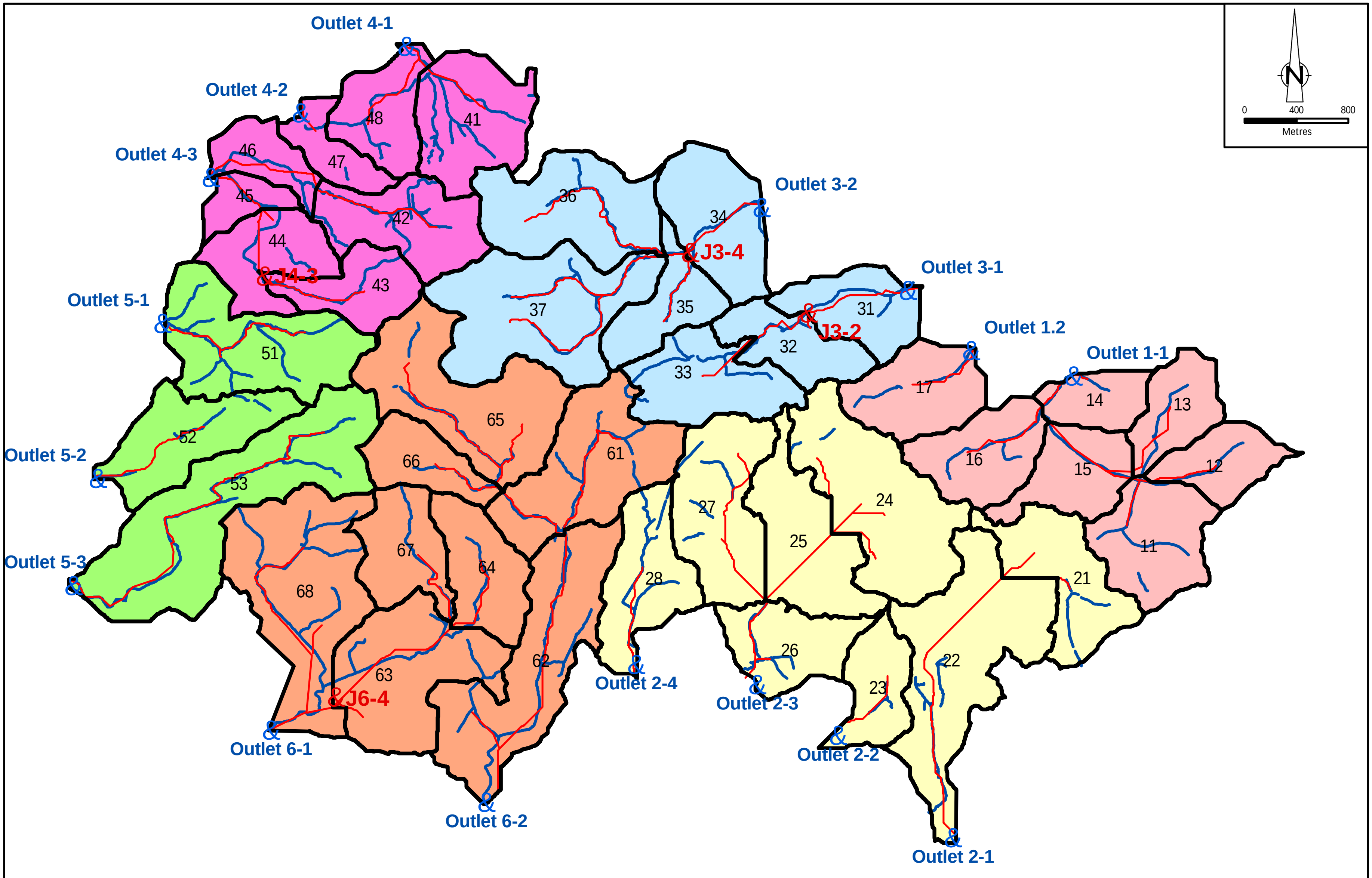
- Proposed Mine Pit
- Proposed Stockpiles
- Agriculture
- Corridor
- Developed (Residential/ Industrial)
- Forest
- Mine
- Water
- Wetland

CRA

Figure C.2

Land Use Map
Miller's Creek Mine Extension Project
CGC Inc. - Windsor Plant
Hants County, Nova Scotia

Figure-2.mxd July 21, 2009



Source: 2 Meter DEM

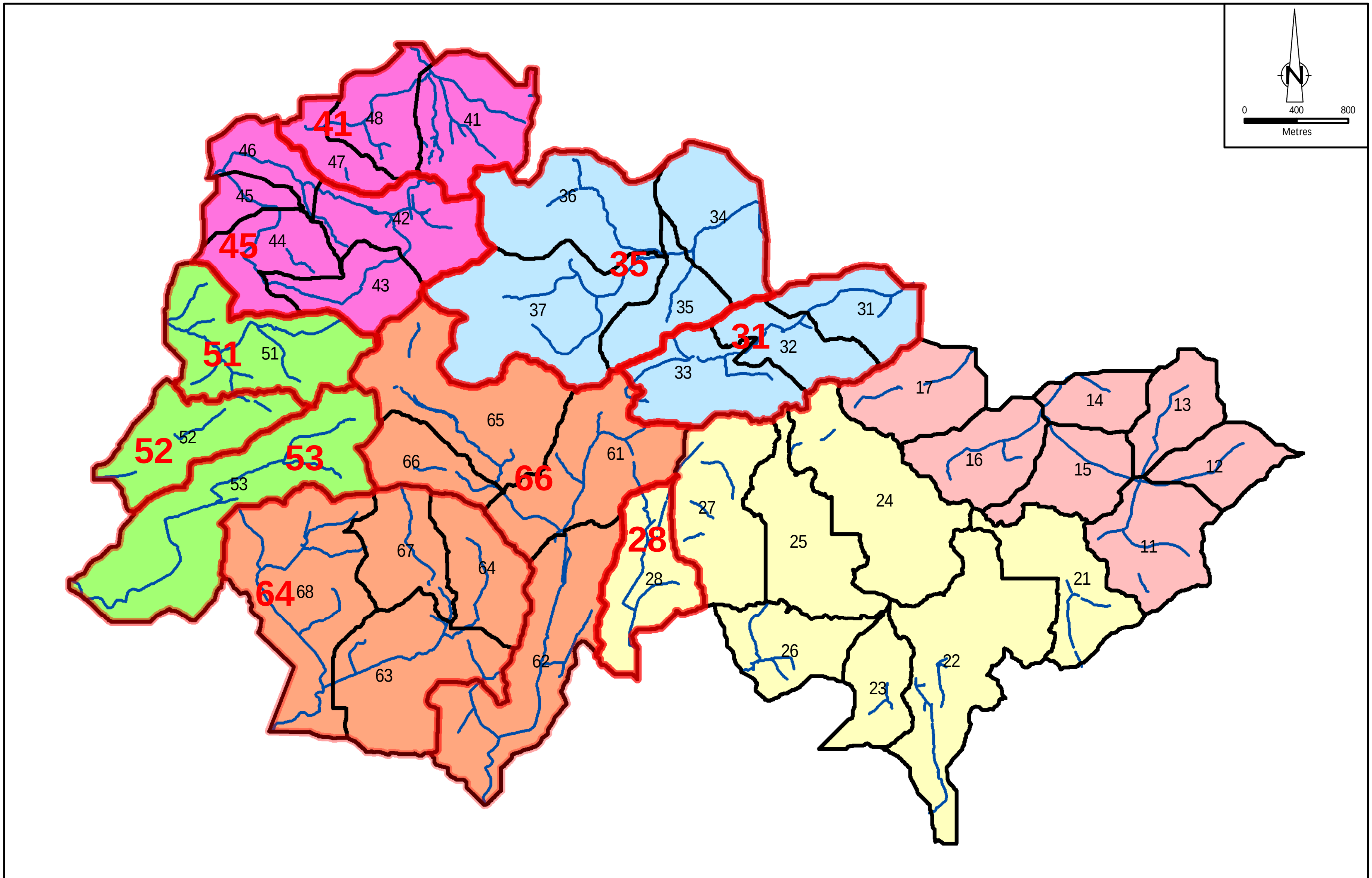
Figure C.3

Existing Condition Subcatchment Delineation
Miller's Creek Mine Extension Project
CGC Inc. - Windsor Plant
Hants County, Nova Scotia

Subcatchments Boundary
Stream Network Generated from DEM
River

& Junction
& Outlet

Figure-3.mxd August 12, 2009



Source: 2 Meter DEM

CGC Subcatchments Boundary and Number "35"

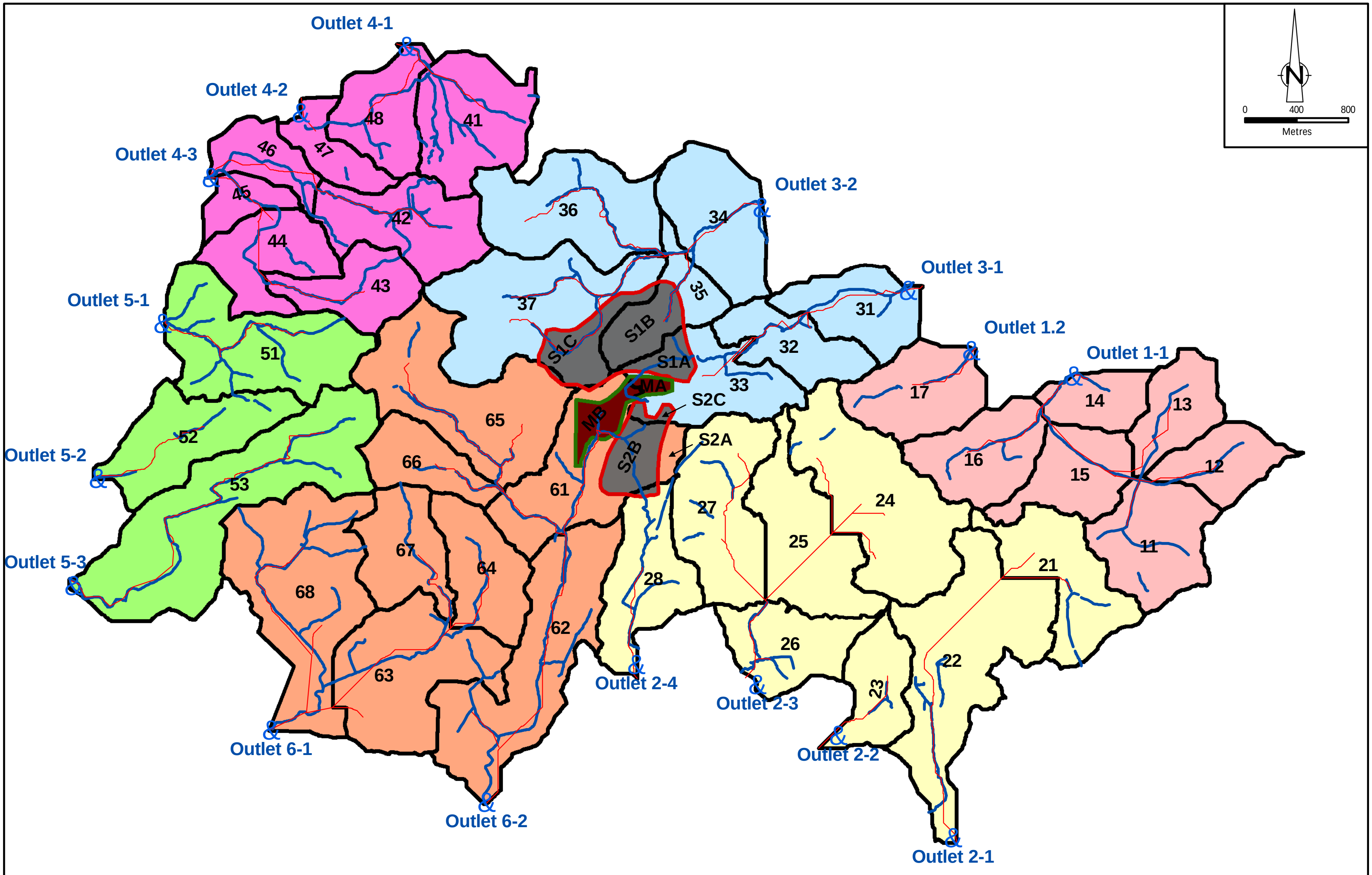
CRA Subcatchments Boundary and Number "35"

River

Figure C.4

CRA and CGC Subcatchment Delineation Comparison
Miller's Creek Mine Extension Project
CGC Inc. - Windsor Plant
Hants County, Nova Scotia

Figure-4.mxd August 12, 2009



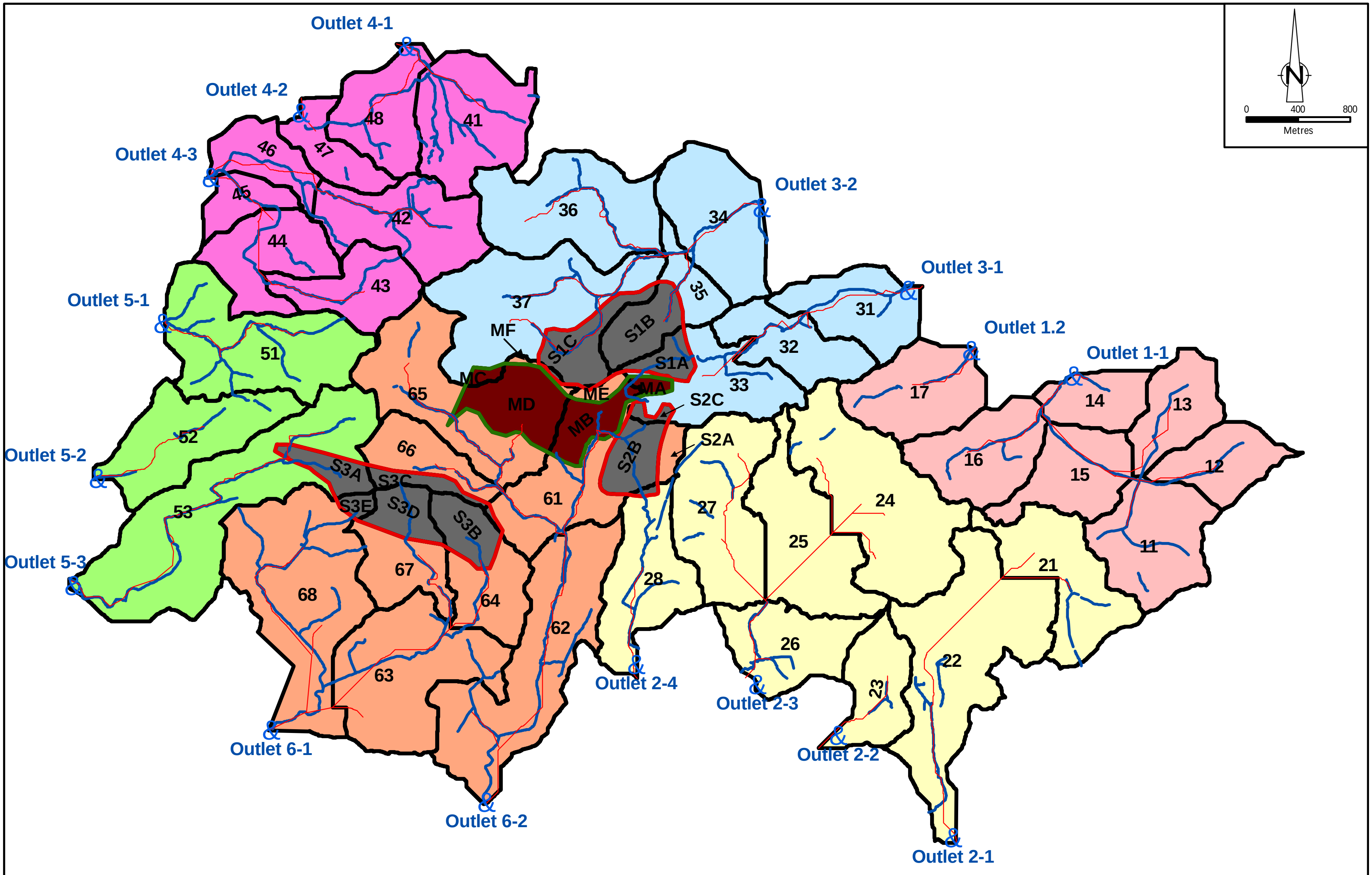
Source: 2 Meter DEM

Figure C.5

End of 20 years Subcatchment Delineation
Miller's Creek Mine Extension Project
CGC Inc. - Windsor Plant
Hants County, Nova Scotia

Subcatchemnts Boundary
Stream Network Generated from DEM
River
Mine 20 years
Stockpiles 20 years
& Outlet

Figure-5.mxd August 12, 2009



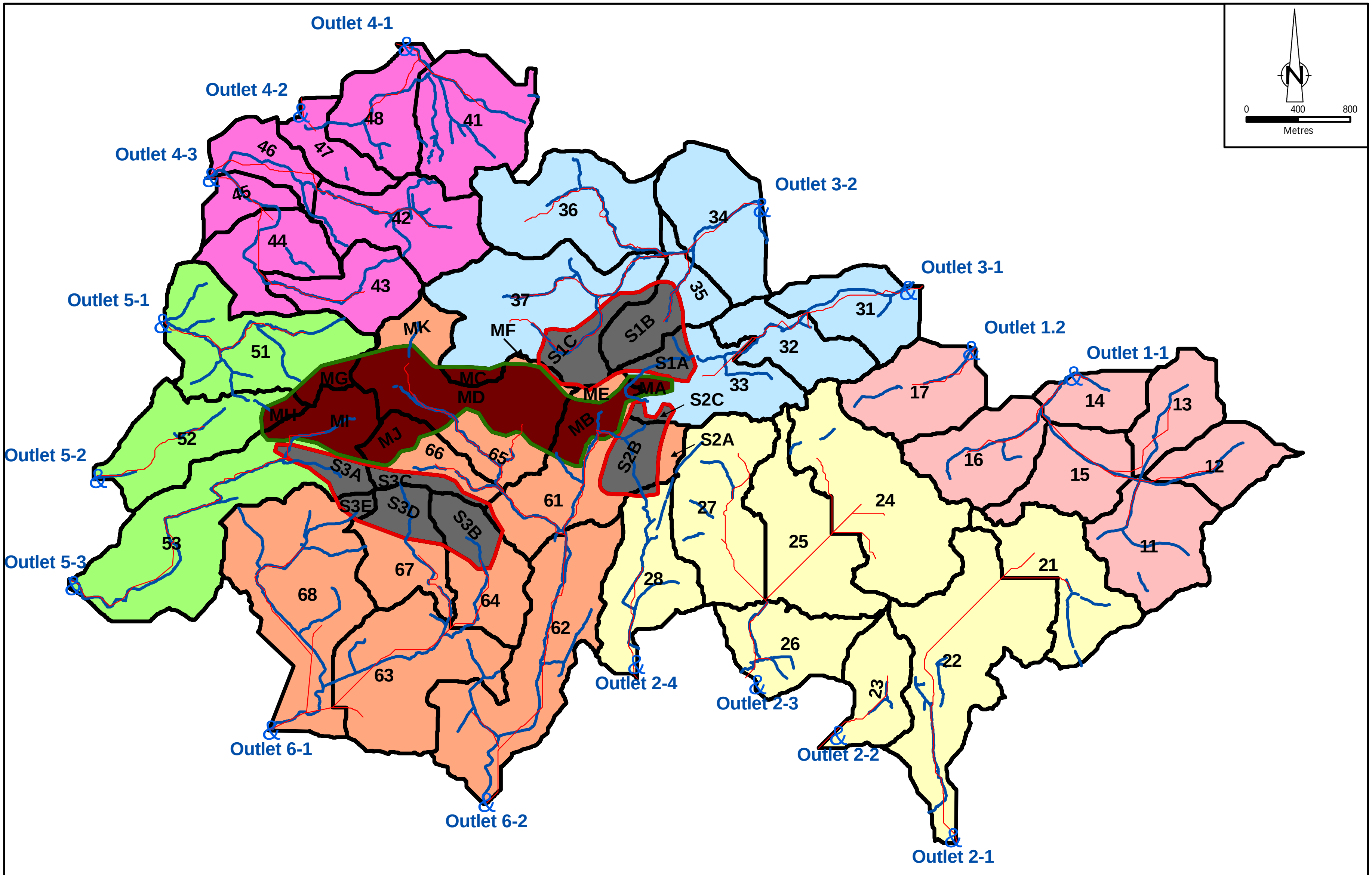
Source: 2 Meter DEM

Subcatchments Boundary
Stream Network Generated from DEM
River
Mine 40 years
Stockpiles 40 years
& Outlet

Figure C.6

End of 40 years Subcatchment Delineation
Miller's Creek Mine Extension Project
CGC Inc. - Windsor Plant
Hants County, Nova Scotia

Figure-6.mxd August 12, 2009



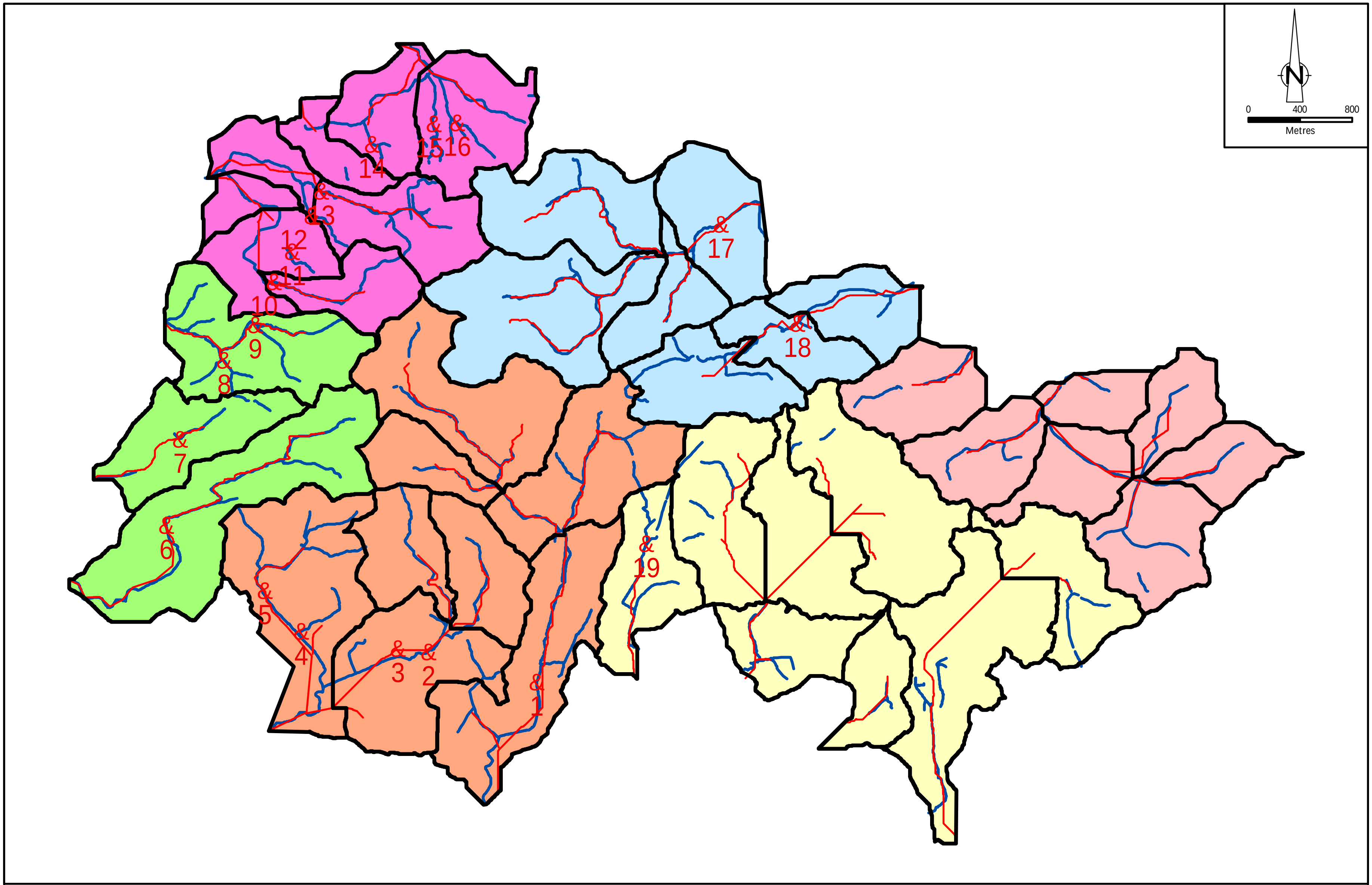
Source: 2 Meter DEM

Figure C.7

End of Mine Life (70 years) Subcatchment Delineation
Miller's Creek Mine Extension Project
CGC Inc. - Windsor Plant
Hants County, Nova Scotia

Subcatchments Boundary
Stream Network Generated from DEM
River
Mine 70 years
Stockpiles 70 years
& Outlet

Figure-7.mxd August 12, 2009



Source: 2 Meter DEM

Subcatchments Boundary
Stream Network Generated from DEM
& Flow Monitoring Location
River

Figure C.8

Flow Monitoring Location
Miller's Creek Mine Extension Project
CGC Inc. - Windsor Plant
Hants County, Nova Scotia

Figure-8.mxd August 12, 2009

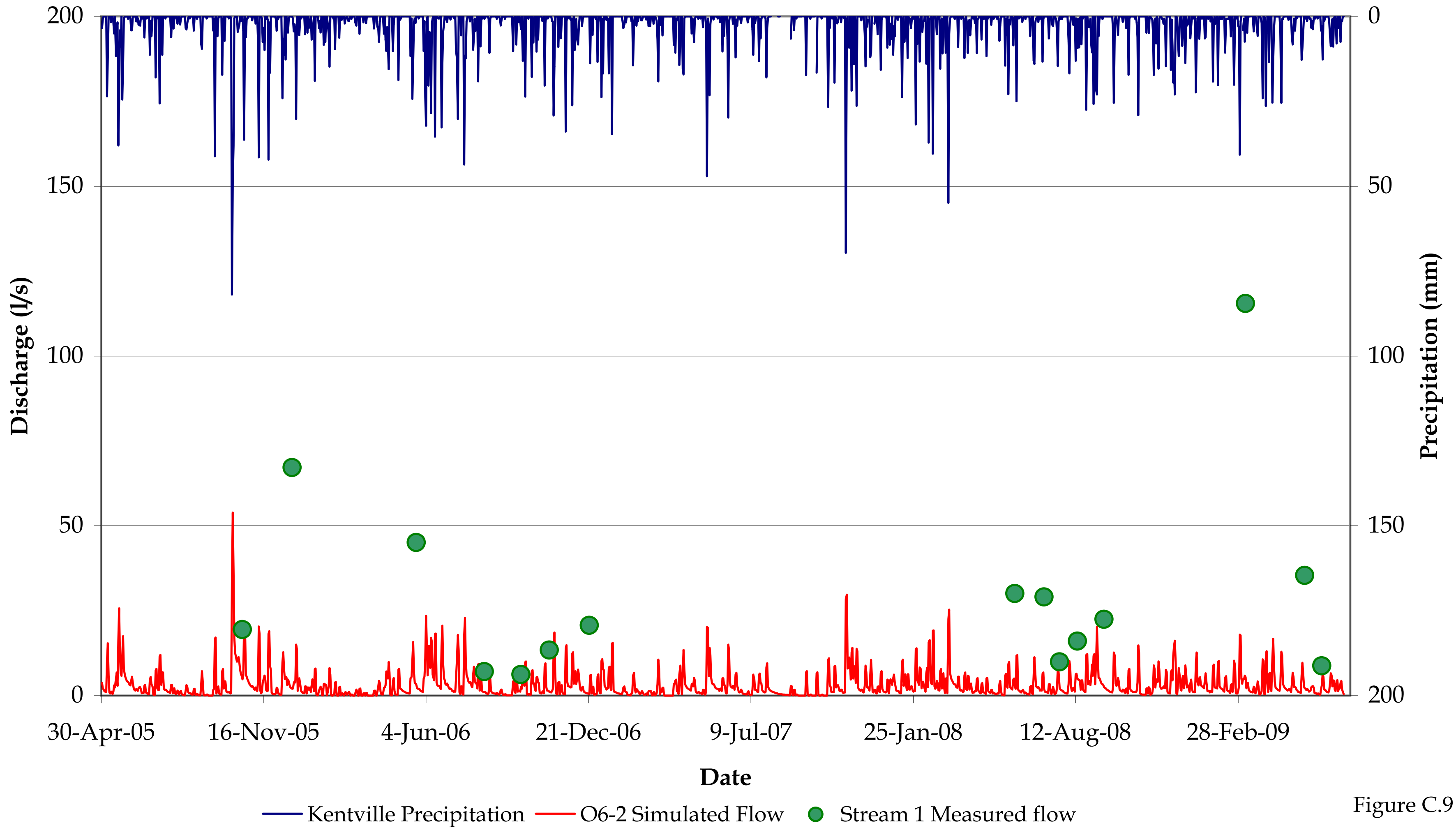


Figure C.9

Outlet O6-2 Hydrograph
Miller's Creek Mine Extension Project
CGC Inc. - Windsor Plant
Hants County, Nova Scotia

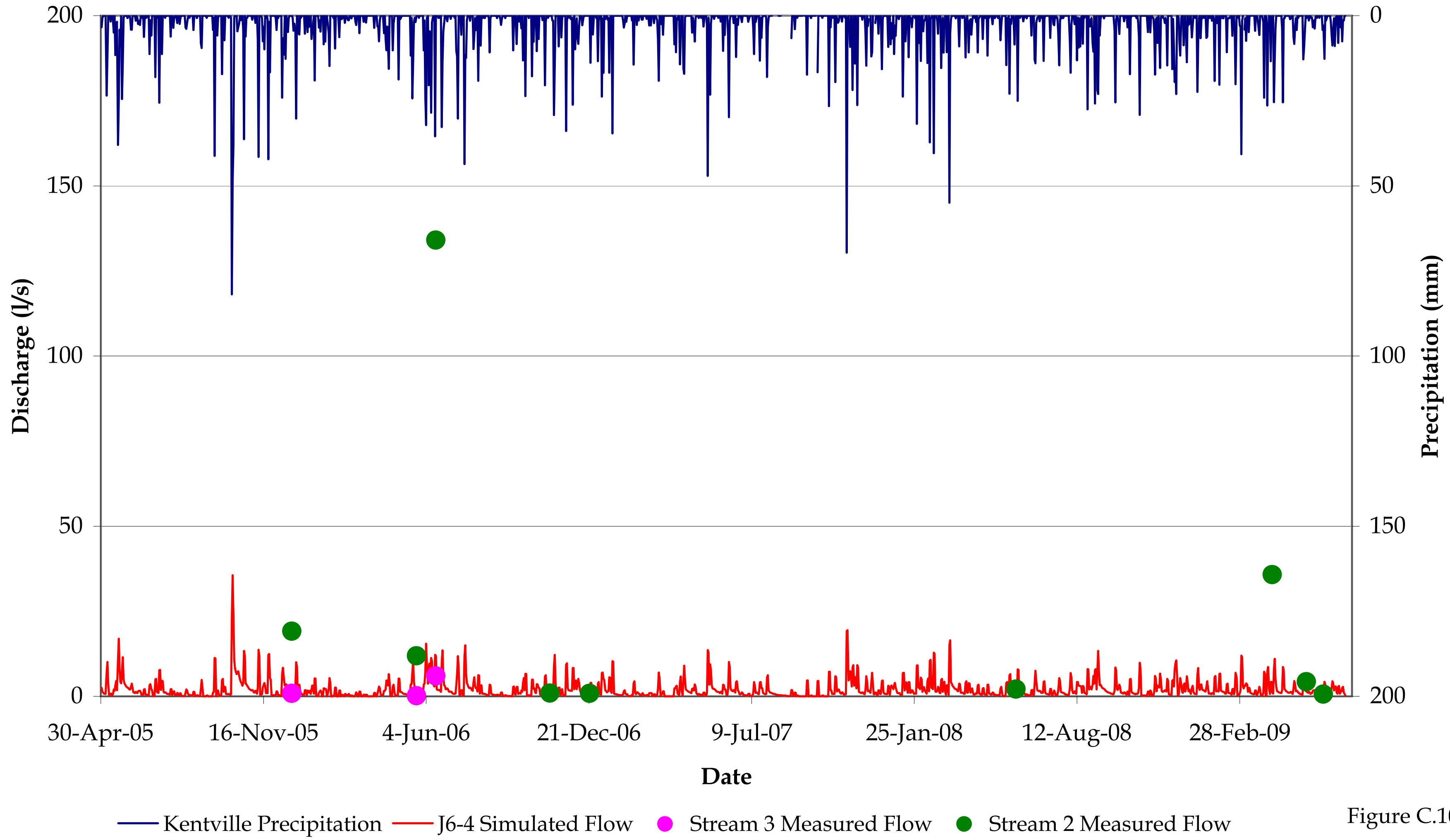


Figure C.10

Junction J6-4 Hydrograph
Miller's Creek Mine Extension Project
CGC Inc. - Windsor Plant
Hants County, Nova Scotia

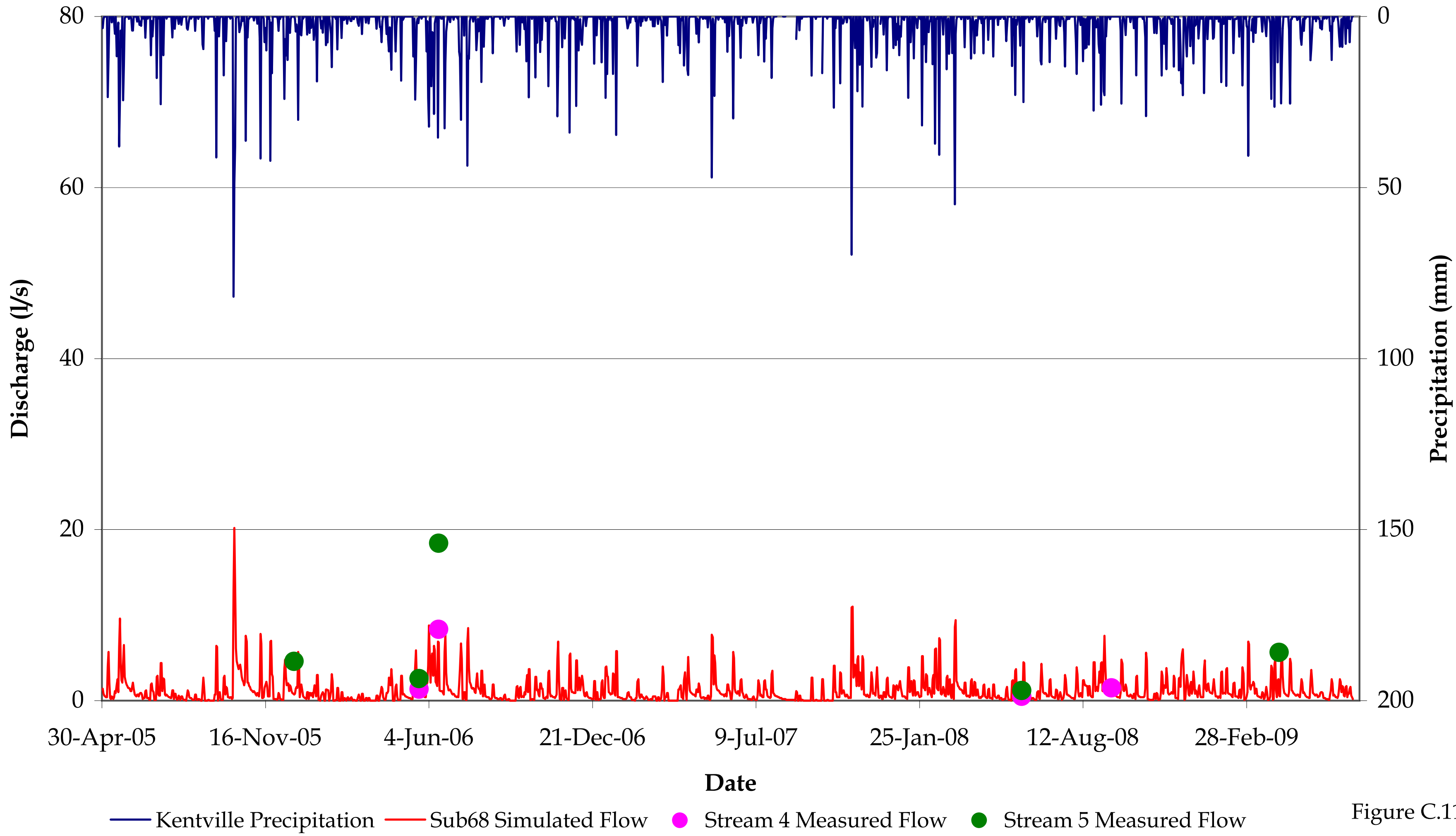


Figure C.11

Subcatchment S68 Hydrograph
Miller's Creek Mine Extension Project
CGC Inc. - Windsor Plant
Hants County, Nova Scotia

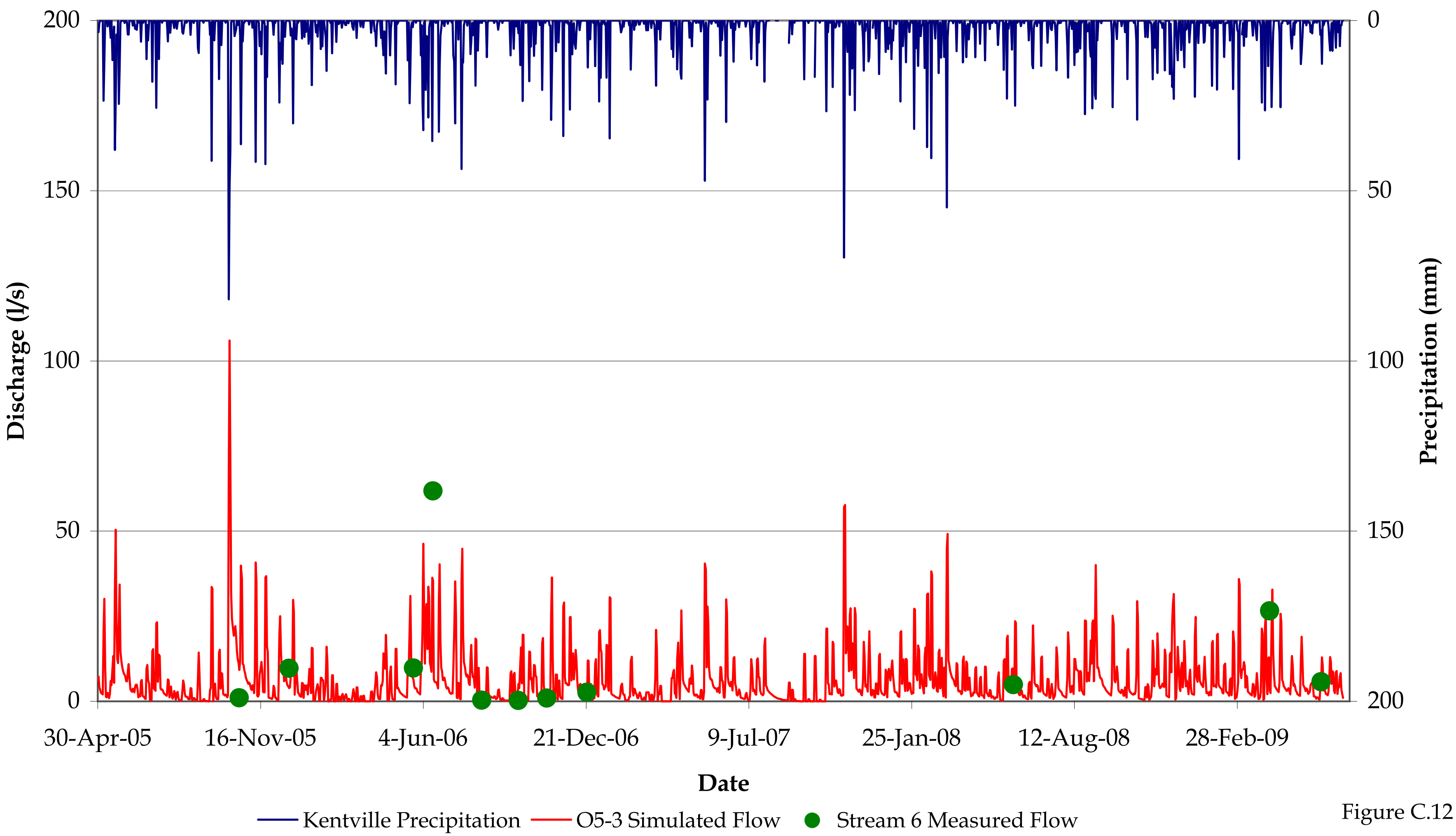


Figure C.12

Outlet O5-3 Hydrograph
Miller's Creek Mine Extension Project
CGC Inc. - Windsor Plant
Hants County, Nova Scotia

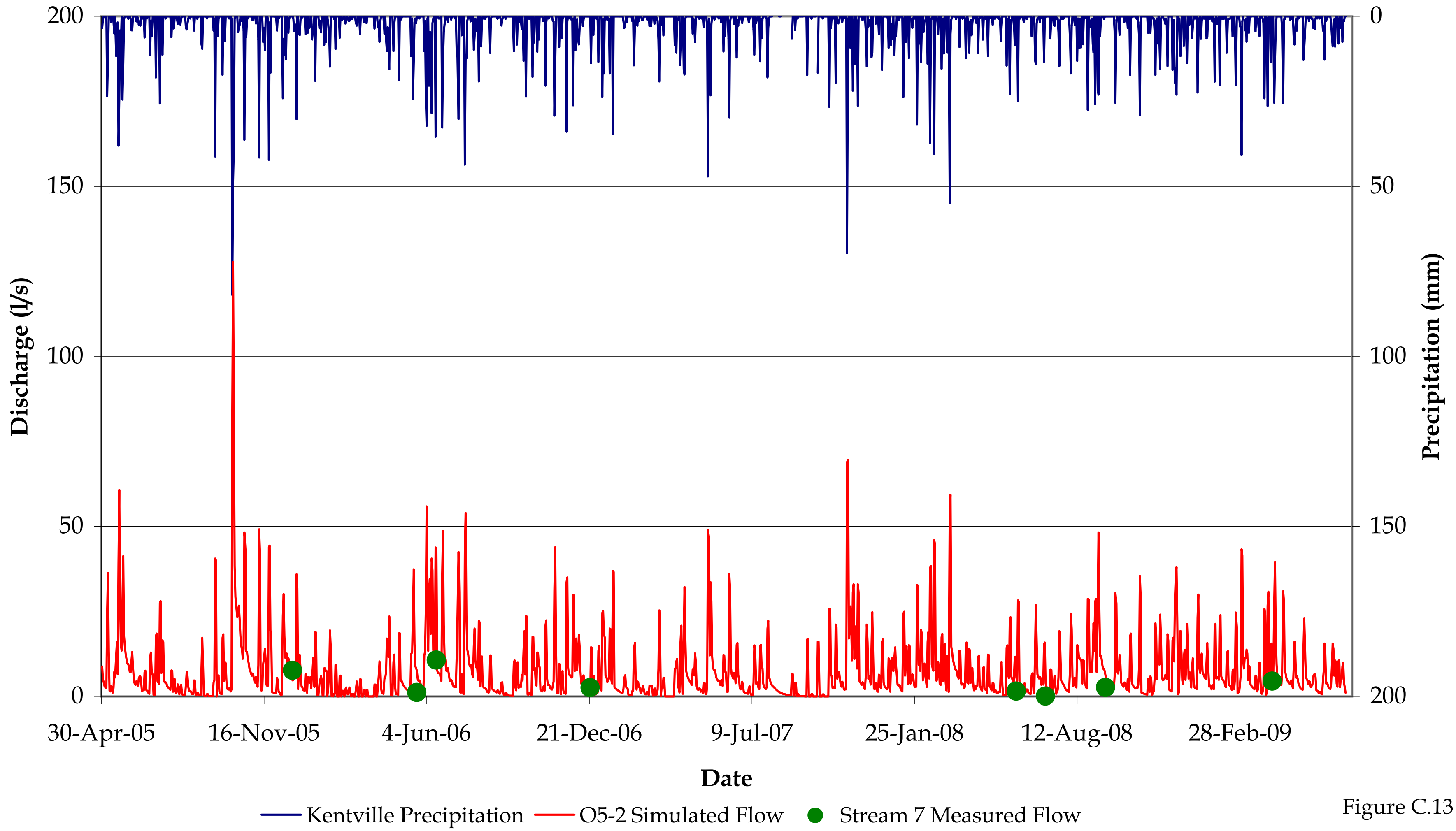


Figure C.13

Outlet O5-2 Hydrograph
Miller's Creek Mine Extension Project
CGC Inc. - Windsor Plant
Hants County, Nova Scotia

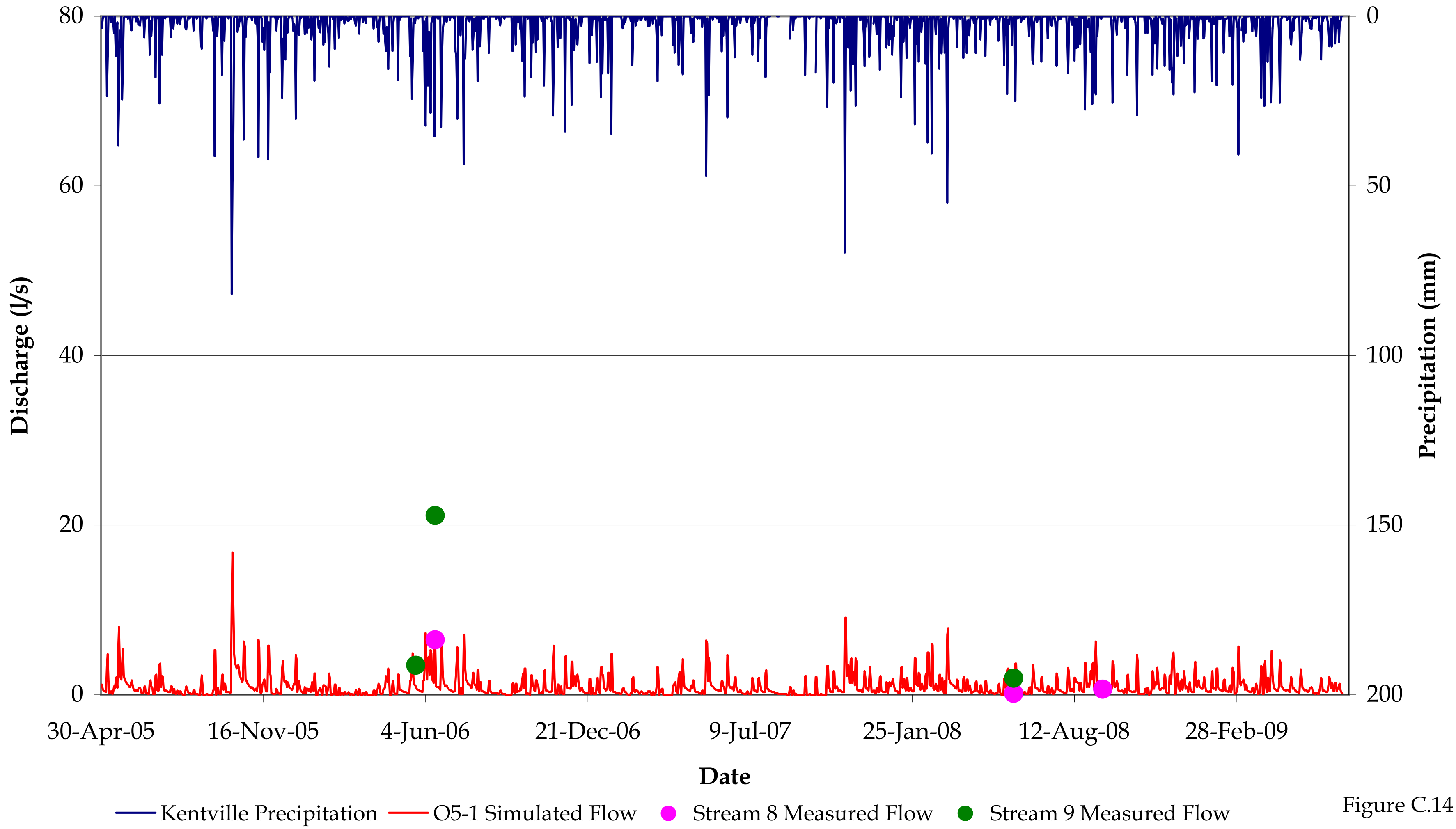


Figure C.14

Outlet O5-1 Hydrograph
Miller's Creek Mine Extension Project
CGC Inc. - Windsor Plant
Hants County, Nova Scotia

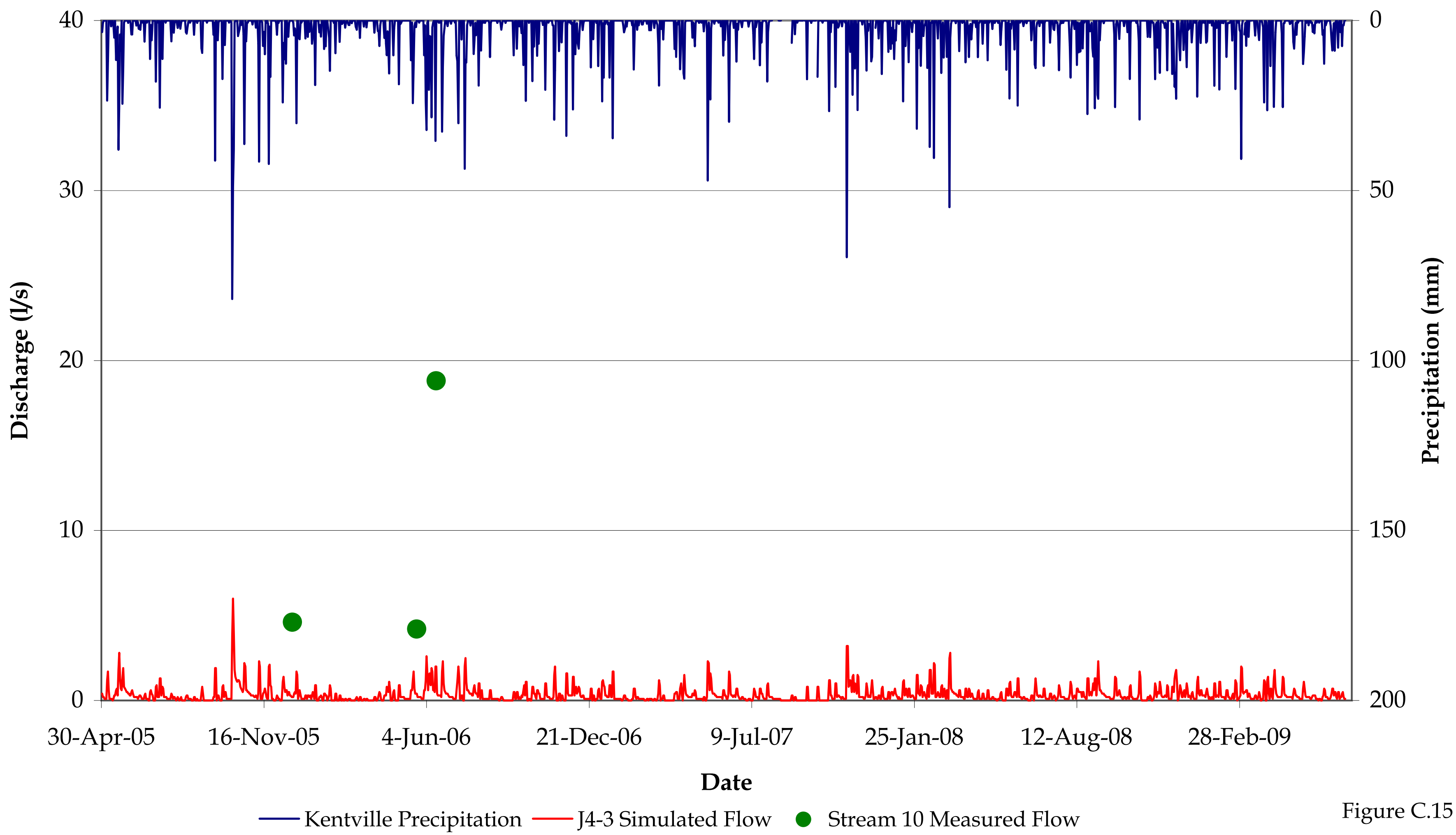


Figure C.15

Junction J4-3 Hydrograph
Miller's Creek Mine Extension Project
CGC Inc. - Windsor Plant
Hants County, Nova Scotia

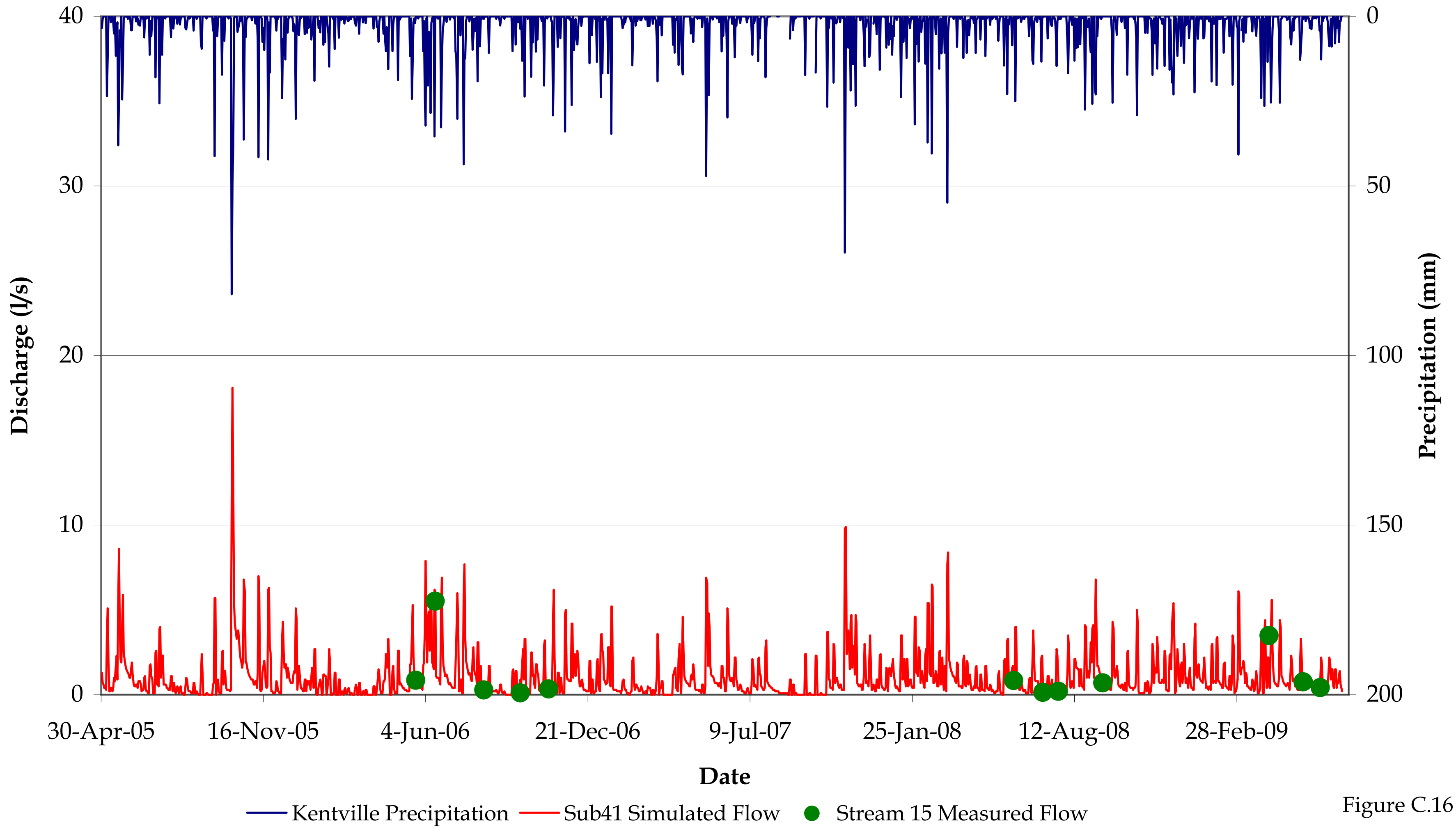


Figure C.16

Subcatchment S41 Hydrograph
Miller's Creek Mine Extension Project
CGC Inc. - Windsor Plant
Hants County, Nova Scotia

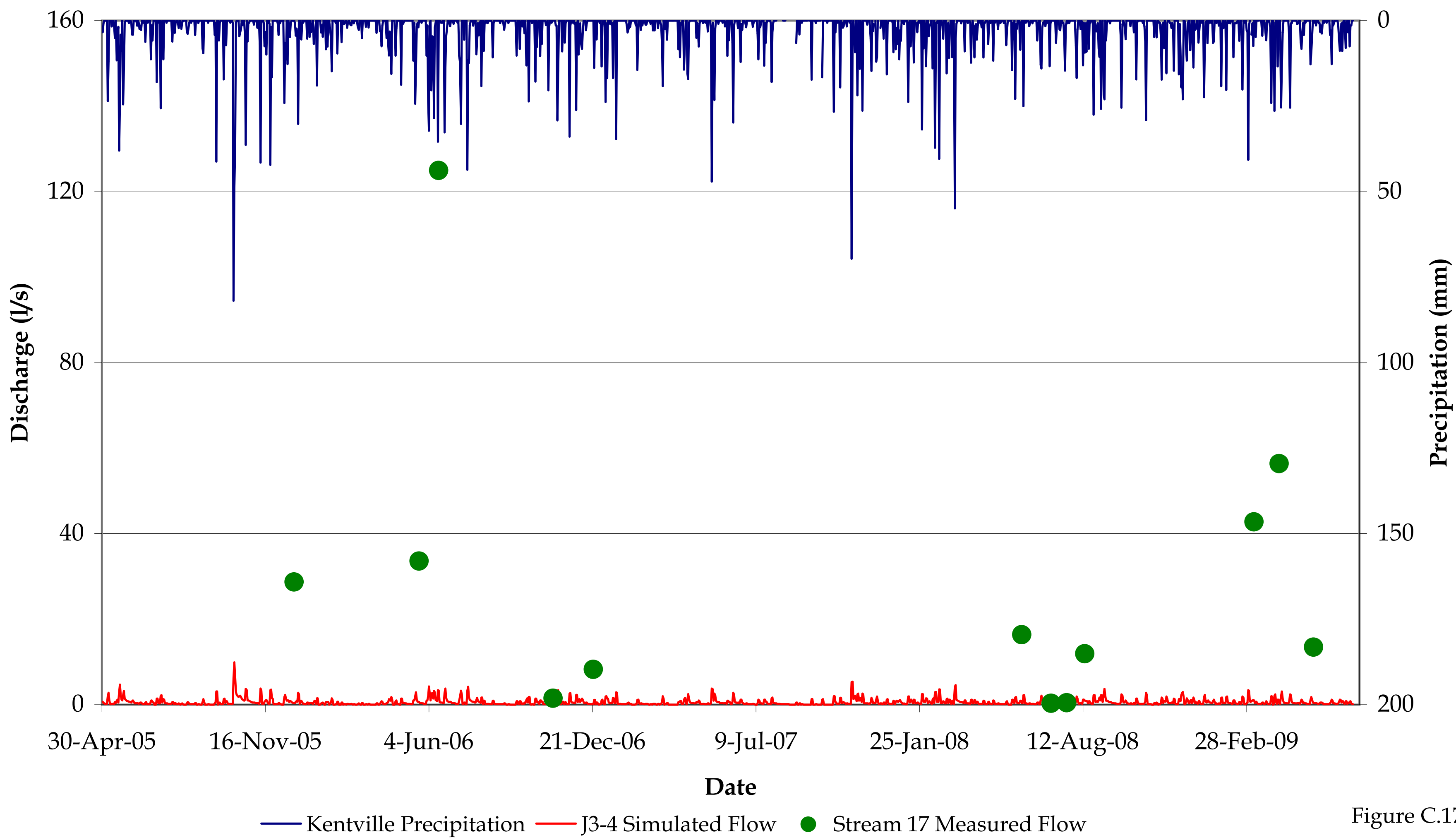


Figure C.17

Junction J3-4 Hydrograph
Miller's Creek Mine Extension Project
CGC Inc. - Windsor Plant
Hants County, Nova Scotia

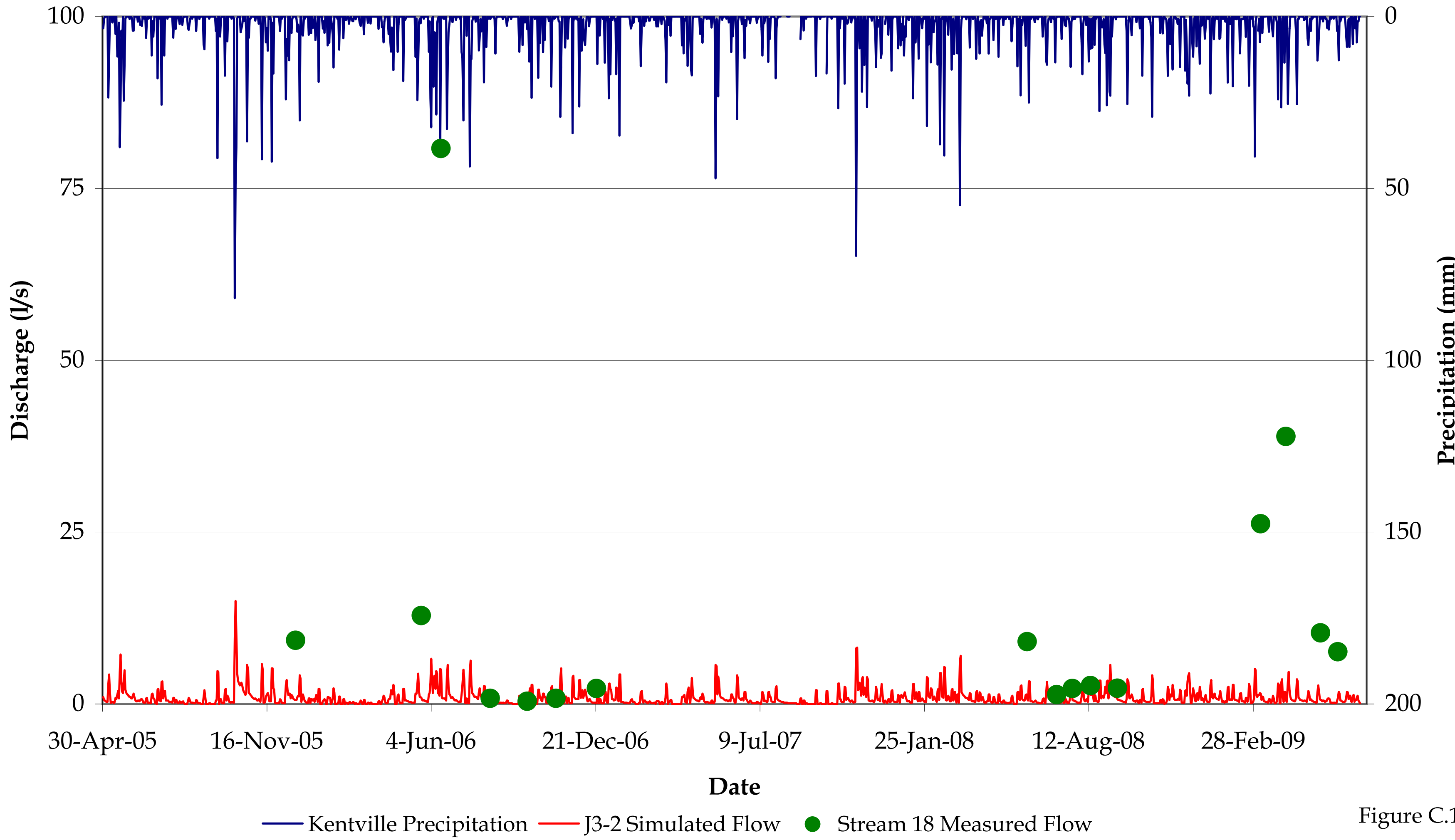


Figure C.18

Junction J3-2 Hydrograph
Miller's Creek Mine Extension Project
CGC Inc. - Windsor Plant
Hants County, Nova Scotia

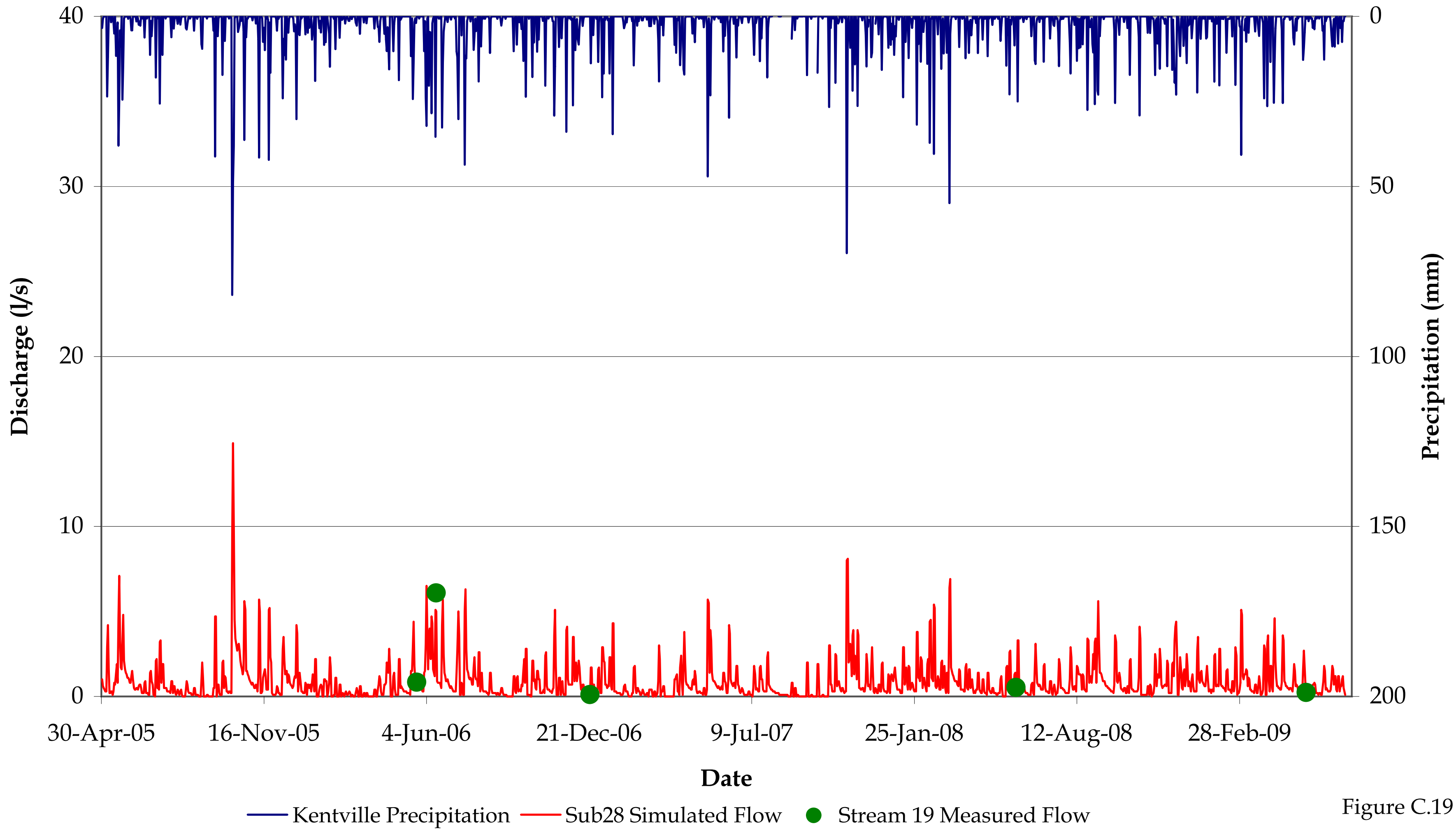


Figure C.19

Subcatchment S28 Hydrograph
Miller's Creek Mine Extension Project
CGC Inc. - Windsor Plant
Hants County, Nova Scotia

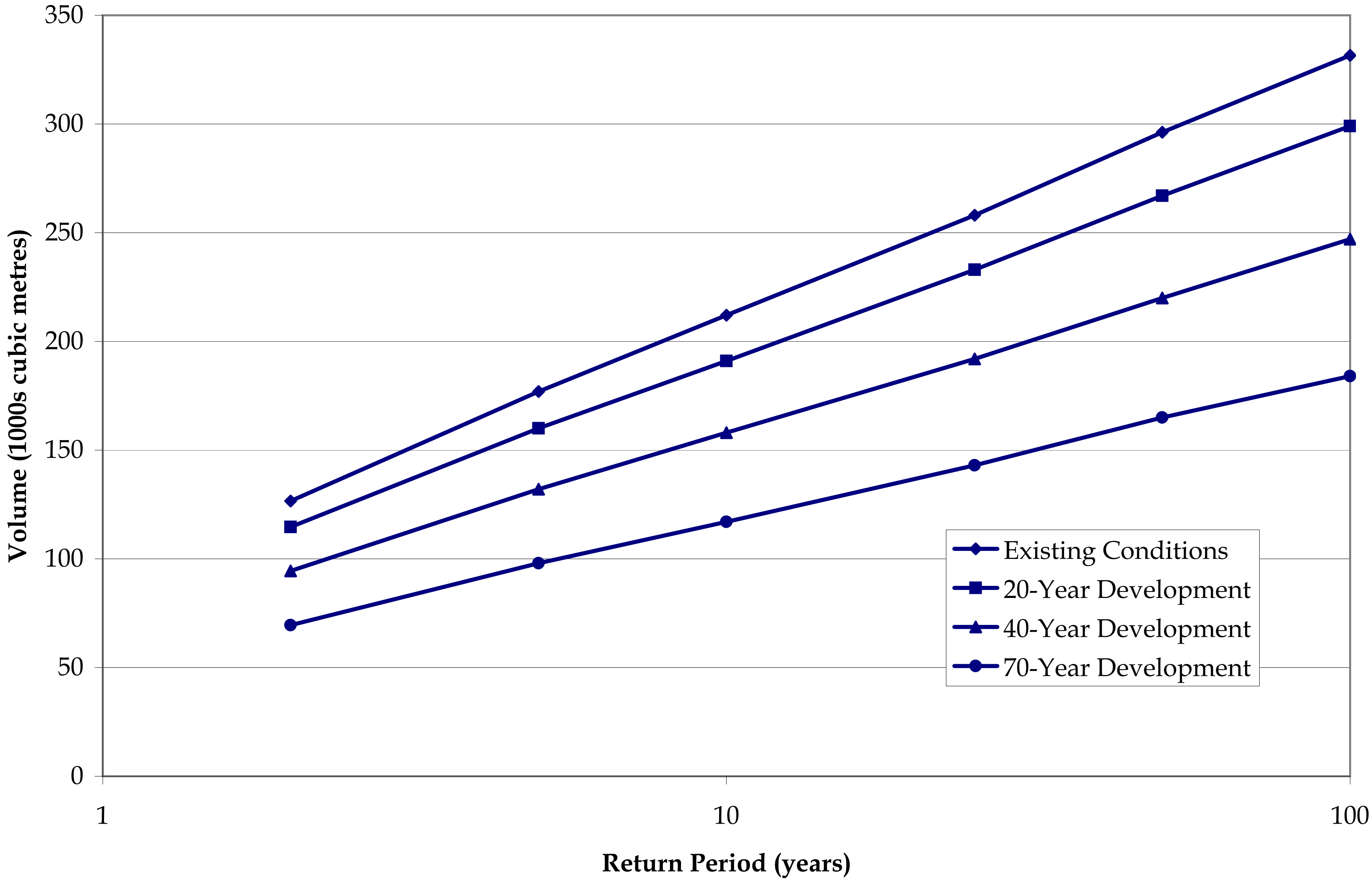


Figure C.20

OUTLET O6-2: VOLUME OF WATER INTERCEPTED BY YEAR-OF-DEVELOPMENT AND RETURN PERIOD
CGC INC. - WINDSOR PLANT
Hants County, Nova Scotia

TABLE C.1

SUMMARY OF DESIGN STORM PARAMETERS
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Return Event	Total Rainfall Depth1 (mm)
2-year	57
5-year	75
10-year	87
25-year	102
50-year	114
100-year	125

Notes:

1 Rainfall depths determined
Rainfall Frequency Atlas of Canada

2 Generated hyetograph for HEC-HMS model assumes a Soil
Conservation Service (SCS) Type III Storm Event Distribution

TABLE C.2a

EXISTING CONDITIONS SUB-CATCHMENT PARAMETERS - WATERSHED 1
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	Area	Impervious Area	Longest Flow Path		Initial Loss	Constant Rate	Lag Time
	km2	%	Length (m)	Slope (m/m)	mm	mm/hr	min
11	0.700	14	1293	0.023	1.0	5	21
12	0.402	3	1350	0.026	0.2	5	20
13	0.427	17	1301	0.023	0.2	5	21
14	0.327	13	636	0.055	0.2	5	9
15	0.522	4	1551	0.030	0.2	5	22
16	0.601	9	1310	0.047	0.2	5	16
17	0.617	14	1268	0.047	0.2	5	15

TABLE C.2b

EXISTING CONDITIONS SUB-CATCHMENT PARAMETERS - WATERSHED 2
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	Area	Impervious Area	Longest Flow Path		Initial Loss	Constant Rate	Lag Time
	km2	%	Length (m)	Slope (m/m)	mm	mm/hr	min
21	0.707	2	1217	0.039	3.0	10	16
22	1.409	4	2430	0.014	3.0	10	40
23	0.436	2	1385	0.045	1.0	5	17
24	1.227	0	1380	0.048	3.0	10	16
25	0.807	0	1605	0.038	3.0	10	20
26	0.555	4	1151	0.052	1.0	5	14
27	0.892	0	1990	0.022	1.0	5	29
28	0.675	3	1741	0.029	0.5	5	24

TABLE C.2c

EXISTING CONDITIONS SUB-CATCHMENT PARAMETERS - WATERSHED 3
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	Area	Impervious Area	Longest Flow Path		Initial Loss	Constant Rate	Lag Time
	km2	%	Length (m)	Slope (m/m)	mm	mm/hr	min
31	0.526	22	1289	0.032	0.2	5	18
32	0.469	4	609	0.089	0.2	5	7
33	0.701	0	1193	0.022	1.0	8	20
34	0.724	8	752	0.002	0.2	5	33
35	0.454	0	1223	0.034	2.0	8	17
36	0.948	0	2239	0.023	0.2	5	31
37	1.303	0	2526	0.022	1.0	5	35

TABLE C.2d

EXISTING CONDITIONS SUB-CATCHMENT PARAMETERS - WATERSHED 4
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	Area	Impervious Area	Longest Flow Path		Initial Loss	Constant Rate	Lag Time
	km2	%	Length (m)	Slope (m/m)	mm	mm/hr	min
41	0.766	3	1120	0.050	0.2	5	14
42	0.701	1	1645	0.022	0.2	5	25
43	0.460	1	1449	0.038	0.2	5	19
44	0.554	8	910	0.044	0.2	5	12
45	0.213	0	525	0.019	0.2	5	11
46	0.324	3	1039	0.014	0.2	5	21
47	0.292	2	1111	0.040	0.2	5	15
48	0.503	2	1285	0.034	0.2	5	18

TABLE C.2e

EXISTING CONDITIONS SUB-CATCHMENT PARAMETERS - WATERSHED 5
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	Area	Impervious Area	Longest Flow Path		Initial Loss	Constant Rate	Lag Time
	km2	%	Length (m)	Slope (m/m)	mm	mm/hr	min
51	1.046	2	1914	0.031	0.5	5	25
52	0.725	23	2000	0.032	1.0	5	26
53	1.653	8	3467	0.018	2.0	5	49

TABLE C.2f

EXISTING CONDITIONS SUB-CATCHMENT PARAMETERS - WATERSHED 6
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	Area	Impervious Area	Longest Flow Path		Initial Loss	Constant Rate	Lag Time
	km2	%	Length (m)	Slope (m/m)	mm	mm/hr	min
61	1.057	0	1774	0.025	2.0	15	25
62	1.287	2	2367	0.002	0.2	15	88
63	1.047	4	1163	0.001	0.2	8	73
64	0.569	0	1449	0.031	1.0	5	20
65	1.181	1	2069	0.024	2.0	10	29
66	0.413	0	1290	0.036	2.0	10	17
67	0.540	0	912	0.051	1.0	5	12
68	1.395	2	2773	0.018	0.2	10	41

TABLE C.3a

END OF 20 YEARS SUB-CATCHMENT PARAMETERS - PIT AND STOCKPILES
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	Area	Impervious Area	Longest Flow Path		Initial Loss	Constant Rate	Lag Time
	km2	%	Length (m)	Slope (m/m)	mm	mm/hr	min
Proposed Mine							
A	0.037	100	250	0.001	1	8	18
B	0.137	100	580	0.043	2	15	24
Stockpile 1							
A	0.113	100	590	0.045	1	8	18
B	0.249	100	875	0.034	1	8	18
C	0.258	100	1122	0.012	1	5	36
Stockpile 2							
A	0.072	100	157	0.053	2	15	24
B	0.212	100	488	0.055	2	15	24
C	0.033	100	219	0.029	1	8	18

TABLE C.3b

END OF 20 YEARS SUB-CATCHMENT PARAMETERS - WATERSHED 1
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	Area	Impervious Area	Longest Flow Path		Initial Loss	Constant Rate	Lag Time
	km2	%	Length (m)	Slope (m/m)	mm	mm/hr	min
11	0.700	14	1293	0.023	1.0	5	21
12	0.402	3	1350	0.026	0.2	5	20
13	0.427	17	1301	0.023	0.2	5	21
14	0.327	13	636	0.055	0.2	5	9
15	0.522	4	1551	0.030	0.2	5	22
16	0.601	9	1310	0.047	0.2	5	16
17	0.617	14	1268	0.047	0.2	5	15

TABLE C.3c

END OF 20 YEARS SUB-CATCHMENT PARAMETERS - WATERSHED 2
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	Area	Impervious Area	Longest Flow Path		Initial Loss	Constant Rate	Lag Time
	km2	%	Length (m)	Slope (m/m)	mm	mm/hr	min
21	0.707	2	1217	0.039	3.0	10	16
22	1.409	4	2430	0.014	3.0	10	40
23	0.436	2	1385	0.045	1.0	5	17
24	1.227	0	1380	0.048	3.0	10	16
25	0.807	0	1605	0.038	3.0	10	20
26	0.555	4	1151	0.052	1.0	5	14
27	0.892	0	1990	0.022	1.0	5	29
28	0.675	3	1741	0.029	0.5	5	24

TABLE 3d

END OF 20 YEARS SUB-CATCHMENT PARAMETERS - WATERSHED 3
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	Area	Impervious Area	Longest Flow Path		Initial Loss	Constant Rate	Lag Time
	km2	%	Length (m)	Slope (m/m)	mm	mm/hr	min
31	0.526	22	1289	0.032	0.2	5	18
32	0.469	4	609	0.089	0.2	5	7
33	0.518	0	1089	0.014	1.0	8	20
34	0.724	8	752	0.002	0.2	5	33
35	0.205	0	348	0.035	2.0	8	17
36	0.948	1	2239	0.023	0.2	5	31
37	1.044	0	2102	0.027	1.0	5	35

TABLE C.3e

END OF 20 YEARS SUB-CATCHMENT PARAMETERS - WATERSHED 4
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	Area	Impervious Area	Longest Flow Path		Initial Loss	Constant Rate	Lag Time
	km2	%	Length (m)	Slope (m/m)	mm	mm/hr	min
41	0.766	3	1120	0.050	0.2	5	14
42	0.701	1	1645	0.022	0.2	5	25
43	0.460	1	1449	0.038	0.2	5	19
44	0.554	8	910	0.044	0.2	5	12
45	0.213	0	525	0.019	0.2	5	11
46	0.324	3	1039	0.014	0.2	5	21
47	0.292	2	1111	0.040	0.2	5	15
48	0.503	2	1285	0.034	0.2	5	18

TABLE C.3f

END OF 20 YEARS SUB-CATCHMENT PARAMETERS - WATERSHED 5
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	Area	Impervious Area	Longest Flow Path		Initial Loss	Constant Rate	Lag Time
	km2	%	Length (m)	Slope (m/m)	mm	mm/hr	min
51	1.046	2	1914	0.031	0.5	5	25
52	0.725	23	2000	0.032	1.0	5	26
53	1.653	8	3467	0.018	2.0	5	49

TABLE C.3g

END OF 20 YEARS SUB-CATCHMENT PARMETERS - WATERSHED 6
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	Area	Impervious Area	Longest Flow Path		Initial Loss	Constant Rate	Lag Time
	km2	%	Length (m)	Slope (m/m)	mm	mm/hr	min
61	0.636	1	982	0.010	2.0	15	25
62	1.287	2	2367	0.002	0.2	15	88
63	1.047	4	1163	0.001	0.2	8	73
64	0.569	0	1449	0.031	1.0	5	20
65	1.181	1	2069	0.024	2.0	10	29
66	0.413	0	1290	0.036	2.0	10	17
67	0.540	0	912	0.051	1.0	5	12
68	1.395	2	2773	0.018	0.2	10	41

TABLE C.4a

END OF 40 YEARS SUB-CATCHMENT PARAMETERS - PIT AND STOCKPILES
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	Area	Impervious Area	Longest Flow Path		Initial Loss	Constant Rate	Lag Time
	km2	%	Length (m)	Slope (m/m)	mm	mm/hr	min
Proposed Mine							
A	0.037	100	250	0.001	1.0	8	18
B	0.203	100	742	0.057	2.0	15	24
C	0.030	100	182	0.095	1.0	5	36
D	0.348	100	919	0.026	2.0	10	30
E	0.052	100	454	0.018	2.0	15	24
F	0.031	100	164	0.060	1.0	5	18
Stockpile 1							
A	0.113	100	590	0.045	1.0	8	18
B	0.249	100	875	0.034	1.0	8	18
C	0.258	100	1122	0.012	1.0	5	36
Stockpile 2							
A	0.072	100	157	0.053	2.0	15	24
B	0.212	100	488	0.055	2.0	15	24
C	0.033	100	219	0.029	1.0	8	18
Stockpile 3							
A	0.142	100	785	0.012	2.0	5	48
B	0.204	100	759	0.049	1.0	5	18
C	0.095	100	386	0.040	2.0	10	18
D	0.184	100	420	0.092	1.0	5	12
E	0.044	100	238	0.049	0.2	10	30

TABLE C.4b

END OF 40 YEARS SUB-CATCHMENT PARAMETERS - WATERSHED 1
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	Area	Impervious Area	Longest Flow Path		Initial Loss	Constant Rate	Lag Time
	km2	%	Length (m)	Slope (m/m)	mm	mm/hr	min
11	0.700	14	1293	0.023	1.0	5	21
12	0.402	3	1350	0.026	0.2	5	20
13	0.427	17	1301	0.023	0.2	5	21
14	0.327	13	636	0.055	0.2	5	9
15	0.522	4	1551	0.030	0.2	5	22
16	0.601	9	1310	0.047	0.2	5	16
17	0.617	14	1268	0.047	0.2	5	15

TABLE C.4c

END OF 40 YEARS SUB-CATCHMENT PARAMETERS - WATERSHED 2
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	Area	Impervious Area	Longest Flow Path		Initial Loss	Constant Rate	Lag Time
	km2	%	Length (m)	Slope (m/m)	mm	mm/hr	min
21	0.707	2	1217	0.039	3.0	10	16
22	1.409	4	2430	0.014	3.0	10	40
23	0.436	2	1385	0.045	1.0	5	17
24	1.227	0	1380	0.048	3.0	10	16
25	0.807	0	1605	0.038	3.0	10	20
26	0.555	4	1151	0.052	1.0	5	14
27	0.892	0	1990	0.022	1.0	5	29
28	0.675	3	1741	0.029	0.5	5	24

TABLE C.4d

END OF 40 YEARS SUB-CATCHMENT PARAMETERS - WATERSHED 3
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	Area	Impervious Area	Longest Flow Path		Initial Loss	Constant Rate	Lag Time
	km2	%	Length (m)	Slope (m/m)	mm	mm/hr	min
31	0.526	22	1289	0.032	0.2	5	18
32	0.469	4	609	0.089	0.2	5	7
33	0.518	0	1089	0.014	1.0	8	20
34	0.724	8	752	0.002	0.2	5	33
35	0.205	0	348	0.035	2.0	8	17
36	0.948	1	2239	0.023	0.2	5	31
37	1.044	0	2102	0.027	1.0	5	35

TABLE C.4e

END OF 40 YEARS SUB-CATCHMENT PARAMETERS - WATERSHED 4
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	Area	Impervious Area	Longest Flow Path		Initial Loss	Constant Rate	Lag Time
	km2	%	Length (m)	Slope (m/m)	mm	mm/hr	min
41	0.766	3	1120	0.050	0.2	5	14
42	0.701	1	1645	0.022	0.2	5	25
43	0.460	1	1449	0.038	0.2	5	19
44	0.554	8	910	0.044	0.2	5	12
45	0.213	0	525	0.019	0.2	5	11
46	0.324	3	1039	0.014	0.2	5	21
47	0.292	2	1111	0.040	0.2	5	15
48	0.503	2	1285	0.034	0.2	5	18

TABLE C.4f

END OF 40 YEARS SUB-CATCHMENT PARAMETERS - WATERSHED 5
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	Area	Impervious Area	Longest Flow Path		Initial Loss	Constant Rate	Lag Time
	km2	%	Length (m)	Slope (m/m)	mm	mm/hr	min
51	1.046	2	1914	0.031	0.5	5	25
52	0.725	23	2000	0.032	1.0	5	26
53	1.511	9	3314	0.013	2.0	5	48

TABLE C.4g

END OF 40 YEARS SUB-CATCHMENT PARAMETERS - WATERSHED 6
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	Area	Impervious Area	Longest Flow Path		Initial Loss	Constant Rate	Lag Time
	km2	%	Length (m)	Slope (m/m)	mm	mm/hr	min
61	0.517	1	982	0.010	2.0	15	24
62	1.287	2	2367	0.002	0.2	15	88
63	1.047	4	1163	0.001	0.2	8	73
64	0.364	0	690	0.012	1.0	5	18
65	0.802	3	2046	0.025	2.0	10	30
66	0.318	1	1290	0.036	2.0	10	18
67	0.355	0	970	0.014	1.0	5	12
68	1.351	2	2534	0.015	0.2	10	30

TABLE C.5a

END OF QUARRY LIFE (70 YEARS) SUB-CATCHMENT PARAMETERS - PIT AND STOCKPILES
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	Area	Impervious Area	Longest Flow Path		Initial Loss	Constant Rate	Lag Time
	km2	%	Length (m)	Slope (m/m)	mm	mm/hr	min
Proposed Mine							
A	0.037	100	250	0.001	1.0	8	18
B	0.212	100	742	0.057	2.0	15	24
C	0.053	100	182	0.095	1.0	5	36
D	0.726	100	919	0.026	2.0	10	30
E	0.052	100	454	0.018	2.0	15	24
F	0.031	100	164	0.060	1.0	5	18
G	0.086	100	449	0.008	0.5	5	24
H	0.052	100	340	0.087	1.0	5	24
I	0.292	100	1055	0.009	2.0	5	48
J	0.130	100	298	0.091	2.0	10	18
K	0.193	100	447	0.043	1.0	5	30
Stockpile 1							
A	0.113	100	590	0.045	1.0	8	18
B	0.249	100	875	0.034	2.0	8	18
C	0.258	100	1122	0.012	1.0	5	36
Stockpile 2							
A	0.072	100	157	0.053	2.0	15	24
B	0.212	100	488	0.055	2.0	15	24
C	0.032	100	219	0.029	1.0	8	18
Stockpile 3							
A	0.142	100	785	0.012	2.0	5	48
B	0.204	100	759	0.049	1.0	5	18
C	0.095	100	386	0.040	2.0	10	18
D	0.184	100	420	0.092	1.0	5	12
E	0.044	100	238	0.049	0.2	10	30

TABLE C.5b

END OF QUARRY LIFE (70 YEARS) SUB-CATCHMENT PARAMETERS - WATERSHED 1
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	Area	Impervious Area	Longest Flow Path		Initial Loss	Constant Rate	Lag Time
	km2	%	Length (m)	Slope (m/m)	mm	mm/hr	min
11	0.700	14	1293	0.023	1.0	5	21
12	0.402	3	1350	0.026	0.2	5	20
13	0.427	17	1301	0.023	0.2	5	21
14	0.327	13	636	0.055	0.2	5	9
15	0.522	4	1551	0.030	0.2	5	22
16	0.601	9	1310	0.047	0.2	5	16
17	0.617	14	1268	0.047	0.2	5	15

TABLE C.5c

END OF QUARRY LIFE (70 YEARS) SUB-CATCHMENT PARAMETERS - WATERSHED 2
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	Area	Impervious Area	Longest Flow Path		Initial Loss	Constant Rate	Lag Time
	km2	%	Length (m)	Slope (m/m)	mm	mm/hr	min
21	0.707	2	1217	0.039	3.0	10	16
22	1.409	4	2430	0.014	3.0	10	40
23	0.436	2	1385	0.045	1.0	5	17
24	1.227	0	1380	0.048	3.0	10	16
25	0.807	0	1605	0.038	3.0	10	20
26	0.555	4	1151	0.052	1.0	5	14
27	0.892	0	1990	0.022	1.0	5	29
28	0.675	3	1741	0.029	0.5	5	24

TABLE C.5d

END OF QUARRY LIFE (70 YEARS) SUB-CATCHMENT PARAMETERS - WATERSHED 3
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	Area	Impervious Area	Longest Flow Path		Initial Loss	Constant Rate	Lag Time
	km2	%	Length (m)	Slope (m/m)	mm	mm/hr	min
31	0.526	22	1289	0.032	0.2	5	18
32	0.469	4	609	0.089	0.2	5	7
33	0.518	0	1089	0.014	1.0	8	20
34	0.724	8	752	0.002	0.2	5	33
35	0.205	0	348	0.035	2.0	8	17
36	0.948	1	2239	0.023	0.2	5	31
37	0.992	0	1920	0.018	1.0	5	35

TABLE C.5e

END OF QUARRY LIFE (70 YEARS) SUB-CATCHMENT PARAMETERS - WATERSHED 4
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	Area	Impervious Area	Longest Flow Path		Initial Loss	Constant Rate	Lag Time
	km2	%	Length (m)	Slope (m/m)	mm	mm/hr	min
41	0.766	3	1120	0.050	0.2	5	14
42	0.701	1	1645	0.022	0.2	5	25
43	0.460	1	1449	0.038	0.2	5	19
44	0.554	8	910	0.044	0.2	5	12
45	0.213	0	525	0.019	0.2	5	11
46	0.324	3	1039	0.014	0.2	5	21
47	0.292	2	1111	0.040	0.2	5	15
48	0.503	2	1285	0.034	0.2	5	18

TABLE C.5f

END OF QUARRY LIFE (70 YEARS) SUB-CATCHMENT PARAMETERS - WATERSHED 5
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	Area	Impervious Area	Longest Flow Path		Initial Loss	Constant Rate	Lag Time
	km2	%	Length (m)	Slope (m/m)	mm	mm/hr	min
51	0.960	2	1914	0.031	0.5	5	24
52	0.674	25	1660	0.021	1.0	5	24
53	1.219	11	2375	0.013	2.0	5	48

TABLE C.5g

END OF QUARRY LIFE (70 YEARS) SUB-CATCHMENT PARAMETERS - WATERSHED 6
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	Area	Impervious Area	Longest Flow Path		Initial Loss	Constant Rate	Lag Time
	km2	%	Length (m)	Slope (m/m)	mm	mm/hr	min
61	0.517	1	982	0.010	2.0	15	24
62	1.287	2	2367	0.002	0.2	15	88
63	1.047	4	1163	0.001	0.2	8	73
64	0.364	0	690	0.012	1.0	5	18
65	0.262	5	793	0.035	2.0	10	30
66	0.188	0	991	0.020	2.0	10	18
67	0.355	0	970	0.014	1.0	5	12
68	1.351	2	2534	0.015	0.2	10	30

TABLE C.6a

EXISTING CONDITIONS SUMMARY OF MODEL SCENARIO RESULTS - RUNOFF PEAK DISCHARGE AND VOLUME - WATERSHED 1
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	2-year		5-year		10-year		25-year		50-year		100-year	
	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)
11	0.8	37	1.1	50	1.3	59	1.5	70	1.8	80	2.0	89
12	0.4	19	0.6	26	0.7	31	0.8	37	1.0	43	1.1	48
13	0.5	23	0.7	31	0.8	36	1.0	44	1.1	50	1.2	55
14	0.4	17	0.5	23	0.6	27	0.7	33	0.8	37	0.9	41
15	0.5	25	0.8	34	0.9	40	1.1	49	1.3	56	1.4	63
16	0.6	30	0.9	41	1.1	49	1.3	59	1.5	67	1.7	75
17	0.7	33	0.9	44	1.1	52	1.4	62	1.6	71	1.7	79

TABLE C.6b

EXISTING CONDITIONS SUMMARY OF MODEL SCENARIO RESULTS - RUNOFF PEAK DISCHARGE AND VOLUME - WATERSHED 2
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	2-year		5-year		10-year		25-year		50-year		100-year	
	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)
21	0.6	26	0.8	36	1.0	43	1.2	52	1.4	60	1.6	67
22	1.1	53	1.6	73	1.9	87	2.4	105	2.8	120	3.1	134
23	0.4	21	0.6	28	0.8	33	0.9	40	1.0	46	1.2	52
24	0.9	44	1.4	62	1.7	73	2.1	89	2.4	102	2.7	114
25	0.6	29	0.9	41	1.1	48	1.4	58	1.6	67	1.8	75
26	0.6	27	0.8	36	1.0	43	1.2	52	1.3	60	1.5	67
27	0.9	41	1.3	56	1.5	67	1.8	81	2.1	93	2.4	104
28	0.7	32	1.0	43	1.2	52	1.4	63	1.6	72	1.8	80

TABLE C.6c

EXISTING CONDITIONS SUMMARY OF MODEL SCENARIO RESULTS - RUNOFF PEAK DISCHARGE AND VOLUME - WATERSHED 3
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	2-year		5-year		10-year		25-year		50-year		100-year	
	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)
31	0.6	30	0.8	39	1.0	46	1.2	55	1.4	63	1.5	70
32	0.5	23	0.7	31	0.8	36	1.0	44	1.1	50	1.3	56
33	0.6	28	0.9	38	1.0	45	1.3	55	1.5	63	1.6	70
34	0.8	36	1.1	48	1.3	58	1.5	69	1.8	79	2.0	89
35	0.4	18	0.6	25	0.7	29	0.8	36	0.9	41	1.1	46
36	1.0	44	1.3	60	1.6	71	2.0	87	2.3	99	2.5	111
37	1.3	60	1.8	82	2.2	97	2.7	118	3.1	136	3.5	152

TABLE C.6d

EXISTING CONDITIONS SUMMARY OF MODEL SCENARIO RESULTS - RUNOFF PEAK DISCHARGE AND VOLUME - WATERSHED 4
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	2-year		5-year		10-year		25-year		50-year		100-year	
	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)
41	0.8	37	1.1	50	1.3	59	1.6	71	1.8	82	2.1	92
42	0.7	33	1.0	44	1.2	53	1.5	64	1.7	74	1.9	83
43	0.5	22	0.7	29	0.8	35	1.0	42	1.1	49	1.2	55
44	0.6	28	0.8	37	1.0	44	1.2	54	1.4	61	1.5	68
45	0.2	10	0.3	13	0.4	16	0.4	19	0.5	22	0.6	25
46	0.3	15	0.5	21	0.6	25	0.7	30	0.8	35	0.9	39
47	0.3	14	0.4	19	0.5	22	0.6	27	0.7	31	0.8	35
48	0.5	24	0.7	32	0.9	38	1.1	46	1.2	53	1.3	60

TABLE C.6e

EXISTING CONDITIONS SUMMARY OF MODEL SCENARIO RESULTS - RUNOFF PEAK DISCHARGE AND VOLUME - WATERSHED 5
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	2-year		5-year		10-year		25-year		50-year		100-year	
	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)
51	1.1	49	1.5	67	1.8	80	2.2	97	2.5	111	2.8	124
52	0.9	41	1.2	55	1.4	65	1.7	77	1.9	87	2.1	97
53	1.7	82	2.4	111	2.9	131	3.5	158	4.0	181	4.5	202

TABLE C.6f

EXISTING CONDITIONS SUMMARY OF MODEL SCENARIO RESULTS - RUNOFF PEAK DISCHARGE AND VOLUME - WATERSHED 6
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	2-year		5-year		10-year		25-year		50-year		100-year	
	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)
61	0.6	31	1.0	44	1.2	53	1.5	65	1.8	76	2.0	85
62	0.7	38	1.1	54	1.4	65	1.8	80	2.1	92	2.3	103
63	0.9	43	1.3	58	1.5	69	1.9	83	2.2	95	2.4	106
64	0.6	26	0.8	36	1.0	43	1.2	52	1.4	59	1.5	67
65	0.9	44	1.3	61	1.6	72	2.0	87	2.3	100	2.6	112
66	0.3	15	0.5	21	0.6	25	0.7	30	0.8	34	0.9	38
67	0.5	25	0.8	34	0.9	41	1.1	49	1.3	57	1.4	63
68	1.1	51	1.6	71	1.9	84	2.4	102	2.7	117	3.1	131

TABLE C.7a

END OF 20 YEARS SUMMARY OF MODEL SCENARIO RESULTS - RUNOFF PEAK DISCHARGE AND VOLUME - WATERSHED 1
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	2-year		5-year		10-year		25-year		50-year		100-year	
	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)
11	0.8	37	1.1	50	1.3	59	1.5	70	1.8	80	2.0	89
12	0.4	19	0.6	26	0.7	31	0.8	37	1.0	43	1.1	48
13	0.5	23	0.7	31	0.8	36	1.0	44	1.1	50	1.2	55
14	0.4	17	0.5	23	0.6	27	0.7	33	0.8	37	0.9	41
15	0.5	25	0.8	34	0.9	40	1.1	49	1.3	56	1.4	63
16	0.6	30	0.9	41	1.1	49	1.3	59	1.5	67	1.7	75
17	0.7	33	0.9	44	1.1	52	1.4	62	1.6	71	1.7	79

TABLE C.7b

END OF 20 YEARS SUMMARY OF MODEL SCENARIO RESULTS - RUNOFF PEAK DISCHARGE AND VOLUME - WATERSHED 2
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	2-year		5-year		10-year		25-year		50-year		100-year	
	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)
21	0.6	26	0.8	36	1.0	43	1.2	52	1.4	60	1.6	67
22	1.1	53	1.6	73	1.9	87	2.4	105	2.8	120	3.1	134
23	0.4	21	0.6	28	0.8	33	0.9	40	1.0	46	1.2	52
24	0.9	44	1.4	62	1.7	73	2.1	89	2.4	102	2.7	114
25	0.6	29	0.9	41	1.1	48	1.4	58	1.6	67	1.8	75
26	0.6	27	0.8	36	1.0	43	1.2	52	1.3	60	1.5	67
27	0.9	41	1.3	56	1.5	67	1.8	81	2.1	93	2.4	104
28	0.7	32	1.0	43	1.2	52	1.4	63	1.6	72	1.8	80

TABLE C.7c

END OF 20 YEARS SUMMARY OF MODEL SCENARIO RESULTS - RUNOFF PEAK DISCHARGE AND VOLUME - WATERSHED 3
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	2-year		5-year		10-year		25-year		50-year		100-year	
	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)
31	0.6	30	0.8	39	1.0	46	1.2	55	1.4	63	1.5	70
32	0.5	23	0.7	31	0.8	36	1.0	44	1.1	50	1.3	56
33	0.4	21	0.6	28	0.8	33	0.9	40	1.1	46	1.2	52
34	0.8	36	1.1	48	1.3	58	1.5	69	1.8	79	2.0	89
35	0.2	8	0.3	11	0.3	13	0.4	16	0.4	19	0.5	21
36	1.0	44	1.3	60	1.6	71	2.0	87	2.3	99	2.5	111
37	1.0	48	1.5	65	1.8	78	2.2	95	2.5	109	2.8	122

TABLE C.7d

END OF 20 YEARS SUMMARY OF MODEL SCENARIO RESULTS - RUNOFF PEAK DISCHARGE AND VOLUME - WATERSHED 4
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	2-year		5-year		10-year		25-year		50-year		100-year	
	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)
41	0.8	37	1.1	50	1.3	59	1.6	71	1.8	82	2.1	92
42	0.7	33	1.0	44	1.2	53	1.5	64	1.7	74	1.9	83
43	0.5	22	0.7	29	0.8	35	1.0	42	1.1	49	1.2	55
44	0.6	28	0.8	37	1.0	44	1.2	54	1.4	61	1.5	68
45	0.2	10	0.3	13	0.4	16	0.4	19	0.5	22	0.6	25
46	0.3	15	0.5	21	0.6	25	0.7	30	0.8	35	0.9	39
47	0.3	14	0.4	19	0.5	22	0.6	27	0.7	31	0.8	35
48	0.5	24	0.7	32	0.9	38	1.1	46	1.2	53	1.3	60

TABLE C.7e

END OF 20 YEARS SUMMARY OF MODEL SCENARIO RESULTS - RUNOFF PEAK DISCHARGE AND VOLUME - WATERSHED 5
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	2-year		5-year		10-year		25-year		50-year		100-year	
	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)
51	1.1	49	1.5	67	1.8	80	2.2	97	2.5	111	2.8	124
52	0.9	41	1.2	55	1.4	65	1.7	77	1.9	87	2.1	97
53	1.7	82	2.4	111	2.9	131	3.5	158	4.0	181	4.5	202

TABLE C.7f

END OF 20 YEARS SUMMARY OF MODEL SCENARIO RESULTS - RUNOFF PEAK DISCHARGE AND VOLUME - WATERSHED 6
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	2-year		5-year		10-year		25-year		50-year		100-year	
	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)
61	0.4	18	0.6	27	0.7	32	0.9	40	1.1	46	1.2	51
62	0.7	38	1.1	54	1.4	65	1.8	80	2.1	92	2.3	103
63	0.9	43	1.3	58	1.5	69	1.9	83	2.2	95	2.4	106
64	0.6	26	0.8	36	1.0	43	1.2	52	1.4	59	1.5	67
65	0.9	44	1.3	61	1.6	72	2.0	87	2.3	100	2.6	112
66	0.3	15	0.5	21	0.6	25	0.7	30	0.8	34	0.9	38
67	0.5	25	0.8	34	0.9	41	1.1	49	1.3	57	1.4	63
68	1.1	51	1.6	71	1.9	84	2.4	102	2.7	117	3.1	131

TABLE C.8a

END OF 40 YEARS SUMMARY OF MODEL SCENARIO RESULTS - RUNOFF PEAK DISCHARGE AND VOLUME - WATERSHED 1
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	2-year		5-year		10-year		25-year		50-year		100-year	
	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)
11	0.8	37	1.1	50	1.3	59	1.5	70	1.8	80	2.0	89
12	0.4	19	0.6	26	0.7	31	0.8	37	1.0	43	1.1	48
13	0.5	23	0.7	31	0.8	36	1.0	44	1.1	50	1.2	55
14	0.4	17	0.5	23	0.6	27	0.7	33	0.8	37	0.9	41
15	0.5	25	0.8	34	0.9	40	1.1	49	1.3	56	1.4	63
16	0.6	30	0.9	41	1.1	49	1.3	59	1.5	67	1.7	75
17	0.7	33	0.9	44	1.1	52	1.4	62	1.6	71	1.7	79

TABLE C.8b

END OF 40 YEARS SUMMARY OF MODEL SCENARIO RESULTS - RUNOFF PEAK DISCHARGE AND VOLUME - WATERSHED 2
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	2-year		5-year		10-year		25-year		50-year		100-year	
	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)
21	0.6	26	0.8	36	1.0	43	1.2	52	1.4	60	1.6	67
22	1.1	53	1.6	73	1.9	87	2.4	105	2.8	120	3.1	134
23	0.4	21	0.6	28	0.8	33	0.9	40	1.0	46	1.2	52
24	0.9	44	1.4	62	1.7	73	2.1	89	2.4	102	2.7	114
25	0.6	29	0.9	41	1.1	48	1.4	58	1.6	67	1.8	75
26	0.6	27	0.8	36	1.0	43	1.2	52	1.3	60	1.5	67
27	0.9	41	1.3	56	1.5	67	1.8	81	2.1	93	2.4	104
28	0.7	32	1.0	43	1.2	52	1.4	63	1.6	72	1.8	80

TABLE C.8c

END OF 40 YEARS SUMMARY OF MODEL SCENARIO RESULTS - RUNOFF PEAK DISCHARGE AND VOLUME - WATERSHED 3
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	2-year		5-year		10-year		25-year		50-year		100-year	
	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)
31	0.6	30	0.8	39	1.0	46	1.2	55	1.4	63	1.5	70
32	0.5	23	0.7	31	0.8	36	1.0	44	1.1	50	1.3	56
33	0.4	21	0.6	28	0.8	33	0.9	40	1.1	46	1.2	52
34	0.8	36	1.1	48	1.3	58	1.5	69	1.8	79	2.0	89
35	0.2	8	0.3	11	0.3	13	0.4	16	0.4	19	0.5	21
36	1.0	44	1.3	60	1.6	71	2.0	87	2.3	99	2.5	111
37	1.0	47	1.4	64	1.7	76	2.1	92	2.4	106	2.7	118

TABLE C.8d

END OF 40 YEARS SUMMARY OF MODEL SCENARIO RESULTS - RUNOFF PEAK DISCHARGE AND VOLUME - WATERSHED 4
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	2-year		5-year		10-year		25-year		50-year		100-year	
	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)
41	0.8	37	1.1	50	1.3	59	1.6	71	1.8	82	2.1	92
42	0.7	33	1.0	44	1.2	53	1.5	64	1.7	74	1.9	83
43	0.5	22	0.7	29	0.8	35	1.0	42	1.1	49	1.2	55
44	0.6	28	0.8	37	1.0	44	1.2	54	1.4	61	1.5	68
45	0.2	10	0.3	13	0.4	16	0.4	19	0.5	22	0.6	25
46	0.3	15	0.5	21	0.6	25	0.7	30	0.8	35	0.9	39
47	0.3	14	0.4	19	0.5	22	0.6	27	0.7	31	0.8	35
48	0.5	24	0.7	32	0.9	38	1.1	46	1.2	53	1.3	60

TABLE C.8e

END OF 40 YEARS SUMMARY OF MODEL SCENARIO RESULTS - RUNOFF PEAK DISCHARGE AND VOLUME - WATERSHED 5
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	2-year		5-year		10-year		25-year		50-year		100-year	
	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)
51	1.1	49	1.5	67	1.8	80	2.2	97	2.5	111	2.8	124
52	0.9	41	1.2	55	1.4	65	1.7	77	1.9	87	2.1	97
53	1.6	75	2.2	102	2.7	121	3.2	146	3.7	166	4.1	186

TABLE C.8f

END OF 40 YEARS SUMMARY OF MODEL SCENARIO RESULTS - RUNOFF PEAK DISCHARGE AND VOLUME - WATERSHED 6
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	2-year		5-year		10-year		25-year		50-year		100-year	
	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)
61	0.3	15	0.5	22	0.6	26	0.7	32	0.9	37	1.0	42
62	0.7	38	1.1	54	1.4	65	1.8	80	2.1	92	2.3	103
63	0.9	43	1.3	58	1.5	69	1.9	83	2.2	95	2.4	106
64	0.4	17	0.5	23	0.6	27	0.8	33	0.9	38	1.0	43
65	0.6	30	0.9	42	1.1	49	1.4	60	1.6	68	1.8	77
66	0.2	12	0.4	16	0.4	19	0.5	23	0.6	26	0.7	30
67	0.4	16	0.5	22	0.6	27	0.7	32	0.8	37	0.9	42
68	1.1	50	1.5	69	1.9	82	2.3	99	2.6	114	3.0	127

TABLE C.9a

END OF QUARRY LIFE (70 YEARS) SUMMARY OF MODEL SCENARIO RESULTS - RUNOFF PEAK DISCHARGE AND VOLUME - WATERSHED 1
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	2-year		5-year		10-year		25-year		50-year		100-year	
	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)
11	0.8	37	1.1	50	1.3	59	1.5	70	1.8	80	2.0	89
12	0.4	19	0.6	26	0.7	31	0.8	37	1.0	43	1.1	48
13	0.5	23	0.7	31	0.8	36	1.0	44	1.1	50	1.2	55
14	0.4	17	0.5	23	0.6	27	0.7	33	0.8	37	0.9	41
15	0.5	25	0.8	34	0.9	40	1.1	49	1.3	56	1.4	63
16	0.6	30	0.9	41	1.1	49	1.3	59	1.5	67	1.7	75
17	0.7	33	0.9	44	1.1	52	1.4	62	1.6	71	1.7	79

TABLE C.9b

END OF QUARRY LIFE (70 YEARS) SUMMARY OF MODEL SCENARIO RESULTS - RUNOFF PEAK DISCHARGE AND VOLUME - WATERSHED 2
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	2-year		5-year		10-year		25-year		50-year		100-year	
	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)
21	0.6	26	0.8	36	1.0	43	1.2	52	1.4	60	1.6	67
22	1.1	53	1.6	73	1.9	87	2.4	105	2.8	120	3.1	134
23	0.4	21	0.6	28	0.8	33	0.9	40	1.0	46	1.2	52
24	0.9	44	1.4	62	1.7	73	2.1	89	2.4	102	2.7	114
25	0.6	29	0.9	41	1.1	48	1.4	58	1.6	67	1.8	75
26	0.6	27	0.8	36	1.0	43	1.2	52	1.3	60	1.5	67
27	0.9	41	1.3	56	1.5	67	1.8	81	2.1	93	2.4	104
28	0.7	32	1.0	43	1.2	52	1.4	63	1.6	72	1.8	80

TABLE C.9c

END OF QUARRY LIFE (70 YEARS) SUMMARY OF MODEL SCENARIO RESULTS - RUNOFF PEAK DISCHARGE AND VOLUME - WATERSHED 3
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	2-year		5-year		10-year		25-year		50-year		100-year	
	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)
31	0.6	30	0.8	39	1.0	46	1.2	55	1.4	63	1.5	70
32	0.5	23	0.7	31	0.8	36	1.0	44	1.1	50	1.3	56
33	0.4	21	0.6	28	0.8	34	0.9	41	1.1	46	1.2	52
34	0.8	36	1.1	48	1.3	58	1.5	69	1.8	79	2.0	89
35	0.2	8	0.3	11	0.3	13	0.4	16	0.4	18	0.5	21
36	1.0	44	1.3	60	1.6	71	2.0	87	2.3	99	2.5	111
37	1.0	46	1.4	62	1.7	74	2.0	90	2.3	103	2.6	116

TABLE C.9d

END OF QUARRY LIFE (70 YEARS) SUMMARY OF MODEL SCENARIO RESULTS - RUNOFF PEAK DISCHARGE AND VOLUME - WATERSHED 4
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	2-year		5-year		10-year		25-year		50-year		100-year	
	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)
41	0.8	37	1.1	50	1.3	59	1.6	71	1.8	82	2.1	92
42	0.7	33	1.0	44	1.2	53	1.5	64	1.7	74	1.9	83
43	0.5	22	0.7	29	0.8	35	1.0	42	1.1	49	1.2	55
44	0.6	28	0.8	37	1.0	44	1.2	54	1.4	61	1.5	68
45	0.2	10	0.3	13	0.4	16	0.4	19	0.5	22	0.6	25
46	0.3	15	0.5	21	0.6	25	0.7	30	0.8	35	0.9	39
47	0.3	14	0.4	19	0.5	22	0.6	27	0.7	31	0.8	35
48	0.5	24	0.7	32	0.9	38	1.1	46	1.2	53	1.3	60

TABLE C.9e

END OF QUARRY LIFE (70 YEARS) SUMMARY OF MODEL SCENARIO RESULTS - RUNOFF PEAK DISCHARGE AND VOLUME - WATERSHED 5
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	2-year		5-year		10-year		25-year		50-year		100-year	
	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)	Peak Discharge (m^3/s)	Volume ($1000\ m^3$)
51	1.0	45	1.4	61	1.7	73	2.0	89	2.3	102	2.6	114
52	0.8	39	1.1	52	1.3	61	1.6	72	1.8	82	2.0	91
53	1.3	62	1.8	84	2.2	99	2.6	119	3.0	136	3.4	152

TABLE C.9f

END OF QUARRY LIFE (70 YEARS) SUMMARY OF MODEL SCENARIO RESULTS - RUNOFF PEAK DISCHARGE AND VOLUME - WATERSHED 6
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	2-year		5-year		10-year		25-year		50-year		100-year	
	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)
61	0.3	15	0.5	21	0.6	26	0.7	31	0.8	36	1.0	41
62	0.7	38	1.1	54	1.4	65	1.8	80	2.1	92	2.3	103
63	0.9	43	1.3	58	1.5	69	1.9	83	2.2	95	2.4	106
64	0.4	17	0.5	23	0.6	27	0.8	33	0.9	38	1.0	43
65	0.2	10	0.3	14	0.4	16	0.5	20	0.5	23	0.6	25
66	0.1	7	0.2	9	0.3	11	0.3	14	0.4	16	0.4	18
67	0.4	16	0.5	22	0.6	27	0.7	32	0.8	37	0.9	42
68	1.0	50	1.5	69	1.9	82	2.3	99	2.6	113	3.0	127

TABLE C.10

END OF 20 YEARS SUMMARY OF MODEL SCENARIO RESULTS - RUNOFF PEAK DISCHARGE AND VOLUME - PIT AND STOCKPILES
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	2-year		5-year		10-year		25-year		50-year		100-year	
	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)
Proposed Mine	0.3	10	0.4	13.0	0.4	15	0.5	18	0.6	20	0.6	22
Stockpile 1	1.0	35	1.3	46.5	1.5	54	1.8	63	2.0	71	2.2	78
Stockpile 2	0.5	18	0.7	23.8	0.8	28	0.9	32	1.0	36	1.1	40

TABLE C.11

END OF 40 YEARS SUMMARY OF MODEL SCENARIO RESULTS - RUNOFF PEAK DISCHARGE AND VOLUME - PIT AND STOCKPILES
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	**2-year**		**5-year**		**10-year**		**25-year**		**50-year**		**100-year**	
	Peak Discharge (m^3/s)	**Volume** (1000 m^3)	**Peak Discharge** (m^3/s)	**Volume** (1000 m^3)	**Peak Discharge** (m^3/s)	**Volume** (1000 m^3)	**Peak Discharge** (m^3/s)	**Volume** (1000 m^3)	**Peak Discharge** (m^3/s)	**Volume** (1000 m^3)	**Peak Discharge** (m^3/s)	**Volume** (1000 m^3)
Proposed Mine	1.1	40	1.5	53	1.7	61	2.0	72	2.3	80	2.5	88
Stockpile 1	1.0	35	1.3	47	1.5	54	1.8	63	2.0	71	2.2	78
Stockpile 2	0.5	18	0.7	24	0.8	28	0.9	32	1.0	36	1.1	40
Stockpile 3	1.1	38	1.4	50	1.7	58	1.9	68	2.2	76	2.4	84

TABLE C.12

END OF QUARRY LIFE (70 YEARS) SUMMARY OF MODEL SCENARIO RESULTS - RUNOFF PEAK DISCHARGE AND VOLUME - PIT AND STOCKPILES
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Sub-Catchment ID	2-year		5-year		10-year		25-year		50-year		100-year	
	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)	Peak Discharge (m^3/s)	Volume (1000 m^3)
Proposed Mine	3.0	105	3.9	138	4.5	160	5.3	187	5.9	209	6.5	229
Stockpiles 1	1.0	35	1.3	47	1.5	54	1.8	63	2.0	71	2.2	78
Stockpiles 2	0.5	18	0.7	24	0.8	28	0.9	32	1.0	36	1.1	40
Stockpiles 3	1.1	38	1.4	50	1.7	58	1.9	68	2.2	76	2.4	84

TABLE C.13

COMPARISON BETWEEN OUTLET DISCHARGE VOLUMES
FOR EXISTING CONDITIONS, 20-YEAR, 40-YEAR, AND END OF QUARRY LIFE
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Outlet ID	Area km^2	2yr Event Volume $1000m^3$	5yr Event Volume $1000m^3$	10yr Event Volume $1000m^3$	25yr Event Volume $1000m^3$	50yr Event Volume $1000m^3$	100yr Event Volume $1000m^3$
EX O1-1	2.979	151	204	241	290	331	370
20yr O1-1	2.979	151	204	241	290	331	370
40yr O1-1	2.979	151	204	241	290	331	370
EQL O1-1	2.979	151	204	241	290	331	370
EX O1-2	0.617	33	44	52	62	71	79
20yr O1-2	0.617	33	44	52	62	71	79
40yr O1-2	0.617	33	44	52	62	71	79
EQL O1-2	0.617	33	44	52	62	71	79
EX O2-1	2.116	79	109	129	157	179	201
20yr O2-1	2.116	79	109	129	157	179	201
40yr O2-1	2.116	79	109	129	157	179	201
EQL O2-1	2.116	79	109	129	157	179	201
EX O2-2	0.436	21	28	33	40	46	52
20yr O2-2	0.436	21	28	33	40	46	52
40yr O2-2	0.436	21	28	33	40	46	52
EQL O2-2	0.436	21	28	33	40	46	52
EX O2-3	3.481	141	193	230	279	320	358
20yr O2-3	3.481	141	193	230	279	320	358
40yr O2-3	3.481	141	193	230	279	320	358
EQL O2-3	3.481	141	193	230	279	320	358
EX O2-4	0.675	32	43	52	63	72	80
20yr O2-4	0.675	32	43	52	63	72	80
40yr O2-4	0.675	32	43	52	63	72	80
EQL O2-4	0.675	32	43	52	63	72	80
EX O3-1	1.696	80	107	127	154	175	196
20yr O3-1	1.513	72	98	116	139	159	178
40yr O3-1	1.513	72	98	116	139	159	178
EQL O3-1	1.514	72	98	116	139	159	178
EX O3-2	3.429	157	213	254	308	352	395
20yr O3-2	2.921	135	184	219	265	304	340
40yr O3-2	2.891	134	182	217	262	301	337
EQL O3-2	2.869	133	180	215	260	298	334

Note: EX stands for Existing Conditions
20yr stands for Mine development after 20 years
40yr stands for Mine development after 40 years
EQL stands for End of Mine Life

TABLE C.14

**COMPARISON BETWEEN OUTLET DISCHARGE VOLUMES
FOR EXISTING CONDITIONS, 20-YEAR, 40-YEAR, AND END OF QUARRY LIFE
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA**

Outlet ID	Area km^2	2yr Event Volume $1000m^3$	5yr Event Volume $1000m^3$	10yr Event Volume $1000m^3$	25yr Event Volume $1000m^3$	50yr Event Volume $1000m^3$	100yr Event Volume $1000m^3$
EX O4-1	1.269	60	81	97	117	134	151
20yr O4-1	1.269	60	81	97	117	134	151
40yr O4-1	1.269	60	81	97	117	134	151
EQL O4-1	1.269	60	81	97	117	134	151
EX O4-2	0.292	14	19	22	27	31	35
20yr O4-2	0.292	14	19	22	27	31	35
40yr O4-2	0.292	14	19	22	27	31	35
EQL O4-2	0.292	14	19	22	27	31	35
EX O4-3	2.252	107	145	173	209	239	268
20yr O4-3	2.252	107	145	173	209	239	268
40yr O4-3	2.252	107	145	173	209	239	268
EQL O4-3	2.252	107	145	173	209	239	268
EX O5-1	1.046	49	67	80	97	111	124
20yr O5-1	1.046	49	67	80	97	111	124
40yr O5-1	1.046	49	67	80	97	111	124
EQL O5-1	0.96	45	61	73	89	102	114
EX O5-2	0.725	41	55	65	77	87	97
20yr O5-2	0.725	41	55	65	77	87	97
40yr O5-2	0.725	41	55	65	77	87	97
EQL O5-2	0.674	39	52	61	72	82	91
EX O5-3	1.653	82	111	131	158	181	202
20yr O5-3	1.653	82	111	131	158	181	202
40yr O5-3	1.511	75	102	121	146	166	186
EQL O5-3	1.219	62	84	99	119	136	152
EX O6-1	3.551	144	197	234	283	324	363
20yr O6-1	3.551	144	197	234	283	324	363
40yr O6-1	3.117	125	171	203	246	281	315
EQL O6-1	3.117	125	171	203	245	281	315
EX O6-2	3.938	127	177	212	258	296	332
20yr O6-2	3.517	115	160	191	233	267	299
40yr O6-2	2.924	94	132	158	192	220	247
EQL O6-2	2.245	70	98	117	143	165	184

Note: EX stands for Existing Conditions
20yr stands for Mine development after 20 years
40yr stands for Mine development after 40 years
EQL stands for End of Mine Life

(C.2) SAMPLING PROTOCOL

SURFACE WATER SAMPLING PROTOCOL – MILLER'S CREEK MINE EXTENSION

There are many different types of waters that can be sampled, requiring different sampling equipment, but most of the samples are treated similarly once they have been collected. In the case of groundwater, the drilling of a well and the contaminants that may be associated with the materials used in well construction are considered to be a part of the overall sampling equipment and are discussed in the subsection on groundwater. The types of water that may be most commonly sampled at contaminated sites include surface waters (rivers, lakes, artificial impoundments, runoff, etc.), groundwaters and springwaters, wastewaters (mine drainage, landfill leachate, industrial effluents, etc.), and ice. Other types of water that may be sampled infrequently, if at all, include saline waters, estuarine waters and brines, waters resulting from atmospheric precipitation and condensation (rain, snow, for, and dew), process water, potable (drinking) waters, glacial melt waters, steam, water for subsurface injections, and water discharges including waterborne materials. The sampling of these latter water sources will not be addressed since most of them require special equipment that is not likely to be needed for the sources of water found at most contaminated sites.

Problems Unique to Sampling Water

Waters are usually very heterogeneous, both spatially and temporally, making it difficult to obtain truly representative samples. Solids with specific gravities only slightly greater than that of water are usually inorganic. They will remain suspended in the flow, but will also form strata in smoothly flowing channels. Oils and solids lighter than water (usually organic) will float on, or near, the surface. Some liquids, such as halogenated organic compounds, are heavier than water and will sink to the bottom. The chemical composition of lakes and ponds may also vary significantly depending on the season. The composition of flowing waters, such as streams, depends on the flow and may also vary with the depth. Stratification within some bodies of water is common. In lakes shallower than about 5 m, wind action usually causes mixing, so neither chemical nor thermal stratification is likely for prolonged periods; however, both may occur in deeper lakes. Rapidly flowing shallow rivers usually show no chemical or thermal stratification, but deep rivers can exhibit chemical stratification with or without accompanying thermal stratification. Stratification may also commonly occur where two streams merge, such as the point where an effluent enters a river. Stratification is also a problem with ocean sampling; various species may be stratified at different depths. In addition, the composition of near shore waters usually differs greatly from waters far from shore. Estuarine sampling is even more complex because stratifications move up rivers unevenly.

Water sample contamination is always a problem, and it increases in importance as the analyte concentration levels decrease. To some extent, contamination sources may depend on the body of water being sampled. For instance, in groundwater monitoring, contamination from well construction materials can be significant and material blanks become very important. However, many potential contamination sources are common to all water samples.

Reviewing Site Information and Reconnaissance

Site information should be reviewed for sources of possible water contamination. The more background information that can be found, the better the sampling and analysis programs can be planned. Also, as described in earlier sections, a preliminary site reconnaissance to inspect the potential locations where water samples will be taken will help significantly in planning the sampling efforts. Surprises can often be avoided and plans can be made to include any special sampling or safety equipment to overcome unusual physical barriers if an adequately planned site visit is made prior to the full sampling effort.

Representative Sampling Approaches

The following general principles apply to the collection of representative water samples:

- Do not include large nonhomogeneous particles, such as leaves and detritus, in the sample.

- In flowing waters, place the sampling apparatus upstream to avoid contamination. Sampling from the upstream side of a bridge enables the collector to see whether any floating material is coming downstream and aids in preventing contamination of the sample.

- Collect a sufficient volume to permit replicate analyses and quality control testing. If not specified, the basic required volume is a summation of the volumes required for analysis of all the parameters of interest.

The collection of representative water samples requires the use of a variety of sampling equipment depending on the station, the medium to be sampled, and the analyte list. The choice of sampler type must be closely related to the analyte list in order to avoid sample contamination. In addition to being analyte and station specific, the sampling equipment must also provide suitable sample volumes and be suitable for use in a wide variety of environmental conditions. Special guidelines, discussed later, apply to obtaining representative samples from groundwaters, rivers, and streams. Additional special guidelines apply to sampling all types of surface waters under winter conditions.

Collecting Representative Water Samples from Rivers and Streams

When collecting surface water samples, direct dipping of the sample container into the stream or water is acceptable unless the sample container contains preservatives. If preserved, a pre-cleaned unpreserved sample container should be used to collect the surface water sample. The surface water sample is then transferred to the appropriate preserved sample container. When collecting surface water samples, submerse the inverted bottle to the desired sample depth and tilt the opening of the sample container upstream to fill. Rinse the sampling bottle three or four times with the water collected above. It is important that the sample bottle be well rinsed with the water to be sampled before the sample is collected unless preservative has been added to the sample bottle prior to sampling or the bottle is sterile.

During surface water sample collection, wading or movement may cause sediment deposits to be re-suspended and can result in biased samples. Wading is acceptable if the stream has a noticeable current and the samples are collected directly in the sample container when faced upstream. If the stream is too deep to wade in or if additional samples must be collected at various depths, additional sampling equipment will be required.

For water quality sampling sites located on a homogeneous reach of a river or stream, the collection of depth-integrated samples in a single vertical may be adequate. For small streams, a grab sample taken at the centroid of flow is usually adequate. When a single fixed intake point is used, it should be located at about 60% of the stream depth in an area of maximum turbulence, and the intake velocity should be equal to or greater than the average water velocity.

For sampling a site located on a nonhomogeneous reach of a river or stream, it is necessary to sample the channel cross section at the location at a specified number of points and depths. The number and type of samples taken will depend on the width, depth and discharge; the amount of suspended sediment being transported; and aquatic life present. Generally, the more points that are sampled along the cross section, the more representative the composite sample will be. Three to five vertical sampling points are usually sufficient, and fewer are necessary for narrow and shallow streams.

Whenever possible, surface water samples should be collected a minimum of 6 inches (15 cm) below the surface, with the sample bottles being completely submerged. Taking the surface water sample at this depth eliminates the collection of floating debris in the sample container.

Surface water sample collection where the flow depth is less than 1 inch (<2.5 cm) requires the use of special equipment to eliminate sediment disturbance. Surface water sampling may be conducted with a container then transferred to the appropriate sample container, or collection may be performed using a peristaltic pump. A small excavation in the stream bed to create a sump for sample collection can also be considered but should be prepared in advance to allow all the sediment to settle prior to surface water sampling activities.

Sample Preservation

During sample collection ensure water samples are preserved according to laboratory requirements. If required and supplied by the laboratory, preserve the samples in accordance with the Quality Assurance Project Plan (QAPP). Some laboratories pre-preserve bottles so that once the water sample is added the preservation is completed. If preservation of a sample does not meet the requirements of the QAPP, it may be necessary to add additional preservative, or note on the chain-of-custody that incomplete sample preservation has occurred.

Once sample collection is complete, samples are placed in a cooler on ice to maintain a sample temperature no more than 4°C.

QA/QC

The QA/QC sampling was conducted on approximately 1% of samples that were submitted for analyses. This included collecting a duplicate sample at one location and submitting it to the laboratory for analysis. The results of this testing were used to evaluate the reliability of the sampling.

SURFACE WATER FLOW MEASUREMENTS PROTOCOL – MILLER'S CREEK MINE EXTENSION

In the context of flow monitoring, flow systems are typically differentiated into two categories: open systems and closed systems.

Closed systems are characterized by closed conduits which are flowing completely filled and pressurized e.g., potable water lines and industrial process lines. Although measurement of flow through a closed system shares some of the fundamentals with open system flow measurement, the methods and equipment are significantly different (i.e., flow is typically measured by a device inserted into the conduit such as flow nozzles, venturi meters, orifice meters, and pitot tube flow meters). Closed channel flow is rarely encountered in surface water management, except in surcharged sewers.

Open flow may be defined as flow in which the water flows with a free surface. Examples are rivers, ditches, streams, creeks, etc. Some closed channels, such as sewers and culverts when flowing partially full and not under pressure, may also be classified as an open flow system.

To implement a flow monitoring program, the reason for the monitoring must be understood. Flow monitoring is project specific and the project objectives will provide the criteria for developing the appropriate flow monitoring program, including:

- monitoring location(s);
- events; e.g., discrete event (one time, monthly, quarterly, etc.) or continuous monitoring; dry weather base flow or storm flow events;
- method; e.g., velocity-area method, hydraulic structure method etc.; automated versus manual; and
- equipment.

The accuracy of flow measurements are very sensitive to the care and judgment exercised when taking readings or measurements. Regardless of the flow measurement method selected, it is important to understand the limitations of the measurement technique and the range of accuracy possible. For example, instantaneous remotely collected flow measurements utilizing a velocity probe and area measurements at best can provide results with an accuracy of ±10 percent; whereas the installation of a temporary weir or flume (i.e., primary measuring device) will greatly improve the accuracy of results (i.e., ±2 percent). It is important for the practitioner to understand the program needs and select the measurement technique that best suits the accuracy required for the studies undertaken.

The practitioner must also know the channel size and understand its hydrology to select an appropriate measuring range, method (e.g., timed volume for small flows, hydraulic structure for medium flows, or velocity-area for a large stream or river), equipment type (flume versus weir, V-Notch weir versus broad crested weir), sizing (e.g., weir opening size), and to predict instream impacts.

Discrete instantaneous monitoring events will typically be measured using manual (e.g., velocity-area) methods. The measuring location should have a smooth bottom and a fairly uniform depth. The velocity should be well distributed across the stream, and the flow perpendicular to the section. Avoid areas of turbulence (e.g., bends, obstructions in stream or culvert, invert drop sections). Select areas to verify upstream results (i.e., redundancy). Be aware of the location of point source inflows.

Rate of Flow

There are many methods to determine the rate of flow in open channels. The following outlines the most common methods.

Timed Volume

In this method, the entire contents of the flow stream (usually culvert discharge) are collected in a container for a fixed length of time. The weight or volume of the water is then determined and the mean flow rate calculated. The flow rate over the period of the collection must be relatively uniform for this method to be appropriate. A field application of this technique is the "bucket and stopwatch" method. This method is limited to fairly low flow rates and is not suited for continuous measurement. However, this method is well suited to calibration applications or developing a stage/flow curve for a hydraulic structure.

Velocity-Area

The flow rate is calculated by determining the flow velocity through a cross-section and then multiplying the measured velocity by the flow area. This method is suitable for manual, discrete monitoring events, such as during quarterly monitoring events, by using a portable velocity meter and a surveyed cross-section. Although the velocity-area method is typically used for discrete monitoring events, it is sometimes used for continuous monitoring (mainly in sewers) in cases where the hydraulic structure method is not suitable due to backwater, debris, etc.

A complication in this simple procedure is that the velocity profile of a section varies throughout its depth and width and, therefore, numerous measurements must be taken. Some velocity meters (e.g., Doppler technology) will take hundreds of readings throughout the cross-section and average them. Other technologies will provide the velocity only in the immediate vicinity of the probe. For these technologies, numerous readings must be taken. A cross-section with a fairly regular section, free from obstructions (large rocks, fallen logs), and having a fairly uniform velocity distribution perpendicular to the cross-section should be selected.

For shallow cross-sections, the (vertical) average velocity should be calculated approximately every horizontal 0.15 meters (0.5 feet) to 0.3 meters (1.0 feet) and multiplied by the cross-sectional area (measured depth multiplied by the interval width) for each individual interval. The following are some of the more common methods of selecting a grid and measuring velocity for the velocity-area method: six-tenths depth method.

The six-tenths depth method consists of measuring the velocity at 0.6 of the depth from the water surface. It is generally used for shallow flows where the two-point method is not applicable at depths of 0.1 to 0.8 meters (0.3 to 2.5 feet). This method gives reasonable results.

Secondary Measurement Device – Velocity

There are numerous technologies for velocity measurement. The most commonly used by CRA is discussed below. Most technologies come with a wading rod, which enables placement of the probe at the desired depth (e.g., 0.6 of the depth from the water surface for the six-tenths velocity-area method).

<u>Electromagnetic</u> (e.g., Montedero-Whitney PVM-2A and Marsh McBirney): This technology uses Faraday's principle to measure the velocity of water flowing immediately around the probe. It may be used for either manual or automated monitoring events. It is one of the easiest to use technologies for velocity measurement. It provides an instantaneous or time averaged readout of the velocity of water at the point which the probe is inserted. It may be used in difficult conditions such as slow moving, shallow, and vegetated conditions. Its main disadvantages are short battery life and requirements for frequent calibration and verification.

Secondary Measurement Device – Depth

Manual depth measurements for the velocity-area method are taken using a carpenters measuring tape (not recommended), meter or yard stick, wading rod, or survey rod. For manual measurement methods for the hydraulic structure method, staff gages are the most common equipment. An acrylic rod covered in water soluble dye, which is then inserted into a mini-stilling well, is an inexpensive piece of equipment which can record the high water level for future manual observation.

The following describes some of the commonly used equipment in continuous water level measurement.

Submerged Pressure Transducer A pressure transducer is submerged directly in the flow stream. The pressure measured by the transducer, in terms of voltage potential, is proportional to the liquid level. Submerged pressure transducers may be affected by changes in the temperature of the flow stream. Stilling wells should be used in large channels with high flow. Also, transducer accuracy diminishes if a shallow depth, 0.3 meters (1.0 feet), of water is not maintained above the transducer, depending on the measuring range of the transducer. Some transducers may measure as low as 2 cm (1 inch - SIGMA) to 4 cm (2 inches - ISCO). Transducers are more delicate than other measuring devices and are susceptible to damage if frozen. Regular inspections of equipment and maintenance are essential, especially with respect to desiccant replacement.

QA/QC

QA/QC for surface water quantity monitoring is not as clearly defined as for water quality sampling. For the purpose of this project, CRA collected water levels using two different methods in selected streams. Pressure transducers were installed in the streams while manual measurements were collected during flow monitoring events to cross-check water elevation data. Manual measurements were collected using a water level meter and/or a staff gauge.

No QA/QC was conducted to verify flow measurements.

(C.3) FLOW MONITORING RESULTS

Table C.3.1

SUMMARY OF STREAM DISCHARGE MEASUREMENTS
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Stream No.[1]	Measured Stream Discharge (L/s)								
	10/21/2005	**12/21/2005**	**5/23/2006**	**6/16/2006**	**8/15/2006**	**9/29/2006**	**11/3/2006**	**12/22/2006**	**5/29/2008**
1	19.4	67.1	45.1	326.5	7.1	6.2	13.4	20.7	30.1
2	N/R[2]	19.1	11.9	134.0	*+/- 0* [3]	*+/- 0*	0.9	0.8	2.1
3	N/R	0.8	0.2	6.0	*+/- 0*	*+/- 0*	*+/- 0*	*+/- 0*	*+/- 0*
4	N/R	*+/- 0*	1.3	8.3	*+/- 0*	*+/- 0*	*+/- 0*	*+/- 0*	0.5
5	N/R	4.6	2.6	18.4	*+/- 0*	*+/- 0*	*+/- 0*	*+/- 0*	1.2
6	0.97	9.7	9.7	61.8	0.3	0.2	0.9	2.7	4.9
7	N/R	7.7	1.2	10.7	*+/- 0*	*+/- 0*	*+/- 0*	2.6	1.5
8	N/R	*+/- 0*	*+/- 0*	6.5	*+/- 0*	*+/- 0*	*+/- 0*	*+/- 0*	0.2
9	N/R	*+/- 0*	3.5	21.1	*+/- 0*	*+/- 0*	*+/- 0*	*+/- 0*	1.9
10	N/R	4.6	4.2	18.8	*+/- 0*	*+/- 0*	*+/- 0*	*+/- 0*	*+/- 0*
11	N/R	*+/- 0*	*+/- 0*	*+/- 0*	*+/- 0*	*+/- 0*	*+/- 0*	*+/- 0*	*+/- 0*
12	N/R	*+/- 0*	0.2	2.1	*+/- 0*	*+/- 0*	*+/- 0*	*+/- 0*	*+/- 0*
13	*+/- 0*	6.1	3.5	36.9	*+/- 0*	*+/- 0*	*+/- 0*	*+/- 0*	2.5
14	N/R	*+/- 0*	*+/- 0*	*+/- 0*	*+/- 0*	*+/- 0*	*+/- 0*	*+/- 0*	*+/- 0*
15	N/R	*+/- 0*	0.8	5.5	0.3	0.1	0.3	*+/- 0*	0.8
16	N/R	*+/- 0*	*+/- 0*	*+/- 0*	*+/- 0*	*+/- 0*	*+/- 0*	*+/- 0*	*+/- 0*
17	*+/- 0*	28.7	33.6	125.0	*+/- 0*	*+/- 0*	1.5	8.3	16.4
18	N/R	9.3	12.8	80.8	0.8	0.4	0.8	2.2	9.0
19	N/R	N/R	0.8	6.1	*+/- 0*	*+/- 0*	*+/- 0*	0.1	0.5
2 Days Before Monitoring PCPN[4] (mm)	1.3	0	0.6	0	0.6	0	0.6	0	8.5
1 Day Before Monitoring PCPN (mm)	0	0	1.9	35.4	0	1.4	0	0	0.6
Monitoring Day PCPN (mm)	0	0	0	0	0.7	3.7	0	0	0

Notes:

1. Refer to Figure 4.2-2 for stream locations.
2. Values shown as N/R indicate no measurement recorded.
3. Values shown as +/- 0 indicate zero flow or minor flows too small to measure.
4. PCPN = precipitation; Precipitation data was obtained from the closest Environment Canada Weather Station, i.e. Kentville, NS.

Table C.3.1

SUMMARY OF STREAM DISCHARGE MEASUREMENTS
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Stream No.[1]	Measured Stream Discharge (L/s)								
	7/4/2008	7/23/2008	8/14/2008	9/16/2008	3/9/2009	4/9/2009	5/21/2009	6/11/2009	Range
1	29.1	9.9	16.0	22.5	115.4	216.9	35.4	8.8	6.2 - 326.5
2	+/- 0	+/- 0	N/R	N/R	N/R	35.7	4.3	0.7	0 - 134.0
3	+/- 0	+/- 0	+/- 0	+/- 0	N/R	+/- 0	+/- 0	+/- 0	0 - 6.0
4	+/- 0	+/- 0	+/- 0	1.5	N/R	+/- 0	+/- 0	+/- 0	0 - 8.3
5	+/- 0	+/- 0	+/- 0	+/- 0	N/R	5.6	+/- 0	+/- 0	0 - 18.4
6	+/- 0	+/- 0	+/- 0	+/- 0	N/R	26.6	+/- 0	5.7	0 - 61.8
7	0.1	+/- 0	+/- 0	2.6	N/R	4.5	+/- 0	+/- 0	0 - 10.7
8	+/- 0	+/- 0	+/- 0	0.7	N/R	+/- 0	+/- 0	+/- 0	0 - 6.5
9	+/- 0	+/- 0	+/- 0	+/- 0	N/R	+/- 0	+/- 0	+/- 0	0 - 21.1
10	+/- 0	+/- 0	+/- 0	+/- 0	N/R	+/- 0	+/- 0	+/- 0	0 - 18.8
11	+/- 0	+/- 0	+/- 0	0.5	N/R	+/- 0	+/- 0	+/- 0	0 - 1.1
12	+/- 0	+/- 0	+/- 0	+/- 0	N/R	0.9	0.1	+/- 0	0 - 2.1
13	+/- 0	+/- 0	+/- 0	0.7	N/R	10.3	+/- 0	+/- 0	0 - 36.9
14	+/- 0	+/- 0	+/- 0	N/R	N/R	+/- 0	+/- 0	+/- 0	0
15	0.1	0.2	+/- 0	0.7	N/R	3.5	0.8	0.4	0 - 5.5
16	+/- 0	+/- 0	+/- 0	+/- 0	N/R	+/- 0	+/- 0	+/- 0	0
17	0.3	0.4	11.9	+/- 0	42.7	56.4	13.5	+/- 0	0 - 125.0
18	1.4	2.3	2.7	2.3	26.2	38.9	10.3	7.6	0 - 80.8
19	+/- 0	+/- 0	+/- 0	+/- 0	N/R	+/- 0	0.2	+/- 0	0 - 6.1
2 Days Before Monitoring PCPN[4] (mm)	13.3	14.6	13.1	0.8	0.7	13.4	4.7	0	-
1 Day Before Monitoring PCPN (mm)	0.8	1.4	0.6	0	7.4	0.6	0	4.2	-
Monitoring Day PCPN (mm)	0	0	9.4	0	0	0	0.7	2.9	-

Notes:

1. Refer to Figure 4.2-2 for stream locations.
2. Values shown as N/R indicate no measurement recorded.
3. Values shown as +/- 0 indicate zero flow or minor flows too small to measure.
4. PCPN = precipitation; Precipitation data was obtained from the closest Environment Canada Weather Station, i.e. Kentville, NS.

(C.4) SURFACEWATER LEVELS

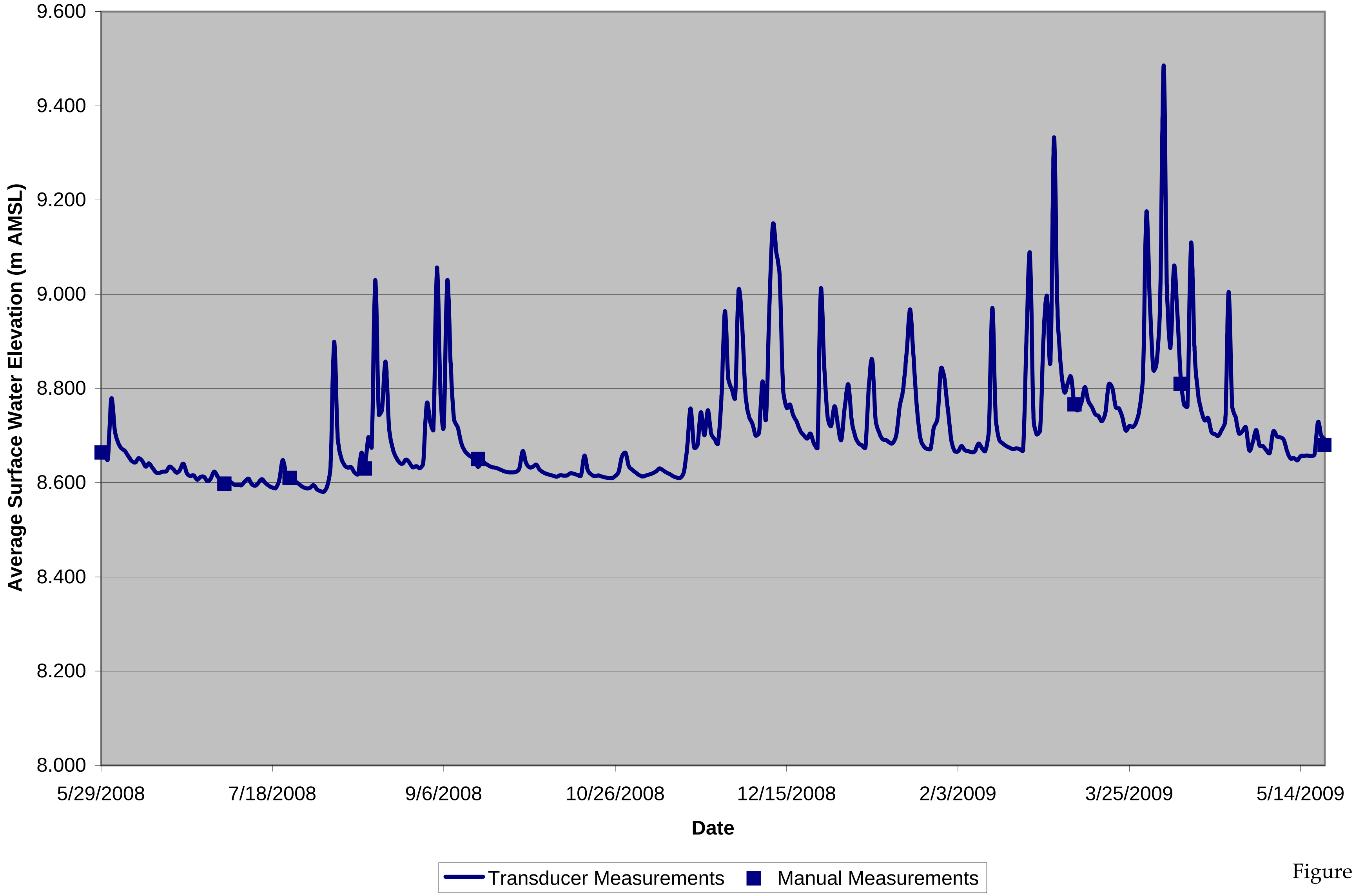


Figure C.4.1

SW-01 Surface Water Elevation Graph
Miller's Creek Mine Extension Project
CGC Inc. - Windsor Plant
Hants County, Nova Scotia

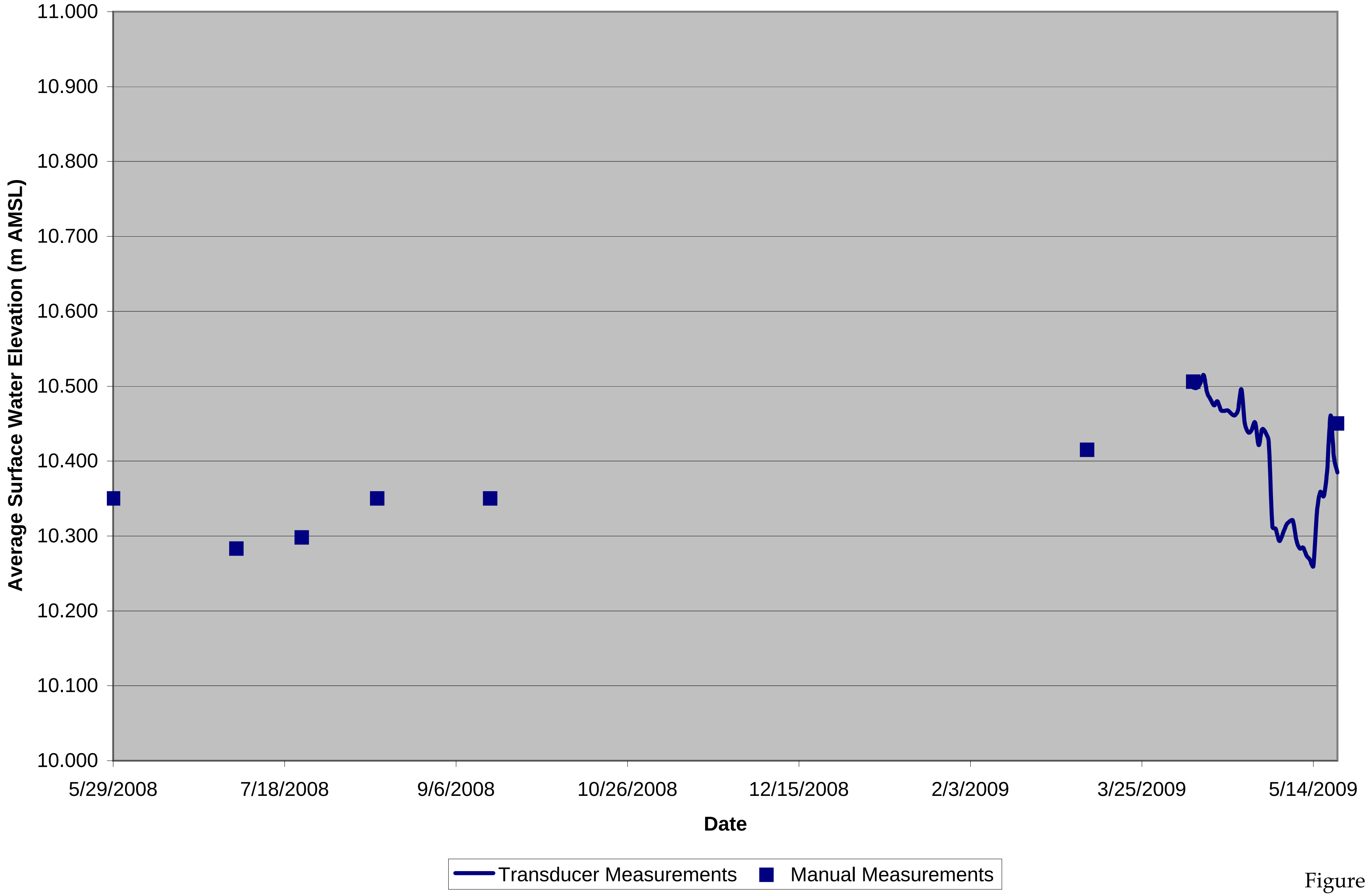


Figure C.4.2

SW-17 Surface Water Elevation Graph
Miller's Creek Mine Extension Project
CGC Inc. - Windsor Plant
Hants County, Nova Scotia

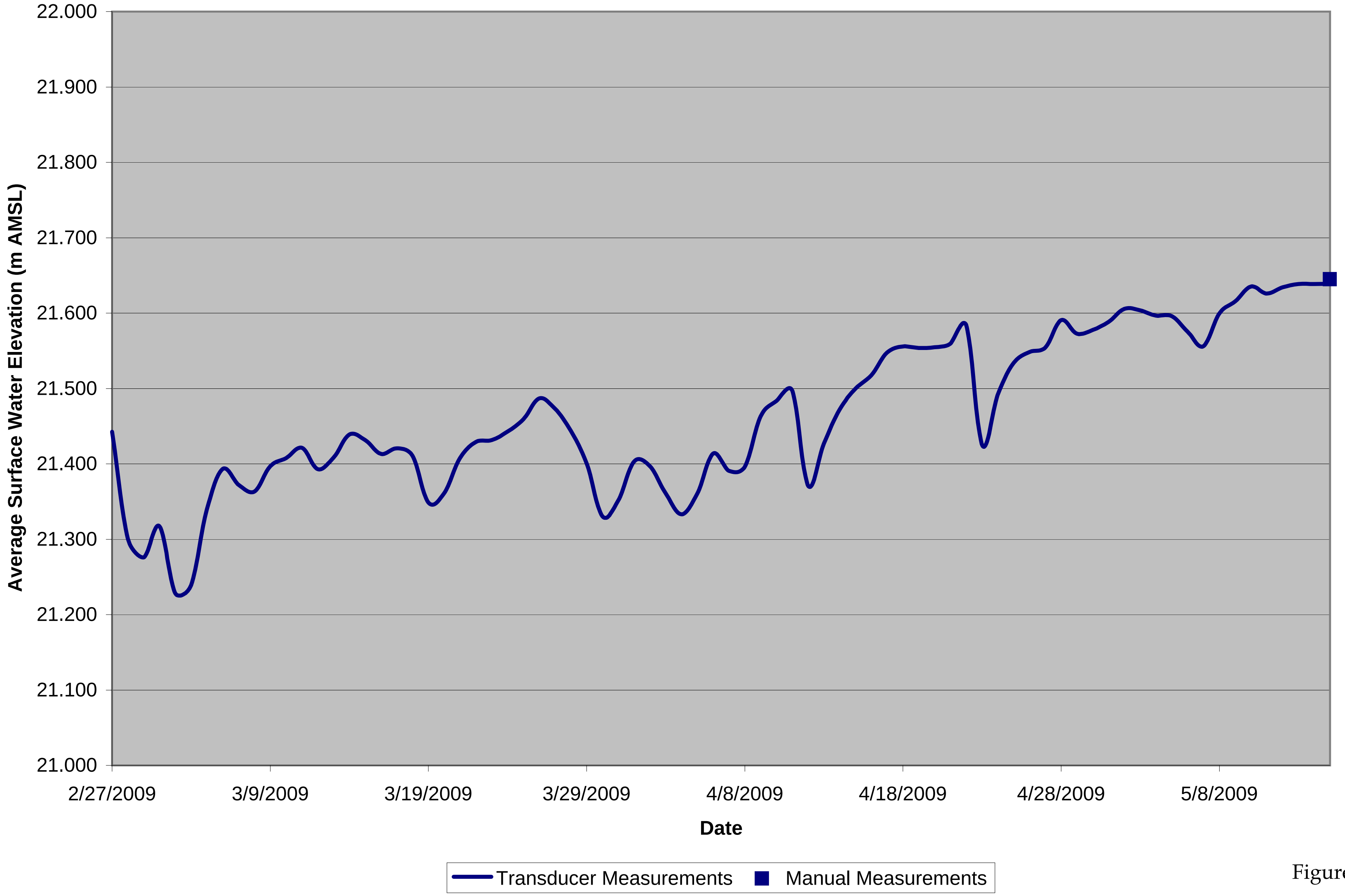


Figure C.4.3

SW-18 Surface Water Elevation Graph
Miller's Creek Mine Extension Project
CGC Inc. - Windsor Plant
Hants County, Nova Scotia

Table C.4.1

SW-01 SURFACE WATER LEVEL DATA
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Elevation of stream bed/ bottom of staff gauge 8 m

SW-01 MANUAL MEASUREMENT DATA

Date	Time	Average SWL (m - staff gauge)	Average SWL (masl)
5/29/2008	10:38	0.664	8.664
7/4/2008	9:20	0.598	8.598
7/23/2008	9:20	0.610	8.610
8/14/2008	9:33	0.630	8.630
9/16/2008	10:15	0.650	8.650
3/9/2009	15:48	0.766	8.766
4/9/2009	14:00	0.81	8.810
5/21/2009	10:16	0.68	8.680

SW-01 PRESSURE TRANSDUCER DATA

Date	Average SWL (m - staff gauge)	Average SWL (masl)
5/29/2008	0.669	8.669
5/30/2008	0.670	8.670
5/31/2008	0.650	8.650
6/1/2008	0.779	8.779
6/2/2008	0.711	8.711
6/3/2008	0.685	8.685
6/4/2008	0.672	8.672
6/5/2008	0.667	8.667
6/6/2008	0.656	8.656
6/7/2008	0.646	8.646
6/8/2008	0.643	8.643
6/9/2008	0.652	8.652
6/10/2008	0.646	8.646
6/11/2008	0.634	8.634
6/12/2008	0.641	8.641
6/13/2008	0.631	8.631
6/14/2008	0.622	8.622
6/15/2008	0.621	8.621
6/16/2008	0.624	8.624
6/17/2008	0.624	8.624
6/18/2008	0.634	8.634
6/19/2008	0.629	8.629
6/20/2008	0.622	8.622
6/21/2008	0.626	8.626
6/22/2008	0.641	8.641

Table C.4.1

SW-01 SURFACE WATER LEVEL DATA
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

SW-01 PRESSURE TRANSDUCER DATA

Date	Average SWL (m - staff gauge)	Average SWL (masl)
6/23/2008	0.621	8.621
6/24/2008	0.614	8.614
6/25/2008	0.616	8.616
6/26/2008	0.606	8.606
6/27/2008	0.613	8.613
6/28/2008	0.613	8.613
6/29/2008	0.603	8.603
6/30/2008	0.608	8.608
7/1/2008	0.624	8.624
7/2/2008	0.613	8.613
7/3/2008	0.606	8.606
7/4/2008	0.607	8.607
7/5/2008	0.603	8.603
7/6/2008	0.601	8.601
7/7/2008	0.595	8.595
7/8/2008	0.595	8.595
7/9/2008	0.595	8.595
7/10/2008	0.603	8.603
7/11/2008	0.608	8.608
7/12/2008	0.597	8.597
7/13/2008	0.594	8.594
7/14/2008	0.601	8.601
7/15/2008	0.607	8.607
7/16/2008	0.599	8.599
7/17/2008	0.593	8.593
7/18/2008	0.590	8.590
7/19/2008	0.589	8.589
7/20/2008	0.607	8.607
7/21/2008	0.648	8.648
7/22/2008	0.619	8.619
7/23/2008	0.610	8.610
7/24/2008	0.605	8.605
7/25/2008	0.601	8.601
7/26/2008	0.596	8.596
7/27/2008	0.590	8.590
7/28/2008	0.588	8.588
7/29/2008	0.589	8.589
7/30/2008	0.595	8.595
7/31/2008	0.586	8.586
8/1/2008	0.582	8.582
8/2/2008	0.581	8.581
8/3/2008	0.594	8.594
8/4/2008	0.635	8.635
8/5/2008	0.899	8.899
8/6/2008	0.697	8.697

Table C.4.1

SW-01 SURFACE WATER LEVEL DATA
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

SW-01 PRESSURE TRANSDUCER DATA

Date	Average SWL (m - staff gauge)	Average SWL (masl)
8/7/2008	0.655	8.655
8/8/2008	0.637	8.637
8/9/2008	0.632	8.632
8/10/2008	0.633	8.633
8/11/2008	0.621	8.621
8/12/2008	0.619	8.619
8/13/2008	0.663	8.663
8/14/2008	0.641	8.641
8/15/2008	0.697	8.697
8/16/2008	0.676	8.676
8/17/2008	1.030	9.030
8/18/2008	0.745	8.745
8/19/2008	0.754	8.754
8/20/2008	0.856	8.856
8/21/2008	0.718	8.718
8/22/2008	0.676	8.676
8/23/2008	0.655	8.655
8/24/2008	0.643	8.643
8/25/2008	0.640	8.640
8/26/2008	0.649	8.649
8/27/2008	0.642	8.642
8/28/2008	0.633	8.633
8/29/2008	0.635	8.635
8/30/2008	0.631	8.631
8/31/2008	0.641	8.641
9/1/2008	0.767	8.767
9/2/2008	0.730	8.730
9/3/2008	0.713	8.713
9/4/2008	1.057	9.057
9/5/2008	0.789	8.789
9/6/2008	0.720	8.720
9/7/2008	1.028	9.028
9/8/2008	0.847	8.847
9/9/2008	0.736	8.736
9/10/2008	0.719	8.719
9/11/2008	0.686	8.686
9/12/2008	0.669	8.669
9/13/2008	0.660	8.660
9/14/2008	0.655	8.655
9/15/2008	0.651	8.651
9/16/2008	0.633	8.633
9/17/2008	0.646	8.646
9/18/2008	0.642	8.642
9/19/2008	0.637	8.637
9/20/2008	0.633	8.633

Table C.4.1

SW-01 SURFACE WATER LEVEL DATA
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

SW-01 PRESSURE TRANSDUCER DATA

Date	Average SWL (m - staff gauge)	Average SWL (masl)
9/21/2008	0.632	8.632
9/22/2008	0.630	8.630
9/23/2008	0.626	8.626
9/24/2008	0.624	8.624
9/25/2008	0.622	8.622
9/26/2008	0.622	8.622
9/27/2008	0.623	8.623
9/28/2008	0.630	8.630
9/29/2008	0.667	8.667
9/30/2008	0.642	8.642
10/1/2008	0.632	8.632
10/2/2008	0.634	8.634
10/3/2008	0.638	8.638
10/4/2008	0.627	8.627
10/5/2008	0.622	8.622
10/6/2008	0.619	8.619
10/7/2008	0.616	8.616
10/8/2008	0.614	8.614
10/9/2008	0.613	8.613
10/10/2008	0.616	8.616
10/11/2008	0.615	8.615
10/12/2008	0.616	8.616
10/13/2008	0.620	8.620
10/14/2008	0.619	8.619
10/15/2008	0.617	8.617
10/16/2008	0.615	8.615
10/17/2008	0.658	8.658
10/18/2008	0.627	8.627
10/19/2008	0.618	8.618
10/20/2008	0.614	8.614
10/21/2008	0.615	8.615
10/22/2008	0.614	8.614
10/23/2008	0.611	8.611
10/24/2008	0.610	8.610
10/25/2008	0.610	8.610
10/26/2008	0.614	8.614
10/27/2008	0.623	8.623
10/28/2008	0.657	8.657
10/29/2008	0.664	8.664
10/30/2008	0.635	8.635
10/31/2008	0.627	8.627
11/1/2008	0.621	8.621
11/2/2008	0.616	8.616
11/3/2008	0.613	8.613
11/4/2008	0.615	8.615

Table C.4.1

SW-01 SURFACE WATER LEVEL DATA
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

SW-01 PRESSURE TRANSDUCER DATA

Date	Average SWL (m - staff gauge)	Average SWL (masl)
11/5/2008	0.618	8.618
11/6/2008	0.620	8.620
11/7/2008	0.625	8.625
11/8/2008	0.631	8.631
11/9/2008	0.626	8.626
11/10/2008	0.621	8.621
11/11/2008	0.618	8.618
11/12/2008	0.614	8.614
11/13/2008	0.611	8.611
11/14/2008	0.610	8.610
11/15/2008	0.622	8.622
11/16/2008	0.679	8.679
11/17/2008	0.758	8.758
11/18/2008	0.675	8.675
11/19/2008	0.680	8.680
11/20/2008	0.750	8.750
11/21/2008	0.701	8.701
11/22/2008	0.754	8.754
11/23/2008	0.704	8.704
11/24/2008	0.693	8.693
11/25/2008	0.683	8.683
11/26/2008	0.779	8.779
11/27/2008	0.964	8.964
11/28/2008	0.823	8.823
11/29/2008	0.799	8.799
11/30/2008	0.780	8.780
12/1/2008	1.006	9.006
12/2/2008	0.939	8.939
12/3/2008	0.788	8.788
12/4/2008	0.742	8.742
12/5/2008	0.726	8.726
12/6/2008	0.699	8.699
12/7/2008	0.707	8.707
12/8/2008	0.815	8.815
12/9/2008	0.736	8.736
12/10/2008	0.972	8.972
12/11/2008	1.147	9.147
12/12/2008	1.088	9.088
12/13/2008	1.040	9.040
12/14/2008	0.798	8.798
12/15/2008	0.759	8.759
12/16/2008	0.766	8.766
12/17/2008	0.742	8.742
12/18/2008	0.728	8.728
12/19/2008	0.711	8.711

Table C.4.1

SW-01 SURFACE WATER LEVEL DATA
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

SW-01 PRESSURE TRANSDUCER DATA

Date	Average SWL (m - staff gauge)	Average SWL (masl)
12/20/2008	0.701	8.701
12/21/2008	0.694	8.694
12/22/2008	0.704	8.704
12/23/2008	0.683	8.683
12/24/2008	0.674	8.674
12/25/2008	1.009	9.009
12/26/2008	0.845	8.845
12/27/2008	0.737	8.737
12/28/2008	0.720	8.720
12/29/2008	0.763	8.763
12/30/2008	0.720	8.720
12/31/2008	0.691	8.691
1/1/2009	0.762	8.762
1/2/2009	0.809	8.809
1/3/2009	0.734	8.734
1/4/2009	0.699	8.699
1/5/2009	0.684	8.684
1/6/2009	0.679	8.679
1/7/2009	0.674	8.674
1/8/2009	0.808	8.808
1/9/2009	0.861	8.861
1/10/2009	0.732	8.732
1/11/2009	0.707	8.707
1/12/2009	0.693	8.693
1/13/2009	0.691	8.691
1/14/2009	0.685	8.685
1/15/2009	0.684	8.684
1/16/2009	0.701	8.701
1/17/2009	0.762	8.762
1/18/2009	0.796	8.796
1/19/2009	0.875	8.875
1/20/2009	0.968	8.968
1/21/2009	0.874	8.874
1/22/2009	0.761	8.761
1/23/2009	0.695	8.695
1/24/2009	0.678	8.678
1/25/2009	0.672	8.672
1/26/2009	0.672	8.672
1/27/2009	0.718	8.718
1/28/2009	0.736	8.736
1/29/2009	0.842	8.842
1/30/2009	0.825	8.825
1/31/2009	0.759	8.759
2/1/2009	0.693	8.693
2/2/2009	0.668	8.668

Table C.4.1

SW-01 SURFACE WATER LEVEL DATA
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

SW-01 PRESSURE TRANSDUCER DATA

Date	Average SWL (m - staff gauge)	Average SWL (masl)
2/3/2009	0.667	8.667
2/4/2009	0.678	8.678
2/5/2009	0.669	8.669
2/6/2009	0.667	8.667
2/7/2009	0.665	8.665
2/8/2009	0.667	8.667
2/9/2009	0.683	8.683
2/10/2009	0.673	8.673
2/11/2009	0.668	8.668
2/12/2009	0.711	8.711
2/13/2009	0.971	8.971
2/14/2009	0.742	8.742
2/15/2009	0.692	8.692
2/16/2009	0.683	8.683
2/17/2009	0.678	8.678
2/18/2009	0.675	8.675
2/19/2009	0.671	8.671
2/20/2009	0.673	8.673
2/21/2009	0.672	8.672
2/22/2009	0.669	8.669
2/23/2009	0.902	8.902
2/24/2009	1.086	9.086
2/25/2009	0.738	8.738
2/26/2009	0.702	8.702
2/27/2009	0.712	8.712
2/28/2009	0.923	8.923
3/1/2009	0.996	8.996
3/2/2009	0.863	8.863
3/3/2009	1.332	9.332
3/4/2009	0.979	8.979
3/5/2009	0.849	8.849
3/6/2009	0.792	8.792
3/7/2009	0.810	8.810
3/8/2009	0.824	8.824
3/9/2009	0.760	8.760
3/10/2009	0.753	8.753
3/11/2009	0.770	8.770
3/12/2009	0.803	8.803
3/13/2009	0.774	8.774
3/14/2009	0.761	8.761
3/15/2009	0.745	8.745
3/16/2009	0.742	8.742
3/17/2009	0.730	8.730
3/18/2009	0.749	8.749
3/19/2009	0.809	8.809

Table C.4.1

SW-01 SURFACE WATER LEVEL DATA
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

SW-01 PRESSURE TRANSDUCER DATA

Date	Average SWL (m - staff gauge)	Average SWL (masl)
3/20/2009	0.801	8.801
3/21/2009	0.761	8.761
3/22/2009	0.757	8.757
3/23/2009	0.737	8.737
3/24/2009	0.711	8.711
3/25/2009	0.720	8.720
3/26/2009	0.718	8.718
3/27/2009	0.728	8.728
3/28/2009	0.758	8.758
3/29/2009	0.831	8.831
3/30/2009	1.173	9.173
3/31/2009	0.981	8.981
4/1/2009	0.840	8.840
4/2/2009	0.855	8.855
4/3/2009	0.983	8.983
4/4/2009	1.486	9.486
4/5/2009	1.017	9.017
4/6/2009	0.886	8.886
4/7/2009	1.059	9.059
4/8/2009	0.965	8.965
4/9/2009	0.823	8.823
4/10/2009	0.764	8.764
4/11/2009	0.762	8.762
4/12/2009	1.108	9.108
4/13/2009	0.882	8.882
4/14/2009	0.794	8.794
4/15/2009	0.752	8.752
4/16/2009	0.732	8.732
4/17/2009	0.738	8.738
4/18/2009	0.707	8.707
4/19/2009	0.703	8.703
4/20/2009	0.699	8.699
4/21/2009	0.713	8.713
4/22/2009	0.733	8.733
4/23/2009	1.005	9.005
4/24/2009	0.763	8.763
4/25/2009	0.739	8.739
4/26/2009	0.705	8.705
4/27/2009	0.709	8.709
4/28/2009	0.717	8.717
4/29/2009	0.669	8.669
4/30/2009	0.686	8.686
5/1/2009	0.712	8.712
5/2/2009	0.679	8.679
5/3/2009	0.678	8.678

Table C.4.1

SW-01 SURFACE WATER LEVEL DATA
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

SW-01 PRESSURE TRANSDUCER DATA

Date	Average SWL (m - staff gauge)	Average SWL (masl)
5/4/2009	0.668	8.668
5/5/2009	0.664	8.664
5/6/2009	0.709	8.709
5/7/2009	0.698	8.698
5/8/2009	0.697	8.697
5/9/2009	0.692	8.692
5/10/2009	0.667	8.667
5/11/2009	0.652	8.652
5/12/2009	0.652	8.652
5/13/2009	0.647	8.647
5/14/2009	0.657	8.657
5/15/2009	0.657	8.657
5/16/2009	0.657	8.657
5/17/2009	0.657	8.657
5/18/2009	0.660	8.660
5/19/2009	0.728	8.728
5/20/2009	0.700	8.700
5/21/2009	0.692	8.692

Table C.4.2

SW-17 SURFACE WATER LEVEL DATA
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Elevation of stream bed/ bottom of staff gauge	10	m
Elevation of TOC on staff gauge	1.050	m

SW-17 MANUAL MEASUREMENT DATA

Date	Time	Average SWL (m - staff gauge)	Average SWL (mAMSL)
5/29/2008	14:25	0.350	10.350
7/4/2008	13:25	0.283	10.283
7/23/2008	11:50	0.298	10.298
8/14/2008	12:45	0.350	10.350
9/16/2008	13:00	0.350	10.350
3/9/2009	15:35	0.415	10.415
4/9/2009	10:30	0.506	10.506
5/21/2009	13:34	0.450	10.450

SW-17 PRESSURE TRANSDUCER DATA

Date	Average SWL (m - staff gauge)	Average SWL (mAMSL)
4/9/2009	0.498	10.498
4/10/2009	0.498	10.498
4/11/2009	0.504	10.504
4/12/2009	0.515	10.515
4/13/2009	0.492	10.492
4/14/2009	0.482	10.482
4/15/2009	0.474	10.474
4/16/2009	0.480	10.480
4/17/2009	0.468	10.468
4/18/2009	0.467	10.467
4/19/2009	0.468	10.468
4/20/2009	0.464	10.464
4/21/2009	0.461	10.461
4/22/2009	0.467	10.467
4/23/2009	0.496	10.496
4/24/2009	0.451	10.451
4/25/2009	0.438	10.438
4/26/2009	0.441	10.441
4/27/2009	0.451	10.451
4/28/2009	0.422	10.422
4/29/2009	0.442	10.442
4/30/2009	0.438	10.438

Date	Average SWL (m - staff gauge)	Average SWL (mAMSL)
5/1/2009	0.425	10.425
5/2/2009	0.312	10.312
5/3/2009	0.310	10.310
5/4/2009	0.294	10.294
5/5/2009	0.302	10.302
5/6/2009	0.314	10.314
5/7/2009	0.319	10.319
5/8/2009	0.321	10.321
5/9/2009	0.294	10.294
5/10/2009	0.283	10.283
5/11/2009	0.285	10.285
5/12/2009	0.274	10.274
5/13/2009	0.268	10.268
5/14/2009	0.260	10.260
5/15/2009	0.331	10.331
5/16/2009	0.359	10.359
5/17/2009	0.354	10.354
5/18/2009	0.385	10.385
5/19/2009	0.461	10.461
5/20/2009	0.405	10.405
5/21/2009	0.385	10.385

Table C.4.3

SW-18 SURFACE WATER LEVEL DATA
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Elevation of TOC 22.175 m

SW-18 MANUAL MEASUREMENT DATA

Date	Time	Average SWL (mbTOC)	Average SWL (masl)
5/15/2009	7:50	0.53	21.645

SW-18 PRESSURE TRANSDUCER DATA

Date	Average Daily SWL (m bTOC)	Average SWL (masl)
2/27/2009	0.732	21.443
2/28/2009	0.875	21.300
3/1/2009	0.899	21.276
3/2/2009	0.858	21.317
3/3/2009	0.947	21.228
3/4/2009	0.936	21.239
3/5/2009	0.835	21.340
3/6/2009	0.782	21.393
3/7/2009	0.803	21.372
3/8/2009	0.812	21.363
3/9/2009	0.778	21.397
3/10/2009	0.767	21.408
3/11/2009	0.754	21.421
3/12/2009	0.782	21.393
3/13/2009	0.767	21.408
3/14/2009	0.736	21.439
3/15/2009	0.743	21.432
3/16/2009	0.762	21.413
3/17/2009	0.754	21.421
3/18/2009	0.764	21.411
3/19/2009	0.826	21.349
3/20/2009	0.814	21.361
3/21/2009	0.767	21.408
3/22/2009	0.746	21.429
3/23/2009	0.743	21.432
3/24/2009	0.732	21.443
3/25/2009	0.716	21.459
3/26/2009	0.688	21.487
3/27/2009	0.702	21.473
3/28/2009	0.731	21.444
3/29/2009	0.774	21.401
3/30/2009	0.844	21.331
3/31/2009	0.824	21.351
4/1/2009	0.772	21.403
4/2/2009	0.778	21.397
4/3/2009	0.814	21.361
4/4/2009	0.842	21.333
4/5/2009	0.815	21.360
4/6/2009	0.761	21.414

Date	Average Daily SWL (m bTOC)	Average SWL (masl)
4/7/2009	0.784	21.391
4/8/2009	0.779	21.396
4/9/2009	0.712	21.463
4/10/2009	0.692	21.483
4/11/2009	0.678	21.497
4/12/2009	0.804	21.371
4/13/2009	0.748	21.427
4/14/2009	0.703	21.472
4/15/2009	0.675	21.500
4/16/2009	0.658	21.517
4/17/2009	0.627	21.548
4/18/2009	0.619	21.556
4/19/2009	0.621	21.554
4/20/2009	0.620	21.555
4/21/2009	0.616	21.559
4/22/2009	0.592	21.583
4/23/2009	0.750	21.425
4/24/2009	0.682	21.493
4/25/2009	0.641	21.534
4/26/2009	0.627	21.548
4/27/2009	0.620	21.555
4/28/2009	0.584	21.591
4/29/2009	0.602	21.573
4/30/2009	0.597	21.578
5/1/2009	0.587	21.588
5/2/2009	0.569	21.606
5/3/2009	0.571	21.604
5/4/2009	0.578	21.597
5/5/2009	0.579	21.596
5/6/2009	0.600	21.575
5/7/2009	0.619	21.556
5/8/2009	0.575	21.600
5/9/2009	0.559	21.616
5/10/2009	0.540	21.635
5/11/2009	0.549	21.626
5/12/2009	0.541	21.634
5/13/2009	0.536	21.639
5/14/2009	0.536	21.639
5/15/2009	0.536	21.639

Table C.4.4

SW-01 SURFACE WATER LEVEL DATA QA/QC
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

	Manual			Pressure Transducer			Difference	
Date	**Time**	**Average SWL (m staff gauge)**	**Average SWL (masl)**	**Time**	**Average SWL (m staff gauge)**	**Average SWL (masl)**	**Absolute Difference (m)**	**Percent Difference**
5/29/2008	10:38	0.664	8.664	11:00	0.6566	8.657	0.007	0.09%
7/4/2008	9:20	0.598	8.598	9:00	0.6119	8.612	0.014	0.16%
7/23/2008	9:20	0.610	8.610	9:00	0.6107	8.611	0.001	0.01%
8/14/2008	9:33	0.630	8.630	9:00	0.6273	8.627	0.003	0.03%
9/16/2008	10:15	0.650	8.650	10:00	0.645	8.645	0.005	0.06%
3/9/2009	15:48	0.766	8.766	15:00	0.7724	8.772	0.006	0.07%
4/9/2009	14:00	0.81	8.810	14:00	0.8281	8.828	0.018	0.21%
5/21/2009	10:16	0.68	8.680	10:00	0.6938	8.694	0.014	0.16%

Elevation of stream bed/ bottom of staff gauge 8 m

(C.5) SAMPLING RESULTS

Table C.5.1

S1 SURFACE WATER QUALITY SAMPLING RESULTS
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Parameter	Units	CCME Fresh Water Aquatic Life[1, 2, 3]	S1	S1	S1	S1	S1	S1	S1	S1 - Lab Duplicate	S1	S1	S1	S1	S1 - Lab Duplicate	S1
Sampling Date			**2-Nov-04**	**7-Dec-04**	**12-Jan-05**	**8-Feb-05**	**1-Mar-05**	**13-Apr-05**	**5-May-05**	**5-May-05**	**21-Jun-05**	**11-Jul-05**	**17-Aug-05**	**6-Sep-05**	**6-Sep-05**	**3-Oct-05**
INORGANICS																
Alkalinity (as $CaCO_3$)	mg/L	-	170	130	NS	NS	38	96	130	-	160	170	190	180	-	190
Chloride	mg/L	-	10	11	NS	NS	7.1	10	10	-	11	11	10	11	-	12
Color	TCU	-	9	19	NS	NS	26	19	11	-	12	9.9	9.3	11	-	8
Nitrate + Nitrite (as N)	mg/L	-	ND	0.05	NS	NS	ND	ND	ND	-	ND	ND	ND	ND	ND	ND
Nitrite	mg/L	0.060	ND	ND	NS	NS	ND	ND	ND	-	ND	-	ND	ND	-	-
Ammonia (as N)	mg/L	Varies[4]	ND	0.1	NS	NS	ND	ND	ND	-	ND	ND	ND	0.06	ND	0.08
Total Org. Carbon (by UV)	mg/L	-	2.2	4.0	NS	NS	6.3	3.0	2.7	-	4.1	3.1	2.3	2.2	-	2.7
Orthophosphate (as P)	mg/L	-	ND	ND	NS	NS	ND	ND	ND	-	ND	ND	ND	ND	-	ND
pH	units	6.5-9.0	8.00	7.90	NS	NS	6.85	7.15	7.96	7.88	7.69	7.85	8.08	7.93	-	8.16
Total Phosphorus	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reactive Silica (as SiO_2)	mg/L	-	6.2	6.1	NS	NS	2.6	4.5	4.7	-	5.5	6.3	7.0	7.3	-	7.6
Total Suspended Solids	mg/L	-	36.8	31.8	NS	NS	11	4.3	-	-	-	-	-	3.7	-	-
Sulfate	mg/L	-	1000	800	NS	NS	190	820	560	-	890	1100	1100	1200	-	1200
Turbidity	NTU	-	12.8	4.1	NS	NS	25.0	1.4	2.9	-	140.0	1.1	1.6	2.2	-	3.9
Conductivity	uS/cm		2740	2090	NS	NS	630	1500	1300	1300	1800	2000	2000	2100	-	2000
CALCULATED PARAMETERS																
Nitrate (as N)	mg/L	2.9	ND	0.05	NS	NS	ND	ND	ND	-	ND	-	ND	ND	-	-
Hardness (as $CaCO_3$)	mg/L	-	1120	939	NS	NS	270	870	760	-	1200	1400	1400	1500	-	1400
Bicarbonate (as $CaCO_3$)	mg/L	-	168	129	NS	NS	37.8	95.7	128	-	159	170	188	178	-	187
Carbonate (as $CaCO_3$)	mg/L	-	2	ND	NS	NS	ND	ND	1	-	ND	1	2	1	-	3
TDS (calculated)	mg/L	-	1570	1270	NS	NS	334	1240	961	-	1480	1790	1790	1940	-	1850
Cation Sum	meq/L	-	22.9	19.1	NS	NS	5.76	17.7	15.6	-	24.1	28.4	28.5	31.3	-	28.9
Anion Sum	meq/L	-	24.5	19.6	NS	NS	4.85	19.2	14.5	-	22	26.9	26.9	28.9	-	28
Ion Balance	%	-	3.41	1.07	NS	NS	8.52	3.93	3.52	-	4.47	2.66	2.90	4.02	-	1.53
Langlier Index @ 4C	-	-	0.900	0.630	NS	NS	-1.180	-0.171	0.680	-	0.690	0.930	1.210	1.060	-	1.280
Langlier Index @ 20C	-	-	1.300	1.030	NS	NS	-0.925	0.074	0.930	-	0.930	1.180	1.450	1.300	-	1.530
Saturation pH @ 4C	units	-	7.10	7.27	NS	NS	8.03	7.32	7.28	-	7.00	6.92	6.87	6.87	-	6.88
Saturation pH @ 20C	Units	-	6.70	6.87	NS	NS	7.78	7.08	7.03	-	6.75	6.67	6.63	6.63	-	6.63
METALS																
Aluminum	ug/L	5 / 100[5]	510	340	NS	NS	970	**ND (500)**	130	-	5300	-	ND	150	-	-
Antimony	ug/L	-	ND	ND	NS	NS	ND	ND	ND	-	ND	-	ND	ND	-	-
Arsenic	ug/L	5.0	**ND (20)**	**ND (20)**	NS	NS	ND	**ND (20)**	**ND (20)**	-	**ND (20)**	-	**ND (20)**	**ND (20)**	-	-
Barium	ug/L	-	ND	ND	NS	NS	23	ND	ND	-	72	-	ND	ND	-	-
Beryllium	ug/L	-	ND	ND	NS	NS	ND	ND	ND	-	ND	-	ND	ND	-	-
Bismuth	ug/L	-	ND	ND	NS	NS	ND	ND	ND	-	ND	-	ND	ND	-	-
Boron	ug/L	-	ND	ND	NS	NS	12	ND	ND	-	ND	-	51	ND	-	-
Cadmium	ug/L	0.017[6]	0.2	**ND (3)**	NS	NS	**ND (0.3)**	**ND (3)**	**ND (3)**	-	**ND (3)**	-	**ND (3)**	**ND (3)**	-	-
Chromium	ug/L	8.9(III) / 1.0(VI)[7]	ND	ND	NS	NS	ND	ND	ND	-	ND	-	ND	ND	-	-
Cobalt	ug/L	-	ND	ND	NS	NS	ND	ND	ND	-	ND	-	ND	ND	-	-
Copper	ug/L	2 - 4[8]	**ND (20)**	**ND (20)**	NS	NS	ND	**ND (20)**	**ND (20)**	-	**ND (20)**	**ND (10)**	**ND (20)**	**ND (20)**	-	**ND (20)**
Iron	ug/L	300	7900	**ND (500)**	NS	NS	900	**ND (500)**	**ND (500)**	-	8400	150	**ND (500)**	**ND (500)**	-	2200
Lead	ug/L	1 - 7[9]	ND	ND	NS	NS	0.8	ND	ND	-	8.2	-	ND	ND	-	-
Manganese	ug/L	-	89	98	NS	NS	51	60	81	-	480	150	130	140	-	120
Molyebdenum	ug/L	73	ND	ND	NS	NS	ND	ND	ND	-	ND	-	ND	ND	-	-
Nickel	ug/L	25 - 150[10]	ND	ND	NS	NS	ND	ND	ND	-	ND	-	ND	ND	-	-
Selenium	ug/L	1.0	**ND (10)**	**ND (20)**	NS	NS	**ND (2)**	**ND (20)**	**ND (20)**	-	**ND (20)**	-	**ND (20)**	**ND (20)**	-	-
Silver	ug/L	0.1	**ND (1)**	**ND (5)**	NS	NS	**ND (0.5)**	**ND (5)**	**ND (5)**	-	**ND (5)**	-	**ND (5)**	**ND (5)**	-	-
Strontium	ug/L	-	3900	2700	NS	NS	750	2600	2200	-	3700	-	4400	4900	-	-
Thallium	ug/L	0.8	**ND (1)**	**ND (1)**	NS	NS	ND	**ND (1)**	**ND (1)**	-	**ND (1)**	-	**ND (1)**	**ND (1)**	-	-
Tin	ug/L	-	ND	ND	NS	NS	ND	ND	ND	-	ND	-	ND	ND	-	-
Titanium	ug/L	-	33	ND	NS	NS	25	ND	ND	-	65	-	21	29	-	-
Uranium	ug/L	-	1.3	1.1	NS	NS	0.3	ND	1.1	-	1.9	-	1.8	1.9	-	-
Vanadium	ug/L	-	ND	ND	NS	NS	ND	ND	ND	-	ND	-	ND	ND	-	-
Zinc	ug/L	30	55	**ND (50)**	NS	NS	9	**ND (50)**	**ND (50)**	-	51	**ND (50)**	**ND (50)**	**ND (50)**	-	90
Sodium	mg/L	-	8.8	7.6	NS	NS	5.3	7.3	7.1	-	8.2	8.9	8.3	9.5	-	8.8
Potassium	mg/L	-	1.4	1.6	NS	NS	1.3	1.0	1.1	-	3.0	1.1	1.1	2.3	-	1.5
Phosphorus	mg/L	-	ND	ND	NS	NS	ND	ND	ND	-	0.4	ND	ND	ND	-	-
Calcium	mg/L	-	426	358	NS	NS	100	330	290	-	440	530	540	580	-	540
Magnesium	mg/L	-	14.5	10.9	NS	NS	3.8	9.6	9.3	-	15	15	16	20	-	18

Table C.5.1

S1 SURFACE WATER QUALITY SAMPLING RESULTS
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Parameter	Units	CCME Fresh Water Aquatic Life(1, 2, 3)	S1	S1	S1	S1	S1	S1 - Lab Duplicate	S1	S1	S1	S1	S1	S1	S1	S1	S1
Sampling Date			**21-Nov-05**	**12-Dec-05**	**18-Jan-06**	**8-Feb-06**	**13-Mar-06**	**13-Mar-06**	**1-Apr-06**	**1-May-06**	**6-Jun-06**	**25-Jul-06**	**17-Aug-06**	**19-Sep-06**	**17-Oct-06**	**1-Nov-06**	**11-Dec-06**
INORGANICS																	
Alkalinity (as $CaCO_3$)	mg/L	-	110	68	96	83	97	-	52	150	98	110	170	180	180	130	87
Chloride	mg/L	-	10	9	10	8	15	-	19	11	7	7	10	12	12	11	9
Color	TCU	-	21	28	16	17	10	-	38	10	36	43	12	9	9	19	20
Nitrate + Nitrite (as N)	mg/L	-	0.08	0.23	0.15	0.14	0.18	-	0.36	ND	ND	ND	0.05	0.05	ND	0.05	0.12
Nitrite	mg/L	0.060	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ammonia (as N)	mg/L	Varies(4)	ND	ND	ND	ND	ND	-	0.06	ND	ND	ND	ND	ND	ND	ND	ND
Total Org. Carbon (by UV)	mg/L	-	5.6	7.3	3.9	3.8	3.6	-	10.0	3.0	8.4	11.0	4.0	2.9	3.2	6.5	6.0
Orthophosphate (as P)	mg/L	-	ND	ND	ND	ND	ND	-	0.09	ND	ND	ND	ND	ND	ND	ND	ND
pH	units	6.5-9.0	7.56	7.02	7.70	7.60	7.77	-	7.46	8.02	7.63	7.88	8.24	8.08	8.06	7.99	7.76
Total Phosphorus	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reactive Silica (as SiO_2)	mg/L	-	5.9	5.0	5.4	4.4	4.4	-	3.5	4.7	5.2	6.3	7.0	7.1	6.9	6.4	5.4
Total Suspended Solids	mg/L	-	-	-	5	6	7	-	120	3	9	12	ND	4	1	3	13
Sulfate	mg/L	-	580	320	490	400	450	-	110	840	390	360	1100	1200	1000	630	370
Turbidity	NTU	-	3.3	13.0	7.0	8.1	5.7	-	200.0	1.2	8.4	7.6	1.0	0.6	0.7	2.4	13.0
Conductivity	uS/cm		1200	710	1000	920	990	-	400	1500	900	840	1900	2100	1800	1300	830
CALCULATED PARAMETERS																	
Nitrate (as N)	mg/L	2.9	-	-	0.15	0.14	0.18	-	0.36	ND	ND	ND	0.05	0.05	ND	0.05	0.12
Hardness (as $CaCO_3$)	mg/L	-	720	410	600	510	590		180	1000	520	510	1300	1500	1200	820	490
Bicarbonate (as $CaCO_3$)	mg/L	-	112	68	95	83	97	-	52	147	98	109	172	176	175	130	87
Carbonate (as $CaCO_3$)	mg/L	-	ND	ND	ND	ND	ND	-	ND	1	ND	ND	3	2	2.00	1.00	ND
TDS (calculated)	mg/L	-	951	542	809	671	769	-	248	1360	670	645	1680	1910	1640	1060	635
Cation Sum	meq/L	-	14.8	8.51	12.3	10.4	12.2	-	4.09	20.8	10.7	10.5	25.4	31	24.1	16.8	10.1
Anion Sum	meq/L	-	14.5	8.25	12.4	10.3	11.7	-	3.9	20.8	10.2	9.84	25.7	28.4	25.5	16.1	9.69
Ion Balance	%	-	1.03	1.58	0.49	0.87	1.88	-	2.42	0.05	2.58	3.38	0.65	4.38	2.66	2.16	1.87
Langlier Index @ 4C	-	-	0.258	-0.670	0.269	0.050	0.338	-	-0.664	0.942	0.170	0.460	1.290	1.200	1.100	0.794	0.222
Langlier Index @ 20C	-	-	0.504	-0.430	0.516	0.300	0.585	-	-0.415	1.190	0.417	0.708	1.530	1.450	1.340	1.040	0.469
Saturation pH @ 4C	units	-	7.30	7.70	7.43	7.55	7.43	-	8.12	7.08	7.46	7.42	6.95	6.88	6.96	7.20	7.54
Saturation pH @ 20C	Units	-	7.06	7.45	7.18	7.30	7.19	-	7.88	6.83	7.21	7.17	6.71	6.63	6.72	6.95	7.29
METALS																	
Aluminum	ug/L	5 / 100(5)	-	-	260	390	ND	-	300	ND	ND	130	ND	ND	ND	110	320
Antimony	ug/L	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	ug/L	5.0	-	-	**ND (20)**	**ND (20)**	**ND (20)**	-	ND	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**
Barium	ug/L	-	-	-	ND	ND	ND	-	17	ND	ND	ND	ND	52	ND	ND	ND
Beryllium	ug/L	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bismuth	ug/L	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND
Boron	ug/L	-	-	-	ND	ND	ND	-	13	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ug/L	0.017(6)	-	-	**ND (3)**	**ND (3)**	**ND (3)**	-	**ND (0.3)**	**ND (3)**	**ND (3)**	**ND (3)**	**ND (3)**	**ND (3)**	**ND (3)**	**ND (3)**	**ND (3)**
Chromium	ug/L	8.9(III) / 1.0(VI)(7)	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt	ug/L	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper	ug/L	2 - 4(8)	**ND (10)**	**ND (10)**	**ND (20)**	**ND (20)**	**ND (20)**	-	ND	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**
Iron	ug/L	300	240	530	**ND (500)**	**ND (500)**	**ND (500)**	-	270	**ND (500)**	**ND (500)**	**ND (500)**	**ND (500)**	**ND (500)**	**ND (500)**	**ND (500)**	**ND (500)**
Lead	ug/L	1 - 7(9)	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	ug/L	-	100	90	63	40	100	-	31	130	100	60	100	100	92	120	100
Molyebdenum	ug/L	73	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	ug/L	25 - 150(10)	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND
Selenium	ug/L	1.0	-	-	**ND (20)**	**ND (20)**	**ND (20)**	-	**ND (2)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**
Silver	ug/L	0.1	-	-	**ND (5)**	**ND (5)**	**ND (5)**	-	**ND (0.5)**	**ND (5)**	**ND (5)**	**ND (5)**	**ND (5)**	**ND (5)**	**ND (5)**	**ND (5)**	**ND (5)**
Strontium	ug/L	-	-	-	1700	1300	1800	-	400	3000	1300	1400	4000	4400	3600	2300	1300
Thallium	ug/L	0.8	-	-	**ND (1)**	**ND (1)**	**ND (1)**	-	ND	**ND (1)**	**ND (1)**	**ND (1)**	**ND (1)**	**ND (1)**	**ND (1)**	**ND (1)**	**ND (1)**
Tin	ug/L	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND
Titanium	ug/L	-	-	-	ND	ND	ND	-	16	ND	ND	ND	ND	22	ND	ND	21
Uranium	ug/L	-	-	-	ND	ND	ND	-	0.1	1	ND	ND	1	2	1	ND	ND
Vanadium	ug/L	-	-	-	ND	ND	ND	-	ND	30	ND	ND	ND	ND	ND	ND	ND
Zinc	ug/L	30	**ND (50)**	**ND (50)**	**ND (50)**	**ND (50)**	**ND (50)**	-	6	**ND (50)**	**ND (50)**	**ND (50)**	**ND (50)**	**ND (50)**	**ND (50)**	**ND (50)**	**ND (50)**
Sodium	mg/L	-	6.9	5.2	6.3	5.2	8.7	9.2	11	7.9	6.1	6.6	8.1	9.2	7.7	7.2	6
Potassium	mg/L	-	1.1	1.5	1.0	0.7	1.1	1.1	2.5	0.9	1.3	1.7	1.0	2.2	1.2	1.3	1.4
Phosphorus	mg/L	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.1
Calcium	mg/L	-	270	160	230	190	220	240	65	390	200	190	480	580	450	310	180
Magnesium	mg/L	-	8.9	5.9	7.2	6.1	8.3	8.4	3.7	12	6.6	6.8	14	18	15	11	6.8

Table C.5.1

S1 SURFACE WATER QUALITY SAMPLING RESULTS
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Parameter	**Units**	**CCME Fresh Water Aquatic Life(1, 2, 3)**	**S1**	**S1**	**S1**	**S1**	**S1**	**S1**	**S1**	**S1**	**S1**	**S1**	**S1**	**S1**	**S1**	**S1**	**S1**
Sampling Date			**23-Jan-07**	**20-Feb-07**	**14-Mar-07**	**24-Apr-07**	**8-May-07**	**28-Jun-07**	**24-Jul-07**	**30-Aug-07**	**24-Sep-07**	**31-Oct-07**	**21-Nov-07**	**12-Dec-07**	**10-Jan-08**	**28-Feb-08**	**18-Mar-08**
INORGANICS																	
Alkalinity (as $CaCO_3$)	mg/L	-	110	NS	69	110	130	160	170	150	160	190	120	150	64	77	110
Chloride	mg/L	-	11	NS	9	10	12	10	11	10	11	13	12	14	10	7	12
Color	TCU	-	13	NS	17	10	8	12	12	15	13	11	20	12	28	16	8
Nitrate + Nitrite (as N)	mg/L	-	0.15	NS	0.05	0.08	ND	0.05	0.06	0.08	ND	ND	0.09	0.19	0.23	0.12	0.10
Nitrite	mg/L	0.060	ND	NS	0.01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ammonia (as N)	mg/L	Varies(4)	ND	NS	0.11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Org. Carbon (by UV)	mg/L	-	4.1	NS	5.4	3.4	2.6	4.1	3.9	5.5	3.4	3.6	4.0	3.6	6.1	4.1	2.9
Orthophosphate (as P)	mg/L	-	ND	NS	0.01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
pH	units	6.5-9.0	7.74	NS	7.59	7.92	7.97	7.96	8.09	7.97	8.05	8.05	7.85	7.77	7.52	7.71	7.88
Total Phosphorus	mg/L	-	-	NS	-	-	-	-	-	-	0.023	0.005	0.019	0.008	0.037	0.019	0.010
Reactive Silica (as SiO_2)	mg/L	-	5.3	NS	3.4	4.5	4.7	5.8	6.5	6.5	6.5	7.1	6.0	6.3	4.6	4.2	4.6
Total Suspended Solids	mg/L	-	9	NS	26	5	3	5	4	14	2	1	5	3	14	8	6
Sulfate	mg/L	-	620	NS	220	640	820	870	860	780	970	970	580	680	180	320	820
Turbidity	NTU	-	3.8	NS	13.0	1.3	0.9	1.8	2.1	4.5	0.8	0.8	3.7	1.5	15.0	6.0	3.5
Conductivity	uS/cm		1300	NS	580	1300	1500	1600	1800	1500	1700	1800	1300	1300	510	780	1600
CALCULATED PARAMETERS																	
Nitrate (as N)	mg/L	2.9	0.15	NS	ND	0.08	ND	0.05	ND	0.08	ND	ND	0.09	0.19	0.23	0.12	0.10
Hardness (as $CaCO_3$)	mg/L	-	750	NS	300	790	980	1100	1100	1000	1200	1100	690	820	250	400	1000
Bicarbonate (as $CaCO_3$)	mg/L	-	110	NS	68	110	125	159	171	149	155	190	119	145	64	77	106
Carbonate (as $CaCO_3$)	mg/L	-	ND	NS	ND	ND	1.0	1.0	2.0	1	2	2.00	ND	ND	ND	ND	ND
TDS (calculated)	mg/L	-	1010	NS	394	1040	1300	1410	1450	1300	1580	1550	952	1120	340	542	1310
Cation Sum	meq/L	-	15.3	NS	6.28	16.1	19.9	21.7	23.4	21.3	25.3	22.7	14.2	16.8	5.33	8.14	20.4
Anion Sum	meq/L	-	15.4	NS	6.11	15.8	19.8	21.6	21.7	19.4	23.6	24.3	14.8	17.4	5.33	8.46	19.6
Ion Balance	%	-	0.42	NS	1.37	0.88	0.18	0.37	3.66	4.71	3.42	3.36	1.96	1.90	0.00	1.93	3.45
Langlier Index @ 4C	-	-	0.434	NS	-0.219	0.636	0.807	0.931	1.120	0.914	1.060	1.100	0.560	0.610	-0.377	0.048	0.660
Langlier Index @ 20C	-	-	0.680	NS	0.029	0.882	1.050	1.180	1.360	1.160	1.300	1.340	0.806	0.856	-0.128	0.296	0.905
Saturation pH @ 4C	units	-	7.31	NS	7.81	7.28	7.16	7.03	6.97	7.06	6.99	6.95	7.29	7.16	7.90	7.66	7.22
Saturation pH @ 20C	Units	-	7.06	NS	7.56	7.04	6.92	6.78	6.73	6.81	6.75	6.71	7.04	6.91	7.65	7.41	6.98
METALS																	
Aluminum	ug/L	5 / 100(5)	ND	NS	72	ND	ND	ND	ND	180	ND	ND	ND	ND	190	ND	ND
Antimony	ug/L	-	ND	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	ug/L	5.0	**ND (20)**	NS	ND	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	ND	**ND (20)**	**ND (20)**
Barium	ug/L	-	ND	NS	16	ND	ND	ND	ND	ND	ND	ND	ND	ND	17	ND	ND
Beryllium	ug/L	-	ND	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bismuth	ug/L	-	ND	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Boron	ug/L	-	ND	NS	13	ND	ND	ND	ND	ND	ND	ND	ND	ND	10	ND	ND
Cadmium	ug/L	0.017(6)	**ND (3)**	NS	**ND (0.3)**	**ND (3)**	**ND (3)**	**ND (3)**	**ND (3)**	**ND (3)**	**ND (3)**	**ND (3)**	**ND (3)**	**ND (3)**	**ND (0.3)**	**ND (3)**	**ND (3)**
Chromium	ug/L	8.9(III) / 1.0(VI)(7)	ND	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt	ug/L	-	ND	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper	ug/L	2 - 4(8)	**ND (20)**	NS	ND	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	ND	**ND (20)**	**ND (20)**
Iron	ug/L	300	**ND (500)**	NS	60	**ND (500)**	**ND (500)**	**ND (500)**	**ND (500)**	**ND (500)**	**ND (500)**	**ND (500)**	**ND (500)**	**ND (500)**	160	**ND (500)**	**ND (500)**
Lead	ug/L	1 - 7(9)	ND	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	ug/L	-	57	NS	100	54	88	170	170	140	77	57	90	140	36	28	40
Molyebdenum	ug/L	73	ND	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	ug/L	25 - 150(10)	ND	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Selenium	ug/L	1.0	**ND (20)**	NS	**ND (2)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (2)**	**ND (20)**	**ND (20)**
Silver	ug/L	0.1	**ND (5)**	NS	**ND (0.5)**	**ND (5)**	**ND (5)**	**ND (5)**	**ND (5)**	**ND (5)**	**ND (5)**	**ND (5)**	**ND (5)**	**ND (5)**	**ND (0.5)**	**ND (5)**	**ND (5)**
Strontium	ug/L	-	2200	NS	850	2100	2600	3400	3700	2900	3400	3600	2100	2400	610	1100	2700
Thallium	ug/L	0.8	**ND (1)**	NS	ND	**ND (1)**	**ND (1)**	**ND (1)**	**ND (1)**	**ND (1)**	**ND (1)**	**ND (1)**	**ND (1)**	**ND (1)**	ND	**ND (1)**	**ND (1)**
Tin	ug/L	-	ND	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Titanium	ug/L	-	ND	NS	7	ND	ND	ND	ND	ND	ND	ND	ND	ND	12	ND	ND
Uranium	ug/L	-	ND	NS	0.4	ND	2	1	1	ND	1	1	ND	ND	0.3	ND	1
Vanadium	ug/L	-	ND	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	ug/L	30	**ND (50)**	NS	ND	**ND (50)**	**ND (50)**	**ND (50)**	**ND (50)**	**ND (50)**	**ND (50)**	**ND (50)**	**ND (50)**	**ND (50)**	ND	**ND (50)**	**ND (50)**
Sodium	mg/L	-	8	NS	5	7.6	8.7	8.7	8.9	8	10	10	7.2	9.1	5.1	4.9	8.5
Potassium	mg/L	-	2.0	NS	2.4	1.1	1.1	1.0	1.1	1.0	1.0	1.0	1.4	1.3	1.3	1.0	1.0
Phosphorus	mg/L	-	ND	NS	0.1	ND	ND	ND	ND	ND	ND	2.0	ND	ND	ND	ND	ND
Calcium	mg/L	-	280	NS	110	300	370	410	440	400	470	420	260	310	95	150	380
Magnesium	mg/L	-	9	NS	4.5	8.8	11	12	12	13	15	14	8.4	11	4.1	5.1	10

Table C.5.1

S1 SURFACE WATER QUALITY SAMPLING RESULTS
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Parameter	Units	CCME Fresh Water Aquatic Life[1, 2, 3]	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1
Sampling Date			**29-Apr-08**	**28-May-08**	**24-Jun-08**	**29-Jul-08**	**1-Aug-08**	**24-Sep-08**	**30-Oct-08**	**26-Nov-08**	**15-Dec-08**	**28-Jan-09**	**25-Feb-09**	**31-Mar-09**
INORGANICS														
Alkalinity (as $CaCO_3$)	mg/L	-	120	120	160	200	180	170	160	120	110	NS	NS	55
Chloride	mg/L	-	11	11	12	12	10	12	12	10	11	NS	NS	11
Color	TCU	-	12	28	17	20	33	17	22	36	36	NS	NS	48
Nitrate + Nitrite (as N)	mg/L	-	ND	ND	0.07	0.13	ND	ND	ND	0.19	0.19	NS	NS	0.17
Nitrite	mg/L	0.060	ND	ND	ND	ND	ND	ND	ND	ND	0.03	NS	NS	ND
Ammonia (as N)	mg/L	Varies[4]	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
Total Org. Carbon (by UV)	mg/L	-	4.7	5.9	4.6	4.3	6.8	4.4	5.9	5.6	5.1	NS	NS	5.5
Orthophosphate (as P)	mg/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
pH	units	6.5-9.0	7.99	7.91	8.06	8.06	7.95	7.95	7.84	7.71	7.73	NS	NS	7.41
Total Phosphorus	mg/L	-	0.013	0.053	0.013	0.018	0.017	0.014	0.016	0.045	0.017	NS	NS	0.029
Reactive Silica (as SiO_2)	mg/L	-	3.8	4.5	5.2	6.5	6.3	5.9	6.2	5.7	5.2	NS	NS	3.4
Total Suspended Solids	mg/L	-	17	33	4	6	2	94	ND	16	4	NS	NS	19
Sulfate	mg/L	-	720	590	950	1100	790	900	660	310	490	NS	NS	180
Turbidity	NTU	-	3.5	12.0	0.9	2.7	1.0	0.5	0.7	7.2	2.6	NS	NS	5.8
Conductivity	uS/cm		1500	1200	1800	2000	1500	1700	1400	840	1000	NS	NS	490
CALCULATED PARAMETERS														
Nitrate (as N)	mg/L	2.9	ND	ND	0.07	0.13	ND	ND	ND	0.19	0.16	NS	NS	0.17
Hardness (as $CaCO_3$)	mg/L	-	910	690	1100	1300	930	1100	890	460	650	NS	NS	250
Bicarbonate (as $CaCO_3$)	mg/L	-	122	119	156	193	181	165	164	116	105	NS	NS	55
Carbonate (as $CaCO_3$)	mg/L	-	1.0	ND	2.0	2.0	2	1	1.00	ND	ND	NS	NS	ND
TDS (calculated)	mg/L	-	1180	955	1520	1770	1290	1450	1140	585	830	NS	NS	340
Cation Sum	meq/L	-	18.5	14.2	23.2	25.5	19	22	18.2	9.46	13.2	NS	NS	5.41
Anion Sum	meq/L	-	17.8	14.9	23.2	27.7	20.4	22.3	17.3	9.1	12.6	NS	NS	5.25
Ion Balance	%	-	2.04	2.58	0.04	4.15	3.71	0.68	2.50	1.94	2.44	NS	NS	1.50
Langlier Index @ 4C	-	-	0.800	0.615	1.040	1.150	0.926	0.938	0.771	0.272	0.369	NS	NS	-0.548
Langlier Index @ 20C	-	-	1.050	0.861	1.280	1.400	1.170	1.180	1.020	0.519	0.615	NS	NS	-0.299
Saturation pH @ 4C	units	-	7.19	7.30	7.02	6.91	7.02	7.01	7.07	7.44	7.36	NS	NS	7.96
Saturation pH @ 20C	Units	-	6.94	7.05	6.78	6.66	6.78	6.77	6.82	7.19	7.12	NS	NS	7.71
METALS														
Aluminum	ug/L	5 / 100[5]	240	ND	ND	ND	ND	ND	ND	350	180	NS	NS	500
Antimony	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
Arsenic	ug/L	5.0	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	NS	NS	ND
Barium	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	19
Beryllium	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
Bismuth	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
Boron	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	11
Cadmium	ug/L	0.017[6]	**ND (3)**	**ND (3)**	**ND (3)**	**ND (3)**	**ND (3)**	**ND (3)**	**ND (3)**	**ND (3)**	**ND (3)**	NS	NS	**ND (0.3)**
Chromium	ug/L	8.9(III) / 1.0(VI)[7]	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
Cobalt	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
Copper	ug/L	2 - 4[8]	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	NS	NS	ND
Iron	ug/L	300	**ND (500)**	**ND (500)**	**ND (500)**	**ND (500)**	**ND (500)**	**ND (500)**	**ND (500)**	640	**ND (500)**	NS	NS	560
Lead	ug/L	1 - 7[9]	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	1.1
Manganese	ug/L	-	99	86	ND	200	110	83	67	170	54	NS	NS	55
Molyebdenum	ug/L	73	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
Nickel	ug/L	25 - 150[10]	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
Selenium	ug/L	1.0	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	NS	NS	**ND (2)**
Silver	ug/L	0.1	**ND (5)**	**ND (5)**	**ND (5)**	**ND (5)**	**ND (5)**	**ND (5)**	**ND (5)**	**ND (5)**	**ND (5)**	NS	NS	**ND (0.5)**
Strontium	ug/L	-	2800	2000	3500	4200	2900	3200	2800	1300	1600	NS	NS	670
Thallium	ug/L	0.8	**ND (1)**	**ND (1)**	**ND (1)**	**ND (1)**	**ND (1)**	**ND (1)**	**ND (1)**	**ND (1)**	**ND (1)**	NS	NS	ND
Tin	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
Titanium	ug/L	-	20	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	14
Uranium	ug/L	-	1	ND	1	1	1	ND	ND	ND	ND	NS	NS	0.2
Vanadium	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
Zinc	ug/L	30	**ND (50)**	**ND (50)**	**ND (50)**	**ND (50)**	**ND (50)**	**ND (50)**	**ND (50)**	**ND (50)**	**ND (50)**	NS	NS	7
Sodium	mg/L	-	8.1	8.1	9.5	9.2	8.1	8.7	8.6	6.6	6.6	NS	NS	7
Potassium	mg/L	-	1.1	1.3	1.3	1.5	1.4	1.2	1.9	1.9	1.4	NS	NS	1.1
Phosphorus	mg/L	-	ND	ND	0.1	ND	0.2	0.2	0.5	ND	0.2	NS	NS	ND
Calcium	mg/L	-	350	260	430	480	350	410	340	170	250	NS	NS	95
Magnesium	mg/L	-	11	8.4	13	15	11	12	11	7.3	7.7	NS	NS	3.6

Table C.5.2

S2 SURFACE WATER QUALITY SAMPLING RESULTS
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Parameter	Units	CCME Fresh Water Aquatic Life[1, 2, 3]	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2
Sampling Date			**2-Nov-04**	**7-Dec-04**	**12-Jan-05**	**8-Feb-05**	**1-Mar-05**	**13-Apr-05**	**5-May-05**	**21-Jun-05**	**11-Jul-05**	**17-Aug-05**	**6-Sep-05**	**3-Oct-05**	**21-Nov-05**	**12-Dec-05**	**18-Jan-06**
INORGANICS																	
Alkalinity (as $CaCO_3$)	mg/L	-	160	87	NS	NS	32	85	87	140	170	180	170	180	61	38	55
Chloride	mg/L	-	7	7	NS	NS	5.8	6	6.8	13	48	52	72	19	5	6	5
Color	TCU	-	10	17	NS	NS	30	14	14	9.3	9.4	7.3	7.1	7	22	26	18
Nitrate + Nitrite (as N)	mg/L	-	ND	0.15	NS	NS	0.09	0.09	ND	0.10	0.08	ND	0.07	ND	0.14	0.14	0.25
Nitrite	mg/L	0.060	ND	ND	NS	NS	0.09	0.09	ND	ND	-	ND	0.01	-	-	-	ND
Ammonia (as N)	mg/L	Varies[4]	ND	ND	NS	NS	ND	ND	ND	ND	0.08	0.11	0.15	ND	ND	ND	ND
Total Org. Carbon (by UV)	mg/L	-	3.2	5.2	NS	NS	5.8	3.5	4.1	3.0	3.2	2.3	2.3	2.4	6.1	7.0	3.9
Orthophosphate (as P)	mg/L	-	0.01	ND	NS	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
pH	units	6.5-9.0	7.70	7.30	NS	NS	6.96	7.46	7.03	7.80	7.93	7.63	7.51	7.82	7.51	7.15	7.56
Total Phosphorus	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reactive Silica (as SiO_2)	mg/L	-	7.9	6.5	NS	NS	3.2	4.5	5.0	6.2	7.5	7.9	8.3	8.2	6.0	4.9	5.4
Total Suspended Solids	mg/L	-	7.1	2.2	NS	NS	5.3	2.5	-	-	-	-	11	-	-	-	3
Sulfate	mg/L	-	920	360	NS	NS	110	360	310	850	1200	1100	1300	1200	250	160	200
Turbidity	NTU	-	0.2	2.0	NS	NS	14.0	1.3	1.2	8.2	10.0	11.0	16.0	0.9	2.1	15.0	4.7
Conductivity	uS/cm		2440	1020	NS	NS	380	800	710	1700	2100	2300	2400	2100	610	410	520
CALCULATED PARAMETERS																	
Nitrate (as N)	mg/L	2.9	ND	0.15	NS	NS	ND	ND	ND	0.10	-	ND	0.06	-	-	-	0.25
Hardness (as $CaCO_3$)	mg/L	-	1050	478	NS	NS	160	430	420	1100	1500	1500	1500	1500	310	220	280
Bicarbonate (as $CaCO_3$)	mg/L	-	159	87	NS	NS	31.9	84.8	87	140	169	179	173	178	60	38	55
Carbonate (as $CaCO_3$)	mg/L	-	ND	ND	NS	NS	ND	ND	ND	ND	1.0	ND	ND	1	ND	ND	ND
TDS (calculated)	mg/L	-	1450	620	NS	NS	201	600	547	1400	1930	1890	2120	1960	422	286	354
Cation Sum	meq/L	-	21.2	9.78	NS	NS	3.32	8.87	8.63	22.2	30.7	30.2	32.6	30	6.36	4.64	5.77
Anion Sum	meq/L	-	22.5	9.44	NS	NS	3.02	9.41	8.42	21	29	28.3	32.2	29.8	6.53	4.27	5.33
Ion Balance	%	-	3.01	1.79	NS	NS	4.65	2.97	1.24	2.80	2.75	3.23	0.53	0.34	1.34	4.22	3.97
Langlier Index @ 4C	-	-	0.560	-0.400	NS	NS	-1.360	-0.130	0.550	0.700	1.020	0.756	0.622	0.935	-0.330	-1.010	-0.360
Langlier Index @ 20C	-	-	0.960	0.000	NS	NS	-1.110	0.118	0.300	1.000	1.270	1.000	0.866	1.180	-0.090	-0.760	-0.111
Saturation pH @ 4C	units	-	7.14	7.70	NS	NS	8.32	7.59	7.58	7.10	6.91	6.87	6.89	6.89	7.85	8.16	7.92
Saturation pH @ 20C	Units	-	6.74	7.30	NS	NS	8.07	7.34	7.34	6.80	6.66	6.63	6.64	6.64	7.60	7.91	7.67
METALS																	
Aluminum	ug/L	5 / 100[5]	64	110	NS	NS	600	**ND (500)**	69	ND	-	ND	ND	-	-	-	170
Antimony	ug/L	-	ND	ND	NS	NS	ND	ND	ND	ND	-	ND	ND	-	-	-	ND
Arsenic	ug/L	5.0	**ND (20)**	**ND (20)**	NS	NS	ND	**ND (20)**	ND	**ND (20)**	-	**ND (20)**	**ND (20)**	-	-	-	ND
Barium	ug/L	-	53	ND	NS	NS	19	ND	28	67	-	85	74	-	-	-	21
Beryllium	ug/L	-	ND	ND	NS	NS	ND	ND	ND	ND	-	ND	ND	-	-	-	ND
Bismuth	ug/L	-	ND	ND	NS	NS	ND	ND	ND	ND	-	ND	ND	-	-	-	ND
Boron	ug/L	-	ND	ND	NS	NS	8.3	ND	16	ND	-	72	140	-	-	-	12
Cadmium	ug/L	0.017[6]	ND	**ND (3)**	NS	NS	**ND (0.3)**	**ND (3)**	**ND (0.3)**	**ND (3)**	-	**ND (3)**	**ND (3)**	-	-	-	**ND (0.3)**
Chromium	ug/L	8.9(III) / 1.0(VI)[7]	ND	ND	NS	NS	ND	ND	ND	ND	-	ND	ND	-	-	-	ND
Cobalt	ug/L	-	ND	ND	NS	NS	ND	ND	ND	ND	-	ND	ND	-	-	-	ND
Copper	ug/L	2 - 4[8]	**ND (20)**	**ND (20)**	NS	NS	ND	**ND (20)**	29	**ND (20)**	**ND (10)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (10)**	**ND (10)**	ND
Iron	ug/L	300	**ND (500)**	**ND (500)**	NS	NS	560	**ND (500)**	ND	720	1200	**ND (500)**	1700	220	90	420	ND
Lead	ug/L	1 - 7[9]	ND	ND	NS	NS	2	ND	ND	ND	-	ND	ND	-	-	-	ND
Manganese	ug/L	-	42	ND	NS	NS	17	ND	19	100	300	160	310	60	ND	30	13
Molyebdenum	ug/L	73	ND	ND	NS	NS	ND	ND	ND	ND	-	ND	ND	-	-	-	ND
Nickel	ug/L	25 - 150[10]	ND	ND	NS	NS	ND	ND	ND	ND	-	ND	ND	-	-	-	ND
Selenium	ug/L	1.0	**ND (10)**	**ND (20)**	NS	NS	**ND (2)**	**ND (20)**	**ND (2)**	**ND (20)**	-	**ND (20)**	**ND (20)**	-	-	-	**ND (2)**
Silver	ug/L	0.1	**ND (1)**	**ND (5)**	NS	NS	**ND (0.5)**	**ND (5)**	**ND (0.5)**	**ND (5)**	-	**ND (5)**	**ND (5)**	-	-	-	**ND (0.5)**
Strontium	ug/L	-	2800	1200	NS	NS	390	1200	1000	3100	-	4300	4300	-	-	-	700
Thallium	ug/L	0.8	**ND (1)**	**ND (1)**	NS	NS	ND	**ND (1)**	ND	**ND (1)**	-	**ND (1)**	**ND (1)**	-	-	-	ND
Tin	ug/L	-	ND	ND	NS	NS	ND	ND	ND	ND	-	ND	ND	-	-	-	ND
Titanium	ug/L	-	21	ND	NS	NS	15	ND	6.9	ND	-	22	28	-	-	-	8
Uranium	ug/L	-	ND	ND	NS	NS	0.2	ND	0.3	1.3	-	1.8	1.1	-	-	-	0.2
Vanadium	ug/L	-	ND	ND	NS	NS	ND	ND	ND	ND	-	ND	ND	-	-	-	ND
Zinc	ug/L	30	**ND (50)**	**ND (50)**	NS	NS	510	**ND (50)**	5.8	**ND (50)**	**ND (50)**	**ND (50)**	**ND (50)**	90	**ND (50)**	**ND (50)**	ND
Sodium	mg/L	-	6	4.6	NS	NS	3.4	4.8	5.4	9.6	26	12	37	12	3.6	3.8	3.6
Potassium	mg/L	-	1.8	1.0	NS	NS	1.0	0.9	0.9	1.2	1.5	1.3	1.6	1.3	0.7	1.0	0.7
Phosphorus	mg/L	-	ND	ND	NS	NS	ND	ND	ND	ND	0.0	ND	ND	-	-	-	ND
Calcium	mg/L	-	404	182	NS	NS	59	160	160	420	560	570	590	570	120	83	110
Magnesium	mg/L	-	9.1	5.7	NS	NS	2.3	5	5.1	11	15	14	15	13	3.9	3.4	3.6

Table C.5.2

S2 SURFACE WATER QUALITY SAMPLING RESULTS
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Parameter	Units	CCME Fresh Water Aquatic Life(1, 2, 3)	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2
Sampling Date			**8-Feb-06**	**13-Mar-06**	**1-Apr-06**	**1-May-06**	**6-Jun-06**	**25-Jul-06**	**17-Aug-06**	**19-Sep-06**	**17-Oct-06**	**1-Nov-06**	**11-Dec-06**	**23-Jan-07**	**20-Feb-07**	**14-Mar-07**	**24-Apr-07**
INORGANICS																	
Alkalinity (as $CaCO_3$)	mg/L	-	50	53	26	100	66	78	170	160	120	81	50	74	140	46	65
Chloride	mg/L	-	5	6	5	8	4	4	17	22	10	12	8	7	12	8	6
Color	TCU	-	19	15	43	12	37	48	13	9	13	20	22	14	6	22	16
Nitrate + Nitrite (as N)	mg/L	-	0.20	0.24	0.23	0.06	0.11	0.13	0.19	0.28	ND	0.16	0.18	0.29	0.23	0.26	0.22
Nitrite	mg/L	0.060	ND	ND	ND	ND	ND	ND	0.01	0.07	ND	ND	ND	ND	ND	0.24	ND
Ammonia (as N)	mg/L	Varies(4)	ND	ND	ND	ND	ND	ND	0.29	0.22	ND	ND	ND	ND	0.05	ND	ND
Total Org. Carbon (by UV)	mg/L	-	4.3	3.8	9.0	3.3	8.6	13.0	3.6	3.0	4.0	6.7	5.9	4.1	2.5	6.0	4.3
Orthophosphate (as P)	mg/L	-	ND	ND	ND	ND	ND	ND	0.02	ND	0.01	ND	ND	ND	ND	ND	ND
pH	units	6.5-9.0	7.62	7.69	7.41	8.08	7.70	7.95	8.20	7.85	7.85	7.91	7.76	7.74	7.84	7.50	7.90
Total Phosphorus	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reactive Silica (as SiO_2)	mg/L	-	4.8	4.3	3.7	5.6	5.7	6.5	8.0	8.1	6.9	6.8	5.6	5.9	7.6	3.9	4.7
Total Suspended Solids	mg/L	-	2	ND	170	2	6	5	ND	17	2	ND	2	13	ND	90	3
Sulfate	mg/L	-	160	210	69	520	140	140	1100	1300	670	300	140	290	850	110	260
Turbidity	NTU	-	4.7	4.5	100.0	0.6	6.5	7.1	1.1	3.4	0.4	1.1	6.8	2.8	0.9	55.0	2.5
Conductivity	uS/cm		470	520	210	1000	440	410	2000	2200	1300	740	400	710	1600	350	600
CALCULATED PARAMETERS																	
Nitrate (as N)	mg/L	2.9	0.20	0.24	0.23	0.06	0.11	0.13	0.18	0.21	ND	0.16	0.18	0.29	0.23	0.24	0.22
Hardness (as $CaCO_3$)	mg/L	-	240	290	95	650	230	230	1300	1500	810	430	200	400	1000	170	350
Bicarbonate (as $CaCO_3$)	mg/L	-	50	53	26	103	66	77	172	164	120	80	50	74	140	46	65
Carbonate (as $CaCO_3$)	mg/L	-	ND	ND	ND	1.0	ND	ND	3	1	ND	ND	ND	ND	ND	ND	ND
TDS (calculated)	mg/L	-	300	369	136	862	285	293	1800	2020	1090	546	263	510	1380	219	454
Cation Sum	meq/L	-	4.91	5.98	2.05	13.3	4.7	4.88	26.1	30.8	16.6	8.81	4.13	8.21	21	3.56	7.18
Anion Sum	meq/L	-	4.54	5.56	2.12	13.2	4.41	4.56	27.8	30.5	16.6	8.28	4.07	7.72	20.9	3.39	6.92
Ion Balance	%	-	4.00	3.66	1.66	0.23	3.21	3.36	3.19	0.56	0.12	3.11	0.73	3.08	0.21	2.45	1.84
Langlier Index @ 4C	-	-	-0.398	-0.228	-1.230	0.711	-0.212	0.119	1.250	0.930	0.615	0.299	-0.330	0.072	0.744	-0.690	0.125
Langlier Index @ 20C	-	-	-0.149	0.021	-0.978	0.957	0.038	0.368	1.500	1.170	0.861	0.547	-0.081	0.320	0.989	-0.440	0.373
Saturation pH @ 4C	units	-	8.02	7.92	8.64	7.37	7.91	7.83	6.95	6.92	7.24	7.61	8.09	7.67	7.10	8.19	7.78
Saturation pH @ 20C	Units	-	7.77	7.67	8.39	7.12	7.66	7.58	6.71	6.68	6.99	7.36	7.84	7.42	6.85	7.94	7.53
METALS																	
Aluminum	ug/L	5 / 100(5)	330	120	570	ND	180	520	ND	ND	ND	63	550	120	ND	200	74
Antimony	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	ug/L	5.0	ND	ND	ND	**ND (20)**	ND	ND	**ND (20)**	**ND (20)**	**ND (20)**	ND	ND	ND	**ND (20)**	ND	ND
Barium	ug/L	-	20	22	16	ND	21	22	74	81	ND	30	20	26	ND	17	25
Beryllium	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bismuth	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Boron	ug/L	-	10	9	7	ND	16	17	65	68	ND	19	12	13	ND	10	17
Cadmium	ug/L	0.017(6)	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (3)**	**ND (0.3)**	**ND (0.3)**	**ND (3)**	**ND (3)**	**ND (3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (3)**	**ND (0.3)**	**ND (0.3)**
Chromium	ug/L	8.9(III) / 1.0(VI)(7)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper	ug/L	2 - 4(8)	ND	ND	ND	**ND (20)**	ND	ND	**ND (20)**	**ND (20)**	**ND (20)**	ND	ND	ND	**ND (20)**	ND	ND
Iron	ug/L	300	210	78	410	**ND (500)**	160	410	**ND (500)**	870	**ND (500)**	79	300	ND	**ND (500)**	160	ND
Lead	ug/L	1 - 7(9)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	ug/L	-	10	14	9	24	7	12	110	160	55	16	15	9	35	24	10
Molyebdenum	ug/L	73	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	ug/L	25 - 150(10)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Selenium	ug/L	1.0	**ND (2)**	**ND (2)**	**ND (2)**	**ND (20)**	**ND (2)**	**ND (2)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (20)**	**ND (2)**	**ND (2)**
Silver	ug/L	0.1	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (5)**	**ND (0.5)**	**ND (0.5)**	**ND (5)**	**ND (5)**	**ND (5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (5)**	**ND (0.5)**	**ND (0.5)**
Strontium	ug/L	-	590	690	180	1700	510	540	3700	4300	2200	950	440	970	2700	370	890
Thallium	ug/L	0.8	ND	ND	ND	**ND (1)**	ND	ND	**ND (1)**	**ND (1)**	**ND (1)**	ND	ND	ND	**ND (1)**	ND	ND
Tin	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Titanium	ug/L	-	9	8	21	ND	9	20	ND	26	ND	7	17	10	ND	11	6
Uranium	ug/L	-	0.2	0.2	ND	ND	0.2	0.1	1	1	ND	0.2	0.2	0.4	1	0.1	0.3
Vanadium	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	ug/L	30	ND	ND	ND	**ND (50)**	ND	ND	**ND (50)**	**ND (50)**	**ND (50)**	ND	5	ND	**ND (50)**	ND	ND
Sodium	mg/L	-	3.2	3.5	2.7	5.7	3.5	3.5	11	14	6.4	4.7	3.2	4	9.2	3.7	4.3
Potassium	mg/L	-	0.6	0.7	0.9	0.9	0.7	0.8	1.3	2.0	1.6	1.0	0.8	1.0	1.1	1.9	0.9
Phosphorus	mg/L	-	ND	ND	ND	ND	ND	ND	0.2	0.2	ND	ND	ND	ND	ND	ND	ND
Calcium	mg/L	-	90	110	35	250	86	88	490	580	310	160	74	150	400	63	130
Magnesium	mg/L	-	3.1	3.7	1.7	7	3	3.3	13	14	8.9	5.4	3	5	10	2.6	4

Table C.5.2

S2 SURFACE WATER QUALITY SAMPLING RESULTS
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Parameter	Units	CCME Fresh Water Aquatic Life(1, 2, 3)	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2
Sampling Date			**8-May-07**	**28-Jun-07**	**24-Jul-07**	**30-Aug-07**	**24-Sep-07**	**31-Oct-07**	**21-Nov-07**	**12-Dec-07**	**10-Jan-08**	**28-Feb-08**	**18-Mar-08**	**29-Apr-08**	**28-May-08**	**24-Jun-08**	**29-Jul-08**
INORGANICS																	
Alkalinity (as $CaCO_3$)	mg/L	-	84	130	190	140	150	180	76	82	37	46	84	95	81	150	170
Chloride	mg/L	-	8	8	110	8	12	14	8	8	5	4	6	11	8	19	21
Color	TCU	-	11	14	9	15	13	12	21	15	42	24	11	14	48	14	17
Nitrate + Nitrite (as N)	mg/L	-	ND	0.23	0.09	0.14	ND	ND	0.14	0.20	0.14	0.11	0.16	ND	ND	0.09	0.16
Nitrite	mg/L	0.060	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ammonia (as N)	mg/L	Varies(4)	ND	ND	0.06	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.08
Total Org. Carbon (by UV)	mg/L	-	3.5	4.9	3.3	5.0	4.0	4.0	4.5	4.2	7.7	4.4	3.1	3.5	7.4	3.5	2.8
Orthophosphate (as P)	mg/L	-	ND	ND	ND	ND	0.02	0.01	ND	ND	ND	ND	ND	ND	ND	ND	ND
pH	units	6.5-9.0	7.99	8.00	7.70	7.93	7.83	7.83	7.89	7.82	7.43	7.64	7.87	8.00	7.95	7.91	7.84
Total Phosphorus	mg/L	-	-	-	-	-	0.065	0.027	0.009	0.007	0.037	0.024	0.012	0.009	0.028	0.009	0.030
Reactive Silica (as SiO_2)	mg/L	-	4.4	7.5	8.4	7.8	8.1	8.5	6.2	6.1	4.6	4.4	5.6	4.0	5.0	7.1	8.6
Total Suspended Solids	mg/L	-	1	1	10	ND	ND	ND	1	6	19	8	ND	1	10	1	5
Sulfate	mg/L	-	420	590	1000	680	1100	1000	240	310	69	110	390	440	230	830	1200
Turbidity	NTU	-	0.6	0.5	16.0	0.6	1.0	1.1	3.0	1.7	18.0	13.0	2.0	0.6	5.7	0.5	1.7
Conductivity	uS/cm		920	1200	1800	1400	1900	1800	640	750	240	340	940	930	630	1700	2100
CALCULATED PARAMETERS																	
Nitrate (as N)	mg/L	2.9	ND	0.23	ND	0.14	ND	ND	0.14	0.20	0.14	0.11	0.16	ND	ND	0.09	0.16
Hardness (as $CaCO_3$)	mg/L	-	550	780	1300	830	1300	1100	310	400	120	150	480	580	310	1000	1300
Bicarbonate (as $CaCO_3$)	mg/L	-	83	132	188	137	147	178	76	82	37	46	83	94	80	150	172
Carbonate (as $CaCO_3$)	mg/L	-	ND	1.0	ND	1	ND	1.00	ND	ND	ND	ND	ND	ND	ND	1.0	1.0
TDS (calculated)	mg/L	-	704	996	1820	1110	1720	1600	431	536	153	204	644	750	423	1360	1880
Cation Sum	meq/L	-	11.2	15.9	28.9	17	26.5	23.3	6.45	8.19	2.59	3.07	9.83	11.9	6.47	20.9	26.5
Anion Sum	meq/L	-	10.6	15.1	27.8	17.1	26	25	6.79	8.33	2.33	3.26	9.9	11.4	6.69	20.8	29.3
Ion Balance	%	-	2.88	2.52	1.91	0.29	0.86	3.62	2.57	0.85	5.28	3.00	1.54	2.40	1.67	0.10	5.07
Langlier Index @ 4C	-	-	0.479	0.801	0.779	0.760	0.822	0.862	0.141	0.188	-0.965	-0.599	0.309	0.557	0.221	0.839	0.888
Langlier Index @ 20C	-	-	0.726	1.050	1.020	1.010	1.070	1.110	0.390	0.436	-0.714	-0.349	0.556	0.803	0.469	1.080	1.130
Saturation pH @ 4C	units	-	7.51	7.20	6.92	7.17	7.01	6.97	7.75	7.63	8.40	8.24	7.56	7.44	7.73	7.07	6.95
Saturation pH @ 20C	Units	-	7.26	6.95	6.68	6.93	6.76	6.72	7.50	7.38	8.14	7.99	7.31	7.20	7.48	6.83	6.71
METALS																	
Aluminum	ug/L	5 / 100(5)	ND	ND	ND	ND	ND	ND	83	170	470	280	ND	ND	200	ND	ND
Antimony	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	ug/L	5.0	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	ND	ND	ND	ND	**ND (20)**	**ND (20)**	ND	**ND (20)**	**ND (20)**
Barium	ug/L	-	ND	ND	66	ND	67	54	25	26	12	15	ND	ND	23	57	79
Beryllium	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bismuth	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Boron	ug/L	-	ND	ND	310	ND	ND	ND	13	12	8	7	ND	ND	17	51	64
Cadmium	ug/L	0.017(6)	**ND (3)**	**ND (3)**	**ND (3)**	**ND (3)**	**ND (3)**	**ND (3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (3)**	**ND (3)**	**ND (0.3)**	**ND (3)**	**ND (3)**
Chromium	ug/L	8.9(III) / 1.0(VI)(7)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper	ug/L	2 - 4(8)	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	ND	ND	ND	ND	**ND (20)**	**ND (20)**	ND	**ND (20)**	**ND (20)**
Iron	ug/L	300	**ND (500)**	**ND (500)**	**ND (500)**	**ND (500)**	**ND (500)**	**ND (500)**	60	53	350	180	**ND (500)**	**ND (500)**	130	**ND (500)**	**ND (500)**
Lead	ug/L	1 - 7(9)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	ug/L	-	ND	29	560	49	69	73	11	15	11	8	ND	20	17	56	160
Molyebdenum	ug/L	73	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	ug/L	25 - 150(10)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Selenium	ug/L	1.0	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (20)**	**ND (20)**	**ND (2)**	**ND (20)**	**ND (20)**
Silver	ug/L	0.1	**ND (5)**	**ND (5)**	**ND (5)**	**ND (5)**	**ND (5)**	**ND (5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (5)**	**ND (5)**	**ND (0.5)**	**ND (5)**	**ND (5)**
Strontium	ug/L	-	1300	2200	4200	2200	3400	3200	820	970	240	380	1400	1600	730	2900	4000
Thallium	ug/L	0.8	**ND (1)**	**ND (1)**	**ND (1)**	**ND (1)**	**ND (1)**	**ND (1)**	ND	ND	ND	ND	**ND (1)**	**ND (1)**	ND	**ND (1)**	**ND (1)**
Tin	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Titanium	ug/L	-	ND	ND	ND	ND	ND	22	8	12	18	10	ND	ND	11	ND	ND
Uranium	ug/L	-	ND	ND	1	ND	1	ND	0.3	0.2	0.1	0.1	ND	ND	0.4	1	1
Vanadium	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	ug/L	30	**ND (50)**	**ND (50)**	**ND (50)**	**ND (50)**	**ND (50)**	**ND (50)**	ND	ND	ND	ND	**ND (50)**	**ND (50)**	ND	**ND (50)**	**ND (50)**
Sodium	mg/L	-	5.4	6.3	80	7	10	11	4.3	4.5	2.7	2.8	4.8	8.4	6.4	14	14
Potassium	mg/L	-	0.9	0.9	1.5	1.0	1.0	2.0	1.0	0.8	0.7	0.7	0.8	1.0	0.9	1.3	1.5
Phosphorus	mg/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.1	ND
Calcium	mg/L	-	210	300	490	320	500	440	120	150	46	55	180	220	120	390	500
Magnesium	mg/L	-	6.3	8.5	14	8	14	11	3.8	5.2	2	2.3	5.8	6.3	3.9	11	13

Table C.5.2

S2 SURFACE WATER QUALITY SAMPLING RESULTS
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Parameter	Units	CCME Fresh Water Aquatic Life[1, 2, 3]	S2	S2	S2	S2	S2	S2	S2	S2
Sampling Date			**1-Aug-08**	**24-Sep-08**	**30-Oct-08**	**26-Nov-08**	**15-Dec-08**	**28-Jan-09**	**25-Feb-09**	**31-Mar-09**
INORGANICS										
Alkalinity (as $CaCO_3$)	mg/L	-	130	170	110	85	80	160	76	55
Chloride	mg/L	-	10	15	10	9	8	16	10	9
Color	TCU	-	30	12	48	30	44	7	25	48
Nitrate + Nitrite (as N)	mg/L	-	0.07	0.07	ND	0.21	0.16	0.16	0.16	0.14
Nitrite	mg/L	0.060	ND	ND	ND	ND	0.03	ND	ND	ND
Ammonia (as N)	mg/L	Varies[4]	ND	0.05	ND	ND	ND	ND	ND	ND
Total Org. Carbon (by UV)	mg/L	-	7.4	3.3	8.6	5.6	5.1	3.3	3.3	5.4
Orthophosphate (as P)	mg/L	-	ND	ND	ND	ND	ND	ND	ND	ND
pH	units	6.5-9.0	7.89	7.83	7.76	7.72	7.91	7.78	7.80	7.53
Total Phosphorus	mg/L	-	0.015	0.017	0.023	0.019	0.016	-	0.012	0.03
Reactive Silica (as SiO_2)	mg/L	-	7.7	7.8	6.9	5.9	5.8	7.6	5.4	4.3
Total Suspended Solids	mg/L	-	ND	2	ND	5	6	28	4	18
Sulfate	mg/L	-	560	980	340	150	230	660	200	120
Turbidity	NTU	-	0.5	0.6	0.7	2.8	3.5	1.9	3.1	7.7
Conductivity	uS/cm		1200	1800	860	510	570	1400	570	380
CALCULATED PARAMETERS										
Nitrate (as N)	mg/L	2.9	0.07	0.07	ND	0.21	0.13	0.16	0.16	0.14
Hardness (as $CaCO_3$)	mg/L	-	720	1200	460	240	310	850	300	170
Bicarbonate (as $CaCO_3$)	mg/L	-	134	170	106	84	79	156	75	55
Carbonate (as $CaCO_3$)	mg/L	-	ND	1	ND	ND	ND	ND	ND	ND
TDS (calculated)	mg/L	-	949	1590	612	314	417	1130	384	238
Cation Sum	meq/L	-	14.8	24.3	9.56	4.99	6.41	17.5	6.32	3.56
Anion Sum	meq/L	-	14.6	24.3	9.51	5.05	6.56	17.4	5.92	3.87
Ion Balance	%	-	0.78	0.14	0.26	0.60	1.16	0.32	3.27	4.17
Langlier Index @ 4C	-	-	0.666	0.863	0.294	-0.077	0.180	0.672	0.046	-0.586
Langlier Index @ 20C	-	-	0.912	1.110	0.541	0.172	0.428	0.918	0.294	-0.337
Saturation pH @ 4C	units	-	7.22	6.97	7.47	7.80	7.73	7.11	7.76	8.12
Saturation pH @ 20C	Units	-	6.98	6.72	7.22	7.55	7.48	6.86	7.51	7.87
METALS										
Aluminum	ug/L	5 / 100[5]	ND	ND	ND	240	270	140	220	560
Antimony	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	ug/L	5.0	**ND (20)**	**ND (20)**	ND	ND	ND	**ND (20)**	ND	ND
Barium	ug/L	-	ND	64	ND	20	22	ND	21	17
Beryllium	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND
Bismuth	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND
Boron	ug/L	-	ND	ND	ND	10	12	ND	11	10
Cadmium	ug/L	0.017[6]	**ND (3)**	**ND (3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (3)**	**ND (0.3)**	**ND (0.3)**
Chromium	ug/L	8.9(III) / 1.0(VI)[7]	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND
Copper	ug/L	2 - 4[8]	**ND (20)**	**ND (20)**	ND	ND	ND	**ND (20)**	ND	ND
Iron	ug/L	300	**ND (500)**	**ND (500)**	ND	230	200	**ND (500)**	**ND (500)**	460
Lead	ug/L	1 - 7[9]	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	ug/L	-	56	110	24	27	18	54	19	22
Molyebdenum	ug/L	73	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	ug/L	25 - 150[10]	ND	ND	ND	ND	ND	ND	ND	ND
Selenium	ug/L	1.0	**ND (20)**	**ND (20)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (20)**	**ND (2)**	**ND (2)**
Silver	ug/L	0.1	**ND (5)**	**ND (5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (5)**	**ND (0.5)**	**ND (0.5)**
Strontium	ug/L	-	1900	3300	1200	550	690	2100	710	360
Thallium	ug/L	0.8	**ND (1)**	**ND (1)**	ND	ND	ND	**ND (1)**	ND	ND
Tin	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND
Titanium	ug/L	-	ND	ND	ND	8	10	ND	10	15
Uranium	ug/L	-	ND	1	ND	0.3	0.3	1	0.3	0.2
Vanadium	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	ug/L	30	**ND (50)**	**ND (50)**	ND	6	6	**ND (50)**	8	6
Sodium	mg/L	-	9.6	11	6.1	5	4.8	12	6.2	4.9
Potassium	mg/L	-	1.4	1.2	1.7	1.1	1.0	1.2	0.8	0.9
Phosphorus	mg/L	-	0.2	0.2	0.4	ND	0.1	0.2	ND	ND
Calcium	mg/L	-	270	460	180	89	120	320	110	62
Magnesium	mg/L	-	7.9	12	5.5	3.5	4	9.8	4.1	2.6

Table C.5.3

S3 SURFACE WATER QUALITY SAMPLING RESULTS
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Parameter	Units	CCME Fresh Water Aquatic Life(1, 2, 3)	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3
Sampling Date			**2-Nov-04**	**7-Dec-04**	**12-Jan-05**	**8-Feb-05**	**1-Mar-05**	**13-Apr-05**	**5-May-05**	**21-Jun-05**	**11-Jul-05**	**17-Aug-05**	**6-Sep-05**	**3-Oct-05**	**21-Nov-05**	**12-Dec-05**	**18-Jan-06**
INORGANICS																	
Alkalinity (as $CaCO_3$)	mg/L	-	180	110	90	100	29	110	110	170	170	170	NS	NS	76	56	71
Chloride	mg/L	-	10	8	7	5.5	6.6	5.4	5.3	6.6	8.2	9.3	NS	NS	6	7	5
Color	TCU	-	12	44	32	31	44	22	26	10	ND	12	NS	NS	55	39	36
Nitrate + Nitrite (as N)	mg/L	-	ND	0.19	0.16	0.16	0.38	0.05	ND	0.10	ND	ND	NS	NS	0.07	0.42	0.19
Nitrite	mg/L	0.060	ND	ND	ND	0.17	0.38	0.05	0.01	ND	-	ND	NS	NS	-	-	ND
Ammonia (as N)	mg/L	Varies(4)	ND	ND	ND	ND	ND	ND	ND	ND	0.05	0.05	NS	NS	ND	ND	ND
Total Org. Carbon (by UV)	mg/L	-	3.3	9.3	6.6	4.8	8.1	5.2	6.8	3.1	3.9	3.7	NS	NS	11.0	8.4	7.1
Orthophosphate (as P)	mg/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND	ND	ND
pH	units	6.5-9.0	7.90	7.40	7.90	7.09	6.97	7.54	7.43	8.20	7.68	7.60	NS	NS	7.47	7.31	7.47
Total Phosphorus	mg/L	-	-	-	-	-	-	-	-	-	-	-	NS	NS	-	-	-
Reactive Silica (as SiO_2)	mg/L	-	7.4	7.4	7.0	7.7	3.3	3.5	4.3	6.6	7.7	7.9	NS	NS	6.3	5.3	5.7
Total Suspended Solids	mg/L	-	6	4.9	-	ND	11	3.9	-	-	-	-	NS	NS	-	-	2
Sulfate	mg/L	-	830	350	280	330	59	280	240	700	930	970	NS	NS	210	120	140
Turbidity	NTU	-	1.1	6.1	6.0	14.0	17.0	2.9	2.3	1.9	3.1	3.5	NS	NS	5.7	12.0	7.7
Conductivity	uS/cm		2280	1020	850	970	210	670	630	1500	1700	1800	NS	NS	560	370	430
CALCULATED PARAMETERS																	
Nitrate (as N)	mg/L	2.9	ND	0.19	0.16	0.02	ND	ND	ND	0.10	-	ND	NS	NS	-	-	0.19
Hardness (as $CaCO_3$)	mg/L	-	1080	485	362	420	100	360	380	930	1200	1300	NS	NS	290	200	230
Bicarbonate (as $CaCO_3$)	mg/L	-	179	110	89	104	28.7	105	108	172	172	174	NS	NS	76	56	70
Carbonate (as $CaCO_3$)	mg/L	-	1	ND	ND	ND	ND	ND	ND	2.0	ND	ND	NS	NS	ND	ND	ND
TDS (calculated)	mg/L	-	1390	629	496	577	133	492	464	1200	1550	1610	NS	NS	381	247	288
Cation Sum	meq/L	-	22.1	10	7.5	8.66	2.23	7.35	7.83	19	25.5	26.3	NS	NS	5.98	4.14	4.73
Anion Sum	meq/L	-	21.1	9.72	7.83	9.11	2.02	7.98	7.21	18.3	23	23.9	NS	NS	5.96	3.79	4.51
Ion Balance	%	-	2.10	1.45	2.16	2.57	4.87	4.11	4.12	2.00	5.20	4.74	NS	NS	0.15	4.38	2.44
Langlier Index @ 4C	-	-	0.810	-0.210	0.090	-0.433	-1.630	-0.036	-0.100	1.100	0.730	0.662	NS	NS	-0.310	-0.750	-0.429
Langlier Index @ 20C	-	-	1.210	0.190	0.490	-0.185	-1.380	0.212	0.140	1.400	0.970	0.906	NS	NS	-0.070	-0.500	-0.180
Saturation pH @ 4C	units	-	7.09	7.61	7.81	7.52	8.60	7.58	7.53	7.00	6.95	6.94	NS	NS	7.79	8.06	7.90
Saturation pH @ 20C	Units	-	6.69	7.21	7.41	7.28	8.35	7.33	7.28	6.80	6.71	6.69	NS	NS	7.54	7.81	7.65
METALS																	
Aluminum	ug/L	5 / 100(5)	**ND (50)**	220	270	480	640	200	110	ND	-	ND	NS	NS	-	-	210
Antimony	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	-	ND	NS	NS	-	-	ND
Arsenic	ug/L	5.0	**ND (20)**	**ND (20)**	ND	**ND (20)**	ND	ND	ND	**ND (20)**	-	**ND (20)**	NS	NS	-	-	ND
Barium	ug/L	-	60	ND	29	ND	21	28	30	61	-	98	NS	NS	-	-	23
Beryllium	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	-	ND	NS	NS	-	-	ND
Bismuth	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	-	ND	NS	NS	-	-	ND
Boron	ug/L	-	63	ND	21	ND	8.8	22	18	ND	-	84	NS	NS	-	-	14
Cadmium	ug/L	0.017(6)	ND	**ND (3)**	**ND (0.3)**	**ND (3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (3)**	-	**ND (3)**	NS	NS	-	-	**ND (0.3)**
Chromium	ug/L	8.9(III) / 1.0(VI)(7)	ND	ND	ND	ND	ND	ND	ND	ND	-	ND	NS	NS	-	-	ND
Cobalt	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	-	ND	NS	NS	-	-	ND
Copper	ug/L	2 - 4(8)	**ND (20)**	**ND (20)**	ND	**ND (20)**	ND	2.9	ND	**ND (20)**	**ND (10)**	**ND (20)**	NS	NS	**ND (10)**	**ND (10)**	ND
Iron	ug/L	300	**ND (500)**	**ND (500)**	430	650	760	ND	210	**ND (500)**	680	**ND (2000)**	NS	NS	510	560	220
Lead	ug/L	1 - 7(9)	ND	ND	ND	ND	0.9	ND	ND	ND	-	ND	NS	NS	-	-	ND
Manganese	ug/L	-	120	81	70	110	48	49	56	380	600	390	NS	NS	60	60	38
Molyebdenum	ug/L	73	ND	ND	ND	ND	ND	ND	ND	ND	-	ND	NS	NS	-	-	ND
Nickel	ug/L	25 - 150(10)	ND	ND	ND	ND	2.3	ND	ND	ND	-	ND	NS	NS	-	-	ND
Selenium	ug/L	1.0	**ND (10)**	**ND (20)**	**ND (2)**	**ND (20)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (20)**	-	**ND (20)**	NS	NS	-	-	**ND (2)**
Silver	ug/L	0.1	**ND (1)**	**ND (5)**	**ND (0.5)**	**ND (5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (5)**	-	**ND (5)**	NS	NS	-	-	**ND (0.5)**
Strontium	ug/L	-	4700	2000	1600	1800	340	1500	1400	4400	-	6100	NS	NS	-	-	860
Thallium	ug/L	0.8	**ND (1)**	**ND (1)**	ND	**ND (1)**	ND	ND	ND	**ND (1)**	-	**ND (1)**	NS	NS	-	-	ND
Tin	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	-	ND	NS	NS	-	-	ND
Titanium	ug/L	-	ND	ND	11	ND	12	12	7.3	ND	-	21	NS	NS	-	-	8
Uranium	ug/L	-	1.4	ND	0.1	ND	0.1	0.6	0.5	1.3	-	1.8	NS	NS	-	-	0.3
Vanadium	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	-	ND	NS	NS	-	-	ND
Zinc	ug/L	30	**ND (50)**	**ND (50)**	6	**ND (50)**	11	8.9	6.8	**ND (50)**	**ND (50)**	**ND (50)**	NS	NS	**ND (50)**	**ND (50)**	ND
Sodium	mg/L	-	11.1	6.4	5.4	5.8	3.9	5	5.4	8.9	12	13	NS	NS	4.7	3.7	3.9
Potassium	mg/L	-	2.7	1.3	1.0	1.2	1.3	1.0	1.1	1.4	1.9	2.0	NS	NS	1.2	2.1	1.0
Phosphorus	mg/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	-	-	ND
Calcium	mg/L	-	404	180	134	150	36	130	140	350	470	480	NS	NS	110	70	83
Magnesium	mg/L	-	16.3	8.6	6.7	7.6	2.6	6.6	7.2	15	20	21	NS	NS	5.8	4.7	4.7

Table C.5.3

S3 SURFACE WATER QUALITY SAMPLING RESULTS
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Parameter	Units	CCME Fresh Water Aquatic Life[1, 2, 3]	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3
Sampling Date			**8-Feb-06**	**13-Mar-06**	**1-Apr-06**	**1-May-06**	**6-Jun-06**	**25-Jul-06**	**17-Aug-06**	**19-Sep-06**	**17-Oct-06**	**1-Nov-06**	**11-Dec-06**	**23-Jan-07**	**20-Feb-07**	**14-Mar-07**	**24-Apr-07**
INORGANICS																	
Alkalinity (as $CaCO_3$)	mg/L	-	57	50	36	140	71	78	190	170	160	100	66	84	NS	33	79
Chloride	mg/L	-	6	8	4	7	4	3	8	10	10	9	6	8	NS	6	11
Color	TCU	-	35	31	47	21	76	92	15	10	16	48	35	32	NS	22	24
Nitrate + Nitrite (as N)	mg/L	-	0.22	0.41	0.36	0.08	0.06	0.09	ND	ND	ND	0.07	0.14	0.14	NS	0.22	ND
Nitrite	mg/L	0.060	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND
Ammonia (as N)	mg/L	Varies[4]	ND	ND	ND	ND	ND	ND	0.18	ND	ND	ND	ND	ND	NS	ND	ND
Total Org. Carbon (by UV)	mg/L	-	5.9	5.8	9.0	5.1	14.0	18.0	4.4	3.1	5.2	12.0	8.2	6.6	NS	6.3	5.8
Orthophosphate (as P)	mg/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND
pH	units	6.5-9.0	7.59	7.51	7.53	7.84	7.52	7.83	8.21	7.64	7.81	7.84	7.80	7.66	NS	7.27	7.84
Total Phosphorus	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	NS	-	-
Reactive Silica (as SiO_2)	mg/L	-	4.9	3.9	3.5	5.4	5.3	6.9	8.3	7.7	8.1	7.4	5.8	6.2	NS	2.2	2.6
Total Suspended Solids	mg/L	-	2	2	60	2	8	6	ND	ND	1	1	4	10	NS	88	3
Sulfate	mg/L	-	120	96	38	450	110	110	860	1100	610	240	110	220	NS	24	210
Turbidity	NTU	-	8.1	7.7	68.0	3.6	12.0	8.3	3.1	5.2	2.4	3.0	8.5	7.6	NS	35.0	2.1
Conductivity	uS/cm		380	300	170	990	390	360	1600	2000	1300	650	370	620	NS	140	610
CALCULATED PARAMETERS																	
Nitrate (as N)	mg/L	2.9	0.22	0.41	0.36	0.08	0.06	0.09	ND	ND	ND	0.07	0.14	0.14	NS	0.22	ND
Hardness (as $CaCO_3$)	mg/L	-	180	150	77	600	200	210	1000	1500	770	380	190	340	NS	65	310
Bicarbonate (as $CaCO_3$)	mg/L	-	56	50	36	135	70	77	191	165	162	102	65	84	NS	33	78
Carbonate (as $CaCO_3$)	mg/L	-	ND	ND	ND	ND	ND	ND	3	ND	ND	ND	ND	ND	NS	ND	ND
TDS (calculated)	mg/L	-	236	206	102	788	250	258	1410	1850	1040	474	242	427	NS	84	393
Cation Sum	meq/L	-	3.79	3.36	1.68	12.4	4.27	4.38	21.2	30	16.3	7.98	3.91	7.06	NS	1.51	6.47
Anion Sum	meq/L	-	3.71	3.25	1.66	12.3	3.91	4.04	22	27.5	15.9	7.29	3.85	6.55	NS	1.36	6.15
Ion Balance	%	-	1.07	1.68	0.72	0.24	4.39	3.95	1.74	4.37	1.43	4.55	0.85	3.75	NS	5.23	2.54
Langlier Index @ 4C	-	-	-0.493	-0.684	-1.080	0.555	-0.417	-0.064	1.240	0.712	0.677	0.286	-0.212	-0.020	NS	-1.450	0.095
Langlier Index @ 20C	-	-	-0.243	-0.434	-0.826	0.802	-0.168	0.185	1.480	0.956	0.923	0.534	0.038	0.228	NS	-1.200	0.343
Saturation pH @ 4C	units	-	8.08	8.19	8.61	7.29	7.94	7.89	6.97	6.93	7.13	7.55	8.01	7.68	NS	8.72	7.75
Saturation pH @ 20C	Units	-	7.83	7.94	8.36	7.04	7.69	7.65	6.73	6.68	6.89	7.31	7.76	7.43	NS	8.47	7.50
METALS																	
Aluminum	ug/L	5 / 100[5]	400	280	610	ND	310	590	ND	ND	ND	140	590	180	NS	150	55
Antimony	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND
Arsenic	ug/L	5.0	ND	ND	ND	**ND (20)**	ND	ND	**ND (20)**	**ND (20)**	**ND (20)**	ND	ND	ND	NS	ND	ND
Barium	ug/L	-	21	19	14	ND	22	23	64	96	ND	31	23	27	NS	11	29
Beryllium	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND
Bismuth	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND
Boron	ug/L	-	12	10	8	ND	18	25	61	68	ND	24	14	19	NS	7	20
Cadmium	ug/L	0.017[6]	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (3)**	**ND (0.3)**	**ND (0.3)**	**ND (3)**	**ND (3)**	**ND (3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**
Chromium	ug/L	8.9(III) / 1.0(VI)[7]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND
Cobalt	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND
Copper	ug/L	2 - 4[8]	ND	ND	ND	**ND (20)**	ND	ND	**ND (20)**	**ND (20)**	**ND (20)**	ND	ND	ND	NS	ND	ND
Iron	ug/L	300	350	300	470	**ND (500)**	520	890	**ND (500)**	1200	**ND (500)**	400	490	210	NS	120	81
Lead	ug/L	1 - 7[9]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND
Manganese	ug/L	-	29	43	16	160	21	20	560	510	150	73	46	45	NS	60	28
Molyebdenum	ug/L	73	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND
Nickel	ug/L	25 - 150[10]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND
Selenium	ug/L	1.0	**ND (2)**	**ND (2)**	**ND (2)**	**ND (20)**	**ND (2)**	**ND (2)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**
Silver	ug/L	0.1	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (5)**	**ND (0.5)**	**ND (0.5)**	**ND (5)**	**ND (5)**	**ND (5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**
Strontium	ug/L	-	650	590	210	2500	650	670	4700	6200	3500	1400	610	1200	NS	170	1200
Thallium	ug/L	0.8	ND	ND	ND	**ND (1)**	ND	ND	**ND (1)**	**ND (1)**	**ND (1)**	ND	ND	ND	NS	ND	ND
Tin	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND
Titanium	ug/L	-	11	11	20	ND	14	20	ND	20	ND	12	17	10	NS	4	6
Uranium	ug/L	-	0.3	0.2	0.1	ND	0.3	0.2	ND	ND	ND	0.6	0.4	0.5	NS	ND	0.4
Vanadium	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND
Zinc	ug/L	30	ND	ND	ND	**ND (50)**	ND	ND	**ND (50)**	86	**ND (50)**	ND	ND	ND	NS	ND	ND
Sodium	mg/L	-	3.6	5.3	2.7	7	4.3	4.1	9.9	13	8	5.6	3.8	6	NS	3	7.3
Potassium	mg/L	-	0.9	1.3	1.2	1.1	0.9	1.8	1.5	5.5	2.3	2.1	1.3	2.0	NS	2.8	1.2
Phosphorus	mg/L	-	ND	ND	ND	ND	ND	ND	ND	1.2	ND	ND	ND	ND	NS	ND	ND
Calcium	mg/L	-	66	56	27	220	74	75	390	540	290	140	67	130	NS	22	110
Magnesium	mg/L	-	3.9	3.7	2.4	10	4.3	4.8	17	25	14	8.3	4.5	6	NS	2.5	5.5

Table C.5.3

S3 SURFACE WATER QUALITY SAMPLING RESULTS
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Parameter	Units	CCME Fresh Water Aquatic Life[1, 2, 3]	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3
Sampling Date			**8-May-07**	**28-Jun-07**	**24-Jul-07**	**30-Aug-07**	**24-Sep-07**	**31-Oct-07**	**21-Nov-07**	**12-Dec-07**	**10-Jan-08**	**28-Feb-08**	**18-Mar-08**	**29-Apr-08**	**28-May-08**	**24-Jun-08**	**29-Jul-08**
INORGANICS																	
Alkalinity (as $CaCO_3$)	mg/L	-	110	150	170	130	160	200	90	110	45	52	110	110	78	150	190
Chloride	mg/L	-	7	6	10	6	8	10	7	8	9	5	7	6	3	9	9
Color	TCU	-	20	25	16	40	19	13	46	24	44	33	13	23	110	30	25
Nitrate + Nitrite (as N)	mg/L	-	ND	0.09	0.11	0.06	ND	ND	0.10	0.24	0.22	0.16	0.12	0.05	ND	0.12	0.12
Nitrite	mg/L	0.060	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ammonia (as N)	mg/L	Varies[4]	ND	ND	ND	ND	0.06	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.08
Total Org. Carbon (by UV)	mg/L	-	6.1	7.0	4.6	10.0	5.2	4.0	7.4	4.8	7.0	5.8	4.0	5.3	13.0	6.5	4.9
Orthophosphate (as P)	mg/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
pH	units	6.5-9.0	7.88	7.85	7.87	7.73	7.76	7.84	7.77	7.86	7.44	7.62	7.80	7.97	7.80	7.81	7.75
Total Phosphorus	mg/L	-	-	-	-	-	0.042	0.011	0.010	0.015	0.033	0.025	0.019	0.016	0.054	0.012	0.014
Reactive Silica (as SiO_2)	mg/L	-	3.7	6.7	7.8	8.2	7.8	8.2	6.7	7.0	5.0	4.6	5.7	3.4	3.6	7.0	8.3
Total Suspended Solids	mg/L	-	1	ND	3	ND	15	6	6	8	9	7	9	4	10	1	3
Sulfate	mg/L	-	350	450	630	460	800	730	220	210	74	93	350	340	110	470	880
Turbidity	NTU	-	0.7	1.1	3.6	0.8	3.8	3.8	5.1	4.9	15.0	11.0	4.5	0.7	13.0	0.8	3.6
Conductivity	uS/cm		810	1000	1400	1000	1500	1500	630	630	270	320	920	850	380	1200	1700
CALCULATED PARAMETERS																	
Nitrate (as N)	mg/L	2.9	ND	0.09	ND	0.06	ND	ND	0.10	0.24	0.22	0.16	0.12	0.05	ND	0.12	0.12
Hardness (as $CaCO_3$)	mg/L	-	470	630	850	610	1100	920	300	320	130	130	480	480	190	720	1000
Bicarbonate (as $CaCO_3$)	mg/L	-	105	145	170	134	159	202	89	104	45	52	107	109	77	153	187
Carbonate (as $CaCO_3$)	mg/L	-	ND	ND	1.0	ND	ND	1.00	ND	ND	ND	ND	ND	ND	ND	ND	ND
TDS (calculated)	mg/L	-	618	802	1090	802	1340	1240	415	423	174	190	624	609	236	869	1420
Cation Sum	meq/L	-	9.77	13	17.6	12.5	21.8	18.9	6.26	6.71	2.91	2.85	9.9	9.95	3.93	14.9	20.7
Anion Sum	meq/L	-	9.64	12.4	16.7	12.4	20.1	19.5	6.65	6.77	2.72	3.12	9.68	9.39	3.84	13.1	22.4
Ion Balance	%	-	0.67	2.25	2.59	0.40	4.08	1.56	3.02	0.45	3.37	4.52	2.20	2.90	1.16	6.55	4.06
Langlier Index @ 4C	-	-	0.405	0.612	0.792	0.441	0.725	0.854	0.062	0.243	-0.862	-0.611	0.336	0.523	-0.135	0.648	0.754
Langlier Index @ 20C	-	-	0.653	0.859	1.040	0.687	0.969	1.100	0.310	0.491	-0.612	-0.360	0.583	0.770	0.115	0.894	0.998
Saturation pH @ 4C	units	-	7.48	7.24	7.08	7.29	7.04	6.99	7.71	7.62	8.30	8.23	7.46	7.45	7.94	7.16	7.00
Saturation pH @ 20C	Units	-	7.23	6.99	6.83	7.04	6.79	6.74	7.46	7.37	8.05	7.98	7.22	7.20	7.69	6.92	6.75
METALS																	
Aluminum	ug/L	5 / 100[5]	ND	ND	ND	ND	ND	ND	120	330	320	310	ND	ND	350	ND	ND
Antimony	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	ug/L	5.0	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	ND	ND	ND	ND	**ND (20)**	**ND (20)**	ND	**ND (20)**	**ND (20)**
Barium	ug/L	-	ND	ND	66	ND	63	54	30	27	18	19	ND	ND	20	53	81
Beryllium	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bismuth	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Boron	ug/L	-	ND	ND	55	ND	57	52	21	18	8	9	ND	ND	18	ND	60
Cadmium	ug/L	0.017[6]	**ND (3)**	**ND (3)**	**ND (3)**	**ND (3)**	**ND (3)**	**ND (3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (3)**	**ND (3)**	**ND (0.3)**	**ND (3)**	**ND (3)**
Chromium	ug/L	8.9(III) / 1.0(VI)[7]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper	ug/L	2 - 4[8]	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	ND	ND	ND	ND	**ND (20)**	**ND (20)**	ND	**ND (20)**	**ND (20)**
Iron	ug/L	300	**ND (500)**	**ND (500)**	**ND (500)**	**ND (500)**	**ND (500)**	**ND (500)**	240	260	270	260	**ND (500)**	**ND (500)**	430	**ND (500)**	**ND (500)**
Lead	ug/L	1 - 7[9]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	ug/L	-	71	240	490	160	320	180	54	60	19	23	55	97	31	44	630
Molyebdenum	ug/L	73	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	ug/L	25 - 150[10]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Selenium	ug/L	1.0	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (20)**	**ND (20)**	**ND (2)**	**ND (20)**	**ND (20)**
Silver	ug/L	0.1	**ND (5)**	**ND (5)**	**ND (5)**	**ND (5)**	**ND (5)**	**ND (5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (5)**	**ND (5)**	**ND (0.5)**	**ND (5)**	**ND (5)**
Strontium	ug/L	-	1800	2900	4000	2500	4300	4300	1300	1300	350	540	2000	2100	640	3100	4800
Thallium	ug/L	0.8	**ND (1)**	**ND (1)**	**ND (1)**	**ND (1)**	**ND (1)**	**ND (1)**	ND	ND	ND	ND	**ND (1)**	**ND (1)**	ND	**ND (1)**	**ND (1)**
Tin	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Titanium	ug/L	-	ND	ND	ND	ND	ND	ND	9	14	11	10	ND	ND	14	ND	ND
Uranium	ug/L	-	ND	ND	1	ND	1	1	0.5	0.4	0.2	0.2	ND	ND	0.3	ND	1
Vanadium	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	ug/L	30	**ND (50)**	**ND (50)**	**ND (50)**	**ND (50)**	**ND (50)**	**ND (50)**	ND	ND	ND	ND	**ND (50)**	**ND (50)**	ND	**ND (50)**	**ND (50)**
Sodium	mg/L	-	6.3	7.5	12	8	11	12	5.4	5.7	6.5	3.2	6.5	7.1	3.9	10	11
Potassium	mg/L	-	1.2	1.0	1.8	2.0	2.0	2.0	1.4	2.0	1.2	1.1	1.2	1.2	1.3	1.6	2.0
Phosphorus	mg/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Calcium	mg/L	-	180	230	320	230	400	340	110	120	47	48	180	180	67	270	380
Magnesium	mg/L	-	8.6	11	13	11	18	16	6.2	7.7	3.1	3.1	9.3	8.5	4.4	12	16

Table C.5.3

S3 SURFACE WATER QUALITY SAMPLING RESULTS
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Parameter	Units	CCME Fresh Water Aquatic Life[1, 2, 3]	S3	S3	S3	S3	S3	S3	S3	S3
Sampling Date			**1-Aug-08**	**24-Sep-08**	**30-Oct-08**	**26-Nov-08**	**15-Dec-08**	**28-Jan-09**	**25-Feb-09**	**31-Mar-09**
INORGANICS										
Alkalinity (as $CaCO_3$)	mg/L	-	150	180	140	79	83	150	NS	42
Chloride	mg/L	-	7	9	9	6	7	7	NS	4
Color	TCU	-	47	19	44	69	87	14	NS	66
Nitrate + Nitrite (as N)	mg/L	-	0.06	0.05	ND	0.13	0.13	0.15	NS	0.14
Nitrite	mg/L	0.060	ND	ND	ND	ND	0.04	ND	NS	ND
Ammonia (as N)	mg/L	Varies[4]	ND	0.06	ND	ND	ND	ND	NS	ND
Total Org. Carbon (by UV)	mg/L	-	9.3	5.4	8.6	7.0	7.4	3.6	NS	5.7
Orthophosphate (as P)	mg/L	-	ND	ND	ND	ND	ND	ND	NS	ND
pH	units	6.5-9.0	7.66	7.91	7.70	7.60	7.77	7.74	NS	7.45
Total Phosphorus	mg/L	-	0.015	0.009	0.023	0.082	0.023	-	NS	0.026
Reactive Silica (as SiO_2)	mg/L	-	8.3	8.1	7.4	5.6	5.8	8.6	NS	3.6
Total Suspended Solids	mg/L	-	1	3	ND	41	6	6	NS	5
Sulfate	mg/L	-	420	700	290	73	150	450	NS	70
Turbidity	NTU	-	1.0	1.3	0.9	30.0	9.0	1.3	NS	5.1
Conductivity	uS/cm		1000	1400	850	320	450	1100	NS	230
CALCULATED PARAMETERS										
Nitrate (as N)	mg/L	2.9	0.06	0.05	ND	0.13	0.09	0.15	NS	0.14
Hardness (as $CaCO_3$)	mg/L	-	600	950	460	140	240	660	NS	110
Bicarbonate (as $CaCO_3$)	mg/L	-	153	182	140	78	82	151	NS	42
Carbonate (as $CaCO_3$)	mg/L	-	ND	1	ND	ND	ND	ND	NS	ND
TDS (calculated)	mg/L	-	776	1210	582	195	314	827	NS	150
Cation Sum	meq/L	-	12.4	19.4	9.53	3.16	4.95	13.7	NS	2.37
Anion Sum	meq/L	-	12.1	18.4	9.17	3.28	5.05	12.7	NS	2.41
Ion Balance	%	-	1.06	2.62	1.93	1.86	1.00	3.80	NS	0.84
Langlier Index @ 4C	-	-	0.425	0.898	0.337	-0.435	-0.052	0.537	NS	-0.942
Langlier Index @ 20C	-	-	0.672	1.140	0.584	-0.185	0.197	0.784	NS	-0.692
Saturation pH @ 4C	units	-	7.24	7.01	7.36	8.04	7.82	7.20	NS	8.39
Saturation pH @ 20C	Units	-	6.99	6.77	7.12	7.79	7.57	6.96	NS	8.14
METALS										
Aluminum	ug/L	5 / 100[5]	ND	ND	ND	890	320	ND	NS	400
Antimony	ug/L	-	ND	ND	ND	ND	ND	ND	NS	ND
Arsenic	ug/L	5.0	**ND (20)**	**ND (20)**	ND	ND	ND	**ND (20)**	NS	ND
Barium	ug/L	-	ND	59	ND	26	24	ND	NS	16
Beryllium	ug/L	-	ND	ND	ND	ND	ND	ND	NS	ND
Bismuth	ug/L	-	ND	ND	ND	ND	ND	ND	NS	ND
Boron	ug/L	-	ND	ND	ND	12	14	ND	NS	9
Cadmium	ug/L	0.017[6]	**ND (3)**	**ND (3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (3)**	NS	**ND (0.3)**
Chromium	ug/L	8.9(III) / 1.0(VI)[7]	ND	ND	ND	ND	ND	ND	NS	ND
Cobalt	ug/L	-	ND	ND	ND	ND	ND	ND	NS	ND
Copper	ug/L	2 - 4[8]	**ND (20)**	**ND (20)**	ND	ND	ND	**ND (20)**	NS	ND
Iron	ug/L	300	**ND (500)**	**ND (500)**	ND	1400	410	**ND (500)**	NS	410
Lead	ug/L	1 - 7[9]	ND	ND	ND	1	ND	ND	NS	ND
Manganese	ug/L	-	200	350	96	150	53	130	NS	27
Molyebdenum	ug/L	73	ND	ND	ND	ND	ND	ND	NS	ND
Nickel	ug/L	25 - 150[10]	ND	ND	ND	ND	ND	ND	NS	ND
Selenium	ug/L	1.0	**ND (20)**	**ND (20)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (20)**	NS	**ND (2)**
Silver	ug/L	0.1	**ND (5)**	**ND (5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (5)**	NS	**ND (0.5)**
Strontium	ug/L	-	2500	3900	2000	500	810	2700	NS	340
Thallium	ug/L	0.8	**ND (1)**	**ND (1)**	ND	ND	ND	**ND (1)**	NS	ND
Tin	ug/L	-	ND	ND	ND	ND	ND	ND	NS	ND
Titanium	ug/L	-	ND	ND	ND	14	9	ND	NS	10
Uranium	ug/L	-	ND	1	ND	0.3	0.3	ND	NS	0.2
Vanadium	ug/L	-	ND	ND	ND	ND	ND	ND	NS	ND
Zinc	ug/L	30	**ND (50)**	**ND (50)**	ND	9	6	**ND (50)**	NS	5
Sodium	mg/L	-	8.8	10	8.1	3.8	4.4	8.2	NS	2.8
Potassium	mg/L	-	1.9	1.6	3.3	2.2	1.2	1.3	NS	0.9
Phosphorus	mg/L	-	0.1	0.3	0.3	ND	ND	0.1	NS	ND
Calcium	mg/L	-	220	350	170	51	86	250	NS	40
Magnesium	mg/L	-	11	15	9.3	4.4	4.9	13	NS	2.7

Table C.5.4

S4 SURFACE WATER QUALITY SAMPLING RESULTS
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Parameter	Units	CCME Fresh Water Aquatic Life[1, 2, 3]	S4	S4	S4	S4	S4	S4	S4	S4	S4	S4	S4	S4	S4 - Lab Duplicate	S4	S4
Sampling Date			**2-Nov-04**	**7-Dec-04**	**12-Jan-05**	**8-Feb-05**	**1-Mar-05**	**13-Apr-05**	**5-May-05**	**21-Jun-05**	**11-Jul-05**	**17-Aug-05**	**6-Sep-05**	**3-Oct-05**	**3-Oct-05**	**21-Nov-05**	**12-Dec-05**
INORGANICS																	
Alkalinity (as $CaCO_3$)	mg/L	-	70	34	NS	NS	10	31	38	58	88	70	72	68	-	24	14
Chloride	mg/L	-	12	7	NS	NS	6.3	7.8	7.9	11	30	39	45	51	-	6	6
Color	TCU	-	8	30	NS	NS	37	20	21	11	20	16	18	18	-	28	40
Nitrate + Nitrite (as N)	mg/L	-	ND	ND	NS	NS	0.05	ND	ND	ND	ND	ND	ND	ND	-	0.08	0.21
Nitrite	mg/L	0.060	ND	ND	NS	NS	0.05	ND	ND	ND	-	ND	ND	-	-	-	-
Ammonia (as N)	mg/L	Varies[4]	ND	ND	NS	NS	ND	ND	ND	ND	ND	0.06	ND	ND	-	ND	ND
Total Org. Carbon (by UV)	mg/L	-	3.4	6.0	NS	NS	6.7	3.9	5.1	3.3	6.3	6.3	6.5	6.7	-	6.9	7.1
Orthophosphate (as P)	mg/L	-	ND	ND	NS	NS	ND	ND	ND	ND	ND	ND	ND	ND	-	ND	ND
pH	units	6.5-9.0	7.40	7.30	NS	NS	6.85	7.48	7.42	7.80	7.65	7.57	7.64	7.44	-	7.22	7.11
Total Phosphorus	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reactive Silica (as SiO_2)	mg/L	-	4.6	5.4	NS	NS	2.9	3.8	4.3	3.6	0.8	0.6	ND	5.8	-	5.1	4.5
Total Suspended Solids	mg/L	-	ND	5.4	NS	NS	6.4	4.4	-	-	-	-	13	-	-	-	-
Sulfate	mg/L	-	220	73	NS	NS	33	75	60	110	96	270	290	320	-	64	31
Turbidity	NTU	-	0.6	9.8	NS	NS	19.0	7.5	7.7	1.7	0.8	1.1	2.1	0.9	0.9	8.2	17.0
Conductivity	uS/cm		680	253	NS	NS	120	250	230	390	460	770	820	890	-	210	120
CALCULATED PARAMETERS																	
Nitrate (as N)	mg/L	2.9	ND	ND	NS	NS	ND	ND	ND	ND	-	ND	ND	-	-	-	-
Hardness (as $CaCO_3$)	mg/L	-	261	112	NS	NS	48	100	110	170	210	360	390	400	-	84	51
Bicarbonate (as $CaCO_3$)	mg/L	-	70	34	NS	NS	10.3	31.2	37.6	58	87.4	69.2	72	67	-	24	14
Carbonate (as $CaCO_3$)	mg/L	-	ND	ND	NS	NS	ND	ND	ND	ND	ND	ND	ND	ND	-	ND	ND
TDS (calculated)	mg/L	-	390	155	NS	NS	72.4	152	144	236	281	521	567	611	-	128	75
Cation Sum	meq/L	-	5.74	2.49	NS	NS	1.17	2.37	2.47	4	5.18	8.8	9.49	9.81	-	1.91	1.21
Anion Sum	meq/L	-	6.32	2.4	NS	NS	1.08	2.41	2.23	3.7	4.59	8.02	8.75	9.43	-	2	1.11
Ion Balance	%	-	4.82	1.86	NS	NS	3.69	0.82	4.98	3.40	6.01	4.63	4.03	2.00	-	2.07	4.39
Langlier Index @ 4C	-	-	-0.680	-1.430	NS	NS	-2.500	-1.080	-1.050	-0.300	-0.230	-0.210	-0.115	-0.342	-	-1.540	-2.090
Langlier Index @ 20C	-	-	-0.280	-1.030	NS	NS	-2.250	-0.831	-0.790	-0.100	-	0.038	0.133	-0.095	-	-1.290	-1.840
Saturation pH @ 4C	units	-	8.08	8.73	NS	NS	9.35	8.56	8.47	8.10	7.89	7.78	7.76	7.78	-	8.76	9.20
Saturation pH @ 20C	Units	-	7.68	8.33	NS	NS	9.10	8.31	8.22	7.90	7.64	7.53	7.51	7.54	-	8.51	8.95
METALS																	
Aluminum	ug/L	5 / 100[5]	13	650	NS	NS	1100	510	270	34	-	13	34	-	-	-	-
Antimony	ug/L	-	ND	ND	NS	NS	ND	ND	ND	ND	-	ND	ND	-	-	-	-
Arsenic	ug/L	5.0	ND	ND	NS	NS	ND	ND	ND	ND	-	ND	ND	-	-	-	-
Barium	ug/L	-	49	21	NS	NS	15	18	19	35	-	64	69	-	-	-	-
Beryllium	ug/L	-	ND	ND	NS	NS	ND	ND	ND	ND	-	ND	ND	-	-	-	-
Bismuth	ug/L	-	ND	ND	NS	NS	ND	ND	ND	ND	-	ND	ND	-	-	-	-
Boron	ug/L	-	30	13	NS	NS	7.4	12	13	24	-	48	54	-	-	-	-
Cadmium	ug/L	0.017[6]	0.04	**ND (0.3)**	NS	NS	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	-	**ND (0.3)**	**ND (0.3)**	-	-	-	-
Chromium	ug/L	8.9(III) / 1.0(VI)[7]	ND	ND	NS	NS	ND	ND	ND	ND	-	ND	ND	-	-	-	-
Cobalt	ug/L	-	ND	ND	NS	NS	ND	ND	ND	ND	-	ND	ND	-	-	-	-
Copper	ug/L	2 - 4[8]	ND	ND	NS	NS	ND	ND	ND	ND	**ND (10)**	ND	ND	**ND (20)**	-	**ND (10)**	**ND (10)**
Iron	ug/L	300	120	460	NS	NS	810	330	220	340	100	ND	200	100	-	340	180
Lead	ug/L	1 - 7[9]	ND	ND	NS	NS	0.5	ND	ND	ND	-	ND	ND	-	-	-	-
Manganese	ug/L	-	190	42	NS	NS	27	48	58	210	150	140	170	120	-	20	20
Molyebdenum	ug/L	73	ND	ND	NS	NS	ND	ND	ND	ND	-	ND	ND	-	-	-	-
Nickel	ug/L	25 - 150[10]	ND	ND	NS	NS	ND	ND	ND	ND	-	ND	ND	-	-	-	-
Selenium	ug/L	1.0	ND	**ND (2)**	NS	NS	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	-	**ND (2)**	**ND (2)**	-	-	-	-
Silver	ug/L	0.1	ND	**ND (0.5)**	NS	NS	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	-	**ND (0.5)**	**ND (0.5)**	-	-	-	-
Strontium	ug/L	-	1100	420	NS	NS	160	390	370	750	-	1100	1500	-	-	-	-
Thallium	ug/L	0.8	ND	ND	NS	NS	ND	ND	ND	ND	-	ND	ND	-	-	-	-
Tin	ug/L	-	ND	ND	NS	NS	ND	ND	ND	ND	-	ND	ND	-	-	-	-
Titanium	ug/L	-	5	15	NS	NS	23	14	6.8	3	-	5.8	6.3	-	-	-	-
Uranium	ug/L	-	0.2	0.2	NS	NS	ND	ND	ND	0.1	-	0.1	0.3	-	-	-	-
Vanadium	ug/L	-	ND	ND	NS	NS	ND	ND	ND	ND	-	ND	ND	-	-	-	-
Zinc	ug/L	30	8	5	NS	NS	5.5	ND	ND	ND	**ND (50)**	ND	5.1	**ND (50)**	-	**ND (50)**	**ND (50)**
Sodium	mg/L	-	11.4	5.2	NS	NS	3.8	5.9	6.5	11	22	33	39	40	-	4.7	3.8
Potassium	mg/L	-	1.2	0.7	NS	NS	0.8	0.7	0.7	0.9	2.1	2.7	3.7	4.7	-	0.6	0.7
Phosphorus	mg/L	-	ND	ND	NS	NS	ND	ND	ND	ND	-	ND	ND	-	-	-	-
Calcium	mg/L	-	90.5	39	NS	NS	16	36	37	59	68	130	130	130	-	29	17
Magnesium	mg/L	-	8.4	3.6	NS	NS	1.7	3.3	3.6	6.2	9.2	12	14	15	-	2.8	2

Table C.5.4

S4 SURFACE WATER QUALITY SAMPLING RESULTS
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Parameter	Units	CCME Fresh Water Aquatic Life[1, 2, 3]	S4 - Lab Duplicate	S4	S4	S4	S4	S4	S4	S4	S4	S4	S4	S4	S4	S4	S4
Sampling Date			**12-Dec-05**	**18-Jan-06**	**18-Jan-06**	**8-Feb-06**	**13-Mar-06**	**1-Apr-06**	**1-May-06**	**6-Jun-06**	**25-Jul-06**	**17-Aug-06**	**19-Sep-06**	**17-Oct-06**	**1-Nov-06**	**11-Dec-06**	**23-Jan-07**
INORGANICS																	
Alkalinity (as $CaCO_3$)	mg/L	-	-	21	-	16	17	12	37	31	32	100	120	43	38	21	NS
Chloride	mg/L	-	-	7	-	6	8	6	8	6	4	17	28	13	11	8	NS
Color	TCU	-	-	30	-	34	24	48	13	48	75	20	21	11	22	30	NS
Nitrate + Nitrite (as N)	mg/L	-	-	0.10	-	0.12	0.39	0.11	ND	ND	ND	ND	ND	ND	ND	ND	NS
Nitrite	mg/L	0.060	-	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS
Ammonia (as N)	mg/L	Varies[4]	-	ND	ND	ND	ND	ND	ND	ND	ND	0.05	ND	ND	ND	ND	NS
Total Org. Carbon (by UV)	mg/L	-	6.9	5.4	-	5.2	3.1	10.0	3.5	9.7	15.0	7.1	7.5	4.4	6.8	6.8	NS
Orthophosphate (as P)	mg/L	-	-	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS
pH	units	6.5-9.0	-	7.25	-	7.55	7.10	7.11	7.25	7.21	7.44	8.14	7.77	7.23	7.37	7.45	NS
Total Phosphorus	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NS
Reactive Silica (as SiO_2)	mg/L	-	-	4.8	-	4.1	3.7	3.4	4.8	5.0	5.9	4.5	2.4	5.7	5.8	4.8	NS
Total Suspended Solids	mg/L	-	-	ND	-	2	4	25	2	5	4	ND	2	1	2	3	NS
Sulfate	mg/L	-	-	45	-	36	44	14	96	45	36	92	77	180	88	42	NS
Turbidity	NTU	-	-	13.0	-	12.0	14.0	44.0	2.7	11.0	17.0	1.2	0.9	2.9	6.4	13.0	NS
Conductivity	uS/cm		-	160	-	140	160	79	290	170	140	390	460	500	290	150	NS
CALCULATED PARAMETERS																	
Nitrate (as N)	mg/L	2.9	-	0.10	-	0.12	0.39	0.11	ND	ND	ND	ND	ND	ND	ND	ND	NS
Hardness (as $CaCO_3$)	mg/L	-	-	70	-	62	69	31	140	78	71	190	180	240	140	63	NS
Bicarbonate (as $CaCO_3$)	mg/L	-	-	21	-	16	17	12	36	31	32	98	115	43	38	21	NS
Carbonate (as $CaCO_3$)	mg/L	-	-	ND	-	ND	ND	ND	ND	ND	ND	1	ND	ND	ND	ND	NS
TDS (calculated)	mg/L	-	-	102	-	84	100	48	190	110	99	261	266	329	189	96	NS
Cation Sum	meq/L	-	-	1.64	-	1.43	1.62	0.793	3.01	1.82	1.69	4.52	4.53	5.16	3.1	1.47	NS
Anion Sum	meq/L	-	-	1.55	-	1.25	1.51	0.717	2.95	1.72	1.5	4.39	4.69	5.06	2.91	1.5	NS
Ion Balance	%	-	-	2.79	-	6.77	3.38	5.03	0.91	2.75	5.93	1.46	1.80	0.95	3.11	1.15	NS
Langlier Index @ 4C	-	-	-	-1.650	-	-1.500	-1.880	-2.370	-1.150	-1.470	-1.280	0.284	-0.059	-0.896	-1.000	-1.500	NS
Langlier Index @ 20C	-	-	-	-1.400	-	-1.250	-1.630	-2.110	-0.896	-1.220	-1.020	0.533	0.190	-0.647	-0.754	-1.250	NS
Saturation pH @ 4C	units	-	-	8.90	-	9.05	8.98	9.48	8.40	8.68	8.72	7.86	7.83	8.13	8.37	8.95	NS
Saturation pH @ 20C	Units	-	-	8.65	-	8.80	8.73	9.22	8.15	8.43	8.46	7.61	7.58	7.88	8.12	8.70	NS
METALS																	
Aluminum	ug/L	5 / 100[5]	-	540	-	560	460	770	140	710	1700	ND	41	94	290	1200	NS
Antimony	ug/L	-	-	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS
Arsenic	ug/L	5.0	-	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS
Barium	ug/L	-	-	15	-	14	15	11	25	16	19	30	29	45	24	16	NS
Beryllium	ug/L	-	-	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS
Bismuth	ug/L	-	-	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS
Boron	ug/L	-	-	9	-	8	7	8	19	14	19	29	31	25	17	10	NS
Cadmium	ug/L	0.017[6]	-	**ND (0.3)**	-	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	NS
Chromium	ug/L	8.9(III) / 1.0(VI)[7]	-	ND	-	ND	ND	ND	ND	ND	2	ND	ND	ND	ND	ND	NS
Cobalt	ug/L	-	-	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS
Copper	ug/L	2 - 4[8]	-	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	4	NS
Iron	ug/L	300	-	320	-	310	310	500	240	490	1200	ND	70	170	180	600	NS
Lead	ug/L	1 - 7[9]	-	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.5	NS
Manganese	ug/L	-	-	18	-	14	20	14	160	17	13	16	92	180	42	20	NS
Molyebdenum	ug/L	73	-	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS
Nickel	ug/L	25 - 150[10]	-	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS
Selenium	ug/L	1.0	-	**ND (2)**	-	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	NS
Silver	ug/L	0.1	-	**ND (0.5)**	-	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	NS
Strontium	ug/L	-	-	240	-	190	250	86	510	250	230	680	660	880	470	190	NS
Thallium	ug/L	0.8	-	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS
Tin	ug/L	-	-	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS
Titanium	ug/L	-	-	15	-	9	14	22	3	24	55	ND	2	5	9	35	NS
Uranium	ug/L	-	-	ND	-	ND	ND	ND	ND	ND	0.1	0.1	0.4	ND	ND	0.1	NS
Vanadium	ug/L	-	-	ND	-	ND	ND	ND	ND	ND	3	ND	ND	ND	ND	ND	NS
Zinc	ug/L	30	-	ND	-	ND	ND	ND	ND	ND	5	ND	ND	ND	ND	8	NS
Sodium	mg/L	-	-	4.2	-	3.9	4.8	3.4	6.5	5.1	4.8	14	19	8.2	6.5	4.1	NS
Potassium	mg/L	-	-	0.8	-	0.5	0.7	0.9	0.8	0.6	0.9	1.1	2.5	1.3	1.0	0.6	NS
Phosphorus	mg/L	-	-	ND	-	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS
Calcium	mg/L	-	-	24	-	21	24	10	47	27	24	64	59	82	48	21	NS
Magnesium	mg/L	-	-	2.5	-	2	2.4	1.4	4.2	2.6	2.7	8.2	8.2	7.9	4.7	2.3	NS

Table C.5.4

S4 SURFACE WATER QUALITY SAMPLING RESULTS
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Parameter	Units	CCME Fresh Water Aquatic Life[1, 2, 3]	S4	S4	S4	S4	S4	S4	S4	S4	S4	S4	S4	S4	S4	S4	S4
Sampling Date			**20-Feb-07**	**14-Mar-07**	**24-Apr-07**	**8-May-07**	**28-Jun-07**	**24-Jul-07**	**30-Aug-07**	**24-Sep-07**	**31-Oct-07**	**21-Nov-07**	**12-Dec-07**	**10-Jan-08**	**28-Feb-08**	**18-Mar-08**	**29-Apr-08**
INORGANICS																	
Alkalinity (as $CaCO_3$)	mg/L	-	NS	18	23	29	75	92	81	140	74	35	NS	16	19	35	38
Chloride	mg/L	-	NS	10	8	9	9	17	8	17	11	9	NS	7	6	8	10
Color	TCU	-	NS	21	19	12	26	24	31	35	21	27	NS	38	29	16	22
Nitrate + Nitrite (as N)	mg/L	-	NS	0.41	0.07	ND	ND	0.06	0.06	0.07	ND	ND	NS	0.10	0.09	0.09	ND
Nitrite	mg/L	0.060	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND
Ammonia (as N)	mg/L	Varies[4]	NS	ND	ND	ND	0.11	0.09	0.12	0.18	0.07	ND	NS	ND	ND	ND	ND
Total Org. Carbon (by UV)	mg/L	-	NS	5.5	4.5	3.4	8.1	8.1	10.0	9.0	7.3	4.3	NS	6.7	4.9	3.9	4.0
Orthophosphate (as P)	mg/L	-	NS	ND	ND	ND	ND	0.01	ND	ND	0.01	ND	NS	ND	ND	ND	ND
pH	units	6.5-9.0	NS	7.09	7.32	7.51	7.39	7.47	7.92	7.56	7.41	7.32	NS	7.00	7.19	7.34	7.48
Total Phosphorus	mg/L	-	NS	-	-	-	-	-	-	0.019	0.018	0.016	NS	0.029	0.030	0.016	0.027
Reactive Silica (as SiO_2)	mg/L	-	NS	3.5	3.1	2.3	3.5	4.8	5.8	5.9	5.8	5.3	NS	3.8	3.9	4.4	3.7
Total Suspended Solids	mg/L	-	NS	54	2	3	8	5	4	3	20	4	NS	9	9	7	8
Sulfate	mg/L	-	NS	32	62	81	72	150	88	80	130	70	NS	25	27	82	77
Turbidity	NTU	-	NS	34.0	7.7	2.3	6.3	3.1	4.2	3.7	24.0	11.0	NS	16.0	15.0	14.0	7.4
Conductivity	uS/cm		NS	140	210	260	310	560	350	460	440	250	NS	110	120	270	270
CALCULATED PARAMETERS																	
Nitrate (as N)	mg/L	2.9	NS	0.41	0.07	ND	0.24	ND	0.06	0.07	ND	ND	NS	0.10	0.09	0.09	ND
Hardness (as $CaCO_3$)	mg/L	-	NS	59	87	120	150	260	170	220	200	99	NS	46	44	110	120
Bicarbonate (as $CaCO_3$)	mg/L	-	NS	18	23	29	75	92	81	136	74	35	NS	16	19	35	38
Carbonate (as $CaCO_3$)	mg/L	-	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND
TDS (calculated)	mg/L	-	NS	89	127	163	200	344	228	289	277	151	NS	68	70	167	167
Cation Sum	meq/L	-	NS	1.52	2	2.73	3.48	5.94	3.89	5.2	4.44	2.29	NS	1.11	1.09	2.59	2.71
Anion Sum	meq/L	-	NS	1.34	1.99	2.53	3.28	5.4	3.7	4.88	4.46	2.41	NS	1.03	1.11	2.64	2.64
Ion Balance	%	-	NS	6.29	0.25	3.80	2.96	4.76	2.50	3.17	0.22	2.55	NS	3.74	0.91	0.35	1.31
Langlier Index @ 4C	-	-	NS	-1.950	-1.440	-1.030	-0.657	-0.301	-0.055	-0.108	-0.559	-1.220	NS	-2.200	-1.950	-1.150	-0.964
Langlier Index @ 20C	-	-	NS	-1.700	-1.190	-0.780	-0.407	-0.052	0.195	0.141	-0.309	-0.969	NS	-1.950	-1.690	-0.900	-0.714
Saturation pH @ 4C	units	-	NS	9.04	8.76	8.54	8.05	7.77	7.98	7.67	7.97	8.54	NS	9.20	9.14	8.49	8.44
Saturation pH @ 20C	Units	-	NS	8.79	8.51	8.29	7.80	7.52	7.23	7.42	7.72	8.29	NS	8.95	8.88	8.24	8.19
METALS																	
Aluminum	ug/L	5 / 100[5]	NS	220	290	98	37	13	110	13	20	390	NS	580	310	250	580
Antimony	ug/L	-	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND
Arsenic	ug/L	5.0	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND
Barium	ug/L	-	NS	14	18	23	31	52	34	38	53	19	NS	11	11	21	29
Beryllium	ug/L	-	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND
Bismuth	ug/L	-	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND
Boron	ug/L	-	NS	7	12	16	13	28	21	27	20	11	NS	6	ND	11	16
Cadmium	ug/L	0.017[6]	NS	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**
Chromium	ug/L	8.9(III) / 1.0(VI)[7]	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND
Cobalt	ug/L	-	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND
Copper	ug/L	2 - 4[8]	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	15
Iron	ug/L	300	NS	130	220	ND	**ND (500)**	280	610	210	120	310	NS	400	210	210	670
Lead	ug/L	1 - 7[9]	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	1.8
Manganese	ug/L	-	NS	47	31	73	1300	1900	1000	3000	1200	83	NS	27	20	110	220
Molyebdenum	ug/L	73	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND
Nickel	ug/L	25 - 150[10]	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND
Selenium	ug/L	1.0	NS	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**
Silver	ug/L	0.1	NS	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**
Strontium	ug/L	-	NS	160	330	430	500	1000	580	710	770	350	NS	130	160	430	460
Thallium	ug/L	0.8	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND
Tin	ug/L	-	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND
Titanium	ug/L	-	NS	8	11	4	4	3	4	ND	4	14	NS	16	6	10	14
Uranium	ug/L	-	NS	ND	ND	ND	0.1	0.2	0.1	0.3	0.1	ND	NS	ND	ND	ND	ND
Vanadium	ug/L	-	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND
Zinc	ug/L	30	NS	23	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	17
Sodium	mg/L	-	NS	6.9	5.6	6.7	9.3	17	8.8	15	9.8	6.4	NS	3.8	4.1	6.8	7.7
Potassium	mg/L	-	NS	1.4	0.7	0.8	1.0	1.9	1.1	1.6	1.7	0.9	NS	0.7	0.7	0.8	0.9
Phosphorus	mg/L	-	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND
Calcium	mg/L	-	NS	19	30	42	52	90	58	73	67	34	NS	15	15	39	40
Magnesium	mg/L	-	NS	2.6	2.8	4.1	5.6	8	6.6	10	7.4	3.3	NS	1.8	1.7	3.7	4.1

Table C.5.4

S4 SURFACE WATER QUALITY SAMPLING RESULTS
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Parameter	Units	CCME Fresh Water Aquatic Life(1, 2, 3)	S4	S4	S4	S4	S4	S4	S4	S4	S4	S4	S4
Sampling Date			**28-May-08**	**24-Jun-08**	**29-Jul-08**	**1-Aug-08**	**24-Sep-08**	**30-Oct-08**	**26-Nov-08**	**15-Dec-08**	**28-Jan-09**	**25-Feb-09**	**31-Mar-09**
INORGANICS													
Alkalinity (as $CaCO_3$)	mg/L	-	31	84	180	65	120	63	39	29	NS	NS	16
Chloride	mg/L	-	7	9	15	10	16	12	11	9	NS	NS	6
Color	TCU	-	110	46	60	46	34	63	51	91	NS	NS	60
Nitrate + Nitrite (as N)	mg/L	-	ND	ND	0.20	ND	0.06	ND	0.14	0.09	NS	NS	0.08
Nitrite	mg/L	0.060	ND	ND	0.04	ND	ND	ND	ND	0.03	NS	NS	ND
Ammonia (as N)	mg/L	Varies(4)	ND	0.11	0.17	ND	0.14	ND	ND	ND	NS	NS	ND
Total Org. Carbon (by UV)	mg/L	-	10.0	9.5	12.0	10.0	9.2	8.8	5.4	7.2	NS	NS	6.5
Orthophosphate (as P)	mg/L	-	0.01	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
pH	units	6.5-9.0	7.45	7.53	7.68	7.28	7.45	7.40	7.32	7.27	NS	NS	7.08
Total Phosphorus	mg/L	-	0.053	0.021	0.009	0.023	0.016	0.040	0.046	0.026	NS	NS	0.025
Reactive Silica (as SiO_2)	mg/L	-	4.1	3.3	5.2	5.3	5.3	5.3	5.2	4.8	NS	NS	3.4
Total Suspended Solids	mg/L	-	9	4	2	2	5	3	27	6	NS	NS	19
Sulfate	mg/L	-	40	95	52	92	65	93	41	44	NS	NS	26
Turbidity	NTU	-	20.0	2.1	4.0	1.4	2.0	6.0	15.0	9.3	NS	NS	7.2
Conductivity	uS/cm		170	400	480	350	390	370	200	160	NS	NS	100
CALCULATED PARAMETERS													
Nitrate (as N)	mg/L	2.9	ND	ND	0.16	ND	0.06	ND	0.14	0.05	NS	NS	0.08
Hardness (as $CaCO_3$)	mg/L	-	71	190	220	160	190	160	85	70	NS	NS	40
Bicarbonate (as $CaCO_3$)	mg/L	-	31	84	182	64	118	63	39	29	NS	NS	16
Carbonate (as $CaCO_3$)	mg/L	-	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
TDS (calculated)	mg/L	-	103	240	281	220	243	219	121	110	NS	NS	65
Cation Sum	meq/L	-	1.72	4.18	5	3.74	4.33	3.55	2.04	1.69	NS	NS	1
Anion Sum	meq/L	-	1.63	3.92	5.18	3.5	4.16	3.54	1.94	1.77	NS	NS	1.03
Ion Balance	%	-	2.69	3.21	1.77	3.31	2.00	0.14	2.51	2.31	NS	NS	1.48
Langlier Index @ 4C	-	-	-1.270	-0.388	0.127	-0.808	-0.343	-0.714	-1.230	-1.490	NS	NS	-2.170
Langlier Index @ 20C	-	-	-1.020	-0.138	0.377	-0.558	-0.093	-0.464	-0.980	-1.240	NS	NS	-1.920
Saturation pH @ 4C	units	-	8.72	7.92	7.55	8.09	7.79	8.11	8.55	8.76	NS	NS	9.25
Saturation pH @ 20C	Units	-	8.47	7.67	7.30	7.84	7.54	7.86	8.30	8.51	NS	NS	9.00
METALS													
Aluminum	ug/L	5 / 100(5)	810	29	ND	23	14	250	600	650	NS	NS	650
Antimony	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
Arsenic	ug/L	5.0	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
Barium	ug/L	-	17	34	20	30	29	33	21	16	NS	NS	13
Beryllium	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
Bismuth	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
Boron	ug/L	-	12	22	28	22	17	19	8	9	NS	NS	6
Cadmium	ug/L	0.017(6)	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	NS	NS	**ND (0.3)**
Chromium	ug/L	8.9(III) / 1.0(VI)(7)	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
Cobalt	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
Copper	ug/L	2 - 4(8)	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
Iron	ug/L	300	550	190	310	200	200	500	810	540	NS	NS	550
Lead	ug/L	1 - 7(9)	ND	ND	ND	ND	ND	ND	0.6	ND	NS	NS	1
Manganese	ug/L	-	39	920	2000	580	1700	320	130	65	NS	NS	45
Molyebdenum	ug/L	73	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
Nickel	ug/L	25 - 150(10)	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
Selenium	ug/L	1.0	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	NS	NS	**ND (2)**
Silver	ug/L	0.1	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	NS	NS	**ND (0.5)**
Strontium	ug/L	-	230	700	840	590	610	700	270	210	NS	NS	130
Thallium	ug/L	0.8	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
Tin	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
Titanium	ug/L	-	27	3	ND	2	ND	7	10	12	NS	NS	11
Uranium	ug/L	-	ND	0.2	0.4	0.1	0.2	0.1	ND	ND	NS	NS	ND
Vanadium	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	NS	NS	ND
Zinc	ug/L	30	ND	ND	ND	ND	ND	6	7	5	NS	NS	9
Sodium	mg/L	-	5.8	8.8	13	10	13	8.5	6.3	5.5	NS	NS	3.9
Potassium	mg/L	-	1.0	1.6	1.8	1.3	1.5	1.9	1.2	1.0	NS	NS	0.7
Phosphorus	mg/L	-	ND	ND	ND	ND	ND	0.2	ND	ND	NS	NS	ND
Calcium	mg/L	-	24	64	71	56	61	54	29	24	NS	NS	13
Magnesium	mg/L	-	2.7	6.4	10	5.7	8	5.1	3.2	2.6	NS	NS	1.5

Table C.5.5

S5 SURFACE WATER QUALITY SAMPLING RESULTS
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Parameter	Units	CCME Fresh Water Aquatic Life[1, 2, 3]	S5	S5 - Duplicate	S5	S5 - Duplicate	S5	S5 - Duplicate	S5	S5	S5	S5	S5 - Lab Duplicate	S5	S5	S5	S5 - Lab Duplicate
Sampling Date			**2-Nov-04**	**2-Nov-04**	**7-Dec-04**	**7-Dec-04**	**12-Jan-05**	**12-Jan-05**	**8-Feb-05**	**1-Mar-05**	**13-Apr-05**	**5-May-05**	**5-May-05**	**21-Jun-05**	**11-Jul-05**	**17-Aug-05**	**17-Aug-05**
INORGANICS																	
Alkalinity (as $CaCO_3$)	mg/L	-	93	95	44	44	47	44	NS	19	38	42	41	60	71	79	-
Chloride	mg/L	-	33	32	19	19	22	19	NS	9.8	17	19	18	26	30	32	-
Color	TCU	-	6	7	24	25	16	25	NS	21	16	19	-	12	ND	7.2	-
Nitrate + Nitrite (as N)	mg/L	-	0.58	0.41	0.14	0.13	0.24	0.13	NS	ND	0.11	0.10	-	0.50	0.91	0.95	0.95
Nitrite	mg/L	0.060	ND	ND	ND	ND	ND	ND	NS	ND	0.11	ND	-	ND	-	ND	-
Ammonia (as N)	mg/L	Varies[4]	ND	ND	ND	ND	ND	ND	NS	ND	ND	0.06	-	ND	ND	0.05	0.05
Total Org. Carbon (by UV)	mg/L	-	2.2	2.4	8.7	8.6	5.4	8.6	NS	4.9	4.9	7.0	-	4.0	2.8	2.4	-
Orthophosphate (as P)	mg/L	-	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND	ND	-
pH	units	6.5-9.0	7.80	7.70	7.00	7.00	7.00	7.00	NS	6.43	7.17	7.18	7.17	7.50	7.50	7.44	-
Total Phosphorus	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reactive Silica (as SiO_2)	mg/L	-	8.3	8.2	4.9	4.9	5.1	4.9	NS	2.4	1.4	1.7	1.9	5.7	8.3	9.0	-
Total Suspended Solids	mg/L	-	7.6	-	-	-	0	-	NS	4.2	2.5	-	-	-	-		-
Sulfate	mg/L	-	170	170	180	180	190	180	NS	100	140	150	-	130	110	100	-
Turbidity	NTU	-	7.3	8.0	1.9	1.9	1.1	1.9	NS	6.5	0.8	0.6	0.5	0.7	0.4	0.9	-
Conductivity	uS/cm		675	675	564	573	626	573	NS	360	420	430	440	470	480	480	-
CALCULATED PARAMETERS																	
Nitrate (as N)	mg/L	2.9	0.58	0.41	0.14	0.13	0.24	0.13	NS	ND	ND	0.10	-	0.50	-	0.95	-
Hardness (as $CaCO_3$)	mg/L	-	235	233	224	225	230	225	NS	140	180	200	200	200	220	210	-
Bicarbonate (as $CaCO_3$)	mg/L	-	92	95	44	44	47	44	NS	19.3	38.1	42	40.7	60.2	70.5	78.9	-
Carbonate (as $CaCO_3$)	mg/L	-	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND	ND	-
TDS (calculated)	mg/L	-	388	385	334	335	353	335	NS	189	266	290	136	295	304	300	-
Cation Sum	meq/L	-	5.84	5.76	5.22	5.26	5.38	5.26	NS	3.18	4.13	4.77	-	4.9	5.35	5.12	-
Anion Sum	meq/L	-	6.38	6.37	5.17	5.17	5.53	5.17	NS	2.79	4.21	4.48	-	4.6	4.64	4.71	-
Ion Balance	%	-	4.43	4.99	0.49	0.90	1.36	0.90	NS	6.51	0.98	3.12	-	2.90	7.09	4.18	-
Langlier Index @ 4C	-	-	-0.180	-0.270	-1.330	-1.330	-1.290	-1.330	NS	-2.180	-1.100	-0.998	-0.985	-0.500	-0.410	-0.449	-
Langlier Index @ 20C	-	-	0.220	0.130	-0.930	-0.930	-0.890	-0.930	NS	-1.930	-0.853	-0.749	-0.735	-0.200	-0.160	-0.200	-
Saturation pH @ 4C	units	-	7.98	7.97	8.33	8.33	0.29	8.33	NS	8.60	8.27	8.18	8.16	8.00	7.92	7.89	-
Saturation pH @ 20C	Units	-	7.58	7.57	7.93	7.93	7.89	7.93	NS	8.36	8.02	7.93	7.91	7.80	7.67	7.64	-
METALS																	
Aluminum	ug/L	5 / 100[5]	8	6	80	100	50	100	NS	240	ND	24	23	17	-	14	-
Antimony	ug/L	-	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND	-	ND	-
Arsenic	ug/L	5.0	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND	-	ND	-
Barium	ug/L	-	45	44	28	26	28	26	NS	18	22	23	23	35	-	37	-
Beryllium	ug/L	-	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND	-	ND	-
Bismuth	ug/L	-	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND	-	ND	-
Boron	ug/L	-	45	47	45	45	40	45	NS	25	37	42	42	46	-	42	-
Cadmium	ug/L	0.017[6]	ND	ND	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	NS	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	-	**ND (0.3)**	-
Chromium	ug/L	8.9(III) / 1.0(VI)[7]	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND	-	ND	-
Cobalt	ug/L	-	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND	-	ND	-
Copper	ug/L	2 - 4[8]	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND	**ND (10)**	ND	-
Iron	ug/L	300	ND	ND	ND	ND	210	ND	NS	310	80	110	100	220	150	210	-
Lead	ug/L	1 - 7[9]	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	0.7	-	ND	-
Manganese	ug/L	-	130	120	50	49	100	49	NS	45	34	34	34	210	280	240	-
Molyebdenum	ug/L	73	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND	-	ND	-
Nickel	ug/L	25 - 150[10]	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND	-	ND	-
Selenium	ug/L	1.0	ND	1	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	NS	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	-	**ND (2)**	-
Silver	ug/L	0.1	ND	ND	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	NS	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	-	**ND (0.5)**	-
Strontium	ug/L	-	860	830	750	740	830	740	NS	470	640	690	680	820	-	740	-
Thallium	ug/L	0.8	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND	-	ND	-
Tin	ug/L	-	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND	-	ND	-
Titanium	ug/L	-	3	3	5	5	4	5	NS	7.1	3.6	3.1	3.2	3.3	-	2.4	-
Uranium	ug/L	-	0.1	0.1	0.2	0.1	ND	0.1	NS	ND	ND	ND	ND	ND	-	ND	-
Vanadium	ug/L	-	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND	-	ND	-
Zinc	ug/L	30	ND	ND	5	ND	14	ND	NS	ND	ND	ND	ND	ND	**ND (50)**	ND	-
Sodium	mg/L	-	25.8	24.6	16.5	16.8	17.3	16.8	NS	8.6	13	15	15	18	21	21	-
Potassium	mg/L	-	1.0	1.0	1.1	1.1	1.0	1.1	NS	1.0	1.0	0.9	1.0	0.7	0.9	0.9	-
Phosphorus	mg/L	-	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	ND	ND	-	ND	-
Calcium	mg/L	-	85.9	85.2	79.7	80.3	82.6	80.3	NS	49	64	73	70	74	81	76	-
Magnesium	mg/L	-	4.9	5	6	6	5.8	6	NS	3.6	4.3	5.2	5.1	4.7	4.6	4.3	-

Table C.5.5

S5 SURFACE WATER QUALITY SAMPLING RESULTS
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Parameter	Units	CCME Fresh Water Aquatic Life(1, 2, 3)	S5	S5 - Lab Duplicate	S5	S5	S5	S5	S5	S5	S5 - Lab Duplicate	S5	S5	S5	S5	S5	S5
Sampling Date			**6-Sep-05**	**6-Sep-05**	**3-Oct-05**	**21-Nov-05**	**12-Dec-05**	**18-Jan-06**	**8-Feb-06**	**13-Mar-06**	**13-Mar-06**	**1-Apr-06**	**1-May-06**	**6-Jun-06**	**25-Jul-06**	**17-Aug-06**	**19-Sep-06**
INORGANICS																	
Alkalinity (as $CaCO_3$)	mg/L	-	78	-	80	34	36	28	24	41	-	30	48	56	100	84	79
Chloride	mg/L	-	34	-	32	22	21	15	12	19	-	18	22	14	14	27	31
Color	TCU	-	6.4	-	6	27	27	21	19	20	-	19	14	44	64	14	9
Nitrate + Nitrite (as N)	mg/L	-	1.00	-	1.10	0.18	0.15	0.16	0.17	0.20	-	0.07	0.34	ND	0.05	0.85	0.96
Nitrite	mg/L	0.060	ND	-	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND
Ammonia (as N)	mg/L	Varies(4)	ND	-	ND	ND	ND	ND	ND	ND	-	ND	ND	ND	ND	0.06	ND
Total Org. Carbon (by UV)	mg/L	-	2.1	-	2.7	7.9	7.5	4.6	4.9	3.7	-	5.7	4.6	11.0	16.0	4.4	2.9
Orthophosphate (as P)	mg/L	-	ND	-	ND	ND	ND	ND	ND	ND	-	ND	ND	ND	ND	ND	ND
pH	units	6.5-9.0	7.57	-	7.66	6.96	6.80	6.97	7.16	6.92	6.99	7.21	7.16	6.97	7.71	7.87	7.37
Total Phosphorus	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reactive Silica (as SiO_2)	mg/L	-	9.8	-	10.0	5.0	5.4	4.3	3.7	4.1	-	0.9	3.8	3.8	6.5	9.0	9.9
Total Suspended Solids	mg/L	-	4.4	-	-	-	-	ND	ND	3	-	24	2	4	4	ND	3
Sulfate	mg/L	-	110	-	110	240	260	170	140	180	-	160	170	140	120	130	120
Turbidity	NTU	-	0.6	0.7	0.5	3.1	2.2	4.6	3.6	6.0	-	13.0	0.9	16.0	1.3	1.0	0.6
Conductivity	uS/cm		480	-	490	610	620	440	430	510	520	480	490	450	440	480	520
CALCULATED PARAMETERS																	
Nitrate (as N)	mg/L	2.9	1.00	-	-	-	-	0.16	0.17	0.20	-	0.07	0.34	ND	0.05	0.85	0.96
Hardness (as $CaCO_3$)	mg/L	-	210	-	220	270	310	200	180	240	-	210	220	210	230	220	200
Bicarbonate (as $CaCO_3$)	mg/L	-	77.9	-	80	34	36	28	24	41	-	30	48	56	99	84	79
Carbonate (as $CaCO_3$)	mg/L	-	ND	-	ND	ND	ND	ND	ND	ND	-	ND	ND	ND	ND	ND	ND
TDS (calculated)	mg/L	-	306	-	316	412	450	295	251	341	-	298	325	291	309	328	314
Cation Sum	meq/L	-	5.16	-	5.33	6.29	7.12	4.69	4.04	5.63	-	4.92	5.24	4.91	5.3	5.33	4.93
Anion Sum	meq/L	-	4.82	-	4.93	6.29	6.74	4.43	3.74	5.13	-	4.52	5.02	4.48	4.97	5.24	5.06
Ion Balance	%	-	3.39	-	3.98	0.02	2.79	2.87	3.92	4.64	-	4.29	2.11	4.51	3.18	0.84	1.35
Langlier Index @ 4C	-	-	-0.329	-	-0.214	-1.220	-1.300	-1.390	-1.320	-1.210	-	-1.110	-0.930	-1.070	-0.042	0.023	-0.544
Langlier Index @ 20C	-	-	-0.080	-	0.035	-0.970	-1.050	-1.140	-1.070	-0.957	-	-0.858	-0.681	-0.825	0.207	0.272	-0.295
Saturation pH @ 4C	units	-	7.90	-	7.87	8.18	8.10	8.36	8.48	8.13	-	8.32	8.09	8.04	7.75	7.85	7.91
Saturation pH @ 20C	Units	-	7.65	-	7.63	7.93	7.85	8.11	8.23	7.88	-	8.07	7.84	7.80	7.50	7.60	7.67
METALS																	
Aluminum	ug/L	5 / 100(5)	13	-	-	-	-	180	190	43	-	43	26	44	14	ND	11
Antimony	ug/L	-	ND	-	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND
Arsenic	ug/L	5.0	ND	-	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND
Barium	ug/L	-	39	-	-	-	-	23	20	32	-	25	39	25	29	40	43
Beryllium	ug/L	-	ND	-	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND
Bismuth	ug/L	-	ND	-	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND
Boron	ug/L	-	39	-	-	-	-	55	42	46	-	55	57	74	72	52	46
Cadmium	ug/L	0.017(6)	**ND (0.3)**	-	-	-	-	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	-	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**
Chromium	ug/L	8.9(III) / 1.0(VI)(7)	ND	-	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND
Cobalt	ug/L	-	ND	-	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND
Copper	ug/L	2 - 4(8)	ND	-	**ND (20)**	**ND (10)**	**ND (10)**	ND	ND	ND	-	ND	ND	ND	ND	ND	ND
Iron	ug/L	300	ND	-	110	380	590	180	200	290	-	110	170	240	140	140	280
Lead	ug/L	1 - 7(9)	ND	-	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND
Manganese	ug/L	-	210	-	150	110	150	39	39	480	-	31	160	45	17	270	200
Molyebdenum	ug/L	73	ND	-	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND
Nickel	ug/L	25 - 150(10)	ND	-	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND
Selenium	ug/L	1.0	**ND (2)**	-	-	-	-	**ND (2)**	**ND (2)**	**ND (2)**	-	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**
Silver	ug/L	0.1	**ND (0.5)**	-	-	-	-	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	-	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**
Strontium	ug/L	-	880	-	-	-	-	730	610	870	-	710	750	670	800	800	810
Thallium	ug/L	0.8	ND	-	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND
Tin	ug/L	-	ND	-	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND
Titanium	ug/L	-	2.7	-	-	-	-	13	7	4	-	5	3	4	2	ND	2
Uranium	ug/L	-	ND	-	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND
Vanadium	ug/L	-	ND	-	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND
Zinc	ug/L	30	ND	-	**ND (50)**	**ND (50)**	**ND (50)**	ND	ND	ND	-	ND	ND	ND	ND	ND	ND
Sodium	mg/L	-	23	-	23	19	19	14	11	17	-	16	17	16	14	20	79
Potassium	mg/L	-	1.1	-	1.0	1.3	1.3	0.9	0.7	1.1	-	0.9	0.9	0.6	0.9	0.9	1.2
Phosphorus	mg/L	-	ND	-	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND
Calcium	mg/L	-	76	-	79	97	110	72	64	87	-	75	81	74	84	81	74
Magnesium	mg/L	-	4.3	-	4.4	7.1	8.1	5.5	4.6	6.4	-	5.7	5.4	5.6	5.8	5	4.1

Table C.5.5

S5 SURFACE WATER QUALITY SAMPLING RESULTS
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Parameter	Units	CCME Fresh Water Aquatic Life[1, 2, 3]	S5	S5	S5	S5	S5	S5	S5	S5	S5	S5	S5	S5	S5	S5	S5
Sampling Date			**17-Oct-06**	**1-Nov-06**	**11-Dec-06**	**23-Jan-07**	**20-Feb-07**	**14-Mar-07**	**24-Apr-07**	**8-May-07**	**28-Jun-07**	**24-Jul-07**	**30-Aug-07**	**24-Sep-07**	**31-Oct-07**	**21-Nov-07**	**12-Dec-07**
INORGANICS																	
Alkalinity (as $CaCO_3$)	mg/L	-	83	63	33	27	83	65	39	52	71	77	120	97	110	57	110
Chloride	mg/L	-	29	28	15	13	27	27	15	21	17	23	21	21	27	15	24
Color	TCU	-	8	21	20	19	12	19	15	14	27	13	42	24	18	36	33
Nitrate + Nitrite (as N)	mg/L	-	0.95	0.26	0.11	0.18	0.64	0.23	0.14	0.25	0.24	0.67	0.23	0.48	0.45	0.10	0.23
Nitrite	mg/L	0.060	ND	0.26	ND	ND	ND	0.01	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ammonia (as N)	mg/L	Varies[4]	ND	ND	ND	ND	0.06	0.05	ND	ND	ND	ND	0.06	0.06	0.05	ND	0.06
Total Org. Carbon (by UV)	mg/L	-	2.8	8.3	6.7	5.0	4.0	6.5	4.9	4.0	7.9	4.5	13.0	5.9	6.0	6.6	7.0
Orthophosphate (as P)	mg/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.01	ND	ND
pH	units	6.5-9.0	7.44	7.45	7.23	7.03	7.43	7.04	7.45	7.60	7.47	7.98	7.70	7.56	7.63	7.33	7.43
Total Phosphorus	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	0.032	0.006	0.011	0.004
Reactive Silica (as SiO_2)	mg/L	-	9.0	5.3	4.4	4.1	7.9	5.3	1.6	2.9	4.5	8.3	7.8	8.3	8.7	5.0	7.7
Total Suspended Solids	mg/L	-	1	3	2	ND	4	55	1	2	1	1	3	3	2	7	3
Sulfate	mg/L	-	150	250	190	150	170	130	160	180	130	120	100	140	130	160	190
Turbidity	NTU	-	0.1	1.9	2.8	2.8	6.2	27.0	0.9	0.7	1.4	2.1	1.3	2.2	1.1	5.9	2.3
Conductivity	uS/cm		560	680	500	440	600	480	480	520	460	520	520	530	560	490	650
CALCULATED PARAMETERS																	
Nitrate (as N)	mg/L	2.9	0.95	ND	0.11	0.18	0.64	0.22	0.14	ND	ND	ND	0.23	0.48	ND	0.10	0.23
Hardness (as $CaCO_3$)	mg/L	-	240	340	230	190	270	210	210	250	220	220	210	240	230	200	290
Bicarbonate (as $CaCO_3$)	mg/L	-	83	62	33	27	83	65	38	52	70	76	121	96	106	57	112
Carbonate (as $CaCO_3$)	mg/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TDS (calculated)	mg/L	-	355	479	330	273	376	301	295	355	299	304	306	339	349	309	419
Cation Sum	meq/L	-	5.64	7.8	5.13	4.27	6.2	4.92	4.83	5.76	5.06	5.39	5.08	5.66	5.62	4.7	6.59
Anion Sum	meq/L	-	5.68	7.31	5.04	4.13	5.9	4.78	4.51	5.48	4.69	4.64	5.14	5.4	5.73	4.93	6.82
Ion Balance	%	-	0.35	3.24	0.93	1.62	2.48	1.44	3.43	2.49	3.79	7.48	0.59	2.35	0.97	2.39	1.72
Langlier Index @ 4C	-	-	-0.380	-0.386	-1.030	-1.370	-0.356	-0.945	-0.754	-0.418	-0.461	0.093	-0.009	-0.200	-0.107	-0.728	-0.213
Langlier Index @ 20C	-	-	-0.131	-0.138	-0.783	-1.120	-0.107	-0.696	-0.505	-0.169	-0.212	0.342	0.240	0.049	0.142	-0.479	0.035
Saturation pH @ 4C	units	-	7.82	7.84	8.26	8.40	7.79	7.99	8.20	8.02	7.93	7.89	7.71	7.76	7.74	8.06	7.64
Saturation pH @ 20C	Units	-	7.57	7.59	8.01	8.15	7.54	7.74	7.96	7.77	7.68	7.64	7.46	7.51	7.49	7.81	7.40
METALS																	
Aluminum	ug/L	5 / 100[5]	ND	33	160	100	17	56	18	11	ND	ND	31	ND	ND	63	26
Antimony	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	ug/L	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Barium	ug/L	-	39	47	23	23	46	31	28	36	35	55	48	56	48	26	52
Beryllium	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bismuth	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Boron	ug/L	-	42	77	56	43	50	36	47	56	37	57	58	63	44	52	53
Cadmium	ug/L	0.017[6]	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**
Chromium	ug/L	8.9(III) / 1.0(VI)[7]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper	ug/L	2 - 4[8]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron	ug/L	300	52	360	170	130	260	310	70	ND	**ND (500)**	170	620	300	57	150	320
Lead	ug/L	1 - 7[9]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	ug/L	-	85	160	39	50	590	610	40	78	170	310	220	290	190	34	1700
Molyebdenum	ug/L	73	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	ug/L	25 - 150[10]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Selenium	ug/L	1.0	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**
Silver	ug/L	0.1	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**
Strontium	ug/L	-	820	1100	720	620	890	650	720	810	730	840	810	830	850	670	1000
Thallium	ug/L	0.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tin	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Titanium	ug/L	-	3	5	7	6	4	6	3	3	2	2	2	2	3	7	4
Uranium	ug/L	-	ND	0.2	ND	ND	0.1	ND	ND	ND	ND	ND	ND	ND	0.1	ND	0.1
Vanadium	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	ug/L	30	ND	ND	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium	mg/L	-	18	23	14	10	18	18	13	17	16	21	18	19	21	13	19
Potassium	mg/L	-	1.1	1.9	1.2	2.0	1.0	1.5	1.2	1.2	0.9	1.2	2.0	1.3	1.4	2.1	2.0
Phosphorus	mg/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Calcium	mg/L	-	88	120	79	68	97	74	76	90	78	81	76	87	83	72	100
Magnesium	mg/L	-	5.2	9	6.7	5	6.4	4.8	5.4	6.3	5.9	4.8	5.3	5.7	6.1	5.7	7.6

Table C.5.5

S5 SURFACE WATER QUALITY SAMPLING RESULTS
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Parameter	Units	CCME Fresh Water Aquatic Life(1, 2, 3)	S5	S5	S5	S5	S5	S5	S5	S5	S5	S5	S5	S5	S5	S5	S5
Sampling Date			**10-Jan-08**	**28-Feb-08**	**18-Mar-08**	**29-Apr-08**	**28-May-08**	**24-Jun-08**	**29-Jul-08**	**1-Aug-08**	**24-Sep-08**	**30-Oct-08**	**26-Nov-08**	**15-Dec-08**	**28-Jan-09**	**25-Feb-09**	**31-Mar-09**
INORGANICS																	
Alkalinity (as $CaCO_3$)	mg/L	-	84	40	38	55	61	77	88	110	91	95	96	47	89	83	36
Chloride	mg/L	-	24	12	12	17	16	22	24	13	20	19	22	12	24	17	7
Color	TCU	-	22	15	15	16	33	21	22	52	26	29	40	47	19	31	36
Nitrate + Nitrite (as N)	mg/L	-	0.20	0.12	0.25	0.22	0.18	0.57	0.84	0.18	0.46	0.18	0.15	0.11	0.30	0.11	0.11
Nitrite	mg/L	0.060	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.02	ND	ND	ND
Ammonia (as N)	mg/L	Varies(4)	0.12	ND	ND	ND	ND	0.06	0.06	ND	0.06	ND	ND	ND	0.11	0.35	ND
Total Org. Carbon (by UV)	mg/L	-	5.3	3.7	4.4	3.9	7.3	4.9	3.7	12.0	5.2	8.1	8.6	6.5	4.8	4.7	4.5
Orthophosphate (as P)	mg/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
pH	units	6.5-9.0	7.19	7.24	7.19	7.49	7.54	7.51	7.53	7.47	7.36	7.46	7.43	7.32	7.40	7.32	7.05
Total Phosphorus	mg/L	-	0.011	0.012	0.008	0.014	0.022	0.006	0.015	0.032	0.012	0.021	0.033	0.011	-	0.13	ND
Reactive Silica (as SiO_2)	mg/L	-	5.4	3.9	3.8	2.7	2.3	6.5	8.5	7.0	7.7	7.0	4.9	4.0	7.5	5.6	3.0
Total Suspended Solids	mg/L	-	6	4	2	1	2	ND	12	3	1	2	13	3	1	ND	5
Sulfate	mg/L	-	240	140	120	130	130	120	120	120	130	120	120	160	180	170	120
Turbidity	NTU	-	6.8	5.1	2.6	0.7	0.9	1.1	4.7	0.9	1.4	0.8	7.1	2.6	1.1	2.1	5.5
Conductivity	uS/cm		700	490	410	440	450	490	510	470	500	500	530	440	600	560	320
CALCULATED PARAMETERS																	
Nitrate (as N)	mg/L	2.9	0.20	0.12	0.25	0.22	0.18	0.57	0.84	0.18	0.46	0.18	0.15	0.09	0.30	0.11	0.11
Hardness (as $CaCO_3$)	mg/L	-	330	200	170	190	200	210	210	230	240	230	230	200	270	240	150
Bicarbonate (as $CaCO_3$)	mg/L	-	84	40	38	54	60	77	87	108	91	94	96	47	89	83	36
Carbonate (as $CaCO_3$)	mg/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TDS (calculated)	mg/L	-	471	268	238	269	275	298	314	314	321	311	315	290	391	351	221
Cation Sum	meq/L	-	7.54	4.5	3.9	4.39	4.62	5.08	5.02	5.3	5.49	5.26	5.53	4.55	6.25	5.55	3.41
Anion Sum	meq/L	-	7.41	4.02	3.64	4.26	4.33	4.68	5.08	5.09	5.06	4.99	5.03	4.52	6.22	5.62	3.47
Ion Balance	%	-	0.87	5.63	1.12	1.50	3.24	4.10	0.59	2.02	4.08	2.63	4.73	0.33	0.24	0.63	0.87
Langlier Index @ 4C	-	-	-0.540	-0.966	-1.080	-0.605	-0.495	-0.384	-0.321	-0.254	-0.423	-0.326	-0.349	-0.824	-0.360	-0.515	-1.300
Langlier Index @ 20C	-	-	-0.292	-0.717	-0.834	-0.356	-0.246	-0.135	-0.072	-0.005	-0.174	-0.077	-0.100	-0.574	-0.111	-0.266	-1.050
Saturation pH @ 4C	units	-	7.73	8.21	8.27	8.10	8.04	7.89	7.85	7.72	7.78	7.79	7.78	8.14	7.76	7.84	8.35
Saturation pH @ 20C	Units	-	7.48	7.96	8.02	7.85	7.79	7.65	7.60	7.48	7.53	7.54	7.53	7.89	7.51	7.59	8.10
METALS																	
Aluminum	ug/L	5 / 100(5)	43	54	32	17	11	ND	ND	ND	ND	16	320	110	48	53	300
Antimony	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	ug/L	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Barium	ug/L	-	38	29	25	33	27	44	45	38	44	35	32	20	45	38	21
Beryllium	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bismuth	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Boron	ug/L	-	72	39	31	46	50	52	48	63	50	50	40	46	47	57	33
Cadmium	ug/L	0.017(6)	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**
Chromium	ug/L	8.9(III) / 1.0(VI)(7)	ND	ND	ND	ND	4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper	ug/L	2 - 4(8)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron	ug/L	300	140	75	84	160	120	53	140	270	180	240	830	400	330	700	330
Lead	ug/L	1 - 7(9)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.5	ND	ND	ND	0.7
Manganese	ug/L	-	530	50	58	84	85	160	270	160	260	150	200	43	860	1100	51
Molyebdenum	ug/L	73	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	ug/L	25 - 150(10)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Selenium	ug/L	1.0	2	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**
Silver	ug/L	0.1	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**
Strontium	ug/L	-	1000	690	550	690	660	770	790	760	750	870	800	640	920	840	490
Thallium	ug/L	0.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tin	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Titanium	ug/L	-	9	5	4	3	3	2	2	2	2	2	11	5	4	6	8
Uranium	ug/L	-	0.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.3	0.1	0.1	0.1	ND
Vanadium	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	ug/L	30	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	6	ND	ND	5	ND
Sodium	mg/L	-	21	11	9.8	14	15	18	18	15	17	15	18	10	18	14	7
Potassium	mg/L	-	2.1	1.4	1.2	1.4	1.3	1.2	1.2	2.3	1.4	2.0	2.9	1.6	1.6	1.6	1.1
Phosphorus	mg/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.2	ND	ND	ND	ND	ND
Calcium	mg/L	-	110	71	62	67	70	77	76	82	86	81	82	71	96	85	54
Magnesium	mg/L	-	11	5.2	4	4.8	5.5	4.9	4.9	6	5.5	5.7	6.9	5.9	7.4	7.2	4.3

Table C.5.6

S6 SURFACE WATER QUALITY SAMPLING RESULTS
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Parameter	Units	CCME Fresh Water Aquatic Life(1, 2, 3)	S6	S6 - Lab Duplicate	S6	S6	S6	S6	S6 - Lab Duplicate	S6	S6	S6	S6	S6	S6	S6
Sampling Date			**21-Nov-05**	**29-Nov-05**	**12-Dec-05**	**18-Jan-06**	**8-Feb-06**	**13-Mar-06**	**13-Mar-06**	**1-Apr-06**	**1-May-06**	**6-Jun-06**	**25-Jul-06**	**17-Aug-06**	**19-Sep-06**	**17-Oct-06**
INORGANICS																
Alkalinity (as $CaCO_3$)	mg/L	-	60	-	34	75	62	44	-	35	98	78	90	260	280	52
Chloride	mg/L	-	7	-	7	8	7	10	-	10	7	6	5	120	78	10
Color	TCU	-	31	-	41	22	23	23	-	48	23	50	67	20	63	18
Nitrate + Nitrite (as N)	mg/L	-	0.08	-	0.30	0.16	0.18	0.46	0.46	0.21	ND	ND	ND	ND	ND	ND
Nitrite	mg/L	0.060	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND
Ammonia (as N)	mg/L	Varies(4)	ND	-	ND	ND	ND	ND	-	ND	ND	ND	ND	0.1	0.36	ND
Total Org. Carbon (by UV)	mg/L	-	7.2	-	8.7	4.1	4.8	3.1	-	10.0	7.3	11.0	16.0	4.9	19.0	6.1
Orthophosphate (as P)	mg/L	-	ND	-	ND	ND	ND	ND	-	ND	ND	ND	ND	ND	0.3	ND
pH	units	6.5-9.0	7.23	7.26	6.96	7.24	7.23	7.22	-	7.37	8.01	7.24	7.75	7.72	7.57	7.42
Total Phosphorus	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reactive Silica (as SiO_2)	mg/L	-	5.3	-	4.6	5.0	4.4	3.6	-	3.5	2.3	4.9	7.0	11.0	16.0	7.3
Total Suspended Solids	mg/L	-	-	-	-	2	2	3	-	21	3	8	4	5	58	ND
Sulfate	mg/L	-	190	-	84	210	170	90	-	23	360	110	93	88	13	440
Turbidity	NTU	-	7.8	-	16.0	8.6	11.0	15.0	-	120.0	2.5	20.0	14.0	2.0	15.0	0.3
Conductivity	uS/cm		520	520	250	560	520	310	-	150	840	400	340	880	810	930
CALCULATED PARAMETERS																
Nitrate (as N)	mg/L	2.9	-	-	-	0.16	0.18	0.46	-	0.21	ND	ND	ND	ND	ND	ND
Hardness (as $CaCO_3$)	mg/L	-	260	-	130	310	250	150	-	63	490	190	190	370	280	540
Bicarbonate (as $CaCO_3$)	mg/L	-	60	-	34	74	62	44	-	35	97	78	90	257	278	51
Carbonate (as $CaCO_3$)	mg/L	-	ND	-	ND	ND	ND	ND	-	ND	ND	ND	ND	1	ND	ND
TDS (calculated)	mg/L	-	349	-	172	395	328	195	-	90	630	249	240	590	454	702
Cation Sum	meq/L	-	5.35	-	2.74	6.42	5.22	3.18	-	1.53	10	4.07	4.07	10.4	8.22	11.1
Anion Sum	meq/L	-	5.45	-	2.64	6.08	5.1	3.08	-	1.49	9.72	4.04	3.88	10.4	8.05	10.4
Ion Balance	%	-	0.90	-	1.78	2.69	1.15	1.66	-	1.16	1.49	0.36	2.43	0.14	1.03	3.18
Langlier Index @ 4C	-	-	-0.685	-	-1.470	-0.510	-0.677	-1.030	-	-1.320	0.530	-0.674	-0.101	0.536	0.314	-0.311
Langlier Index @ 20C	-	-	-0.437	-	-1.220	-0.261	-0.428	-0.784	-	-1.070	0.778	-0.425	0.149	0.784	0.562	-0.064
Saturation pH @ 4C	units	-	7.92	-	8.43	7.75	7.91	8.25	-	8.69	7.48	7.91	7.85	7.18	7.26	7.73
Saturation pH @ 20C	Units	-	7.67	-	8.18	7.50	7.66	8.00	-	8.44	7.23	7.67	7.60	6.94	7.01	7.48
METALS																
Aluminum	ug/L	5 / 100(5)	-	-	-	330	280	360	-	830	140	440	1200	ND	120	ND
Antimony	ug/L	-	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND
Arsenic	ug/L	5.0	-	-	-	ND	ND	ND	-	ND	**ND (20)**	ND	ND	ND	4	**ND (20)**
Barium	ug/L	-	-	-	-	21	18	16	-	13	ND	20	20	50	78	ND
Beryllium	ug/L	-	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND
Bismuth	ug/L	-	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND
Boron	ug/L	-	-	-	-	11	8	7	-	10	ND	18	19	17	23	ND
Cadmium	ug/L	0.017(6)	-	-	-	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	-	**ND (0.3)**	**ND (3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (3)**
Chromium	ug/L	8.9(III) / 1.0(VI)(7)	-	-	-	ND	ND	ND	-	ND	ND	ND	3	ND	ND	ND
Cobalt	ug/L	-	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND
Copper	ug/L	2 - 4(8)	**ND (10)**	-	**ND (10)**	ND	ND	ND	-	ND	**ND (20)**	ND	ND	ND	ND	**ND (20)**
Iron	ug/L	300	290	-	420	ND	180	260	-	620	**ND (500)**	390	930	ND	1900	**ND (500)**
Lead	ug/L	1 - 7(9)	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	0.9	ND
Manganese	ug/L	-	ND	-	10	7	6	9	-	9	65	10	16	2000	2500	28
Molyebdenum	ug/L	73	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND
Nickel	ug/L	25 - 150(10)	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND
Selenium	ug/L	1.0	-	-	-	**ND (2)**	**ND (2)**	**ND (2)**	-	**ND (2)**	**ND (20)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (20)**
Silver	ug/L	0.1	-	-	-	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	-	**ND (0.5)**	**ND (5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (5)**
Strontium	ug/L	-	-	-	-	790	640	360	-	100	1300	480	430	690	560	1300
Thallium	ug/L	0.8	-	-	-	ND	ND	ND	-	ND	**ND (1)**	ND	ND	ND	ND	**ND (1)**
Tin	ug/L	-	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND
Titanium	ug/L	-	-	-	-	13	6	15	-	36	ND	21	44	ND	5	ND
Uranium	ug/L	-	-	-	-	0.4	0.4	0.1	-	0.2	ND	0.3	0.3	1.2	1	ND
Vanadium	ug/L	-	-	-	-	ND	ND	ND	-	ND	ND	ND	2	ND	ND	ND
Zinc	ug/L	30	**ND (50)**	-	**ND (50)**	ND	ND	ND	-	ND	**ND (50)**	ND	ND	8	17	**ND (50)**
Sodium	mg/L	-	4.5	-	3.9	4.6	4.1	5	-	5.5	5.2	5.7	5.2	68	280	5.2
Potassium	mg/L	-	0.9	-	1.3	1.1	0.8	0.8	-	1.1	0.8	0.7	1.2	1.6	20.0	1.2
Phosphorus	mg/L	-	-	-	-	ND	ND	ND	-	ND	ND	ND	ND	ND	0.7	ND
Calcium	mg/L	-	97	-	46	120	95	54	-	22	190	71	70	140	100	200
Magnesium	mg/L	-	3.4	-	2.5	3.6	2.9	2.7	-	1.7	5	2.8	3.4	6.3	6	7

Table C.5.6

S6 SURFACE WATER QUALITY SAMPLING RESULTS
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Parameter	Units	CCME Fresh Water Aquatic Life[1, 2, 3]	S6	S6	S6	S6	S6	S6	S6	S6	S6	S6	S6	S6	S6	S6
Sampling Date			**1-Nov-06**	**11-Dec-06**	**23-Jan-07**	**20-Feb-07**	**14-Mar-07**	**24-Apr-07**	**8-May-07**	**28-Jun-07**	**24-Jul-07**	**30-Aug-07**	**24-Sep-07**	**31-Oct-07**	**21-Nov-07**	**12-Dec-07**
INORGANICS																
Alkalinity (as $CaCO_3$)	mg/L	-	71	60	84	NS	41	64	79	150	120	170	190	140	93	92
Chloride	mg/L	-	12	8	8	NS	10	8	10	6	39	81	98	16	10	14
Color	TCU	-	30	28	16	NS	19	20	18	29	23	28	26	26	21	22
Nitrate + Nitrite (as N)	mg/L	-	ND	0.05	0.17	NS	ND	ND	ND	ND	ND	0.06	ND	ND	ND	0.17
Nitrite	mg/L	0.060	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ammonia (as N)	mg/L	Varies[4]	ND	ND	ND	NS	ND	ND	ND	ND	ND	0.09	ND	ND	ND	ND
Total Org. Carbon (by UV)	mg/L	-	9.2	6.8	5.0	NS	5.2	5.8	5.2	8.4	7.4	8.3	5.9	8.8	4.5	5.0
Orthophosphate (as P)	mg/L	-	ND	ND	ND	NS	ND	ND	ND	ND	0.02	ND	ND	ND	ND	ND
pH	units	6.5-9.0	7.66	7.58	7.55	NS	7.30	7.67	7.84	7.75	7.51	7.46	7.55	7.68	7.72	7.58
Total Phosphorus	mg/L	-	-	-	-	NS	-	-	-	-	-	-	0.061	0.008	0.018	0.037
Reactive Silica (as SiO_2)	mg/L	-	6.6	5.1	5.3	NS	3.5	1.5	2.1	4.9	7.8	9.3	8.9	7.3	5.9	6.0
Total Suspended Solids	mg/L	-	1	3	4	NS	14	2	1	1	1	3	3	ND	1	19
Sulfate	mg/L	-	120	110	420	NS	100	250	260	300	230	130	100	240	220	140
Turbidity	NTU	-	4.5	14.0	3.9	NS	16.0	3.0	0.9	0.6	0.8	1.3	1.7	0.4	3.7	9.5
Conductivity	uS/cm		420	380	940	NS	330	660	660	820	780	860	860	750	640	510
CALCULATED PARAMETERS																
Nitrate (as N)	mg/L	2.9	ND	0.05	0.17	NS	0.24	ND	0.25		ND	0.06	ND	ND	ND	0.17
Hardness (as $CaCO_3$)	mg/L	-	230	170	560	NS	150	340	370	490	390	340	340	380	310	230
Bicarbonate (as $CaCO_3$)	mg/L	-	71	60	84	NS	41	64	78	149	123	169	185	142	93	91
Carbonate (as $CaCO_3$)	mg/L	-	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TDS (calculated)	mg/L	-	281	237	718	NS	210	439	470	604	527	498	508	513	417	318
Cation Sum	meq/L	-	4.84	3.75	11.5	NS	3.37	7.04	7.67	10.2	8.92	8.46	9.27	8.19	6.42	5.08
Anion Sum	meq/L	-	4.33	3.78	10.7	NS	3.27	6.73	7.24	9.45	8.28	8.47	8.57	8.32	6.67	5.2
Ion Balance	%	-	5.59	0.44	3.64	NS	1.51	2.25	2.88	3.62	3.72	0.06	3.92	0.79	1.91	1.17
Langlier Index @ 4C	-	-	-0.222	-0.482	0.055	NS	-0.966	-0.119	0.169	0.462	0.046	0.080	0.200	0.273	0.050	-0.196
Langlier Index @ 20C	-	-	0.028	-0.233	0.302	NS	-0.716	0.129	0.417	0.710	0.294	0.328	0.448	0.521	0.298	0.053
Saturation pH @ 4C	units	-	7.88	8.06	7.50	NS	8.27	7.79	7.67	7.29	7.46	7.38	7.35	7.41	7.67	7.78
Saturation pH @ 20C	Units	-	7.63	7.81	7.25	NS	8.02	7.54	7.42	7.04	7.22	7.13	7.10	7.16	7.42	7.53
METALS																
Aluminum	ug/L	5 / 100[5]	230	1000	160	NS	310	96	41	ND	ND	31	ND	ND	94	730
Antimony	ug/L	-	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	ug/L	5.0	ND	ND	ND	NS	ND	ND	ND	**ND (20)**	ND	ND	ND	ND	ND	ND
Barium	ug/L	-	25	20	ND	NS	17	24	27	ND	47	46	57	34	21	27
Beryllium	ug/L	-	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bismuth	ug/L	-	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Boron	ug/L	-	16	10	ND	NS	9	21	19	ND	30	20	16	10	11	8
Cadmium	ug/L	0.017[6]	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	NS	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**
Chromium	ug/L	8.9(III) / 1.0(VI)[7]	ND	ND	ND	NS	ND	ND	ND	ND	ND	3	ND	ND	ND	ND
Cobalt	ug/L	-	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper	ug/L	2 - 4[8]	ND	3	ND	NS	ND	ND	ND	**ND (20)**	ND	ND	ND	ND	ND	ND
Iron	ug/L	300	180	540	ND	NS	210	ND	ND	**ND (500)**	ND	290	130	ND	78	330
Lead	ug/L	1 - 7[9]	ND	0.6	ND	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	ug/L	-	20	15	ND	NS	31	7	20	85	210	290	450	110	11	10
Molyebdenum	ug/L	73	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	ug/L	25 - 150[10]	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Selenium	ug/L	1.0	**ND (2)**	**ND (2)**	**ND (2)**	NS	**ND (2)**	**ND (2)**	**ND (2)**	**ND (20)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (2)**
Silver	ug/L	0.1	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	NS	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**
Strontium	ug/L	-	470	430	1500	NS	360	900	890	1300	980	720	650	930	850	560
Thallium	ug/L	0.8	ND	ND	ND	NS	ND	ND	ND	**ND (1)**	ND	ND	ND	ND	ND	ND
Tin	ug/L	-	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Titanium	ug/L	-	9	29	ND	NS	12	8	5	ND	4	3	2	5	8	18
Uranium	ug/L	-	0.3	0.3	ND	NS	0.1	0.4	0.6	1	0.7	0.8	1.4	0.1	0.5	0.3
Vanadium	ug/L	-	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	ug/L	30	ND	13	ND	NS	ND	ND	ND	**ND (50)**	7	19	ND	ND	ND	ND
Sodium	mg/L	-	6.1	5.3	5	NS	5.4	5.6	6.8	6.5	26	36	54	12	6.4	8
Potassium	mg/L	-	1.3	1.3	2.0	NS	1.3	1.1	1.0	0.4	1.1	1.4	1.5	1.3	1.6	1.3
Phosphorus	mg/L	-	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Calcium	mg/L	-	84	65	220	NS	58	130	140	190	150	130	130	140	120	86
Magnesium	mg/L	-	4.2	2.7	5	NS	2.4	3.3	4.3	5.6	4.8	5.6	6.9	5.5	4.3	4.5

Table C.5.6

S6 SURFACE WATER QUALITY SAMPLING RESULTS
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

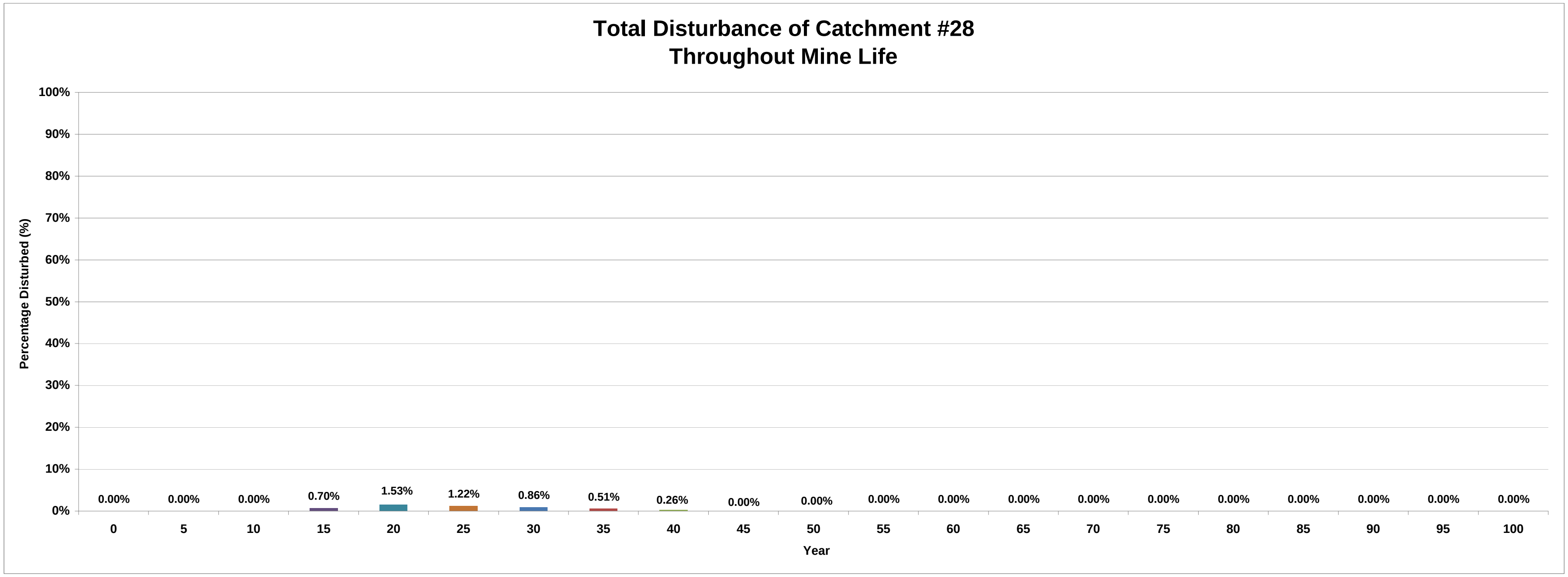
Parameter	Units	CCME Fresh Water Aquatic Life[1, 2, 3]	S6	S6	S6	S6	S6	S6	S6	S6	S6	S6	S6	S6	S6	S6
Sampling Date			**10-Jan-08**	**28-Feb-08**	**18-Mar-08**	**29-Apr-08**	**28-May-08**	**24-Jun-08**	**29-Jul-08**	**1-Aug-08**	**24-Sep-08**	**30-Oct-08**	**26-Nov-08**	**15-Dec-08**	**28-Jan-09**	**25-Feb-09**
INORGANICS																
Alkalinity (as $CaCO_3$)	mg/L	-	49	47	86	94	75	150	230	130	200	100	95	90	140	NS
Chloride	mg/L	-	7	6	9	10	6	10	210	9	14	14	12	9	9	NS
Color	TCU	-	37	26	13	24	100	32	35	46	19	47	43	35	13	NS
Nitrate + Nitrite (as N)	mg/L	-	0.12	0.10	0.11	ND	ND	ND	0.05	ND	ND	ND	0.06	0.08	0.14	NS
Nitrite	mg/L	0.060	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.01	ND	NS
Ammonia (as N)	mg/L	Varies[4]	ND	ND	ND	ND	ND	ND	1.5	ND	ND	ND	ND	ND	ND	NS
Total Org. Carbon (by UV)	mg/L	-	6.6	4.6	4.1	5.5	12.0	9.6	7.8	11.0	6.3	11.0	5.6	5.5	4.7	NS
Orthophosphate (as P)	mg/L	-	ND	ND	ND	ND	0.01	ND	0.13	ND	ND	ND	ND	ND	ND	NS
pH	units	6.5-9.0	7.34	7.50	7.66	7.79	7.70	7.78	7.51	7.59	7.56	7.55	7.66	7.73	7.66	NS
Total Phosphorus	mg/L	-	0.039	0.033	0.017	0.023	0.047	0.018	0.440	0.016	0.015	0.018	0.031	0.019	-	NS
Reactive Silica (as SiO_2)	mg/L	-	4.3	3.8	4.2	2.0	3.7	5.2	12.0	8.0	6.8	6.4	5.5	5.2	6.1	NS
Total Suspended Solids	mg/L	-	12	8	10	2	5	3	38	ND	180	1	9	3	14	NS
Sulfate	mg/L	-	65	96	430	230	100	510	170	340	750	120	88	240	440	NS
Turbidity	NTU	-	21.0	18.0	4.5	1.0	15.0	0.8	15.0	0.4	0.6	1.1	4.6	3.2	3.2	NS
Conductivity	uS/cm		250	330	1000	650	350	1200	1400	880	1600	520	390	660	1100	NS
CALCULATED PARAMETERS																
Nitrate (as N)	mg/L	2.9	0.12	0.10	0.11	ND	ND	ND	0.05	ND	ND	ND	0.06	0.07	0.14	NS
Hardness (as $CaCO_3$)	mg/L	-	120	140	550	340	170	700	490	490	1000	260	180	360	660	NS
Bicarbonate (as $CaCO_3$)	mg/L	-	49	46	86	93	75	150	229	130	195	100	95	89	144	NS
Carbonate (as $CaCO_3$)	mg/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS
TDS (calculated)	mg/L	-	158	193	716	442	227	903	835	639	1300	307	241	455	811	NS
Cation Sum	meq/L	-	2.61	2.95	11.2	7.11	3.64	14.3	14.4	10.2	20.8	5.52	3.94	7.44	13.4	NS
Anion Sum	meq/L	-	2.45	3.1	10.9	6.98	3.76	14	14.2	9.95	19.9	4.83	4.07	7.02	12.4	NS
Ion Balance	%	-	1.36	2.48	0.96	0.92	1.62	1.27	0.49	1.29	2.36	6.67	1.62	2.90	4.07	NS
Langlier Index @ 4C	-	-	-0.941	-0.752	0.165	0.168	-0.277	0.601	0.361	0.234	0.616	-0.141	-0.190	0.111	0.450	NS
Langlier Index @ 20C	-	-	-0.691	-0.502	0.412	0.417	-0.028	0.847	0.607	0.482	0.861	0.108	0.060	0.359	0.697	NS
Saturation pH @ 4C	units	-	8.28	8.25	7.50	7.62	7.98	7.18	7.15	7.36	6.94	7.69	7.85	7.62	7.21	NS
Saturation pH @ 20C	Units	-	8.03	8.00	7.25	7.37	7.73	6.93	6.90	7.11	6.70	7.44	7.60	7.37	6.96	NS
METALS																
Aluminum	ug/L	5 / 100[5]	390	380	ND	64	700	ND	ND	ND	ND	79	330	250	130	NS
Antimony	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS
Arsenic	ug/L	5.0	ND	ND	**ND (20)**	ND	ND	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	ND	ND	ND	**ND (20)**	NS
Barium	ug/L	-	13	15	ND	26	17	ND	74	ND	ND	25	22	22	ND	NS
Beryllium	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS
Bismuth	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS
Boron	ug/L	-	8	7	ND	15	14	ND	ND	ND	ND	11	8	9	ND	NS
Cadmium	ug/L	0.017[6]	**ND (0.3)**	**ND (0.3)**	**ND (3)**	**ND (0.3)**	**ND (0.3)**	**ND (3)**	**ND (3)**	**ND (3)**	**ND (3)**	**ND (0.3)**	**ND (0.3)**	**ND (0.3)**	**ND (3)**	NS
Chromium	ug/L	8.9(III) / 1.0(VI)[7]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS
Cobalt	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS
Copper	ug/L	2 - 4[8]	ND	ND	**ND (20)**	ND	ND	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	ND	ND	ND	**ND (20)**	NS
Iron	ug/L	300	280	290	**ND (500)**	ND	500	**ND (500)**	**ND (500)**	**ND (500)**	**ND (500)**	140	380	200	**ND (500)**	NS
Lead	ug/L	1 - 7[9]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS
Manganese	ug/L	-	8	7	ND	41	17	ND	800	56	220	49	41	18	82	NS
Molyebdenum	ug/L	73	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS
Nickel	ug/L	25 - 150[10]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS
Selenium	ug/L	1.0	**ND (2)**	**ND (2)**	**ND (20)**	**ND (2)**	**ND (2)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (20)**	**ND (2)**	**ND (2)**	**ND (2)**	**ND (20)**	NS
Silver	ug/L	0.1	**ND (0.5)**	**ND (0.5)**	**ND (5)**	**ND (0.5)**	**ND (0.5)**	**ND (5)**	**ND (5)**	**ND (5)**	**ND (5)**	**ND (0.5)**	**ND (0.5)**	**ND (0.5)**	**ND (5)**	NS
Strontium	ug/L	-	250	360	1300	930	390	2000	1100	1400	3000	700	430	910	1600	NS
Thallium	ug/L	0.8	ND	ND	**ND (1)**	ND	ND	**ND (1)**	**ND (1)**	**ND (1)**	**ND (1)**	ND	ND	ND	**ND (1)**	NS
Tin	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS
Titanium	ug/L	-	14	16	ND	6	26	ND	ND	ND	ND	4	8	10	ND	NS
Uranium	ug/L	-	0.2	0.2	ND	0.5	0.2	1	1	ND	2	0.4	0.5	0.4	ND	NS
Vanadium	ug/L	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS
Zinc	ug/L	30	ND	ND	**ND (50)**	ND	ND	**ND (50)**	**ND (50)**	**ND (50)**	**ND (50)**	5	6	5	**ND (50)**	NS
Sodium	mg/L	-	3.8	3.6	5.8	6.4	5.3	8	99	7.6	8.5	7.7	6.2	5.7	5.7	NS
Potassium	mg/L	-	1.1	0.9	1.3	1.2	1.0	0.6	5.0	1.2	1.3	2.0	1.2	1.3	1.5	NS
Phosphorus	mg/L	-	ND	ND	ND	ND	ND	ND	0.2	0.1	0.2	0.3	ND	0.1	0.2	NS
Calcium	mg/L	-	44	52	210	130	62	270	180	190	390	95	66	140	250	NS
Magnesium	mg/L	-	2.3	2	4.6	4.1	3.2	7	8	5.6	8.8	4.7	3.8	4.1	6.3	NS

Table C.5.6

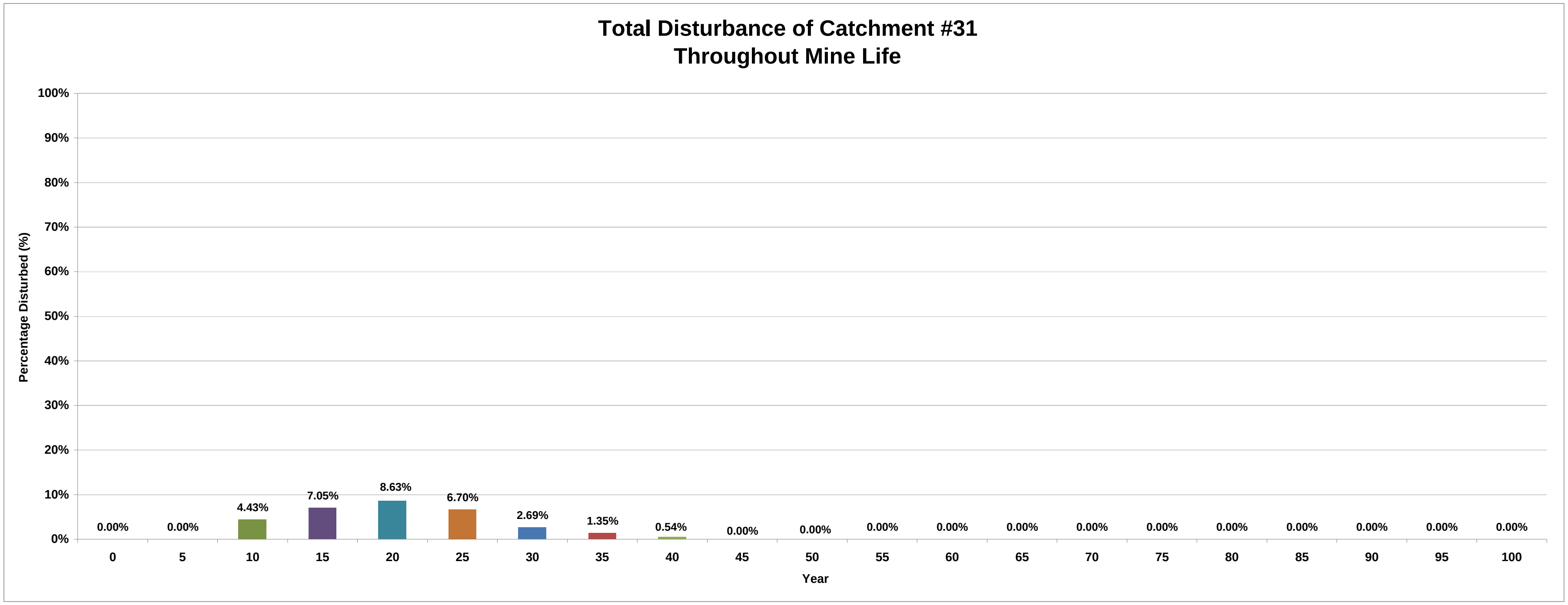
S6 SURFACE WATER QUALITY SAMPLING RESULTS
MILLER'S CREEK MINE EXTENSION PROJECT
CGC INC. - WINDSOR PLANT
HANTS COUNTY, NOVA SCOTIA

Parameter	Units	CCME Fresh Water Aquatic Life(1, 2, 3)	S6
Sampling Date			**31-Mar-09**
INORGANICS			
Alkalinity (as $CaCO_3$)	mg/L	-	47
Chloride	mg/L	-	5
Color	TCU	-	52
Nitrate + Nitrite (as N)	mg/L	-	0.11
Nitrite	mg/L	0.060	0.01
Ammonia (as N)	mg/L	Varies(4)	ND
Total Org. Carbon (by UV)	mg/L	-	5.4
Orthophosphate (as P)	mg/L	-	ND
pH	units	6.5-9.0	7.33
Total Phosphorus	mg/L	-	0.032
Reactive Silica (as SiO_2)	mg/L	-	3.8
Total Suspended Solids	mg/L	-	10
Sulfate	mg/L	-	84
Turbidity	NTU	-	8.1
Conductivity	uS/cm		270
CALCULATED PARAMETERS			
Nitrate (as N)	mg/L	2.9	0.10
Hardness (as $CaCO_3$)	mg/L	-	120
Bicarbonate (as $CaCO_3$)	mg/L	-	47
Carbonate (as $CaCO_3$)	mg/L	-	ND
TDS (calculated)	mg/L	-	175
Cation Sum	meq/L	-	2.65
Anion Sum	meq/L	-	2.84
Ion Balance	%	-	3.46
Langlier Index @ 4C	-	-	-0.963
Langlier Index @ 20C	-	-	-0.713
Saturation pH @ 4C	units	-	8.29
Saturation pH @ 20C	Units	-	8.04
METALS			
Aluminum	ug/L	5 / 100(5)	530
Antimony	ug/L	-	ND
Arsenic	ug/L	5.0	ND
Barium	ug/L	-	13
Beryllium	ug/L	-	ND
Bismuth	ug/L	-	ND
Boron	ug/L	-	7
Cadmium	ug/L	0.017(6)	**ND (0.3)**
Chromium	ug/L	8.9(III) / 1.0(VI)(7)	ND
Cobalt	ug/L	-	ND
Copper	ug/L	2 - 4(8)	ND
Iron	ug/L	300	400
Lead	ug/L	1 - 7(9)	ND
Manganese	ug/L	-	13
Molyebdenum	ug/L	73	ND
Nickel	ug/L	25 - 150(10)	ND
Selenium	ug/L	1.0	**ND (2)**
Silver	ug/L	0.1	**ND (0.5)**
Strontium	ug/L	-	270
Thallium	ug/L	0.8	ND
Tin	ug/L	-	ND
Titanium	ug/L	-	13
Uranium	ug/L	-	0.2
Vanadium	ug/L	-	ND
Zinc	ug/L	30	ND
Sodium	mg/L	-	3.7
Potassium	mg/L	-	0.9
Phosphorus	mg/L	-	ND
Calcium	mg/L	-	46
Magnesium	mg/L	-	2

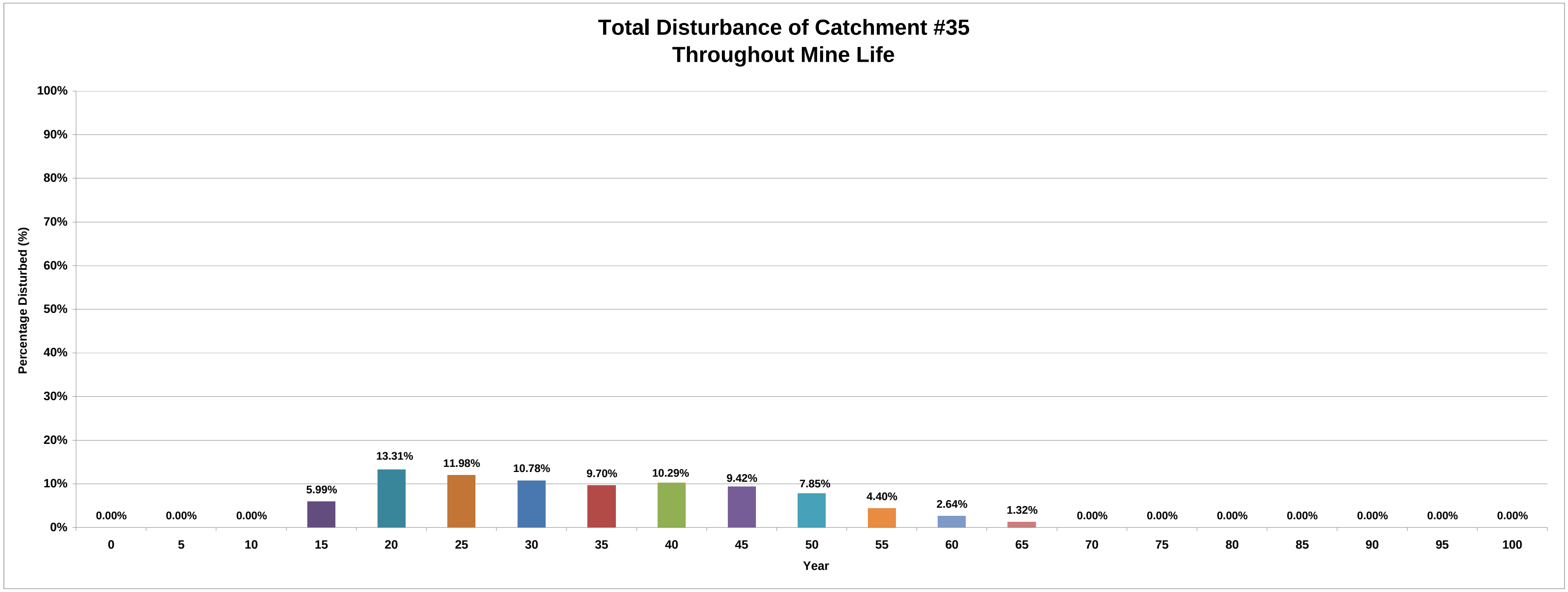
(C.6) AVONDALE CATCHMENT AREAS



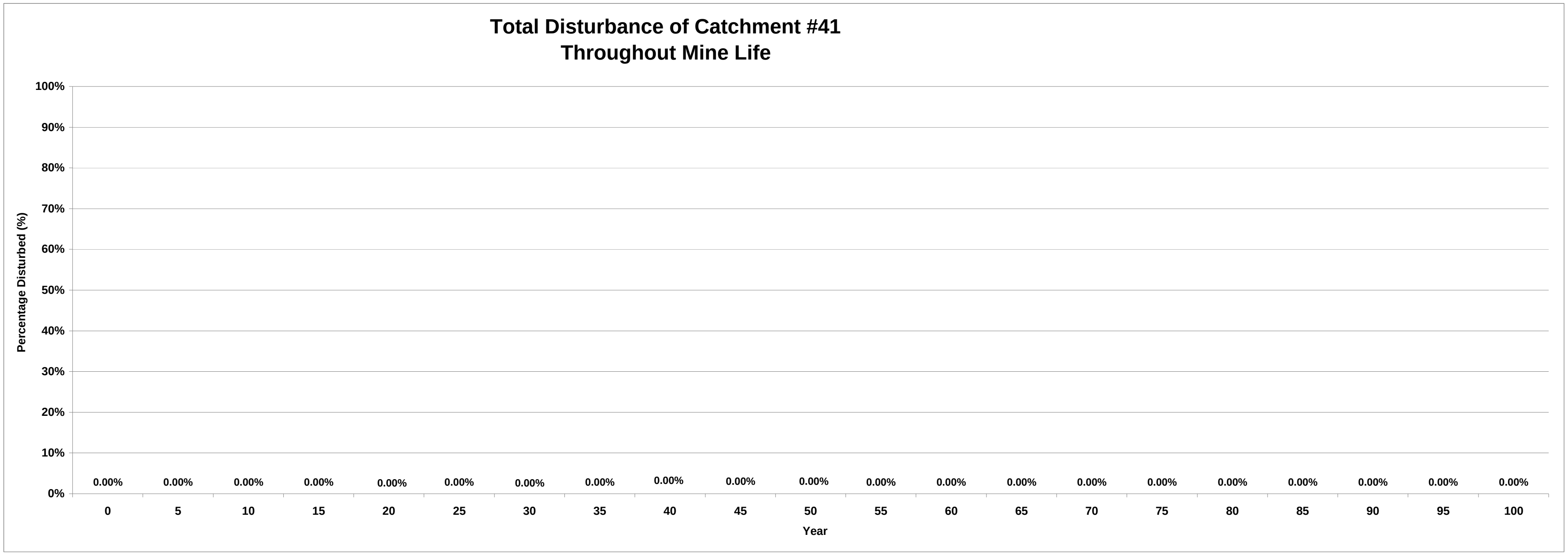
Year	Area of Catchment Disturbed by Pit (ha)	Percentage of Catchment Disturbed by Pit (%)	Area of Catchment Disturbed by Stockpiles (ha)	Percentage of Catchment Disturbed by Stockpiles (%)	Area of Stockpiles Within Catchment Reclaimed (ha)	Percentage of Stockpiles Within Catchment Reclaimed (%)	Area of Pit Within Catchment Reclaimed(ha)	Percentage of Pit Within Catchment Reclaimed(%)	Total Realized Catchment Area Disturbed (ha)	Total Realized Catchment Percentage Disturbed (%)
0	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
5	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
10	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
15	0.00	0.00%	0.47	0.70%	0.00	0.00%	0.00	N/A	0.47	0.70%
20	0.00	0.00%	1.15	1.70%	0.11	10.00%	0.00	N/A	1.03	1.53%
25	0.00	0.00%	1.15	1.70%	0.32	28.00%	0.00	N/A	0.83	1.22%
30	0.00	0.00%	1.15	1.70%	0.57	49.60%	0.00	N/A	0.58	0.86%
35	0.00	0.00%	1.15	1.70%	0.80	69.76%	0.00	N/A	0.35	0.51%
40	0.00	0.00%	1.15	1.70%	0.97	84.88%	0.00	N/A	0.17	0.26%
45	0.00	0.00%	1.15	1.70%	1.15	100.00%	0.00	N/A	0.00	0.00%
50	0.00	0.00%	1.15	1.70%	1.15	100.00%	0.00	N/A	0.00	0.00%
55	0.00	0.00%	1.15	1.70%	1.15	100.00%	0.00	N/A	0.00	0.00%
60	0.00	0.00%	1.15	1.70%	1.15	100.00%	0.00	N/A	0.00	0.00%
65	0.00	0.00%	1.15	1.70%	1.15	100.00%	0.00	N/A	0.00	0.00%
70	0.00	0.00%	1.15	1.70%	1.15	100.00%	0.00	N/A	0.00	0.00%
75	0.00	0.00%	1.15	1.70%	1.15	100.00%	0.00	N/A	0.00	0.00%
80	0.00	0.00%	1.15	1.70%	1.15	100.00%	0.00	N/A	0.00	0.00%
85	0.00	0.00%	1.15	1.70%	1.15	100.00%	0.00	N/A	0.00	0.00%
90	0.00	0.00%	1.15	1.70%	1.15	100.00%	0.00	N/A	0.00	0.00%
95	0.00	0.00%	1.15	1.70%	1.15	100.00%	0.00	N/A	0.00	0.00%
100	0.00	0.00%	1.15	1.70%	1.15	100.00%	0.00	N/A	0.00	0.00%



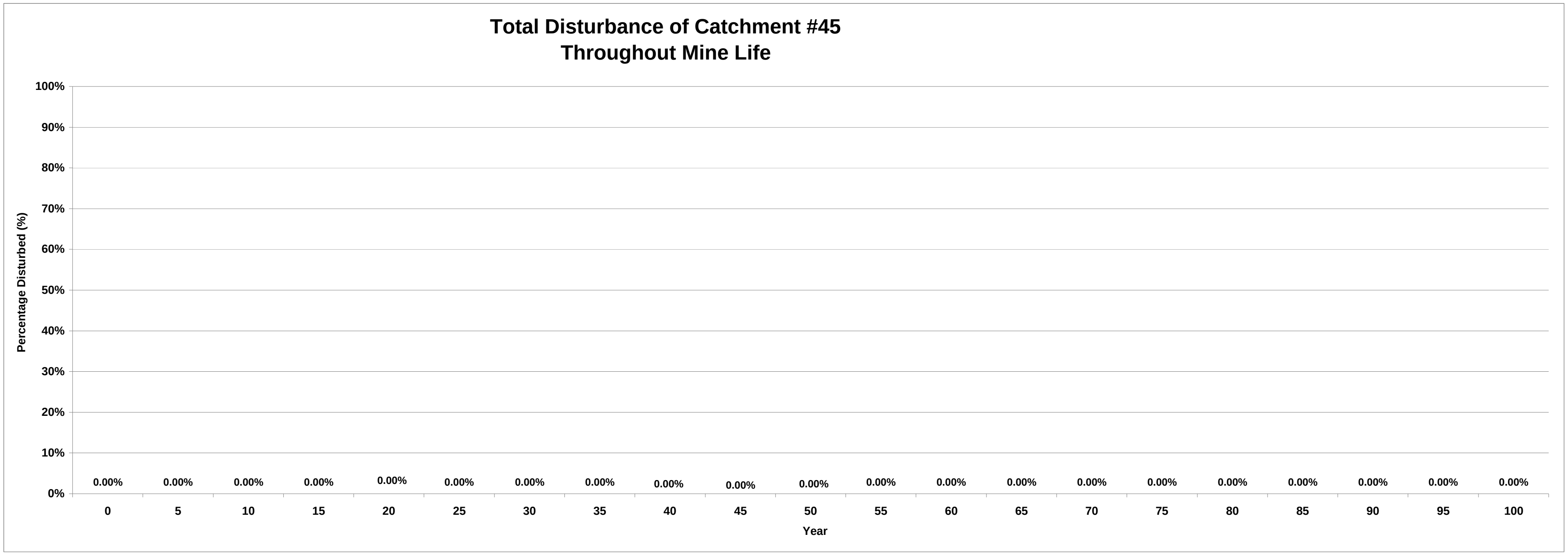
Year	Area of Catchment Disturbed by Pit (ha)	Percentage of Catchment Disturbed by Pit (%)	Area of Catchment Disturbed by Stockpiles (ha)	Percentage of Catchment Disturbed by Stockpiles (%)	Area of Stockpiles Within Catchment Reclaimed (ha)	Percentage of Stockpiles Within Catchment Reclaimed (%)	Area of Pit Within Catchment Reclaimed(ha)	Percentage of Pit Within Catchment Reclaimed(%)	Total Realized Catchment Area Disturbed (ha)	Total Realized Catchment Percentage Disturbed
0	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
5	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
10	2.79	1.65%	4.72	2.78%	0.00	N/A	0.00	N/A	7.51	4.43%
15	3.28	1.93%	9.64	5.68%	0.96	10.00%	0.00	N/A	11.96	7.05%
20	3.76	2.21%	14.55	8.58%	3.68	25.30%	0.00	N/A	14.63	8.63%
25	3.76	2.21%	14.55	8.58%	6.94	47.71%	0.00	N/A	11.37	6.70%
30	3.76	2.21%	14.55	8.58%	9.99	68.63%	3.76	100.00%	4.57	2.69%
35	3.76	2.21%	14.55	8.58%	12.27	84.31%	3.76	100.00%	2.28	1.35%
40	3.76	2.21%	14.55	8.58%	13.64	93.73%	3.76	100.00%	0.91	0.54%
45	3.76	2.21%	14.55	8.58%	14.55	100.00%	3.76	100.00%	0.00	0.00%
50	3.76	2.21%	14.55	8.58%	14.55	100.00%	3.76	100.00%	0.00	0.00%
55	3.76	2.21%	14.55	8.58%	14.55	100.00%	3.76	100.00%	0.00	0.00%
60	3.76	2.21%	14.55	8.58%	14.55	100.00%	3.76	100.00%	0.00	0.00%
65	3.76	2.21%	14.55	8.58%	14.55	100.00%	3.76	100.00%	0.00	0.00%
70	3.76	2.21%	14.55	8.58%	14.55	100.00%	3.76	100.00%	0.00	0.00%
75	3.76	2.21%	14.55	8.58%	14.55	100.00%	3.76	100.00%	0.00	0.00%
80	3.76	2.21%	14.55	8.58%	14.55	100.00%	3.76	100.00%	0.00	0.00%
85	3.76	2.21%	14.55	8.58%	14.55	100.00%	3.76	100.00%	0.00	0.00%
90	3.76	2.21%	14.55	8.58%	14.55	100.00%	3.76	100.00%	0.00	0.00%
95	3.76	2.21%	14.55	8.58%	14.55	100.00%	3.76	100.00%	0.00	0.00%
100	3.76	2.21%	14.55	8.58%	14.55	100.00%	3.76	100.00%	0.00	0.00%



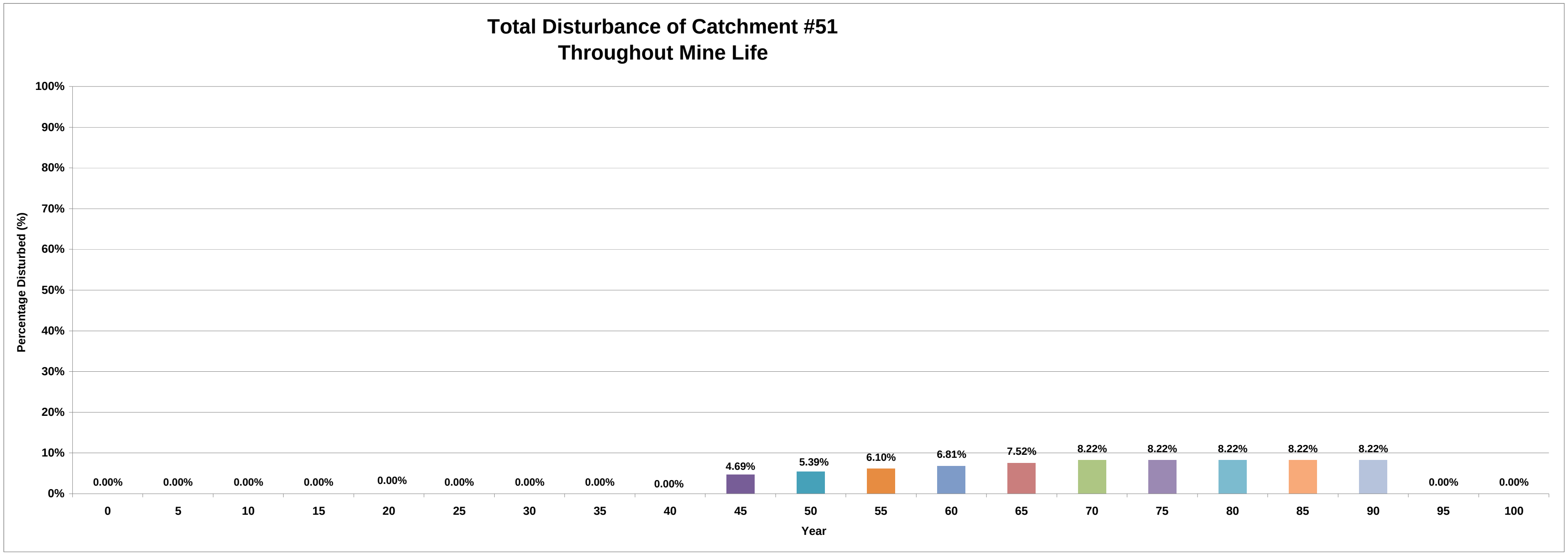
Year	Area of Catchment Disturbed by Pit (ha)	Percentage of Catchment Disturbed by Pit (%)	Area of Catchment Disturbed by Stockpiles (ha)	Percentage of Catchment Disturbed by Stockpiles (%)	Area of Stockpiles Within Catchment Reclaimed (ha)	Percentage of Stockpiles Within Catchment Reclaimed (%)	Area of Pit Within Catchment Reclaimed(ha)	Percentage of Pit Within Catchment Reclaimed(%)	Total Realized Catchment Area Disturbed (ha)	Total Realized Catchment Percentage Disturbed
0	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
5	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
10	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
15	0.00	0.00%	20.53	5.99%	0.00	N/A	0.00	N/A	20.53	5.99%
20	0.00	0.00%	50.71	14.79%	5.07	10.00%	0.00	N/A	45.64	13.31%
25	0.00	0.00%	50.71	14.79%	9.64	19.00%	0.00	N/A	41.08	11.98%
30	0.00	0.00%	50.71	14.79%	13.74	27.10%	0.00	N/A	36.97	10.78%
35	0.00	0.00%	50.71	14.79%	17.44	34.39%	0.00	N/A	33.27	9.70%
40	5.34	1.56%	50.71	14.79%	20.77	40.95%	0.00	0.00%	35.29	10.29%
45	5.34	1.56%	50.71	14.79%	23.76	46.86%	0.00	0.00%	32.29	9.42%
50	5.34	1.56%	50.71	14.79%	29.15	57.48%	0.00	0.00%	26.90	7.85%
55	5.34	1.56%	50.71	14.79%	35.62	70.24%	5.34	100.00%	15.09	4.40%
60	5.34	1.56%	50.71	14.79%	41.66	82.14%	5.34	100.00%	9.06	2.64%
65	5.34	1.56%	50.71	14.79%	46.19	91.07%	5.34	100.00%	4.53	1.32%
70	5.34	1.56%	50.71	14.79%	50.71	100.00%	5.34	100.00%	0.00	0.00%
75	5.34	1.56%	50.71	14.79%	50.71	100.00%	5.34	100.00%	0.00	0.00%
80	5.34	1.56%	50.71	14.79%	50.71	100.00%	5.34	100.00%	0.00	0.00%
85	5.34	1.56%	50.71	14.79%	50.71	100.00%	5.34	100.00%	0.00	0.00%
90	5.34	1.56%	50.71	14.79%	50.71	100.00%	5.34	100.00%	0.00	0.00%
95	5.34	1.56%	50.71	14.79%	50.71	100.00%	5.34	100.00%	0.00	0.00%
100	5.34	1.56%	50.71	14.79%	50.71	100.00%	5.34	100.00%	0.00	0.00%



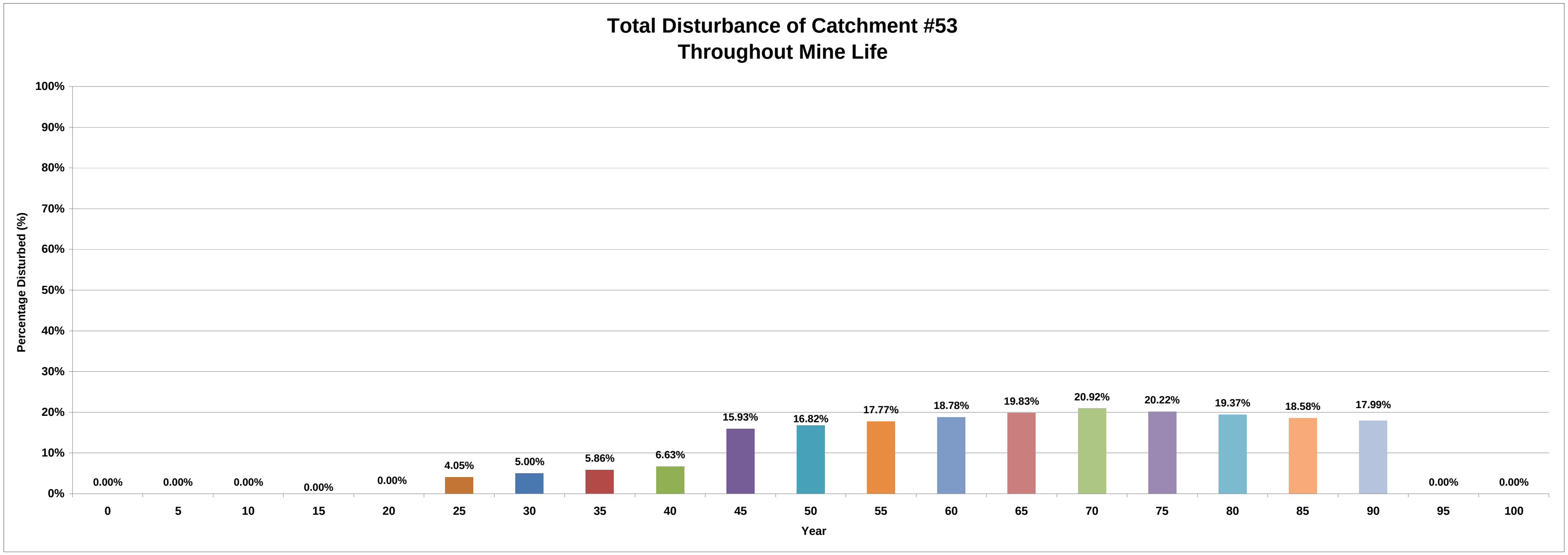
Year	Area of Catchment Disturbed by Pit (ha)	Percentage of Catchment Disturbed by Pit (%)	Area of Catchment Disturbed by Stockpiles (ha)	Percentage of Catchment Disturbed by Stockpiles (%)	Area of Stockpiles Within Catchment Reclaimed (ha)	Percentage of Stockpiles Within Catchment Reclaimed (%)	Area of Pit Within Catchment Reclaimed(ha)	Percentage of Pit Within Catchment Reclaimed(%)	Total Realized Catchment Area Disturbed (ha)	Total Realized Catchment Percentage Disturbed
0	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
5	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
10	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
15	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
20	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
25	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
30	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
35	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
40	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
45	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
50	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
55	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
60	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
65	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
70	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
75	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
80	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
85	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
90	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
95	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
100	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%



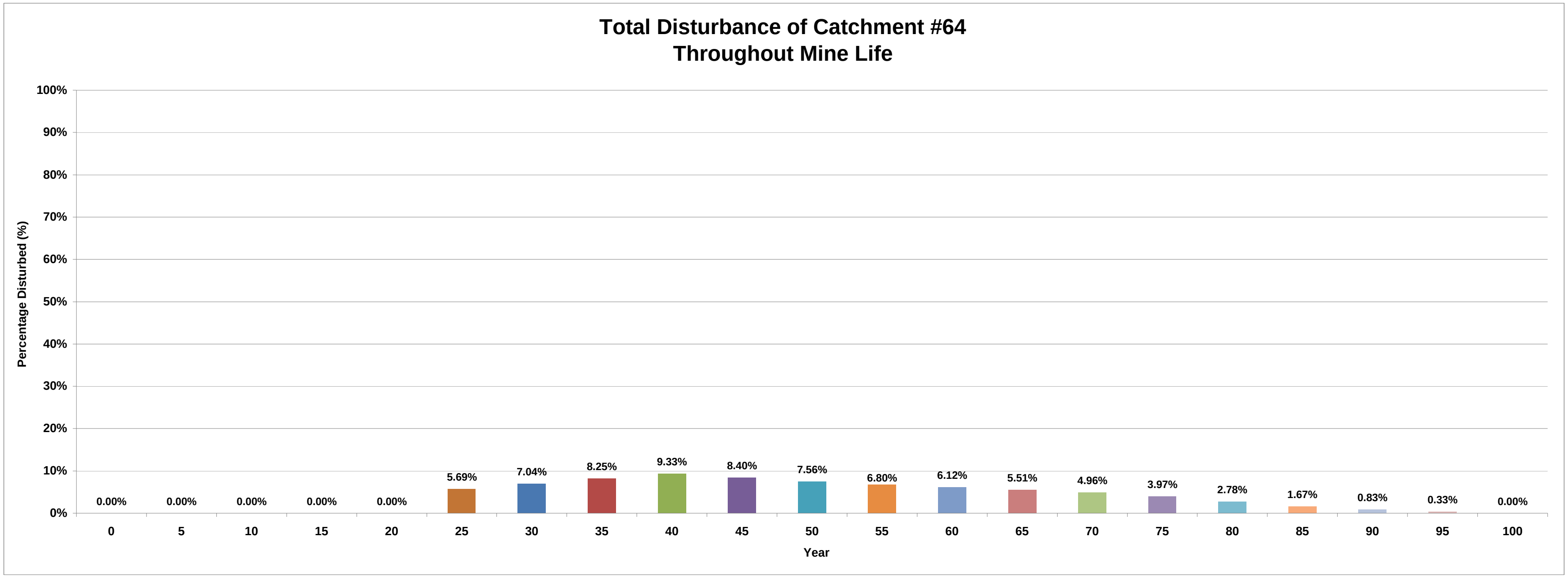
Year	Area of Catchment Disturbed by Pit (ha)	Percentage of Catchment Disturbed by Pit (%)	Area of Catchment Disturbed by Stockpiles (ha)	Percentage of Catchment Disturbed by Stockpiles (%)	Area of Stockpiles Within Catchment Reclaimed (ha)	Percentage of Stockpiles Within Catchment Reclaimed (%)	Area of Pit Within Catchment Reclaimed(ha)	Percentage of Pit Within Catchment Reclaimed(%)	Total Realized Catchment Area Disturbed (ha)	Total Realized Catchment Percentage Disturbed
0	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
5	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
10	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
15	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
20	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
25	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
30	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
35	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
40	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
45	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
50	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
55	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
60	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
65	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
70	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
75	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
80	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
85	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
90	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
95	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
100	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%



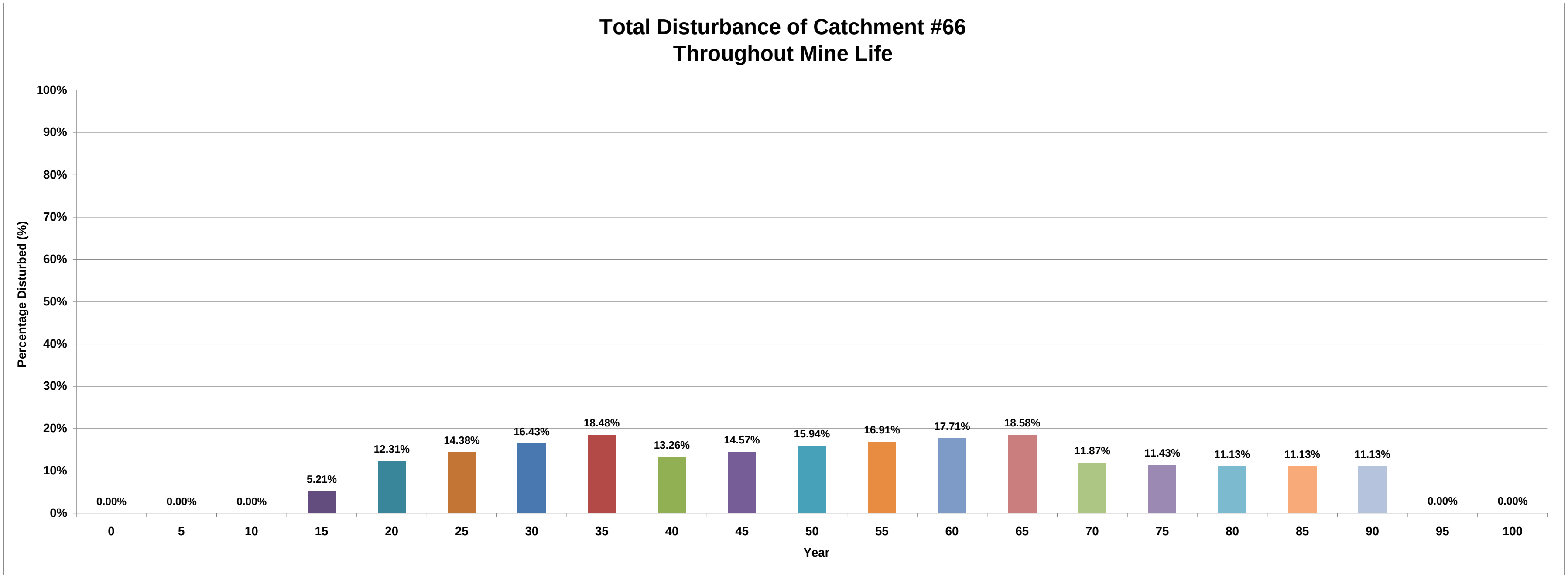
Year	Area of Catchment Disturbed by Pit (ha)	Percentage of Catchment Disturbed by Pit (%)	Area of Catchment Disturbed by Stockpiles (ha)	Percentage of Catchment Disturbed by Stockpiles (%)	Area of Stockpiles Within Catchment Reclaimed (ha)	Percentage of Stockpiles Within Catchment Reclaimed (%)	Area of Pit Within Catchment Reclaimed(ha)	Percentage of Pit Within Catchment Reclaimed(%)	Total Realized Catchment Area Disturbed (ha)	Total Realized Catchment Percentage Disturbed
0	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
5	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
10	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
15	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
20	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
25	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
30	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
35	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
40	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
45	4.91	4.69%	0.00	0.00%	0.00	N/A	0.00	N/A	4.91	4.69%
50	5.64	5.39%	0.00	0.00%	0.00	N/A	0.00	N/A	5.64	5.39%
55	6.38	6.10%	0.00	0.00%	0.00	N/A	0.00	N/A	6.38	6.10%
60	7.12	6.81%	0.00	0.00%	0.00	N/A	0.00	N/A	7.12	6.81%
65	7.86	7.52%	0.00	0.00%	0.00	N/A	0.00	N/A	7.86	7.52%
70	8.60	8.22%	0.00	0.00%	0.00	N/A	0.00	N/A	8.60	8.22%
75	8.60	8.22%	0.00	0.00%	0.00	N/A	0.00	N/A	8.60	8.22%
80	8.60	8.22%	0.00	0.00%	0.00	N/A	0.00	N/A	8.60	8.22%
85	8.60	8.22%	0.00	0.00%	0.00	N/A	0.00	N/A	8.60	8.22%
90	8.60	8.22%	0.00	0.00%	0.00	N/A	0.00	N/A	8.60	8.22%
95	8.60	8.22%	0.00	0.00%	0.00	N/A	8.60	100.00%	0.00	0.00%
100	8.60	8.22%	0.00	0.00%	0.00	N/A	8.60	100.00%	0.00	0.00%



Year	Area of Catchment Disturbed by Pit (ha)	Percentage of Catchment Disturbed by Pit (%)	Area of Catchment Disturbed by Stockpiles (ha)	Percentage of Catchment Disturbed by Stockpiles (%)	Area of Stockpiles Within Catchment Reclaimed (ha)	Percentage of Stockpiles Within Catchment Reclaimed (%)	Area of Pit Within Catchment Reclaimed(ha)	Percentage of Pit Within Catchment Reclaimed(%)	Total Realized Catchment Area Disturbed (ha)	Total Realized Catchment Percentage Disturbed
0	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
5	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
10	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
15	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
20	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
25	0.00	0.00%	6.69	4.05%	0.00	0.00%	0.00	N/A	6.69	4.05%
30	0.00	0.00%	9.18	5.55%	0.92	10.00%	0.00	N/A	8.26	5.00%
35	0.00	0.00%	11.68	7.07%	1.99	17.07%	0.00	N/A	9.69	5.86%
40	0.00	0.00%	14.17	8.58%	3.21	22.66%	0.00	N/A	10.96	6.63%
45	16.46	9.96%	14.17	8.58%	4.31	30.40%	0.00	0.00%	26.32	15.93%
50	18.92	11.45%	14.17	8.58%	5.29	37.36%	0.00	0.00%	27.80	16.82%
55	21.38	12.94%	14.17	8.58%	6.18	43.62%	0.00	0.00%	29.37	17.77%
60	23.84	14.42%	14.17	8.58%	6.98	49.26%	0.00	0.00%	31.03	18.78%
65	26.30	15.91%	14.17	8.58%	7.70	54.33%	0.00	0.00%	32.77	19.83%
70	28.76	17.40%	14.17	8.58%	8.35	58.90%	0.00	0.00%	34.58	20.92%
75	28.76	17.40%	14.17	8.58%	9.51	67.12%	0.00	0.00%	33.42	20.22%
80	28.76	17.40%	14.17	8.58%	10.91	76.98%	0.00	0.00%	32.02	19.37%
85	28.76	17.40%	14.17	8.58%	12.22	86.19%	0.00	0.00%	30.72	18.58%
90	28.76	17.40%	14.17	8.58%	13.19	93.10%	0.00	0.00%	29.74	17.99%
95	28.76	17.40%	14.17	8.58%	14.17	100.00%	28.76	100.00%	0.00	0.00%
100	28.76	17.40%	14.17	8.58%	14.17	100.00%	28.76	100.00%	0.00	0.00%



Year	Area of Catchment Disturbed by Pit (ha)	Percentage of Catchment Disturbed by Pit (%)	Area of Catchment Disturbed by Stockpiles (ha)	Percentage of Catchment Disturbed by Stockpiles (%)	Area of Stockpiles Within Catchment Reclaimed (ha)	Percentage of Stockpiles Within Catchment Reclaimed (%)	Area of Pit Within Catchment Reclaimed(ha)	Percentage of Pit Within Catchment Reclaimed(%)	Total Realized Catchment Area Disturbed (ha)	Total Realized Catchment Percentage Disturbed (%)
0	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
5	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
10	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
15	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
20	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
25	0.00	0.00%	20.22	5.69%	0.00	0.00%	0.00	N/A	20.22	5.69%
30	0.00	0.00%	27.77	7.82%	2.78	10.00%	0.00	N/A	24.99	7.04%
35	0.00	0.00%	35.31	9.94%	6.03	17.08%	0.00	N/A	29.28	8.25%
40	0.00	0.00%	42.85	12.07%	9.71	22.67%	0.00	N/A	33.14	9.33%
45	0.00	0.00%	42.85	12.07%	13.03	30.40%	0.00	N/A	29.82	8.40%
50	0.00	0.00%	42.85	12.07%	16.01	37.36%	0.00	N/A	26.84	7.56%
55	0.00	0.00%	42.85	12.07%	18.69	43.62%	0.00	N/A	24.16	6.80%
60	0.00	0.00%	42.85	12.07%	21.11	49.26%	0.00	N/A	21.74	6.12%
65	0.00	0.00%	42.85	12.07%	23.28	54.33%	0.00	N/A	19.57	5.51%
70	0.00	0.00%	42.85	12.07%	25.24	58.90%	0.00	N/A	17.61	4.96%
75	0.00	0.00%	42.85	12.07%	28.76	67.12%	0.00	N/A	14.09	3.97%
80	0.00	0.00%	42.85	12.07%	32.99	76.98%	0.00	N/A	9.86	2.78%
85	0.00	0.00%	42.85	12.07%	36.93	86.19%	0.00	N/A	5.92	1.67%
90	0.00	0.00%	42.85	12.07%	39.89	93.10%	0.00	N/A	2.96	0.83%
95	0.00	0.00%	42.85	12.07%	41.67	97.24%	0.00	N/A	1.18	0.33%
100	0.00	0.00%	42.85	12.07%	42.85	100.00%	0.00	N/A	0.00	0.00%



Year	Area of Catchment Disturbed by Pit (ha)	Percentage of Catchment Disturbed by Pit (%)	Area of Catchment Disturbed by Stockpiles (ha)	Percentage of Catchment Disturbed by Stockpiles (%)	Area of Stockpiles Within Catchment Reclaimed (ha)	Percentage of Stockpiles Within Catchment Reclaimed (%)	Area of Pit Within Catchment Reclaimed(ha)	Percentage of Pit Within Catchment Reclaimed(%)	Total Realized Catchment Area Disturbed (ha)	Total Realized Catchment Percentage Disturbed (%)
0	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
5	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
10	0.00	0.00%	0.00	0.00%	0.00	N/A	0.00	N/A	0.00	0.00%
15	11.56	2.94%	8.96	2.28%	0.00	0.00%	0.00	0.00%	20.52	5.21%
20	28.55	7.25%	22.13	5.62%	2.21	10.00%	0.00	0.00%	48.47	12.31%
25	36.24	9.21%	24.84	6.31%	4.48	18.02%	0.00	0.00%	56.60	14.38%
30	43.93	11.16%	27.55	7.00%	6.78	24.62%	0.00	0.00%	64.70	16.43%
35	51.62	13.11%	30.26	7.69%	9.13	30.17%	0.00	0.00%	72.75	18.48%
40	59.29	15.06%	32.97	8.38%	11.51	34.92%	28.55	48.15%	52.20	13.26%
45	66.60	16.92%	32.97	8.38%	13.66	41.43%	28.55	42.87%	57.36	14.57%
50	73.91	18.77%	32.97	8.38%	15.59	47.29%	28.55	38.63%	62.74	15.94%
55	81.22	20.63%	32.97	8.38%	19.07	57.83%	28.55	35.15%	66.57	16.91%
60	88.53	22.49%	32.97	8.38%	23.24	70.48%	28.55	32.25%	69.71	17.71%
65	95.84	24.35%	32.97	8.38%	27.13	82.29%	28.55	29.79%	73.13	18.58%
70	103.12	26.19%	32.97	8.38%	30.05	91.14%	59.29	57.50%	46.74	11.87%
75	103.12	26.19%	32.97	8.38%	31.80	96.46%	59.29	57.50%	44.99	11.43%
80	103.12	26.19%	32.97	8.38%	32.97	100.00%	59.29	57.50%	43.82	11.13%
85	103.12	26.19%	32.97	8.38%	32.97	100.00%	59.29	57.50%	43.82	11.13%
90	103.12	26.19%	32.97	8.38%	32.97	100.00%	59.29	57.50%	43.82	11.13%
95	103.12	26.19%	32.97	8.38%	32.97	100.00%	103.12	100.00%	0.00	0.00%
100	103.12	26.19%	32.97	8.38%	32.97	100.00%	103.12	100.00%	0.00	0.00%

Water Catchment Area Disturbances - 5 Years

Catchment Number (#)	Catchment Area (ha)	Area Catchement Disturbed by Stockpiles (ha)	Percentage Catchement Disturbed by Stockpiles (%)	Area Catchement Disturbed by Pit(ha)	Percentage Catchement Disturbed by Pit(%)
28	67.46	0	0.00%	0	**0.00%**
31	169.58	0	0.00%	0	**0.00%**
35	342.88	0	0.00%	0	**0.00%**
41	156.04	0	0.00%	0	**0.00%**
45	225.18	0	0.00%	0	**0.00%**
51	104.58	0	0.00%	0	**0.00%**
52	72.53	0	0.00%	0	**0.00%**
53	165.28	0	0.00%	0	**0.00%**
64	355.09	0	0.00%	0	**0.00%**
66	393.67	0	0.00%	0	**0.00%**

Water Catchment Area Disturbances - 10 Years

Catchment Number (#)	Catchment Area (ha)	Area Catchement Disturbed by Stockpiles (ha)	Percentage Catchement Disturbed by Stockpiles (%)	Area Catchement Disturbed by Pit(ha)	Percentage Catchement Disturbed by Pit(%)
28	67.46	0	0.00%	0	**0.00%**
31	169.58	4.72	2.78%	2.79	**1.65%**
35	342.88	0	0.00%	0	**0.00%**
41	156.04	0	0.00%	0	**0.00%**
45	225.18	0	0.00%	0	**0.00%**
51	104.58	0	0.00%	0	**0.00%**
52	72.53	0	0.00%	0	**0.00%**
53	165.28	0	0.00%	0	**0.00%**
64	355.09	0	0.00%	0	**0.00%**
66	393.67	0	0.00%	0	**0.00%**

Water Catchment Area Disturbances - 20 Years

Catchment Number (#)	Catchment Area (ha)	Area Catchement Disturbed by Stockpiles (ha)	Percentage Catchement Disturbed by Stockpiles (%)	Area Catchement Disturbed by Pit(ha)	Percentage Catchement Disturbed by Pit(%)
28	67.46	1.15	1.70%	0	**0.00%**
31	169.58	14.55	8.58%	3.76	**2.21%**
35	342.88	50.71	14.79%	0	**0.00%**
41	156.04	0	0.00%	0	**0.00%**
45	225.18	0	0.00%	0	**0.00%**
51	104.58	0	0.00%	0	**0.00%**
52	72.53	0	0.00%	0	**0.00%**
53	165.28	0	0.00%	0	**0.00%**
64	355.09	0	0.00%	0	**0.00%**
66	393.67	22.13	5.62%	28.55	**7.25%**

Water Catchment Area Disturbances - 40 Years

Catchment Number (#)	Catchment Area (ha)	Area Catchement Disturbed by Stockpiles (ha)	Percentage Catchement Disturbed by Stockpiles (%)	Area Catchement Disturbed by Pit (ha)	Percentage Catchement Disturbed by Pit (%)
28	67.46	1.15	1.70%	0	**0.00%**
31	169.58	14.55	8.58%	3.76	**2.21%**
35	342.88	50.71	14.79%	5.34	**1.56%**
41	156.04	0	0.00%	0	**0.00%**
45	225.18	0	0.00%	0	**0.00%**
51	104.58	0	0.00%	0	**0.00%**
52	72.53	0	0.00%	0	**0.00%**
53	165.28	14.17	8.58%	0	**0.00%**
64	355.09	42.85	12.07%	0	**0.00%**
66	393.67	32.97	8.38%	59.29	**15.06%**

Water Catchment Area Disturbances - Mine Life

Catchment Number (#)	Catchment Area (ha)	Area Catchement Disturbed by Stockpiles (ha)	Percentage Catchement Disturbed by Stockpiles (%)	Area Catchement Disturbed by Pit (ha)	Percentage Catchement Disturbed by Pit (%)
28	67.46	1.15	1.70%	0	**0.00%**
31	169.58	14.55	8.58%	3.76	**2.21%**
35	342.88	50.71	14.79%	5.34	**1.56%**
41	156.04	0	0.00%	0	**0.00%**
45	225.18	0	0.00%	0	**0.00%**
51	104.58	0	0.00%	8.60	**8.22%**
52	72.53	0	0.00%	5.13	**7.07%**
53	165.28	14.17	8.58%	28.76	**17.40%**
64	355.09	42.85	12.07%	0	**0.00%**
66	393.67	32.97	8.38%	103.12	**26.19%**

APPENDIX D

RELEVANT APPROVALS

NOVA SCOTIA
Natural Resources

PO Box 698
Halifax, Nova Scotia
B3J 2T9

902 424-7735 F
www.gov.ns.ca
72300-45/001 and 002

July 19, 2005

Mr. Kirk Hillman
Fundy Gypsum Company Limited
P. O. Box 400
Windsor, NS B0N 2T0

Dear Sir:

RE: NON-MINERAL REGISTRATION NOS. 001 AND 002

Enclosed please find the original of Non-Mineral Registration No. 001 and 002, which now replaces Mining Permit No. 0023 and 0024. This Registration has now been signed by the Minister and is fully in effect.

Yours truly,

R. Ratcliffe
Registrar of Mineral
and Petroleum Titles

RR/jlk

Encl.

cc Dr. D. Jones
Mr. T. Lamb
Mr. J. Donahue

NOVA SCOTIA
Natural Resources

Application No. NA
Non-Mineral Registration No. 002

Form 18 - Non-Mineral Registration

(pursuant to the *Mineral Resources Act*, S.N.S. 1990, c. 18, s. 90(2))

This Non-Mineral Registration is issued pursuant to subsection 90(2) of the *Mineral Resources Act*, and grants to Fundy Gypsum Company Limited, hereinafter called "Registrant", of Windsor, Nova Scotia, the right to carry out production of gypsum, in or upon that certain area situated at or near Miller Creek in the County of Hants as described as follows:

Claim(s)	Tract(s)	Claim Reference Map
MNO	2	21 H 1 A
GHJK LNOP Q	3	21 H 1 A
AFGH JKLO PQ	19	21 H 1 A
ABCD EFGH JKLM NOPQ	20	21 H 1 A
ABCD EFGH JKLM NOPQ	21	21 H 1 A
ABCD EFGH JKLM NOP	22	21 H 1 A
BCDE FG	23	21 H 1 A
CD	27	21 H 1 A
ABCD EFGH KLMN O	28	21 H 1 A
ABCD EFGH JKLM NOPQ	29	21 H 1 A
ABHJ Q	30	21 H 1 A

and outlined on Schedule "A" attached to and forming part of this Non-Mineral Registration, hereinafter referred to as "the lands".

1. In this Non-Mineral Registration, "Act" means the *Mineral Resources Act* and regulations as amended, or replacements thereof, and except where the context otherwise requires, words in this Non-Mineral Registration have the same meaning as in the Act.

2. The Registrant must comply with the Act, and must, during the term of this Non-Mineral Registration, work any mine upon the lands in a prudent and efficient manner.

3. The holder of a Non-Mineral Registration for gypsum must pay to the Minister any tax that is due and payable as prescribed by or under the *Gypsum Mining Income Tax Act.*

4. The Registrant must file an annual report on mining operations in Form 16 on or before March 1 in each year of this Non-Mineral Registration specifying all work performed on the area covered by this Non-Mineral Registration during the previous calendar year.

5. The Registrant must indemnify and save harmless the Province from any and all claims, demands, losses, damages, actions or other suits that may hereafter arise out of, or as a result of, any exploration, mining, milling or any other act or omission.

6. The Registrant must not assign, transfer, sublet or in any way divest itself of this Non-Mineral Registration, in whole or in part, without the prior written consent of the Minister of Natural Resources.

7. Any notice given pursuant to this Non-Mineral Registration is valid if given in accordance with Sections 15, 16 and 17 of the *Mineral Resources Regulations*, by registered mail, postage pre-paid, and addressed to the Registrant at P. O. Box 400, Windsor, NS B0N 2T0 Attention: ~~Mr. Kirk Hillman~~, and to the Department of Natural Resources, P.O. Box 698, Halifax, Nova Scotia, B3J ~~2T9~~, Attention: The Registrar. Mr. Bruce Clarisse

8 The Registrant must be registered to do business in Nova Scotia and must maintain the registration in good standing during the term of this Non-Mineral Registration.

9. The provisions of the Non-Mineral Registration are binding on the Registrant and its successors and permitted assigns.

10. The Registrant shall provide the Registrar with written notification

    (a) whenever it is anticipated that production will be suspended for longer than 60 days,

    (b) immediately following a production suspension of longer than 60 days; or

    (c) whenever the Registrant intends to resume production.

11. The Registrant must hold and maintain in good standing all approvals required by the Nova Scotia Department of Environment and Labour and all permits required under all other applicable legislation.

12. Time is of the essence in this Non-Mineral Registration.

13. If there is any inconsistency between any provisions of the Act and this Non-Mineral Registration, the Act prevails over this Non-Mineral Registration to the extent of the inconsistency.

Executed in the name of the Minister of Natural Resources on March 24, 2005, at Halifax, in the County of Halifax.

In the presence of

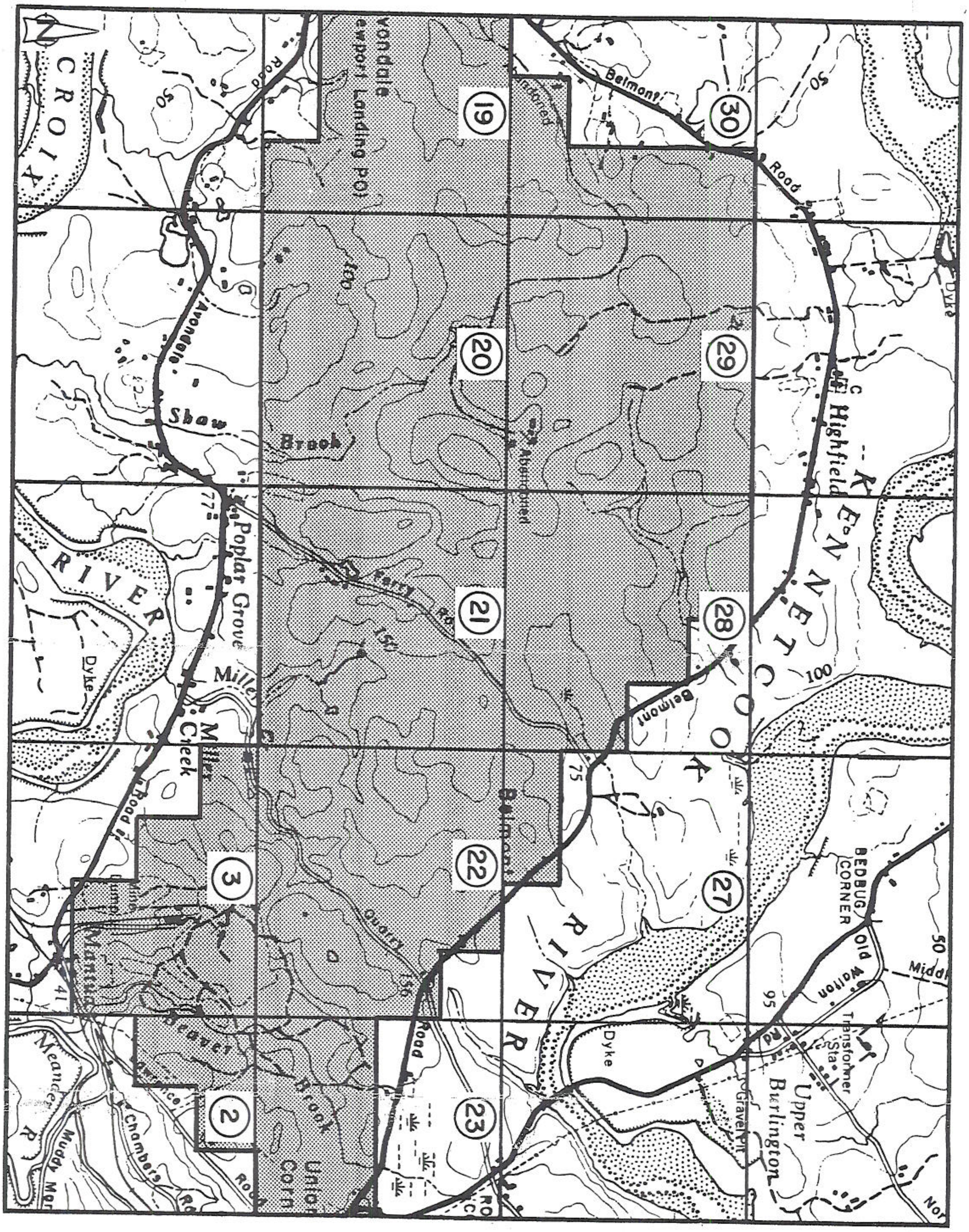
D. MacDonald

Witness | **Minister of Natural Resources**

Witness | **Registrant**

Schedule "A"
Non-Mineral Registration
No. 002

SHEET No. 21-H-1-A



Scale : $\frac{1}{31,680}$ or 2 Inches to 1 Mile

Metres 1000 500 0 1000 2000 3000 4000 Mètres

Yards 1000 500 0 1000 2000 3000 4000 Verges

NOVA SCOTIA
Natural Resources

Application No. NA
Non-Mineral Registration No. 001

Form 18 - Non-Mineral Registration

(pursuant to the *Mineral Resources Act*, S.N.S. 1990, c. 18, s. 90(2))

This Non-Mineral Registration is issued pursuant to subsection 90(2) of the *Mineral Resources Act*, and grants to Fundy Gypsum Company Limited, hereinafter called "Registrant", of Windsor, Nova Scotia, the right to carry out production of gypsum, in or upon that certain area situated at or near Wentworth Creek in the County of Hants as described as follows:

Claim(s)	Tract(s)	Claim Reference Map
JKLM NOPQ	76	21 A 16 D
JKOP Q	77	21 A 16 D
ABCF GHJK LMNO PQ	92	21 A 16 D
BCDE FGHJ KLMN OPQ	93	21 A 16 D
EMNO	94	21 A 16 D
CDEF GM	99	21 A 16 D
ABCD EFGH JMN	100	21 A 16 D
ABCD FGHJ K	101	21 A 16 D

and outlined on Schedule "A" attached to and forming part of this Non-Mineral Registration, hereinafter referred to as "the lands".

1. In this Non-Mineral Registration, "Act" means the *Mineral Resources Act* and regulations as amended, or replacements thereof, and except where the context otherwise requires, words in this Non-Mineral Registration have the same meaning as in the Act.

2. The Registrant must comply with the Act, and must, during the term of this Non-Mineral Registration, work any mine upon the lands in a prudent and efficient manner.

3. The holder of a Non-Mineral Registration for gypsum must pay to the Minister any tax that is due and payable as prescribed by or under the *Gypsum Mining Income Tax Act.*

4. The Registrant must file an annual report on mining operations in Form 16 on or before March 1 in each year of this Non-Mineral Registration specifying all work performed on the area covered by this Non-Mineral Registration during the previous calendar year.

5. The Registrant must indemnify and save harmless the Province from any and all claims, demands, losses, damages, actions or other suits that may hereafter arise out of, or as a result of, any exploration, mining, milling or any other act or omission.

6. The Registrant must not assign, transfer, sublet or in any way divest itself of this Non-Mineral Registration, in whole or in part, without the prior written consent of the Minister of Natural Resources.

7. Any notice given pursuant to this Non-Mineral Registration is valid if given in accordance with Sections 15, 16 and 17 of the *Mineral Resources Regulations*, by registered mail, postage pre-paid, and addressed to the Registrant at P. O. Box 400, Windsor, NS B0N 2T0 Attention: ~~Mr. Kirk Hillman~~, and to the Department of Natural Resources, P.O. Box 698, Halifax, Nova Scotia, B3J 2T9 Attention: The Registrar. Mr. Bruce Clarisse

8 The Registrant must be registered to do business in Nova Scotia and must maintain the registration in good standing during the term of this Non-Mineral Registration.

9. The provisions of the Non-Mineral Registration are binding on the Registrant and its successors and permitted assigns.

10. The Registrant shall provide the Registrar with written notification

    (a) whenever it is anticipated that production will be suspended for longer than 60 days,

    (b) immediately following a production suspension of longer than 60 days; or

    (c) whenever the Registrant intends to resume production.

11. The Registrant must hold and maintain in good standing all approvals required by the Nova Scotia Department of Environment and Labour and all permits required under all other applicable legislation.

12. Time is of the essence in this Non-Mineral Registration.

13. If there is any inconsistency between any provisions of the Act and this Non-Mineral Registration, the Act prevails over this Non-Mineral Registration to the extent of the inconsistency.

Executed in the name of the Minister of Natural Resources on March 24, 2005, at Halifax, in the County of Halifax.

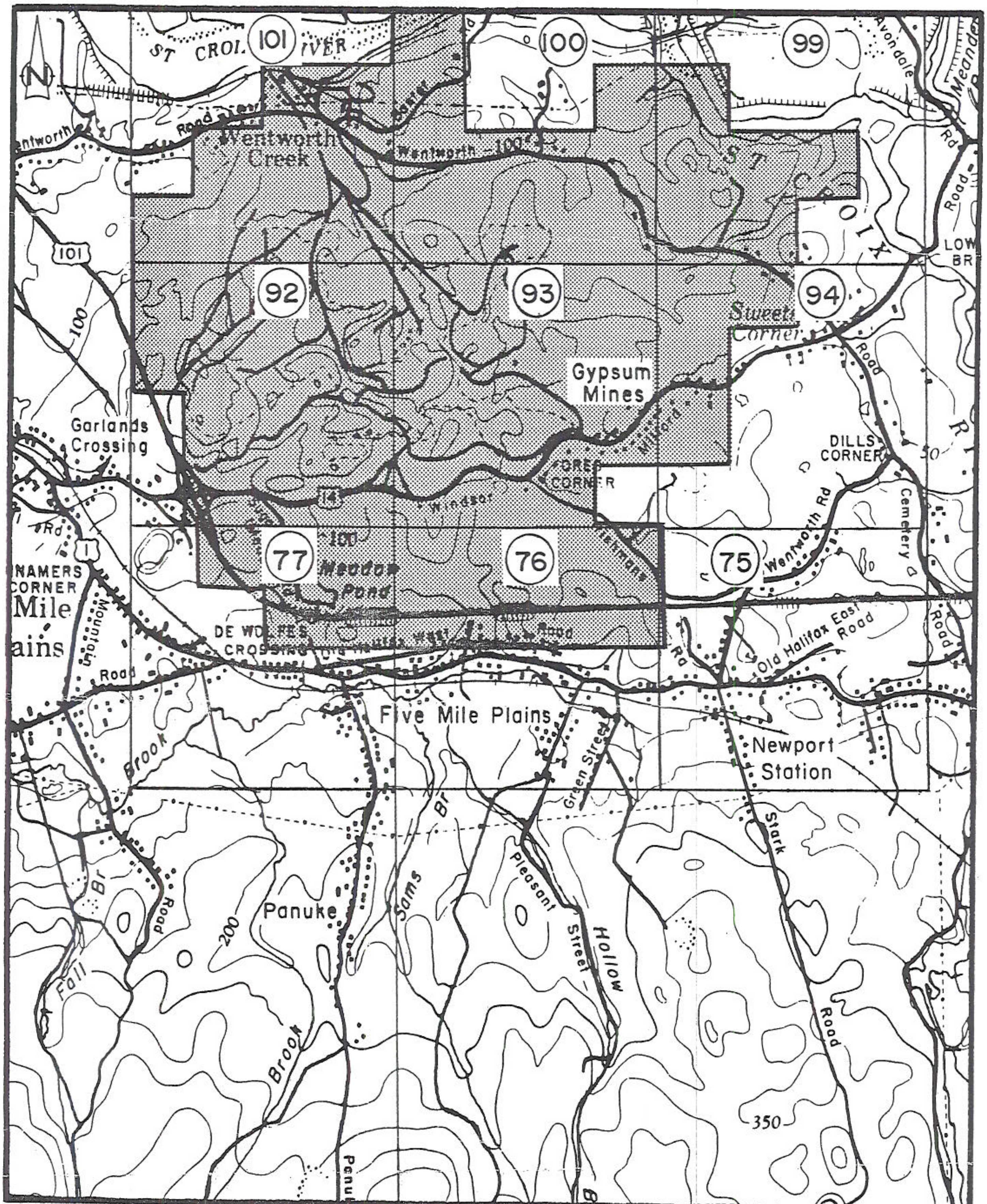
In the presence of

Witness | **Minister of Natural Resources**

Witness | **Registrant**

Schedule "A"
Non-Mineral Registration
No. 001

SHEET No. 21-A-16-D



Scale : $\frac{1}{31,680}$ or 2 Inches to 1 Mile

Metres 1000 500 0 1000 2000 3000 4000 Mètres

Yards 1000 500 0 1000 2000 3000 4000 Verges

APPENDIX E

SPECIES AT RISK
E-1 BLACK ASH (WISQOQ) DRAFT MONITORING REPORT

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1.0 SPECIES AT RISK

Nova Scotia Environment (NSE) provided CGC Inc. (CGC) with a Terms of Reference (TOR) document which outlined specific issues to be discussed in the Focus Report. The only species-at-risk (SAR) occurring on or near the proposed Project site are flora species (vascular plants and cyanolichen species). As stated in the TOR, one endangered plant listed under the *Nova Scotia Endangered Species Act* (ram's-head lady's-slipper), and six others listed under the Nova Scotia general status of wild species including two red listed species (round leaved hepatica and eastern leatherwood) and four yellow listed species (Canada buffalo-berry, thimbleweed, yellow lady slipper and black ash) all occur within the proposed development footprint. Six species of rare lichens are also found within the proposed development area. (Note: The statement in the TOR regarding six rare lichen species occurring within the proposed development area is incorrect, as only three rare lichen species (*Solorina sacatta, Collema cristatum* var. *cristatum* and *Leptogium lichenoides*) occur within the proposed Project footprint. This is discussed further in Section 3.2 Cyanolichen Species of Concern.). At least three species of vascular plants not currently listed under the *Nova Scotia Endangered Species Act* are strong candidates for legal listing and either have formal status assessments already underway (*e.g.* black ash) or impending (*e.g.* round-leaved hepatica). The TOR also requested that the focus of any development or protection plans be on the eastern portion of the site, including Wetland 12, as the proposed Project will begin on the eastern portion of the site and extend westward over time.

The Focus Report TOR document outlined specific concerns associated with species-at-risk that required further study and or information. Issues are discussed in the subsections listed below.

- Section 2 provides an assessment of the ecological significance of the Proponent's lands on the Avon Peninsula, within the provincial context.
- Section 3 provides an assessment of the proposed extent and the ecological integrity of the proposed CGC Conservation Area.
- Section 4 provides a framework for a Protection Plan to protect species at risk occurring within the proposed extraction area.
- Section 5 provides a draft Operations Management Plan for the proposed mine.
- Section 6 discusses reclamation of the proposed Project site.

- Section 7 provides outlines of research and monitoring plans for species at risk within the Conservation Area and reclaimed areas.

2.0 ECOLOGICAL SIGNIFICANCE OF THE PROJECT SITE

This section provides an assessment of the ecological significance of the Proponent's lands on the Avon Peninsula, within the provincial context. The Project site lies in an area of karst topography which provides habitat for some flora species at risk that prefer calcareous soils (*e.g.* gypsum and limestone).

Descriptions of karst topography, survey locations, and each flora species-at-risk known from the Project site within the provincial population context are provided in the following subsections. Specimen counts from other CGC properties surveyed in 2008 are provided for a few species and discussed in relation to provincial population estimates. Issues affecting population estimates and data gaps are also discussed.

While the proposed Project site is often considered to be a karst site of particular species richness and diversity, it should be noted that the proximity of this site to Acadia University may be largely responsible for the wealth of information available for this site. As systematic surveys of all karst areas in NS have not been conducted to date, it is possible that other similar areas of high species diversity exist in the Province. Calcareous areas in Pictou County in particular are poorly known, especially with respect to lichen communities.

2.1 Karst Topography

Karst topography is a type of landscape characteristic of bedrocks which are highly soluble (*e.g.* limestone) and of evaporate deposits such as gypsum and anhydrite (dehydrated gypsum). It is formed by the effects of subterranean water flow on soluble rock layers. Karst areas often display conspicuously pitted topography when the bedrock is near the surface, due to the frequent formation of sinkholes.

In Nova Scotia's Carboniferous Lowlands, karst areas are found in areas underlain by Windsor Group strata. Within Nova Scotia, there is approximately 3200 km^2 of land classified as Lower Carboniferous Windsor Group, all of which has the potential to exhibit karst topography (Figure 1). Neily *et al*. (2003) identified 11,715 ha of karst topography in the lowlands of Hants and Colchester counties alone (Figure 1).

Lower Carboniferous Windsor Group
after Boehner, et al. 2002
5.5 % of Total Province

figure 1
KARST TOPOGRAPHY POTENTIAL
CGC Inc - Windsor Plant
Hants County, Nova Scotia

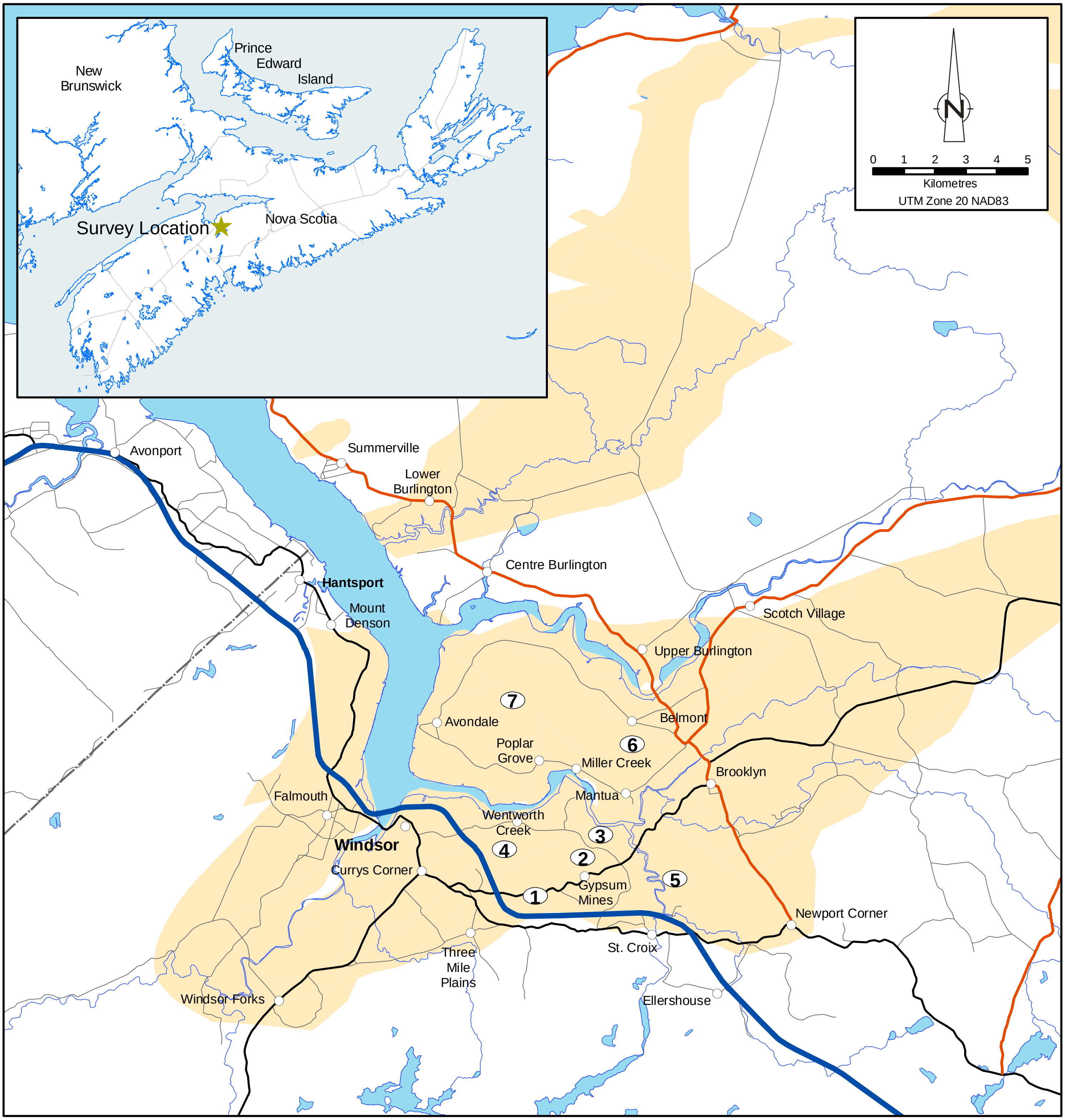
820677K(09)GIS-DA001_karst.mxd August 20, 2009

The proposed Project site will encompass a total area of 393 ha over its lifetime; gypsum extraction will occur on 155 ha. Thus, the total area to be mined over the lifetime of the proposed Project represents 0.05% of the potential karst topography known from the entire Province, and 1.5% of the known karst within Hants and Colchester counties.

Removal of gypsum via mining cannot remove the calcareous nature of an area. Once mining activities have been completed and terrain has been altered, the site will still be fully capable of supporting plant species which prefer soils with high calcium levels (calciphile species). Calciphile vascular plant species, such as yellow lady's-slipper (*Cypripedium parviflorum*) and Canada buffaloberry (*Sheperdia canadensis*), have been observed (B. Cameron, pers. obs.) to be re-established on stockpiles and previously disturbed areas, even without the benefit of progressive re-vegetation activities (discussed further in Section 6, Reclamation).

2.2 Survey Locations

To gain a better understanding of the provincial significance of the proposed Project site on yellow lady's-slipper habitat and populations, and other calciphile flora species, a desktop review and botanical surveys were conducted to provide additional abundance data. Between May 26 and July 18, 2008, CRA ecologists, geologists, and technicians surveyed eight CGC properties. Properties included the active Miller's Creek Mine site, five historically-mined properties (Meadow Pond, Eagle Swamp, Baxter Marsh, Hunter Quarry, and Major King Quarry), and one property with no evidence of historical mining activities (St. Croix). These sites are depicted on Figure 2. All of these sites have all been owned by CGC for many decades and are within ten kilometres of the proposed Project site. CGC has no current plans to mine any of these properties. Each property is described in the following subsections.



Id	Sites
1	**Meadow Pond**
2	**Eagle Swamp**
3	**Baxter Marsh & Hunter Quarry**
4	**Major King**
5	**St. Croix**
6	**Miller's Creek**
7	**Extension Site**

Karst Potential

figure 2

SURVEYED CGC PROPERTIES

CRA Survey June 2008

CGC Inc - Windsor Plant

Hants County, Nova Scotia

820677K(09)GIS-DA002_Surv_prprty.mxd August 20, 2009

2.2.1 Miller's Creek Mine

The Miller's Creek property is bordered by forested and agricultural properties along Avondale, Belmont, Lawrence and Ferry Roads (Figure 2). Much of this property has been mined by CGC, and a portion still supports mining activity. Two large settling ponds are present. Waste rock and overburden piles are also present, which were active until the late 1960s or early 1970s (Bonnie Miles-Dunn, pers. comm. 2008).

2.2.2 Proposed Miller's Creek Mine Extension Area

The proposed Miller's Creek Mine Extension site (hereafter referred to as the proposed Project site) is located on the Avon Peninsula in Hants County, Nova Scotia (Figure 2). The proposed extension of the existing surface mining operation is bound by the Avondale, Belmont and Ferry Roads**.** The Avon Peninsula is surrounded by the Kennetcook River to the north, the St. Croix River to the south and the Avon River to the west.

The proposed active surface footprint of the site is approximately 393 ha within CGC's Non-Mineral Registration Area west of Ferry Road, which contains an area of 1,042 hectares. CGC currently owns 486 ha within the Project site.

The Project site is located within topography which is generally higher than that of the surrounding areas. Salt marshes along the riverbanks give way to gently undulating plains further inland. Surface elevations across the site range from approximately 20 to 75 metres above sea level and slopes range from 1 to 3%, with some local grades of up to 10%. The site is characterized by a series of low rolling hills, with moderately incised drainages and valleys. The topography of the area has been influenced by the underlying bedrock, exhibiting karst features and numerous pits and excavations, with evidence of gypsum extraction dating back to the mid-19th century in some areas. Some sinkholes support small ponds and a former spoil area is now a pond created by a beaver dam.

The Avon Peninsula is currently occupied by approximately 34% forested stands, 6% cleared or partially cleared forest, 39% agricultural use, 10% previously mined areas, and approximately 3% urban (residential, industrial, commercial). The remaining 8% consists of wetlands/scrublands and transportation/power corridors.

2.2.3 Meadow Pond

The Meadow Pond property is located along Highway 14, north of Highway 101. Mining ceased at this property in the 1930s (Figure 2). Approximately 100 ha in size, this site is mostly forested, but has significant cleared areas and numerous trails associated with historic mining activities. Two historic mining excavations currently function as small lakes with associated wetland habitat, and CGC has entered into an agreement with Ducks Unlimited to protect these wetlands as duck habitat. Well-used walking trails are present on the site, and the lakes are popular with local fishers.

2.2.4 Eagle Swamp

The Eagle Swamp property is located directly south of the Baxter Marsh site, across Wentworth Road (Figure 2). Approximately 144 ha of this site were surveyed in 2008. The Eagle Swamp property is mostly forested, but has some cleared area due to historic quarrying and farming activities. Several gypsum cliffs and outcrops are present, and additional karst topography in the form of abundant sinkholes is present within the forested southwestern and southeastern portions of the site. A small amount of wetland habitat is present; however, it is unclear why the property is known as Eagle Swamp. Overmature apple trees (*Malus* sp.) are abundant, suggesting the land may have once been farmed. Cleared areas also show evidence of having been used as cattle pasture within the last decade. Old farming equipment and decaying hay bales are also present. With the exception of the karst areas, which have not been logged, the forest is in varying stages of regrowth. Some karst areas on this site were dominated by mature deciduous trees (American beech) and therefore were more exposed to sun at this time of year than more conifer-dominated karst areas.

2.2.5 Baxter Marsh

The Baxter Marsh property is located along the north side of Wentworth Road and covers 82 ha (Figure 2). The actual marsh after which the site is named is located along the Avon River to the east, and is not actually on the property. The topography is quite hilly, and the northern portion slopes down to the St. Croix River. Gypsum outcrops are present, particularly near the shore, and occur as pillars in some areas. Additional karst topography in the form of sinkholes is present in the southwestern portion of the site. The areas exhibiting karst topography support mature mixed forest, due to the impracticality of logging. There is some evidence of historic quarrying activities on this site. The remainder of the site is mostly forest in various stages of growth, and some cleared area fenced off for horse pasture near the centre of the site. Horses have the run of most of the site (the St. Croix River acts as the northernmost 'fence' for the animals) and well-used horse trails, with associated hoof prints and dung, are very common on this site

2.2.6 Hunter Quarry

The Hunter Quarry property is located near the Baxter Marsh property along Wentworth Road and is approximately 9 ha in area (Figure 2). It is bordered by pasture to the west, the St. Croix River to the north, and Highway 14 to the south and east. This site is mostly covered by forest of varying ages but has some area cleared and fenced for horse and cattle pasture. This site has been heavily impacted by conversion to pasture, grazing and trampling. No evidence of karst topography is apparent.

2.2.7 Major King Quarry

The Major King Quarry property is located west of the current Wentworth Quarry (Figure 2). It is bound by the active Wentworth Quarries to the south and east, Highway 101 to the west, and residential development and fields to the north. Approximately 70 ha of this site were surveyed in 2008. A portion of this site is currently being mined by CGC, with mining activities beginning in the late 1700s. The eastern portion of this site is largely disturbed as it is an active mine site, and two large settling ponds are present. Waste rock and overburden piles, which were active until the mid to late 1950s, are present (Bonnie Miles-Dunn, pers. comm. 2008). The western portion is densely forested and some karst topography in the form of sinkholes exists.

2.2.8 St Croix

The St. Croix property is located along the St. Croix River, north of Highway 101, and is 68 ha in size (Figure 2). This site is entirely forested and is bordered by the St. Croix River to the west, cattle pasture to the south, and mature forest to the east and north. The landscape is quite hilly, and karst topography in the form of abundant sinkholes is present, as are exposed gypsum cliffs along the St. Croix River. Wetlands and associated streams are also present. No evidence of historic quarrying activities was observed during field surveys in 2008.

2.3 Vascular Plant Species-at-risk at the Eight CGC Properties

In Nova Scotia, gypsum areas are usually overlain by glacial tills mixed with gypsum, resulting in soil improved in structure and permeability (Davis and Browne 1997). The soils are also less acidic because of the influence of the gypsum. For this reason, gypsum areas can support plant species not found in surrounding areas. The vegetation of gypsum areas is also influenced by the dryness of the soils. Particularly in dry areas, gypsum is a difficult substrate for plants to germinate and survive on because it typically forms a hard crust when dry, erodes quickly when wet, and is relatively low in available nutrients.

In Nova Scotia, plant species often found in gypsum karst areas include yellow lady's-slipper, eastern leatherwood (*Dirca palustris*), Canada buffaloberry and the ram's-head lady's-slipper (Zinck 1998, Munden 1997, Davis and Browne 1997). Many gypsum-loving species in Nova Scotia tend to bloom in early spring, before the soils become very dry (Davis and Browne 1997).

2.3.1 Yellow Lady's-slipper Distribution and Population

Yellow lady's-slipper (*Cypripedium parviflorum*) is a long-lived, widespread species of orchid, which is quite variable in appearance throughout its range. The yellow flowers are rather showy and are produced in spring. This species, formerly known as *C. calceoleus*, ranges from Newfoundland to British Columbia (Flora of North America, online). In Nova Scotia, yellow lady's-slippers are known to occur in the Windsor Brook area of Hants County, Kings County and in parts of Cape Breton (Zinck 1998). Two varieties of this plant occur in Nova Scotia. Zinck (1998) notes that *C. parviflorum* var. *makasin* (formerly known as var. *parviflorum*) is generally the most common form, except in the region of Sweet's Corner (a community very close to the study site), where the large variety (*C. parviflorum* var. *pubescens)* is more prevalent.

In 2002, the Nova Scotia Vascular Plant Working Group estimated the Nova Scotia population of each of the two varieties of yellow lady's-slipper present in the province to be somewhere between 3,000 and 10,000 stems (a stem is considered equivalent to one plant) (Blaney, ACCDC, pers. comm. 2007). The estimated provincial population of yellow lady's-slipper (var. *pubesecns*) appears to be very conservative.

Due to lack of population and distribution knowledge and the fact that some specimens will be removed by the proposed Project, NSDNR stated that yellow lady's-slipper is the primary flora species of concern for this Project. There is also local public concern for protection of the species. The species is yellow-listed by NSDNR. The global status of this species is G5, and its sub-national status is S3 (sensitive). Both varieties are listed globally as G5T5 (apparently secure to secure) and sub-nationally as S2 (may be at risk).

Desktop surveys conducted for this document involved consulting with local botanists (listed in personal communications section of the References section), the Nova Scotia Museum of Natural History, NSDNR, and the Atlantic Canada Conservation Data Centre, and researching historical reports of flora species of concern occurring on the target properties. Literature searches for relevant habitat and population data were also conducted. Aerial photographs of CGC properties were examined for evidence of gypsum outcrops which are potential habitat for yellow lady's-slipper. Previous surveys conducted for the Miller's Creek Mine Extension Environmental Assessment Registration Document (EARD) were also reviewed. Results of the desktop survey were used to determine the geographical focus of the field portion of this study.

When other flora species of concern were found during surveys, corresponding population data were collected on this species. The numbers of individuals and a habitat description were recorded. All locations of species at risk were recorded with a WAAS-enabled handheld GPS unit with an accuracy of 5 m (Garmin 60CSx or XL12).

Miller's Creek Quarry

One area supporting yellow lady's-slipper was observed at the Miller's Creek quarry in June 2008. This patch consisted of 83 blooming stems and 52 nonblooming stems/seedlings, for a total of 135 stems. The yellow lady's-slippers were growing on a spoil pile believed to have been last used in the 1960s (Bonnie Miles-Dunn, pers. comm. 2008). Photo 1 depicts some of the yellow lady's-slipper from this location.

Photo 1 Yellow lady's-slipper growing on spoil pile at active Miller's Creek quarry, June 2008.

The yellow lady's-slippers were growing on the southeast-facing grassy slope of a waste rock pile left over from previous mining operations. There were very few trees present. The shrub layer was sparse and included balsam fir saplings and fire cherry (*Prunus pensylvanica*). Ground vegetation included vetch (*Vici*a sp.), field horsetail (*Equisetum arvense*), balsam fir seedlings and silky dogwood (*Cornus sericea*).

Proposed Miller's Creek Mine Extension Area (Project Site)

Vascular plant surveys were conducted on this site from 2005 to 2008. The 2005 and 2006 surveys conducted for the proposed Project described yellow lady's-slipper as abundant throughout the site, but did not provide actual counts. These surveys also stated that small numbers of the small variety, *C. parviflorum* var. *makasin* (formerly *var. parviflorum*) were noted, but did not provide numbers or coordinates, although they were reported to occur near Poplar Grove. The vagueness of this data initiated ground-truthing of previously surveyed areas and discussions with the original botanist resulted in an estimated total count of over 1,700 yellow lady's-slipper plants.

To supplement the earlier surveys and to provide better population and distribution information, a resurvey of yellow lady's-slipper was undertaken on the entire Project site on June 6 and July 17, 2008.

The large variety of the small yellow lady's-slipper orchid (*Cypripedium parviflorum* var. *pubescens*) was found to be very common within the proposed Project area and appeared to be associated with previously disturbed, more open areas, particularly along trails, abandoned rail lines and old roads near areas of historic mining activities. Photo 2 depicts yellow lady's slipper growing abundantly near the centre of the Project site. The 2008 survey found a total of 7,936 stems of yellow lady's-slipper on CGC's proposed Project site. Of these, 3,502 stems were within the proposed CGC Conservation Area. A total of 651 stems occur in the planned stockpile location, while 3017 occur within the proposed extraction area. An additional 1038 stems occur within the study area, on private lands or on CGC property outside of the proposed active footprint. Additional yellow lady's-slipper (including a patch of over 600 stems south of CGC lands) are also known to exist on private properties surrounding the proposed CGC Conservation Area, however, these areas were not surveyed due to land access issues.

Photo 2. Yellow lady's-slipper (large variety) growing on old spoil pile near centre of proposed Project site.

All of the yellow lady's-slippers encountered appeared to be the large variety, *C. parviflorum* var. *pubescens.* No specimens of the small variety (var. *makasin*) were found. It should be noted that variation in appearance (due to hybridization within the species and environmental effects) does not always permit accurate identification to variety.

Meadow Pond Property

Yellow lady's-slipper was found to be abundant at the Meadow Pond site. This species was found in several locations on the site, with the majority of plants occurring along old trails and disturbed gypsum areas. A total of 932 stems of yellow lady's-slipper were counted on this site. Plants were most common along the edges of old trails and around areas of historic quarrying activities, in mixed deciduous and coniferous woods of varying ages. The majority of plants consisted of single-stemmed individuals, although two plants with more than four stems were observed. All yellow lady's-slippers observed appeared to be the larger variety (*C. parviflorum* var. *pubescens*).

Yellow lady's-slippers growing on the western portion of the site, in very exposed gypsum areas, tended to be non-blooming and very small even when in bloom, suggesting they were stunted rather than immature. They were usually found growing under small conifers (usually balsam fir) which appeared to offer some protection from desiccation due to sun and wind. This decrease in size in exposed calcareous areas has been noted before for this subspecies (Flora of North America, online).

Eagle Swamp

In 2006, a survey conducted on behalf of CGC described yellow lady's-slipper as common in several areas on CGC's Eagle Swamp property, though no actual counts were provided. In 2008, this species was found to be abundant in gypsum areas at the Eagle Swamp site. Yellow lady's-slipper occurred mainly around exposed gypsum outcrops and in areas of karst topography near the centre of the site. They tended to be found at the top and base of the gypsum cliffs in sunny locations, and around the perimeter of gypsum sinkholes in the forested karst areas. A total of 2,541 stems were detected on this site. All yellow lady's-slippers observed appeared to be the larger variety (*C. parviflorum* var. *pubescens*).

Tree species found in the vicinity of the yellow lady's-slipper included balsam fir, American beech (*Fagus grandifolia*), hemlock, and poplar (*Populus* spp.). The shrub layer was very sparse, but included Canada buffaloberry and Canada honeysuckle (*Lonicera canadensis*). Ground vegetation varied across the site but usually included common dandelion (*Taraxacum offificinale*), coltsfoot (*Tussilago farfara*), and sedges (*Carex* spp) which could not be identified due to the early timing of the survey. Round-lobed hepatica (*Hepatica nobilis*) also occurred with this species at one location.

Baxter Marsh

Surveys by CRA in June 2008 found yellow lady's-slipper to be common on the Baxter Marsh site. This species was found in four locations on the site, with the majority of plants occurring in two of these locations. Two patches were located along the St. Croix River, while a third patch was along the highway to the south, and the fourth was located in the eastern portion of the property. A total of 2,189 stems were found on this site.

The first two patches occurred near gypsum outcrops along the St. Croix River, extending inland along the northern boundary of the site. The northwestern patch was centred on an old quarry and an area of gypsum pillars, and extended northward to the St. Croix River. A total of 928 stems of yellow lady's-slipper were counted within this area. The canopy in this area was quite open (estimated average of 50% closure). Tree species included balsam fir, white spruce (*Picea glauca)*, hemlock, and apple (*Malus pumila)*. The shrub layer was somewhat sparse and included balsam fir saplings, Canada buffaloberry, and creeping juniper (*Juniperus horizontalis*). Ground vegetation included balsam fir seedlings, hawkweed (*Hieracium* sp.) and common dandelion (*Taraxacum officinale*). One area near the shore of the St. Croix River was dominated by overmature apple trees, and the ground vegetation was dominated by non-blooming grasses and sedges (*Carex* spp.) which could not be identified at that time of year.

The second area was centred on exposed gypsum occurring along the shore of the St. Croix River, and extended inland. A total of 1,245 stems of yellow lady's-slipper were counted within this area. The canopy in this area was less open than the previous patch (estimated average of 70% closure). Tree species included balsam fir, hemlock, white spruce and apple. The shrub layer was quite sparse and consisted primarily of balsam fir saplings. Ground vegetation included balsam fir seedlings, hawkweed and common dandelion.

The third, smaller patch was located in the southern portion of the site, along Wentworth Road. This patch was found in an area of karst topography which exhibited abundant sinkholes. A total of 79 single-stemmed plants were counted. The plants were growing on the rims of sinkholes, and very little other ground vegetation was present. The tree canopy was quite dense here (estimated at 85%) and was dominated by mature balsam fir and hemlock. The shrub layer was practically nonexistent, save for a single specimen of Canada buffaloberry.

Ground vegetation was also very sparse and included wild lily of the valley (*Maianthemum canadense*).

A fourth occurrence of yellow lady's-slipper was found on a south-facing slope near a small brook in the eastern portion of the site. This patch numbered 82 single-stemmed plants and occurred mostly within a large patch of ram's-head lady's-slipper (see next section for details on this species). Tree canopy was relatively dense (estimated 75%) and dominated by balsam fir, quaking aspen (*Populus tremuloides*) American beech, white spruce, and some balsam fir. Hemlock was also present. The shrub layer was sparse, and included a few balsam fir saplings. Ground vegetation included balsam fir seedlings, common dandelion, buttercup, and some non-blooming grasses and sedges. The graminoid species could not be identified due to the early timing of the survey (necessary to catch the lady's-slipper in bloom).

All of the yellow lady's-slipper plants encountered appeared to be the large variety (var. *pubescens*), in that they had relatively large flowers and paler, less twisted sepals than the smaller variety (var. *makasin*).

Major King Quarry

One patch of yellow lady's-slipper was observed at the Major King Quarry during surveys by CRA on June 3, 2008. This patch consisted of 283 stems of yellow lady's-slipper. This waste rock pile is believed to have been last used in the mid to late 1950s (Bonnie Miles-Dunn, pers. comm. 2008).

The yellow lady's-slippers were growing on the southeast-facing grassy slope of a waste rock pile left over from previous mining operations (Photo 2). Canada buffaloberry was present, as were hawkweed species and dandelions. Pole-sized balsam fir and white birch (*Betula papyrifera*) grew at the top of the slope. Larch (*Larix laricina*) saplings were also present in the area, and in some locations, the yellow lady's-slipper were growing in the shelter of the larch.

Photo 3 Yellow lady's-slipper growing on waste rock pile at Major King Quarry, June 3 2008.

St Croix

Surveys conducted in 2006 on behalf of CGC reported yellow lady's-slipper to be present at this site in two main areas, but did not provide abundance data.

A survey by CRA on June 4, 2008 found yellow lady's-slipper to be relatively uncommon at this site, despite the abundance of gypsum outcrops. A total of 307 stems of this species were found at this site. These plants were mainly found around the exposed gypsum slopes along the St. Croix River. All of the yellow lady's-slipper encountered appeared to be the large variety, *C. parviflorum* var. *pubescens.*

The canopy was approximately 60% closed at most of the yellow lady's-slipper locations. The tree layer consisted of a mixture of mature balsam fir, American beech, white spruce, hemlock, poplar and white pine (*Pinus strobus*). The shrub layer was very sparse and consisted primarily of balsam fir and hemlock saplings. The ground vegetation layer was sparse as well and included wild sarsaparilla (*Aralia nudicaulis*), speedwell (*Veronica officinalis*), yellow lady's-slipper, wood fern (*Dryopteris intermedia*), bracken fern (*Pteridium aquilinum*), balsam fir seedlings, and dwarf dogwood (*Cornus canadensis*).

Conversations with the owners of the land south of CGC's St. Croix property indicated that yellow lady's-slippers were known to be present on their property as well; however, populations estimates were not available and the property was not surveyed.

2.3.2 Ram's-head Lady's-slipper Distribution and Population

Ram's-head lady's-slipper (*Cypripedium arietinum*) is the smallest species of lady's-slipper present in Nova Scotia and the first to bloom in spring. Habitat for the ram's-head lady's-slipper is described in *Roland's Flora of Nova Scotia* (Zinck 1998) as the rough country of gypsum sinkholes, and in *Native Orchids of Nova Scotia* (Munden 1999) as in and around gypsum sinkholes in a cool shaded environment. This plant is found from Nova Scotia to Saskatchewan, south to New York and Minnesota (Flora of North America, online). In Canada, this species is listed as rare in Nova Scotia (red and S1), Ontario (S3), Quebec (S2) Manitoba (S2) and Saskatchewan (S1). This species is not protected under the federal *Species at Risk Act (SARA)*, but in October 2007 was listed as endangered under the *Nova Scotia Endangered Species Act* (NSESA). Globally, this species is listed as G3 and N3 nationally (vulnerable), due to restricted range or localness. This species is red-listed by NSDNR, meaning it is known or thought to be at risk of extirpation within the province. Ram's-head lady's-slipper is known in Nova Scotia from seven locations throughout the St. Croix to Brooklyn area in Hants County (Blaney and Mazerole 2007). An additional locality also occurs in Cumberland County (Blaney and Mazerole 2007).

Miller's Creek Mine

Additional surveys for ram's-head lady's-slipper were conducted on the Avon Peninsula in 2006 for the 2008 Environmental Assessment Registration Document. This survey found five specimens of ram's-head lady's-slipper on the existing Miller's Creek site, east of Ferry Road. These specimens were described by the surveying botanist as "sickly-looking". Location data was provided to NSDNR, and information gathered from the surveys was included in the 2007 status report prepared by Blaney and Mazerole. These specimens could not be located in 2009; however, as these species may undergo non-seasonal dormancy on occasion, the inability to relocate these plants aboveground does not necessarily indicate that they no longer exist.

Miller's Creek Mine Extension Area

Baseline surveys in 2005 and 2006 found 138 stems of ram's-head lady's-slipper within the study area encompassing CGC's proposed Project site. The majority of these were located within the proposed CGC Conservation Area; however, one patch consisting of eight specimens was on private property adjacent to CGC land and a single specimen was found along Fish Brook, north of the Project site.

In August 2008, a CRA ecologist found an additional patch of ram's-head lady's-slipper within the proposed Conservation Area, totaling 69 stems. Incidental observations in 2009 at one of the locations reported in 2006 (population four stems) resulted in a revised count of 20 stems at this location. These observations increase the total number of ram's-head lady's-slipper stems to 228 on CGC lands on the Avon Peninsula.

Eight additional ram's-head lady's-slipper specimens are known to occur on private properties on the Avon Peninsula, based on the 2006 surveys. The majority of ram's-head lady's-slipper growing on the CGC site exists as single stemmed plants (B. Cameron, pers. obs.).

Meadow Pond

In 2006, a survey conducted on behalf of CGC reported less than 200 ram's-head lady's-slipper plants at the Meadow Pond property. The 2007 Provincial Status Report on the ram's-head lady's-slipper by Blaney and Mazerole reported a minimum of 457 stems of this species at the 'Meadow Pond Site' based on surveys by at least three botanists (including CGC's data). The area considered to be the Meadow Pond site in this document included an area north of Highway 14 which is not part of CGC's Meadow Pond property.

Though not targeting ram's-head lady's-slipper at this site, a CRA ecologist found a total of 352 stems of this species during the yellow lady's-slipper surveys of the CGC Meadow Pond property on 26 and 27 May 2008. At this site, ram's-head lady's-slipper tended to occur in the same general areas as the yellow lady's-slipper, though usually not as close to exposed gypsum as the yellow lady's-slipper. Ram's-head lady's-slipper was usually found growing on slopes with very little other ground vegetation and lots of leafy debris.

The canopy was approximately 70% closed at most of the ram's-head lady's-slipper locations, and the tree layer consisted of a mixture of mature balsam fir, white spruce, hemlock and poplar, with some American beech as well. The shrub layer was very sparse and included balsam fir and hemlock saplings and some scattered beaked hazelnut (*Corylus cornuta*) and Canada honeysuckle. The ground vegetation layer was sparse and included wild sarsaparilla, speedwell, yellow lady's-slipper, wood fern, bracken fern, balsam fir seedlings, and dwarf dogwood. Yellow lady's-slipper was also often present in the general area. One small patch of ram's-head lady's-slipper was found growing within a patch of yellow clintonia (*Clintonia borealis*).

On May 25 2009, CRA ecologists surveyed the area north of Highway 14. A total of 227 stems of this species were detected. Thus, CRA ecologists found a total of 579 stems of this species in 2008 and 2009 within the area described as the Meadow Pond site in the 2007 Status Report. Within the area north of Highway 14, the canopy was over 80% closed, and the tree layer consisted of a mixture of mature balsam fir, white pine, white spruce, hemlock and poplar. The shrub layer included hawthorn (*Craetagus spp*), witch hazel (*Hammaelis virginiana*), balsam fir and hemlock saplings, and Canada honeysuckle. The ground vegetation layer was not as sparse as it was at the locations on the true Meadow Pond property, and included wild sarsaparilla, large-leaf aster (*Aster macrophyllus*), speedwell, the sedge *Carex flacca*, bracken fern, balsam fir seedlings, and dwarf dogwood. Yellow lady's-slipper was not present in the general area.

Eagle Swamp

In 2006, a survey was conducted by an independent botanist and no ram's-head lady's-slippers were found on the Eagle Swamp property. CRA ecologists did not find any ram's-head lady's-slippers on this property during surveys in 2008.

Baxter Marsh

In 2006, a survey was conducted by an independent botanist and no ram's-head lady's-slippers were found on the Baxter Marsh property. Ram's-head lady's-slippers were found on the Baxter Marsh site at three locations during the June 2008 surveys by CRA while surveying for yellow lady's-slippers. Because this is a new find, more information on the species abundance and habitat is provided in this section.

All locations were in forested areas, with one observation occurring in a grassy-forested area and the other two occurring in more typical mature forest habitat, on south-facing slopes.

The first patch discovered, numbering 15 plants (17 stems), was around a fallen conifer on a south-facing grassy slope in a mixed wood forest area. This patch contained five blooming stems of the white-flowered (*alba*) form of ram's-head lady's-slipper (Photo 3), consisting of one three-stemmed plant and two single-stemmed specimens. One stem of the typical form was in bloom and 11 non-blooming single stems were present. No seed pods from previous years were evident. Soils at this location were well-drained. The canopy here was partially closed (estimated 60%) and the trees consisted primarily of mature balsam fir and white spruce, with some apple and poplar. There was a sparse shrub layer consisting mainly of balsam fir saplings. Ground vegetation was sparse and dominated by low non-blooming grasses and sedges and common dandelion. Buttercups and speedwell (*Veronica offficinalis*) were also present. Yellow lady's-slipper was also present in the general area. Leaf litter and deadwood in the form of twigs and small branches were abundant (Photo 4). A horse path traversed the upslope edge of this patch, and piles of horse dung were present nearby.

Photo 4 White (alba) form of ram's-head lady's-slipper growing on the Baxter Marsh site. Photo dated May 28, 2008.

Photo 5 Habitat of ram's-head lady's-slipper growing on the Baxter Marsh site. Photo dated May 28, 2008.

The second patch discovered (Patch B) was found to have a total of 37 stems, 31 of which were in bloom. All were single-stemmed plants. No seed pods from previous years were evident. All of the plants in this patch were found within an area approximately 15 m by 15 m, centred in a small clearing. A well-used horse trail runs through the centre of the patch and several fallen conifers are present (Photo 5 shows the centre of Patch B). This patch is located on a slightly sloping area in an open sunny area in mixed forest. The ground in this patch was mostly moss-covered (non-sphagnum species) and well-drained. Mature balsam fir, black cherry (*Prunus serotina*) and apple trees grew on this site. The shrub layer was nonexistent, and ground vegetation was dominated by low, non-blooming graminoid species and dandelions. A few cherry (*Prunus* sp.) seedlings were present.

Photo 6 Centre of second ram's-head lady's-slipper patch on the Baxter Marsh site, June 2008.

Some ram's-head lady's-slipper stems showed evidence of herbivory in the form of missing flowers. This may be due to varying hares or the horses.

The third patch, Patch C, is located on a south-facing slope at the edge of a sunny clearing. A small stream runs through this clearing along the base of the hill. A total of 577 stems of ram's-head lady's-slippers were found at this site. Many clumps at this site were multi-stemmed, suggesting they were very mature plants or that they were growing under very favorable conditions (Photo 6). Table 1 summarizes the stem counts per plant at this location.

Photo 7 Example of multi-stemmed clump of ram's-head lady's-slippers found at Baxter Marsh.

Table 1. Number of stems per plant at ram's-head lady's-slipper Patch C at Baxter Marsh site.

Number of Stems per Plant	Number of Plants
1 stem-blooming	286
1 stem-non-blooming	84
2-stemmed blooming plants	37
3-stemmed blooming plants	18
4-stemmed blooming plants	7
5-stemmed blooming plants	5
6-stemmed blooming plants	2
7-stemmed blooming plants	2

This patch covered an area approximately 15 x 30 m along the slope. Tree canopy was relatively dense and dominated by American beech, white spruce, and some balsam fir. Hemlock was also present. Some of the ram's-head lady's-slipper plants were growing in direct sunlight, due to close proximity to the clearing at the base of the slope. The shrub layer was very sparse, and included a few balsam fir saplings. Ground vegetation included balsam fir seedlings, dandelions, buttercups, and some non-blooming grasses and sedges. The graminoid species could not be identified due to the very early timing of the survey (necessary to catch the lady's-slippers in bloom).

Photo 8View looking eastward towards Patch C, located approximately midway up the leaf-covered slope visible on the right-hand side of the photo.

Hunter Quarry

Surveys in both 2006 and 2008 noted that suitable habitat for ram's-head lady's-slipper appeared to be present, but that the site was heavily impacted by livestock. No ram's-head lady's-slipper was detected during surveys in 2006 or 2008.

Major King

The major King site is home to the location of the first report of ram's head lady's slipper. In 1954, it was reported that 'several clumps' of this species had been discovered (Erskine 1954). In June 2009, the approximate location of this early record was revisited, and the area was found to support 156 stems, including several large clumps, of this species.

St Croix

A 2006 baseline survey on the St. Croix property reported that no ram's-head lady's-slippers were observed. However, nine plants were reported in a farmer's field to the south of the property. Blaney and Mazerole's 2007 provincial status report on ram's-head lady's-slipper reported 307 stems from the general area encompassing the St. Croix property, based on data from a number of local botanists. It is unclear whether this count includes the specimens located on the Myrta Stewart Easement property, said to support 'significant numbers of ram's head lady's slipper. This property was donated by Patrick Stewart of Brooklyn in 2007 to protect this species.

However, on June 4, 2008, during a survey for yellow lady's-slipper, a CRA ecologist found ram's-head lady's-slipper to be abundant at this site. A total of 1,211 stems of this species were found in two main areas of the site. The vast majority of plants were single blooming stems. Conversations with the landowner to the south of the property indicated that, in addition to yellow lady's-slipper, ram's-head lady's-slipper were known to be present on this property as well (in locations differing from reports indicted in the EARD); however, populations estimates are not available.

The first patch of ram's head lady's-slipper was found along a west-facing slope along the eastern edge of the property. Here the canopy exhibited an average of 75% closure and consisted of mature mixed wood forest. Photo 8 depicts typical habitat at this location. Dominant trees included hemlock, balsam fir, white birch, sugar maple (*Acer saccharum*), and largetooth aspen (*Populus grandidentata*) (in that order). There was no shrub layer present. Ground vegetation was sparse (< 10%) and consisted of wild lily of the valley, bracken fern, balsam fir seedlings, Christmas fern (*Polystichum acrostichoides*), aster species (*Aster* spp.), American beech seedlings, speedwell (*Veronica officinalis*) and wood fern. In several locations, the ram's-head lady's-slipper seemed to occur preferentially in areas with some shelter, such as at the base of large trees or near fallen logs. Blooming stems consisted of 34% of the population in this area, while non-blooming stems made up 48% and 18% of the population consisted of smaller specimens, categorized as seedlings.

Photo 9. Typical habitat of ram's-head lady's-slipper on St. Croix property, June 4 2008.

The second, more extensive patch was found along the upper portion of a west-to-southwest-facing slope along the western edge of the property. Here the canopy exhibited an average of 60% closure and consisted of mature mixed wood forest which tended to have a higher deciduous component than the previous patch. Dominant trees included large-tooth poplar, sugar maple, balsam fir, hemlock, American beech and white spruce (in that order). The shrub layer was very sparse and patchy and included hemlock and white pine saplings, and red osier dogwood (*Cornus stolonifera*). The ground vegetation layer was also quite sparse and included similar species as the previous patch, although it was more diverse and also included woodland horsetail (*Equisetum sylvaticum*), buttercup (*Ranunculus sp*.), lambill (*Kalmia angustifolia*), fir and spruce seedlings, interrupted fern (*Osmunda claytoniana*), wild sarsaparilla (*Aralia nudicaulis*), an unidentified hawkweed (*Hieracium* sp.), an unidentified sedge (*Carex sp*.), northern oak fern (*Gymnocarpium dryopteris*), clasping twisted-stalk (*Streptopus amplexifolius*), a rattlesnake root species (*Prenanthes s*p.), and white ash (*Fraxinus americana*) seedlings. Fallen deadwood covered an average of 8% of the ground throughout this patch and the remainder of the ground was leaf-covered. The population here consisted of 35% blooming stems, 43% nonblooming stems and 22% seedlings. The majority (over 95%) of plants were single-stemmed.

2.3.3 Canada Buffaloberry Distribution and Population

Canada buffaloberry is a deciduous shrub which grows throughout much of the northern and cooler areas of North America (Flora of North America, online). This plant is listed globally as G5 (common globally with secure population) and nationally as N4 (secure). Sub-nationally this species is listed as S2 (may be at risk) and it is yellow-listed by NSDNR. This plant requires calcareous soils (Zinck 198, Hinds 2000) and, therefore, has a localized distribution in Nova Scotia, with abundant plants in the Windsor to Brooklyn area and some in northern Cape Breton (Zinck 1998). Canada buffaloberry is a clonal species which tends to grow in large intertwined patches. Specimens growing within such patches are difficult to differentiate, making precise counts difficult. This species grows well on poor soils and increases soil fertility in its vicinity, and therefore is often used in mine reclamation activities in western North America (Jones 1995).

Miller's Creek Mine

Canada buffalo berry was relatively common at this site, with over 87 specimens detected during the surveys by CRA on June 6 2008. Additional observation of several dozen specimens were noted in June 2009. This species was found primarily in disturbed areas, such as along old roads and on old waste piles. It has been observed to be present on waste rock piles which were disturbed as recently as 12 years ago (Bonnie Miles-Dunn, CGC, pers. comm., 2009).

Miller's Creek Mine Extension Area

In 2006 and 2007, baseline surveys conducted for CGC found Canada buffaloberry at three general areas in the central portion of the study area. This species was described as common to abundant in the centre of the study area, particularly along trails and in previously disturbed areas. No detailed population estimates were provided.

Surveys by CRA in 2008 resulted in an approximate total of 447 plants on the site. Of these, 236 are in the proposed CGC Conservation Area, while 195 are within the extension footprint. A total of 21 specimens are also known to occur within the study area, in areas which will not be impacted.

Meadow Pond

Previous surveys described Canada buffaloberry as common on the site at this time. A total of 15 specimens of Canada buffaloberry were noted during the yellow lady's-slipper surveys of the Meadow Pond site in May 2008. They tended to occur along trails in relatively sunny areas near exposed gypsum.

Eagle Swamp

Canada buffaloberry was found on the Eagle Swamp property near the exposed gypsum, along with yellow lady's-slipper, though usually not in the more shaded karst sinkhole areas. Canada buffaloberry tended to be found in areas receiving direct sunlight or light shade, usually within a few metres of exposed gypsum. A total of 56 plants were counted, many of which appeared to be relatively young plants (based on size, < 30 cm tall).

Baxter Marsh

Canada buffaloberry was found to be quite abundant at the Baxter Marsh site, particularly near exposed gypsum and along the shore. Over 472 apparent plants were counted (exact counts are difficult, as this plant tends to be clonal and to grow in large tangled patches, see Photo 9). Yellow lady's-slipper and Canada buffaloberry were almost always found growing together near exposed gypsum outcrops. Habitat is the same as that described for yellow lady's-slipper at this site, although the Canada buffaloberry tended to grow in more exposed sites with more sunlight and often provided shelter for the yellow lady's-slipper.

Photo 10. Large tangled specimens of Canada buffaloberry growing on gypsum along the shore of the St. Croix River on the Baxter Marsh property. Photo dated May 27, 2008.

Major King

Canada buffaloberry was common at the Major King site, with over 135 specimens detected during the surveys by CRA on June 2 and 3, 2008. This species was found primarily in disturbed areas, such as along old roads and on old waste piles. It was also common in exposed areas where the yellow lady's-slipper was found.

St Croix

Canada buffaloberry was not reported from the St. Croix site during baseline surveys in 2006. CRA ecologists did not observe any specimens of this species at the St. Croix property during a survey on June 4, 2008.

2.3.4 <u>Round-lobed hepatica Distribution and Population</u>

Round-lobed hepatica is a small woodland perennial which is one of the first wildflowers to bloom in spring in Nova Scotia. This species' distribution ranges from Nova Scotia to southern Manitoba (Flora of North America, online). It is listed globally as G5 (common with secure population) and in Nova Scotia as S1. NSDNR classifies this plant as a red-listed species. Habitat for this species is typically dry mixed or hardwood forest (Zinck, 1998). Round-lobed hepatica is rare in Nova Scotia with approximately ten known existing locations (Mark Elderkin, pers. comm. 2006). This species, common around 1900, has been in decline in the province for largely unknown reasons over the past several decades (Marian Munro, pers. comm., 2006). This species is known to occur on two CGC properties, which are outlined below.

Miller's Creek Mine Extension Site

In 2006, over 100 round-lobed hepatica specimens were found during baseline surveys at a location within the proposed Conservation Area.

Eagle Swamp

A CRA ecologist found seven specimens of round-lobed hepatica on the Eagle Swamp property during surveys for yellow lady's-slipper. One specimen is depicted in Photo 10. These occurred together in an area of karst sinkhole topography in mature coniferous forest on the eastern portion of the site. None of the round-lobed hepatica appeared to have bloomed in 2008, based on the lack of spent flowers and/or seed capsules. There was little other ground vegetation in the area, aside from some yellow lady's-slipper and wild lily-of-the-valley, violets (*Viola* sp.), and Christmas fern. Leaf litter and woody debris were abundant. There was no shrub layer present. The tree layer consisted mostly of balsam fir, white spruce, hemlock and American beech.

Photo 11. Round-lobed Hepatica growing on Eagle Swamp property. Photo taken June 2008.

2.3.5 Eastern Leatherwood Distribution and Population

Eastern leatherwood is a shrubby plant of rich deciduous or mixed woods and is one of the least frequent shrubs in Nova Scotia (Zinck 1998). This species is very slow growing, and in Nova Scotia occurs in calcareous areas. NSDNR notes that several additional locations in Nova Scotia have been identified recently (Mark Elderkin, pers. comm., 2006), and the species is wide-ranging elsewhere (westward to Ontario and Minnesota and south to Florida). This species is listed globally as G4 and in Nova Scotia as S1. Eastern leatherwood is also known from a several acre area of mixed hardwoods east of Milford Station and from the St. Croix Area near Newport (Zinck 1998). Eastern leatherwood is known to occur on at least one CGC property. This is outlined below

Miller's Creek Mine Extension Area

A small number of leatherwood specimens were located in 2006 during baseline surveys of the initial study area surveyed for the EARD. Of the four locations found, three are on CGC property. One of these locations, containing two plants, lies within the proposed CGC Conservation Area, while the second, which contains only a single specimen, lies adjacent to the proposed mine footprint. Aproximately 100 leatherwood specimens, ranging from small saplings to specimens with trunks five centimetres in diameter, were detected in 2006 in the northern portion of the Avon Peninsula, during surveys targeting ram's head lady's slipper. Incidental observations during stream surveys in 2009 suggest this number may be closer to 200.

The fourth location, numbering 60 plants, is located on private property adjacent to CGC lands.

2.3.6 Wood Anemone Distribution and Population

Formerly called thimbleweed by NSDNR, wood anemone (*Anemone quinqefolia*), is an early spring–blooming, perennial herbaceous plant which occurs over much of North America (Flora of North America, online). It spreads by underground rhizomes and can carpet an area, making precise counts of individual specimens difficult. It is listed globally as G5 (common with a secure population) and in Nova Scotia as S1/S2. This species is yellow-listed by NSDNR, meaning it is sensitive to human activities or natural events. Wood anemone is known from the Meander River area of Hants County, occasionally in Colchester and Pictou

Counties, and from scattered locations in northern Cape Breton (Zinck 1998). Preferred habitat for this species is in intervals and along streams along calcareous and slate ledges, shores and thickets (Zinck 1998, Hinds 2000).

Wood anemone is known to occur on at least one CGC property. This is outlined below.

Miller's Creek Mine Extension Area

One large patch of this plant, with an estimated 30 specimens, was found within the proposed CGC Conservation Area during baseline surveys conducted in 2006 for the EARD.

2.3.7 Black Ash Distribution and Population

Black ash (*Fra***x***inus nigra*) is a deciduous tree which is native to eastern North America. This small tree species prefers damp woods, low ground and swamps (Zinck 1998). Black ash's subnational rank in Nova Scotia, Manitoba, and Newfoundland is S3 (sensitive), while it is S2 (may be at risk) in Prince Edward Island. Nationally, due to large and secure populations of this species in Ontario, New Brunswick and Quebec, this plant is listed as secure. Globally this species is listed as G5, or common with secure populations. In Nova Scotia, black ash is found from Digby and central Lunenburg Counties to northern Cape Breton, and scattered throughout the northern portion of the mainland, and rare elsewhere (Zinck 1998). This species is yellow-listed by NSDNR and is of particular importance to Nova Scotia's Aboriginal communities (who refer to it as Wis'quoq) due to its use in basket weaving. Black ash is known to occur on at least one CGC property. This is outlined below.

Miller's Creek Mine Extension Area

In 2007, CRA ecologists found a single mature black ash, 24 saplings and four seedlings on the proposed Miller's Creek Mine Extension site, in several wetlands. An additional seven saplings were detected in a wetland outside of the Project footprint. Four saplings are present within the proposed Conservation Area.

2.3.8 Northern White Cedar Distribution and Population

A single specimen of northern white cedar (*Thuja occidentalis*) was discovered at the Baxter Marsh site. This specimen was quite small and was growing at the base of a large conifer on a north-facing slope (Photo 11).

Photo 12. Small specimen of northern white cedar found growing on the Baxter Marsh property, May 27, 2008.

2.3.9 Canada Violet

As discussed in the EARD, an area east of Ferry Road was identified in the NSDNR Significant Habitats Database as having historical records of a rare plant, the Canada Violet (*Viola canadensis*). This plant was listed as extirpated in Nova Scotia by NSDNR in 2003 (Mark Elderkin, pers. comm., 2007). At the request of NSDNR, botanist Tom Neil conducted surveys in 2006 on behalf of CGC, in the area of the historic Canada violet record, to determine if this species might still be present. The Canada violet or any evidence of it was not found.

2.4 Cyanolichen Species-at-Risk on the Project Site

The TOR for the proposed Miller's Creek Mine Extension Project erroneously stated, "Six species of rare lichens are also found within the proposed development footprint". Five rare lichen species have been reported from the study area surveyed for the proposed Project. Three rare lichen species (*Solorina saccata, Collema cristatum* var. *cristatum* and *Leptogium lichenoides*) occur within the proposed Project footprint. Two additional species occur outside of the proposed footprint, one species on CGC land (*L. teretiusculum*) and one species on private land (*Peltigera lepidophora*). These species will not be impacted and, therefore, are not discussed in this document

The following paragraphs discuss each cyanolichen species of concern known from the Project site within the provincial population context. Issues affecting population estimates and data gaps are also discussed.

2.4.1 *Solorina saccata* Distribution and Population

Solorina saccata is a leafy thallose cyanolichen with a circumpolar arctic and boreal distribution, which in North America ranges south to Vermont, Wisconsin, South Dakota, Alberta and British Columbia (Thomson 1984). This species' global status is listed as G4, apparently secure (NatureServe Explorer REF.) It does not have a national or subnational rank in Canada or Nova Scotia. NSDNR lists this species as red, thought to be at risk in the province due to few reports of this species. The distribution map for *S. saccat*a in Brodo *et al*. (2001) depicts this species as occurring in Nova Scotia near the New Brunswick border. NSDNR has only one record of this species in Nova Scotia (Nova Scotia Cyanolichen Status List, 2007); however, this may be due to the lack of field biologists skilled in identifying cyanolichens and the paucity of field surveys. Since the species was detected on the Avon Peninsula in 2005, it has been located in at least one other location elsewhere in Nova Scotia (Anderson, pers. comm., 2008), where the population was estimated at 10 to 15 thalli (T. Neily, pers. comm., 2009).

S. saccata was detected on the proposed Project site at four locations. One of these locations is within the CGC Conservation Area, while the other three are within the planned mine footprint. This species grows on gypsum rock or calcareous soils.

In October 2008, the *S. saccata* locations were visited and population estimates and habitat descriptions obtained. While the overlapping nature of neighbouring specimens makes precise counts very difficult, an estimated 300 individual specimens of *S. saccata* were counted on the proposed Miller's Creek Mine Extension site. Approximately 53 of these specimens occurred within the planned Project footprint, while an estimated 250 were well within the CGC Conservation Area.

Thus, the *S. saccata* specimens known from the Avon Peninsula represent the majority of the known provincial population. An estimated 16.8% of the known population will be removed over the lifetime of the proposed Project.

2.4.2 *Collema cristatum* var. *cristatum* Distribution and Population

In Canada, the lichen *Collema cristatum* var. *cristatum* is known from Ontario, Manitoba, and British Columbia (Brodo *et al*. 2001, NatureServe Canada) and is depicted in Brodo *et al.* (2001) as occurring in New Brunswick, near the Nova Scotia border. It is listed globally as G3/G5, meaning it ranges from being at moderate risk of extinction to secure (NatureServe Canada). This species is not listed by NSDNR, as it was not thought to occur in the province at the time the Cyanolichen Status List was prepared (Anderson, pers. comm., 2007).

C. cristatum var. *cristatum* was found growing on rock at three locations on the proposed Project site. One of these locations is within the CGC Conservation Area, the second is on privately-owned land, and the third is in the planned mine footprint. Each patch of *C. cristatum* was found within an approximate 1 m^2 area. This species was described by the ecologist as not uncommon at these locations. This species is not listed by NSDNR as occurring in Nova Scotia, nor are there other reported locations for this species within Nova Scotia. This species is nondescript and requires microscopy techniques for identification to species level. Further surveys will likely result in additional occurrences of this species within the Province.

Knowledge of the provincial population of this species is not available without targeted province-wide surveys by experienced lichenologists. While it is somewhat unclear what portion of the provincial population is represented by the specimens on the Avon Peninsula, it is clear that the specimens on the Avon Peninsula will not be affected by the Project and there will be no negative impact on the provincial population.

2.4.3 *Leptogium lichenoides* Distribution and Population

The genus *Leptogium* contains several tiny, inconspicuous species which are easily overlooked (Martin *et al.* 2002). Distributions for tiny *Leptogium* species have not been published and are poorly understood (Martin *et al*. 2002). Although this species is not listed by NSDNR as occurring in NS, *L. lichenoides* has been found recently in the province (Anderson, pers. com., 2007), and the distribution map for this species in Brodo *et al.* (2001) includes NS. This species has been collected in four counties in New Brunswick (New Brunswick Museum online database). The NatureServe website (www.natureserve.org) lists this species as being present in Ontario, Quebec, Manitoba and Saskatchewan, and provides a global rank of G5 (secure).

L. lichenoides was found to be quite abundant at five locations on the study site. Two of these are in the CGC Conservation Area, while two occur on privately-owned land and one is located well north of the Project footprint. Most specimens were growing on rock, while one specimen was growing on the bark of an apple tree. None will be removed or disturbed by the proposed Project. While tiny and difficult to identify, this species has been detected elsewhere in Nova Scotia recently (Anderson, pers. com., 2007), and additional surveying will likely locate new occurrences within the province.

Knowledge of the provincial population of this species is not available without targeted province-wide surveys by experienced lichenologists. While it is somewhat unclear what portion of the provincial population is represented by the specimens on the Avon Peninsula, it is clear that the specimens on the Avon Peninsula will not be affected and there will be no negative impact on the provincial population.

Cyanolichen Summary

Some plant and lichen species may be considered uncommon simply because they are difficult to identify and easily overlooked. This is particularly true for lichen species, which, relative to vascular plants, have received very little attention in Nova Scotia, historically. For example, a recent study by McMullin (2007) found 135 lichen species in 51 mature forest plots in southern Nova Scotia. Of these, 26 species (19%) were new records for Nova Scotia, while three were likely new to science, and one appears to represent a new genus. Lichen species of calcareous areas in particular, are poorly known (F. Anderson, pers. comm., 2007). Pictou County, with its significant calcareous areas, is particularly lacking in lichen species reports (Anderson, pers. comm., 2007). The low profile and little-known nature of cyanolichens, coupled with the paucity of field biologists able to identify cyanolichens in the field, has hindered the collection of detailed lichen inventories for much of the province.

Additional surveys in areas of suitable habitat will likely result in additional occurrences of the species discussed above, as well as other lichen species.

2.5 Summary of Ecological Significance of Project Site to Species-at-Risk

A detailed discussion of the provincial populations of each flora-species-at-risk, as well as information on ecological requirements of each species, is provided in the Flora Species-at-Risk report prepared for this Project and provided in Appendix E. Summaries of the ecological significance of the proposed Project site to each species-at-risk known to occur on it are provided in the following paragraphs.

Ram's-head lady's-slipper

The Project site provides habitat for several flora species-at-risk. Of these, perhaps the rarest is the ram's-head lady-slipper, which a 2007 Status Report estimated had a provincial population of >1344 stems. CRA ecologists have since found 2807 stems of this plant on five CGC properties in Hants County alone. Of these 2807 stems, 1718 represent new discoveries not considered in the 2007 status Report. Thus, the revised minimum provincial population is at least 3062 stems. Therefore, the 228 stems of this species occurring in the CGC Conservation Area represent, at the most, 7.5 % of the known provincial population of this species. Furthermore, additional field surveys elsewhere in the province will likely turn up additional occurrences of this species, and increase the provincial population estimate. While the Project site provides habitat for this species, it supports less than 10% of the known provincial population.

Round-lobed hepatica

Round-lobed hepatica, a red-listed species, occurs on the Proposed Project site. All specimens occur within the CGC Conservation Are and therefore will not be removed. In 2002, the Vascular Plant Working Group estimated that there are 1000-3000 specimens of this species in the Province (S. Blaney, ACC DC, pers. comm., 2007). As the Project site supports an estimated 100 specimens of this species, it supports at most 10% of the provincial population of this species, and most likely considerably less due to the lack of systematic surveys province-wide for this species.

Wood Anemone

Wood anemone, a yellow-listed species, occurs on the proposed Project site. All specimens occur within the CGC Conservation Are and therefore will not be removed. In 2002, the Vascular Plant Working Group estimated that there are 1000-3000 specimens of these specimens in the Province (S. Blaney, ACC DC, pers comm, 2007). As the Project site supports an estimated 30 specimens, it cannot be considered to support a significant portion of the provincial population of wood anemone.

Black Ash

Black ash is a yellow-listed species which occurs in wetlands on the Proposed Project site. In 2002, the Vascular Plant Working Group estimated that there are <1000 specimens of this species in the Province (S. Blaney, ACC DC, pers. comm., 2007). As the Project site is known to support 37 specimens of this species, it supports approximately 3.7% of the known provincial population of this species, and most likely considerably less. Of the 37 specimens, 24 will be removed over the lifetime of the Project.

Eastern Leatherwood

Eastern leatherwood, a red-listed species, occurs on the Proposed Project site, mainly within the proposed CGC Conservation Area. A total of 63 specimens occur in the study area surveyed for this project (with another 200 occurring near Fish Brook). In 2002, the Vascular Plant Working Group estimated that there are <1000 specimens of this species in the Province (S. Blaney, ACC DC, pers. comm., 2007). As the Project site supports an estimated 63 specimens of this species, it supports approximately 6.3% of the provincial population of this species, and likely less. Only a single specimen of eastern leatherwood will be removed by the Project.

Canada buffalo-berry

Canada buffalo-berry, also a yellow-listed species, occurs frequently on the proposed Project site. In 2002, the Vascular Plant Working Group estimated that there are 3000 to 10,000 or > 10,000 specimens of this species in the Province (S. Blaney, ACC DC, pers. comm., 2007). While this species may have a very localized distribution, it is often abundant where it occurs (Zinck 1997). As the Project site supports an estimated 447 specimens, it cannot be considered to support a significant portion of the provincial population of this species. None will be removed by the Project. Surveys of other CGC properties yielded an additional 550 specimens of this species. In general, this species was found with yellow lady's slipper wherever exposed gypsum occurred, with the exception of the St. Croix site, where Canada buffalo-berry was not found.

Solorina saccata

Solorina saccata is known to occur on the proposed Project site at four locations, supporting 303 specimens. At the current time only one other location is know for this species in Nova Scotia, supporting 10 to 15 specimens. Thus, the proposed Project site is significant in terms of the provincial population of this species. Distributions of cyanolichen species are poorly known in Nova Scotia, and with additional surveying, this species is likely to be discovered in additional calcareous areas of Nova Scotia. Approximately 53 specimens occur within the proposed extraction area.

Collema cristatum* var *cristatum

Collema cristatum var *cristatum* occurs at three small (<9 m^2) locations on the proposed Project site. At the present time, the Project site is significant in that it is the only known location of this species in Nova Scotia. Surveys by experienced lichenologists in calcareous areas of the Province may result in additional locations for this easily overlooked cyanolichen species. One location occurs within the proposed extraction area.

Leptogium lichenoides

Leptogium lichenoides, a cyanolichen not previously reported from Nova Scotia, was found to be quite abundant at five locations on the study site. Thus, the Project site is ecologically significant for this species. No specimens will be removed by the Project. While tiny and difficult to identify, this species has been detected elsewhere in Nova Scotia recently (Anderson, pers. com., 2007), and additional surveying will likely locate new occurrences within the province.

3.0 PROPOSED CGC CONSERVATION AREA

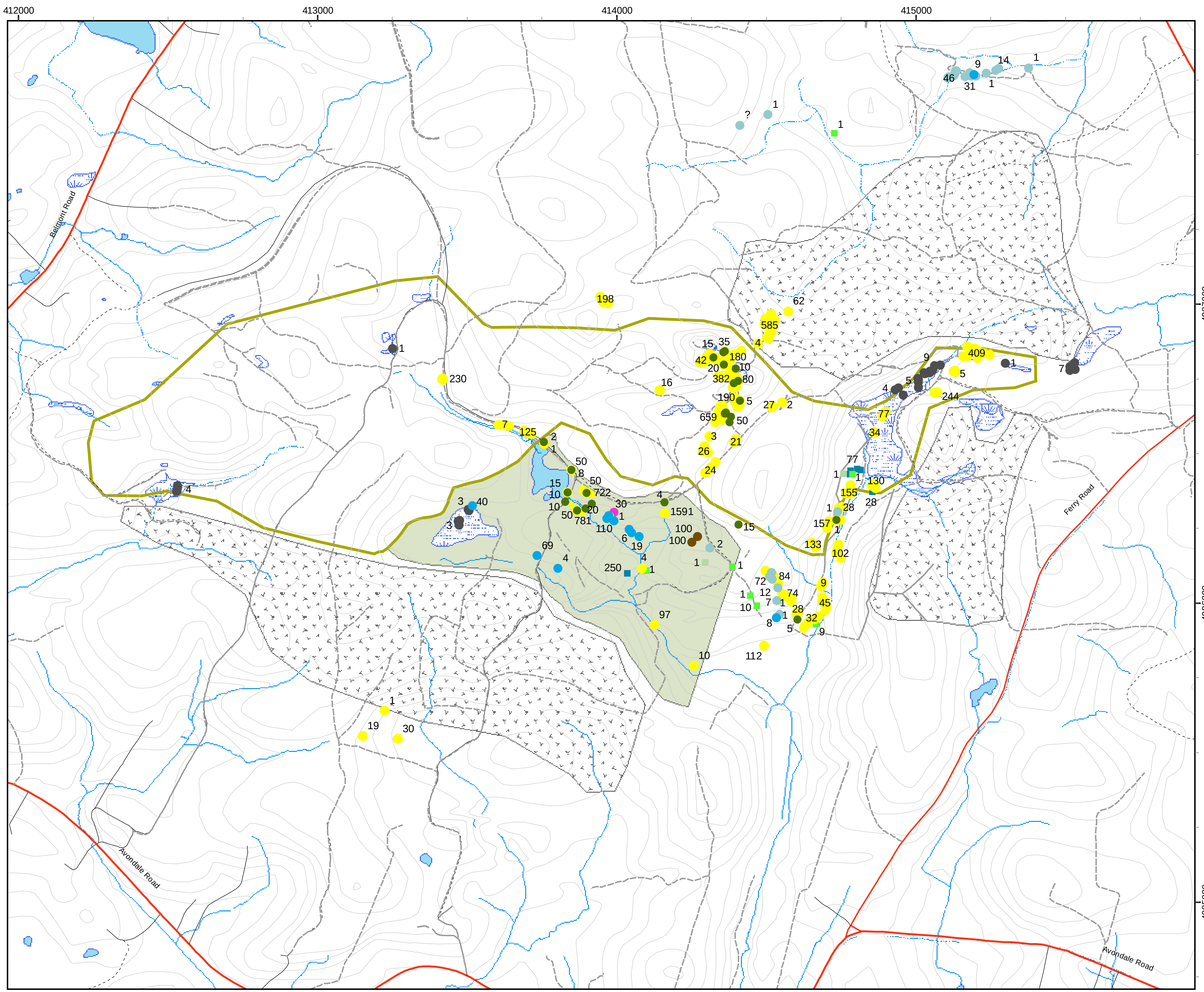
CGC is fully committed to not developing a large piece of mineable land to create a Conservation Area which will protect both the uncommon and rare species which occur in it and their habitat. CGC will also contribute to research programs on the uncommon or rare species within the Conservation Area in collaboration with experts who will provide additional knowledge of these species' habitat requirements and life cycles.

Key Aspects of CGC's commitments to the Proposed Conservation Area include:

- Setting aside approximately 46 ha of mineable land which is host to an important assemblage of provincially and locally important plant species;
- Liaise with NSDNR, local interest groups, community liaison groups, NSE and other groups identified by NSDNR;
- Determining clear boundaries that are based on ecological, legal and technically suitable considerations; and
- Conducting long-term research on plant species within the Conservation Area that is developed with academia and co-sponsored by CGC and is specifically aimed at benefiting those species by providing information on habitat requirements and plant reproduction.

3.1 Areal Extent

The proposed Conservation Area will cover a continuous area of 46 ha (Figure 3). This area encompasses the centre of the site and a small portion (1.2 ha) of the northwestern edge of the Poplar Grove Habitat of Concern, which is an area listed on NSDNR's Significant Habitats and Species database due to the presence of yellow lady's-slipper and eastern leatherwood. The proposed Conservation Area contains a cross-section of the habitat types found within the Project footprint, including wetlands, streams, mature forests, karst topography, and gypsum outcrops and cliffs. It is also known to support specimens of all the listed vascular plant species known from the Project site, and to contain additional suitable habitat for these species.



LEGEND:

Red Listed
- Round-leaved Hepatica
- Ram's-head Lady's-Slipper
- Eastern Leatherwood

Yellow Listed
- Canada Buffalo-Berry
- Small Yellow Lady's-Slipper
- Wood Anemone
- Black Ash

Lichens
- Collema cristatum
- Leptogium lichenoides
- Leptogium teretiusculum
- Peltigera lepidophora
- Solorina saccatta
- Proposed Extraction Area
- Proposed Stockpiles
- Proposed Conservation Area

SOURCE:
Basemap - Nova Scotia Topographic Database, SNS&MR
Mineral Registration - NS Natural Resources.
DPME 51 Feb 2009
Project Data - CGC Inc. & CRA

0 50 100 200 300 400 500
Metres

N

PROJECTION:	DRAWN / CHECKED BY:	MAP ANGLE:
UTM z20 NAD83	JJP /	0° North
SCALE:	**DATE:**	**PROJECT NO:**
1:12,500	August 20, 2009	820677K

820677K (09) GIS-DA003_SpeciesAR.mxd

figure 3
SPECIES-AT-RISK
Miller's Creek Extension Project
CGC Inc. - Windsor Plant
Hants County, Nova Scotia

CONESTOGA-ROVERS & ASSOCIATES

The proposed area was chosen because it represents a cross section of the rare or endangered species found in the Project area. CGC has been very open to discussing changes to the boundaries that are beneficial to rare flora and Project viability. The boundaries have been adjusted several times to minimize impacts to wetlands, streams, and flora species of concern. The proposed CGC Conservation Area boundaries are defined on the east by CGC's property line with adjacent landowners. Species of concern may cross this boundary, but CGC has no control over their current or future status. The southern boundary is controlled partly by the Shaw Brook watershed boundary and the extent of the stockpile that is being created through mine development. The north and west boundaries of the proposed Conservation Area are controlled by the mine boundaries that were chosen to provide a considerable ecological buffer around the areal extent of the ram's-head lady's-slipper. The northern boundary was also selected to follow along the alignment of the historical rail bed, which form a man-made "edge". Since the Miller's Creek Mine Extension EARD was submitted for review in 2008, the northwest boundaries of the Conservation Area have been adjusted to avoid all of Wetland 12. The adjusted boundary is depicted on Figure 3.

3.2 <u>Public Access</u>

CGC is in discussions with NSDNR over how accessible the proposed Conservation Area will be to the public. Many lady's-slipper species are at risk in other parts of their ranges due to illegal collection. There are concerns about access to the populations of ram's-head lady's-slipper and yellow lady's-slipper, as they are threatened in other parts of their range by illegal collection. The small, inconspicuous nature of the ram's-head lady's-slipper also puts specimens at risk of trampling by people visiting known locations. While yellow lady's-slipper are much more visible when in bloom, blooming plants are often accompanied by small inconspicuous seedlings which are easily overlooked and trampled. CRA ecologists observed evidence of trampling of ram's-head lady's-slipper at the Meadow Pond site in 2008.

3.3 <u>Ecological Integrity</u>

Ecological integrity is a term for which a precise definition has not been agreed upon. A widely accepted definition is that used by Parrish *et al*. (2003) who defined ecological integrity as "the ability of an ecological system to support and maintain a community of organisms that has species composition, diversity, and functional organization comparable to those of natural habitats within a region". Other sources define it simply as a measure of the condition of biodiversity in a given ecosystem, biodiversity being the variation of life forms within the ecosystem. A more detailed definition of ecological integrity is given by *www.borealforest.org* as "the quality of a natural unmanaged or managed ecosystem in which the natural ecological processes are sustained, with genetic, species and ecosystem diversity assured for the future". Generally speaking, ecological integrity is usually considered to be the ability of an ecosystem to function healthily, continue to provide natural goods and services and maintain biodiversity.

As ecosystems are very complicated, interconnected systems involving the unique biological, chemical, and physical aspects of the local environment, it is very different to quantitatively measure an ecosystem's ecological integrity. Lindenmayer and Franklin (2002) state that an ecosystem has integrity when:

- its dominant ecological characteristics (*e.g.*, elements of composition, structure, function, and ecological processes) are present within their expected natural ranges of variation; and
- the ecosystem can withstand and recover from (or is resilient to) most perturbations imposed by natural environmental dynamics or human disruptions.

The ecological integrity of the proposed Conservation Area is not predicted to be negatively affected by the proposed Project as no terrain alterations or disturbance activities will be permitted in the Conservation Area. The proposed Project will not affect habitats or species present within the proposed Conservation Area. The following subsections describe environmental habitat requirements of the listed species known to occur in the proposed Conservation Area and explain how these requirements will not be significantly affected by the proposed Project.

3.3.1 Landscape Position

The term landscape refers to the visible features of an area of land, and includes physical elements such as landforms and water bodies, living elements of flora and fauna, and more abstract elements such as exposure and weather conditions. As the position a species occupies within a landscape determines many environmental factors, this section simply provides a general overview of the typical landscape position of each species discussed in this document, while the following sections discuss specific environmental parameters required by each species in detail.

Yellow Lady's-Slipper

Of the forty to fifty lady's-slipper species in North America, the yellow lady's-slipper has the largest range and is found in the greatest diversity of habitats (Flora of North America, online). According to Case (1994) and Newcomb (1989), these include:

- northern cedar-fir fens,
- limestone barrens,
- mixed deciduous forests,
- and roadside ditches.

In addition, (Crow and Hellquist 2000) state that:

- The large variety (var. *pubescens*) is often found in dry to moist sites;
- The small variety (*C. parviflorum* var. *makasin*) is generally found in wetter habitats (Crow and Hellquist 2000); and
- The species as a whole grows both out in the open in direct sun and in forested areas in partly shaded conditions.

In Nova Scotia, yellow lady's-slippers occur on calcareous soils, often near gypsum or limestone outcrops, and occasionally in deciduous forests (Zinck 1997).

Ram's-head Lady's-slipper

Habitat descriptions for ram's-head lady's-slipper vary widely throughout its range. Brzeskiewicz (2000) summarized the three main habitat types in which the ram's-head lady's-slipper is known to inhabit:

- Cool, dense cedar-balsam fir-spruce-tamarack swamps or more open fens with the same tree species (Case 1964, Brackley 1985, Sabourin *et al*. 1999, Brzeskiewicz 2000, Newcomb 1989);

- Nearly pure sand over limestone beach cobble or bedrock, mulched with the needles of coniferous trees, such as pine, cedar or juniper (Case 1964, Brzeskiewicz 2000); and

- Mesic soil of sandy loam, or clay under the partial shade of mixed hardwood/conifer forest (Brower 1977, Sabourin *et al*. 1999, Brzeskiewicz 2000, Newcomb 1989), sometimes in thin soils over limestone or gypsum bedrock (Whiting and Catling 1986, Roland and Smith 1969).

This third habitat best describes the majority of observed habitat for this species in Nova Scotia. When found in drier upland areas, the species is often reported to favor moderate slopes or ledges on slopes (Rousseau 1974, Bouchard *et al*. 1983, Brackley 1985, Ostlie 1990), and sometimes occurs near water (Sabourin *et al*. 1999, Atwood 1984). The age of forest stands where populations occur is varied, but ram's-head lady's-slipper appears to prefer second growth, mid-succession forests formed from old disturbance such as wind throw or fire (Brzeskiewicz 2000). It can also occupy areas such as ice-scoured shores (Atwood 1984), wind-blown ledges, lake bluffs and abandoned pastures (Fleming 2000).

In the southern portion of its range, ram's-head lady's-slipper is found on cool, north facing bluffs (Penskar and Higman 1999, Brzeskiewicz 2000). In the CGC Conservation Area, it was usually found on north or west-facing wooded slopes (B. Cameron, pers. obs.). While this species usually occurs in wooded areas, it has also been shown that the average plant size and the percentage of sexually reproductive individuals are higher in habitats of lower percent canopy cover (Fleming 2000, cited in Blaney and Mazerole 2007). Populations of ram's-head lady's-slipper on CGC sites have generally followed this trend (B. Cameron, pers. obs.).

In Nova Scotia, ram's-head lady's-slipper is known primarily from the "rough country of gypsum sinkholes" (Munden 1997). While this species generally occurs in wooded areas in the vicinity of gypsum outcrops, it usually occurs further away from the exposed gypsum than does yellow lady's-slipper, and only rarely in the immediate vicinity of sinkholes (B. Cameron, pers obs.).

Eastern Leatherwood

Eastern leatherwood is found almost exclusively in mesic, relatively rich, mature hardwood forests or mixed conifer-hardwood forests (Fernald 1950, Newcomb 1989, Zinck 1998). Cooperrider (1995) (cited in Woarn and Horn 1998) described the habitat in Ohio as extending from rich mesic forests to dry uplands. This species has been observed growing primarily under closed forest canopy conditions (Ward and Horn 1998). Eastern leatherwood is usually associated with calcareous soils in Nova Scotia (Zinck 1998).

Round-lobed Hepatica

Round-lobed hepatica grows in forested areas, in association with both conifers and deciduous trees (Flora of North America, Newcomb 1989, Zinck 1998)**.** It tends to grow in shady wooded areas with little other ground vegetation and dry acidic soils, though it can also grow in more open areas with taller ground vegetation to shade it during the summer months (B. Cameron, pers. obs.). Slattery *et al.* (2003) state that this species prefers partly shady to shady conditions.

A closely related species, sharp-lobed hepatica (*H. acutiloba,* syn. *Anemone acutiloba)*, is noted for its tolerance of alkaline limestone-derived soils. Flora of North America (online) notes that round-lobed hepatica occurs in habitats similar to those of sharp-lobed hepatica, but usually in drier sites with more acidic soils.

Canada Buffaloberry

In Nova Scotia, Canada buffaloberry grows on calcareous soils, such as gypsum or talus slopes and along the coast within reach of salt spray (Zinck 1998). It may have a very localized distribution, but it is usually abundant where found (Zinck 1998, Hinds 2000). In Nova Scotia it has been observed to be not uncommon on gypsum outcrops, waste rock piles and slopes (B. Cameron, pers. obs.). This species prefers direct sunlight or light shade (Ladybird Johnston Native Plant Database).

Wood anemone

Wood anemone prefers moist, open woods, thickets, clearings, streamsides, and occasionally swampy areas (Flora of North America, online). This species is found in moist woods (Newcomb 1989), in shaded or partly shaded conditions (Lady Bird Johnston Native Plant Database, online, Phillips and Rix 1991). Within its range, wood anemone occur at elevations from 30-1900 metres above sea level (Flora of North America, online). Preferred habitat for this species in Nova Scotia is described as intervales, streams with calcareous and slate ledges, shores and thickets (Zinck 1998).

Black Ash

Black ash is a small tree which grows in shaded to partly shaded locations, in the shade of taller forest trees (Anderson and Nesom 2007). It is a shade-intolerant pioneer species. Crow and Hellquist (2000) state this species is found in swamps and shores. Black ash sometimes occurs in pure stands, especially on wetter upland sites, but usually occurs mixed with northern white cedar, tamarack (*Larix laricina*), black spruce (*Picea mariana*), balsam fir, American elm (*Ulmus americana*), red maple (*Acer rubrum*), and silver maple (*Acer saccaharinum*) (Anderson and Nesom 2007). It may become established in even-aged pockets or stands following some kind of disturbance (Anderson and Nesom 2007).

Solorina saccata

The cyanolichen *Solorina saccata* is said to grow on calcareous soil or rock and in moist areas on tundra (Nearing 1947, Brodo *et al.* 2001). Thomson (1984) states that *S. saccata* grows best in very moist places, such as in spray from waterfalls; in moist microhabitats, such as hummock sides; sides of animal burrows; seepages; and moist, shaded cliff sides. On the proposed Project site, *S. saccata* occurs primarily in shady conditions (B. Cameron, pers. obs.). The *S. saccata* specimens known from the site do not appear to prefer any particular compass point (B. Cameron, pers. obs.).

Collema cristatum* var. *cristatum

Habitat for *Collema cristatum* var. *cristatum* is usually bare calcareous rock, but it may also occur on limy soil or among mosses (Brodo *et al*. 2001). Degelius (1954) states this species is mainly saxicolous (living on rock) but is practically restricted to calciferous rocks which are periodically wetted. It may also occur on periodically wet soil, especially var. *cristatum*, sometimes bare soil (even fine sand and gypsum), but usually among other plants (Degelius 1954). Occasionally, it has been found on lignum and bark. Degelius (1954) states that *Collema cristatum* prefers rather sunny exposures. Field observations of *C. cristatum* on the proposed Project site support this statement. This species is not reported to prefer any particular compass direction.

Leptogium lichenoides

Brodo *et al.* (2001) lists the habitat for *L. lichenoides* as mossy calcareous rock. This species usually grows on calcareous rocks, generally among mosses or, rarely, on the bases of trees having basic bark (Brodo *et al.* 2001, Sierk 1964). Nearing (1947) states this species is more tolerant of exposed conditions than are other *Leptogium* species. Field observations on the proposed Project site indicate that this species can tolerate direct sun for at least a few hours a day. *L. lichenoides* is not reported to prefer any particular compass direction.

Summary

The proposed Project will not result in changes in landscape position for any species or habitats in the CGC Conservation Area because no logging, clearcutting or road development activities which might affect exposure, elevation, or topographical position of the rare species will occur within the CGC Conservation Area. A small exception is the creation of a few hundred metres of forest edge to be created along the northern boundary, which may have an effect on habitats within this area. Edge effects are discussed in the following section.

3.3.2 Proximity to Forest Edges/Exposure

Along boundaries where two differing habitats meet, a band of habitat (called an ecotone) showing a mixture of characteristics from the two adjacent habitats occurs. Ecotones occur naturally near abrupt boundaries due to changes in soil types, topography, geomorphology (such as rock outcrops) and microclimates, and harbour more species than core areas of ecosystems (Schilthuizen 2000). Ecotones may also be of unnatural origin, such as those between forests and cleared areas created by logging and development activities. Such anthropogenic ecotones are generally referred to as 'edges' and have been the focus of much research.

A large volume of work has been published describing the environmental and biotic dynamics at forest edges (Alverson *et al*. 1988; Andren 1995; Murcia 1995; Sekgororoane and Dilworth 1995; Didham *et al*. 1996). Much research has documented microclimate and vegetation contrasts within forest edges (Kapos 1989; Williams-Linera 1990; Brothers and Spingarn 1991; Chen *et al.* 1992; Matlack 1993). Air temperature, air moisture, vapour pressure deficit (VPD), soil temperature, soil moisture and light intensity are parameters shown to vary between the edge and the interior in some forest fragments (Matlack 1993). In the eastern USA, Matlack (1993) found significant edge effects in light, temperature, litter moisture, vapour pressure deficit, humidity, and shrub cover, and that the majority of these effects disappeared within 50 metres of the edge. In addition, variables which were dependent on direct sun exposure (vapour pressure deficit, temperature, and litter moisture) showed no edge-oriented gradients across north-facing edges.

Predicting the extent and direction of edge effects on local biota; however, is seriously hampered by the wide range of habitats, aspects, climates, geographic locations, definitions of edges, and study designs utilized by such studies (Murcia 1995). Additional difficulties in discerning edge effects arise from the fact that each one of several environmental factors may change within a unique edge zone. Edge effects vary within landscapes and among forest types (Wales 1967; Kapos 1989; Chen e*t al*. 1992). In addition, ecotones and edges are dynamic entities possessing both spatial and temporal properties, thus edge effects differ with disturbance regime and successional state of the two interacting habitats (Whitney and Runkle 1981; Palik and Murphy 1990; Williams-Linera 1990; Matlack 1993). The widths and positions of edges also change over time due to succession or environmental changes on both local and global scales (Wiens *et al.* 1985; Forman 1995).

The distributions of the flora species at risk known to occur in the CGC Conservation Area with respect to edge-type environments are discussed in the following paragraphs.

Yellow lady's-slipper

Of all the lady's-slipper species in North America, the yellow lady's-slipper is found in the greatest diversity of habitats (Flora of North America, online). This topic is discussed further in the Landscape Position section. The species as a whole grows both out in the open in direct sun and in forested areas in partly shaded conditions (Flora of North America, online). On the Proposed Project site, yellow lady's-slipper occurs in greater numbers in previously disturbed areas and edge-type habitats, such as along trails and around old waste rock piles.

Ram's-head lady's-slipper

Ram's-head lady's-slipper is known to occur along edges such as ice-scoured shores (Atwood 1984), wind-blown ledges, lake bluffs and abandoned pastures (Fleming 2000). Thus, ram's-head lady's-slipper does not appear to be negatively affected by edges. Evidence for this statement comes from the fact that ram's-head lady's-slipper in the CGC Conservation Area currently exists within 5 m of an old road. It is also known to occur within 20 m of agricultural fields on one CGC property, and within 50 m of an old road on another CGC property, where it has been known to occur for over 50 years. This location is also within 150 m of an area that has been significantly disturbed (devegetated) by historic mining activities. Thus ram's-head lady's-slipper appears tolerant of varying degrees of edge habitat.

Eastern leatherwood

Eastern leatherwood has been observed growing primarily under closed forest canopy conditions (Ward and Horn 1998). Thus, eastern leatherwood appears to be a species that prefers rather shaded conditions, and could potentially suffer if it became too exposed. This species appears tolerant of some exposure, as a large patch along Fish Brook is growing in the floodplain, where it is more exposed than it would be in a mature forest area.

Round-lobed hepatica

Round-lobed hepatica tends to grow in shady wooded areas; though it can also grow in more open areas with taller ground vegetation to shade it during the summer months (B. Cameron, pers. obs.). There is no published information available regarding the response of this species to edge-type environments, though, Slattery et al. (2003) state that this species prefers partly shady to shady conditions, which often occur at edges. In Nova Scotia, round-lobed hepatica has been observed to grow at the southern edge of forested areas adjacent to rivers (B. Cameron, pers obs). Thus, this species appears tolerant of edge-type environments in Nova Scotia.

Canada buffalo-berry

Canada buffalo-berry naturally occurs along edges, such as gypsum or talus slopes and along coasts within reach of salt spray (Zinck 1998). It prefers direct sunlight or light shade (Ladybird Johnson Native Plant database), and so is tolerant of high levels of exposure. On the Proposed Project site, Canada buffalo-berry occurs primarily in previously disturbed partly exposed areas, such as along trails and around old waste rock piles.

Wood anemone

Among other habitats, wood anemone is said to occur in clearings and streamsides, (Flora of North America, online) in shaded or partly shaded conditions (Newcomb 1989). Clearings exhibit many of the same characteristics as edges (increased temperature and sun exposure, reduced humidity) and thus this species is likely tolerant of many of the environmental effects associated with edges.

Black ash

Black ash is a shade-intolerant pioneer species that often colonizes disturbed areas (Anderson and Nesom 2007). Therefore, it is tolerant of high levels of exposure and will likely thrive in edge habitats.

Solorina saccata

S. saccata prefers shaded areas, with high humidity. On the proposed Project site, S. saccata occurs primarily in shady conditions (B. Cameron, pers. obs.). The specimens known from the site do not appear to prefer any particular compass direction (B. Cameron, pers. obs.). As this species requires shade, it is likely intolerant of east, west, or south-facing exposures, which could increase desiccation rates. This species may occur in edge habitats, provided they are well-shaded and protected from desiccation.

Collema cristatum* var. *cristatum

Collema cristatum var. *cristatum* has been said to prefer rather sunny exposures (Degelius 1954). Field observations of *C. cristatum* on the proposed Project site support this statement, as it occurs in rather open, exposed areas. This species is not reported to prefer any particular compass direction. *C. cristatum* can likely tolerate edge-type habitat, as it occurs in more exposed areas on the Project site than the other cyanolichen species-at-risk do.

Leptogium lichenoides

Leptogium lichenoides is likely somewhat tolerant of edge-type habitats. Nearing (1947) stated this species is more tolerant of exposed conditions than are other *Leptogium species*. Field observations on the proposed Project site indicate that this species can tolerate direct sun for at least a few hours a day. Therefore, it is likely tolerant of edge-type habitats, particularly north-facing edges which would receive the lowest amount of direct sun exposure.

Summary

The proposed CGC Conservation Area has been heavily impacted historically by quarrying, logging, and road development activities. There is approximately 1,200 m of 'hard' edge currently existing within the CGC Conservation Area due to logging activities in the past decade. Over 3,800 m of additional edge-type habitat occurs in the CGC Conservation Area due to mapped old roads and trails alone. These edges along old roads may be considered 'soft' edges, as they are narrow and not as abrupt as an edge between a forest and a large cleared area. Consequently, they do not have as much of an impact on the interior forest conditions, and do not act as barriers to wild fauna or flora.

The proposed mine footprint will result in the creation of approximately 300 m of new edge habitat within the CGC Conservation Area over the life of the project. This will occur once the extraction activities reach the northwestern edge of the CGC Conservation Area. The majority of this new edge will face northwards. In terms of aspect, north-facing edges have the least influence on forest habitats, as Matlock (1993) found that variables that were dependent on direct sun exposure (e.g., vapour pressure deficit, temperature, and litter moisture) showed no edge-oriented gradients along north-facing edges at sites in northeastern USA.

Aside from the 300 m-long edge, the next closest distance to the CGC Conservation Area from the proposed extraction area outline is approximately 40 m. This section is only about 100 m long, and will be located along the northern edge of the CGC Conservation Area. Matlock (1993) showed that many of the environmental effects of edges in forests disappear within 50 m of the edge in studies in eastern USA. Thus, there will be only minimal adverse effects of this edge along the northern boundary of the CGC Conservation Area.

While the project will result in the creation of a small amount of new edge habitat, this will be countered by the natural revegetation of the existing old roads on the site. As these roads are blocked to vehicular traffic, native shrubs and trees will colonize these areas, and the amount of edge habitat within the CGC Conservation Area will decrease. The impacts of edges are known to decrease over time, as the shrub layer at the edge becomes more complex (Murcia 1995). The proposed project will not result in a significant increase in edge habitat within the CGC Conservation Area.

All of the vascular plant species-at-risk and two of the lichen species-at-risk occurring within the CGC Conservation Area are able to tolerate edge-type habitats of some type. The one species which is potentially negatively affected by edges, the lichen *Solorina saccata*, is not located near the new edge habitat to be created, and so will not be affected by the proposed Project. Thus, the creation of a small amount of new edge habitat in the CGC Conservation Area will not adversely affect any of these species.

3.3.3 Climate

Climate is a major factor in determining where a species can survive. The climate of a location is affected by its latitude, terrain, altitude, persistent ice or snow cover, as well as nearby oceans and their currents. Climates can be classified using parameters such as temperature and rainfall to define specific climate types. The most commonly used classification scheme is the one originally developed by Wladimir Köppen, based on the concept that native vegetation is the best expression of climate (Peel *et al*. 2007). According to the Köppen classification system, the proposed Project site is classified as *Dfb*; this indicates that it lies within the warm summer subgroup (*b*) of the humid continental climate zone (*Df*). The humid continental zone is marked by variable weather patterns and a large seasonal temperature variance. It is found over large areas of landmasses in the temperate regions of the mid-latitudes where there is a zone of conflict between polar and tropical air masses. In North

America, the *Dfb* climate zone follows the US-Canada border from eastern Canada to the southern Prairies (Peel *et al*. 2007).

All of the species present within the CGC Conservation Area are tolerant of the environmental conditions defined by the humid continental climate zone, as they occur naturally within this geographic area. The proposed Project will not affect local climate in the region encompassing the CGC Conservation Area because the project will not impact local temperate or precipitation trends. Nor will it affect the Project site's latitude, altitude, or proximity to the Bay of Fundy.

3.3.4 <u>Soil Moisture</u>

Soil moisture is the water that is held in the spaces between soil particles. Surface soil moisture is the water that is in the upper 10 cm of soil, whereas root zone soil moisture is the water that is available to plants, which is generally considered to be in the upper 200 cm of soil. Soil moisture is of fundamental importance to many hydrological, biological and biogeochemical processes. Soils may receive moisture via precipitation, humidity, runoff, and surface and ground water inputs. Water is lost from soils via drainage, evaporation into drier air, and by evapotranspiration from plants.

Soil moisture is derived primarily from precipitation such as rain and snow. When precipitation falls onto the ground's surface, it either infiltrates the soil layer to become soil moisture; or, depending on local topography, soil permeability and moisture levels, runs off over the surface of the soil (surface water). When water infiltrates the soil, it continues to move downward until it reaches a less permeable layer. At this layer, water known as groundwater will accumulate, as the rate of passage through the soil layer decreases. At this level, the soil is 100% saturated. The top of this level is known as the water table. Depth to the water table varies depending on local climate, topography, and soil permeability. Groundwater returns to the surface via springs, and may recharge surface water courses and wetlands. Water in the soil layers above the groundwater table is referred to as soil moisture.

Plant species which live in groundwater-fed wetlands or watercourse may be very reliant on groundwater sources for their water supply. Plants which live in drier upland sites are disconnected from true groundwater sources, as the depth to the water table generally increases in areas with raised topography. Plant communities on sloped sites, particularly in lower slope topographic positions, obtain their water from soil moisture, primarily subsurface soil seepage over less permeable soil horizons. Such subsurface moisture is only recently derived from precipitation, and is not considered to be groundwater, as this water has not yet reached the water table or come from an aquifer.

Soil moisture is essential for the transport of nutrients to and from plants. This transport occurs laterally within the soil and vertically within the plant. Without sufficient moisture, plants cannot photosynthesize and grow. With too much soil moisture, plant roots may drown, leading to the death of the plant. Every species of plant has a range of moisture levels which it can tolerate, and this tolerance range determines where in the landscape a species can survive.

Soil moisture requirements of the listed species of vascular plants occurring within the CGC Conservation Area are discussed in the following paragraphs. Many of these soil moisture requirements have been obtained from the United States Fish and Wildlife Service (USFWS) document entitled "National List of Vascular Plant Species that Occur in Wetlands: 1996 National Summary", which ranks all species of vascular plants in North America on their likelihood of occurring in wetlands.

Lichens are not discussed in this section because precipitation and humidity provide their water supply and they do not utilize soil moisture.

Yellow Lady's-slipper

Yellow lady's-slipper is tolerant of a wide range of soil moisture levels, occurring in exposed, sunny, dry sites as well as in wet woods and bogs (Flora of North America, online). The species as a whole, *Cypripedium parviflorum,* is said to prefer moist soils (Flora of North America). It is classified as a facultative wetland species (FACW-) indicating it is equally likely to occur in wetlands (estimated probability 34% to 66%) or non-wetlands (in this case the minus sign indicates a frequency towards the drier end of the category (USFWS 1996). (Note that the USFWS document does not assign rankings to subspecies). Gleason and Cronquist (1991) state that this species is found in moist woods, while Crow and Hellquist (2000) describe it as occurring in dry to moist sites. The several subspecies within this species, combined with recent taxonomic changes within the species, likely explains some of the vagueness in published habitat descriptions for this species. On the proposed Miller's Creek Mine Extension site, the yellow lady's-slipper is primarily found in moderately well drained uplands, although small numbers of this species occur within Wetland 1.

Ram's-head Lady's-Slipper

Throughout its range, ram's-head lady's-slipper grows in both wetland and non-wetland environments (Brzeskiewicz 2000). Gleason and Cronquist (1991) state this species prefers moist soils, while Crow and Hellquist (2000) state it is found in both swamps and bogs and on dry hillsides. Thus, this species appears capable of surviving under a range of moisture regimes. In the *National List of Vascular Plant Species that Occur in Wetlands: 1996 National Summary* document prepared by the United States Fish and Wildlife Service (USFWS), ram's-head lady's-slipper is classified as a facultative wetland (FACW) species. This designation means that this species can be expected to occur in wetlands an estimated 67 to 99% of the time. However, this assessment is based on habitats observed in the U.S. and does not accurately reflect the Nova Scotia habitat of this species, which is consistently in drier uplands (Blaney and Mazerole 2007, B. Cameron, pers. obs.). On the proposed Miller's Creek Mine Extension site, ram's-head lady's-slipper was found in dry upland habitat, as was the case on all other CGC properties where this species was encountered.

Eastern Leatherwood

Leatherwood prefers moist to dry soils (Lady Bird Johnston Native Plant Database, www.wildflower.org) and is listed as a facultative (FACW) wetland species, indicating it is equally likely to occur in wetlands (estimated probability 34% to 66%) or non-wetlands (USFWS 1996). Gleason and Cronquist (1991) state this species prefers moist soils. Ward and Horn (1998) found that eastern leatherwood specimens were associated with streams at all of their South Carolina study sites. Specimens on the Miller's Creek Mine Extension site were found in two habitats, upland rocky areas and on floodplains of small brooks.

Round-lobed Hepatica

Round-lobed hepatica is generally found in dry wooded sites (Flora of North America, www.efloras.com). Slattery *et al.* (2003) state it is found in dry or rocky woods and on dry upland slopes. Gleason and Cronquist (1991) state this species is found in dry or moist uplands. In Nova Scotia, this species is known to occur along floodplains where plants may occasionally be flooded, with no apparent ill effect noted during subsequent monitoring events (B. Cameron, pers. obs.). Therefore, it appears to be tolerant of widely fluctuating water levels. Most of round-lobed hepatica's active growth occurs in spring, when soil moisture levels are generally higher. The thick waxy cuticle possessed by this species acts to minimize water loss via evapotranspiration from leaves during dry periods. This species is classed as non-wetland (USFWS 1996).

Canada Buffaloberry

Canada buffaloberry is classified as an obligate upland species (UPL), indicating it almost always (estimated probability > 99%) occurs in non-wetlands under natural conditions (USFWS 1996). However, there are also reports of this species preferring moist conditions (The Lady Bird Johnston Wildflower Centre Native Plant Database, www.wildflower.org). This may be due to overall warmer temperatures at the southern edge of the species' range causing specimens to require additional moisture. All of the specimens on the proposed Project site were located in open, relatively well-drained areas.

Wood Anemone

Wood anemone prefers moist, open woods, thickets, clearings, streamsides, and is occasionally found in swampy areas (Gleason and Cronquist 1991, Flora of North America, www. Efloras.com). This species is classified as a facultative upland species (FACU), indicating it usually occurs in non-wetlands (estimated probability 67% to 99%), but may occasionally be found in wetlands (USFWS 1996). It occurs in a moderately well drained area of the proposed CGC Conservation Area.

Black Ash

Black ash requires wet to moist soils and typically grows in bogs and swamps, along streams, or in poorly drained areas that are often seasonally flooded (Burns and Honkala 1990, Gleason and Cronquist 1991, www.borealforest .org). This species is classified as a facultative wetland (FACW) species occurring an estimated 67 to 99% of the time in wetlands (USFWS 1996). Although this species can tolerate semi-stagnant conditions, for best growth it is important that the water be moving so the soil will be aerated even though saturated. All of the specimens observed on the proposed Project site were found in wetlands.

Cyanolichens

As the cyanolichens species at risk known from the proposed Project site grow primarily on rocks or trees, a discussion of soil moisture levels is irrelevant.

Summary

The proposed Project will not significantly affect soil moisture levels for any species or habitats in the CGC Conservation Area. While a portion of the drainage areas for Wetland 12 will eventually be removed, CGC will mitigate this effect by redirecting water from the pit to ensure the water supply to this wetland does not decrease. The Project will not impact the amount of precipitation falling in the CGC Conservation Area, it will simply reroute how some of this precipitation reaches Wetland 12. Potential changes in moisture levels in these wetlands could be monitored by installing soil moisture loggers within these wetlands to obtain soil moisture data both before and after initiation of Project activities. Removal of part of Wetland 12's drainage basin could potentially remove a portion of the water supply to the ram's-head lady's slippers occurring on the northern slope of this wetland, though these specimens likely rely primarily on precipitation. As published reports of plant habitat requirements rarely provide quantitative data, baseline data on soil moisture levels in areas supporting ram's-head lady's-slipper could be obtained via installation of soil moisture meters prior to initiation of project activities. This would provide quantitative, long-term data on soil moisture levels in areas suitable for these species. Should a significant decrease in soil moisture become apparent, CGC could mitigate for this by redirecting water form the settling ponds.

3.3.5 **Humidity**

Humidity is the amount of water vapor in the air. Water vapor enters the environment/atmosphere via evaporation from streams, lakes, and oceans, and via transpiration from plants. The term "humidity" is normally taken to mean relative humidity, which is defined as the ratio of the partial pressure of water vapor in a parcel of air to the saturated vapor pressure of water vapor at a prescribed temperature. Humidity is thus dependent on air temperature. When a very humid air mass is cooled, the water vapor condenses into tiny droplets, which create fog conditions. When humid air is cooled by contact with a cooler surface, the water vapor condenses, forming dew. Humidity is also affected by radiant heat, which can increase the water-holding capacity of an air mass, and by wind, which disperses water vapor, leading to decreased local humidity. Forested areas generally exhibit higher humidity than do nearly non-forested areas, due to transpiration from vegetation and decreased wind speeds. Coastal areas also exhibit higher humidity regimes due to evaporation from lakes and oceans, and often experience fog conditions due to the effect of humid oceanic air masses cooling upon contact with cooler land-derived masses. Fog and dew can play an important role in providing water to coastal species, particularly in arid coastal areas.

While no quantitative data appear to be available on the specific humidity requirements (in the form of actual relative humidity measurements) of the flora species of concern known from the site, it is possible to determine their general humidity tolerance based on their typical habitats. Humidity levels within the CGC Conservation Area are rather high, due to the proximity to the Avon, Kennetcook and St. Croix River systems and the forested nature of much of the Avon Peninsula. The province as a whole exhibits humid conditions, with frequent fog, due to the maritime climate.

Yellow lady's-slipper

Yellow lady's-slipper appears tolerant of a considerable range of humidity levels, as throughout its range it may be found growing both in wetlands and in drier areas where humidity is considerably lower.

Ram's-head lady's-slipper

Ram's-head lady's-slipper appears tolerant of a moderate range of humidity levels, as it is found growing in wetlands and on dry wooded slopes where humidity is considerably lower. It is generally found in or adjacent to forested areas where humidity would be relatively high.

Eastern leatherwood

Eastern leatherwood is tolerant of high humidity, as it usually grows in wet areas and swamps where humidity would be relatively high.

Round-lobed hepatica

Often growing in dry wooded areas, round-lobed hepatica appears tolerant of lower humidity. It possesses a thick waxy cuticle that decreases losses due to transpiration, allowing the plant to conserve water.

Canada buffaloberry

Canada buffaloberry appears tolerant of low humidity. It grows in relatively dry areas and has relatively thick scaly leaves that aid in water conservation.

Wood anemone

Wood anemone prefers relatively high humidity, as it grows in moist areas and occasionally swamps.

Black ash

Black ash grows in a humid climate, where average annual precipitation ranges from 510 to 1,140 mm , 380 to 640 mm of which occurs during the warm season. (Wright and Rauscher 1990). Within its geographic range it is usually found growing in wet areas and swamps, where humidity would be locally elevated.

Cyanolichens
Lichens are very dependent on humidity as a source of moisture. They do not have roots to take up moisture from the substrate, nor do they have a waxy cuticle, as vascular plants do, to reduce water losses via transpiration.

Thomson (1984) states that the lichen *S. saccata* grows best in very humid places, such as in spray from waterfalls and in moist microhabitats, such as hummock sides, sides of animal burrows, seepages and moist shaded cliff sides.

No specific information could be found on humidity tolerance levels of the other uncommon species of lichen known from the proposed Project site (*C. cristatum* var. *cristatum and L. lichenoides*), though cyanolichen species generally prefer high humidity (Nash 1996).

Summary
The proposed Project will not affect humidity levels for any species or habitats in the CGC Conservation Area. While the gradual removal of some forested areas around the perimeter of the CGC Conservation Area may have a slight impact on humidity regimes in these areas, at the microhabitat scale, this impact is minor and will not affect species or habitats within the CGC Conservation Area. The Project will not impact the amount of precipitation falling in the CGC Conservation Area, nor will it affect seasonal trends in precipitation in the area. The project will not affect local evaporation or transpiration rates within the CGC Conservation Area, nor will it affect the temperature of local air masses. It will not impact the role of the Avon, Kennetcook, and St. Croix Rivers, or the Bay of Fundy, on the local humidity or fog regimes. Potential changes in humidity levels near species of concern in the proposed Conservation Area could be monitored by installing humidity loggers near these specimens to obtain long-term humidity data both before and after initiation of Project activities.

3.3.6 Ground and Surface Water Quality

Gypsum is a very water-soluble mineral composed of calcium sulphate ($CaSO_4$) and water. In addition to elevated calcium content, water containing dissolved gypsum also tends to be high in sulphate compounds. Hardness in water is defined as the presence of multivalent cations. Hard water minerals primarily consist of calcium (Ca^{2+}) and magnesium (Mg^{2+}) metal cations, and sometimes other dissolved compounds such as bicarbonates and sulfates. Calcium usually enters the water as either calcium carbonate ($CaCO_3$) in the form of limestone and chalk, or calcium sulfate in the form of other mineral deposits.

Ground and surface water on the Miller's Creek Mine Extension site is generally hard and high in sulphate due to the abundance of gypsum. This does not apply to the majority of listed plant species occurring on the CGC Conservation Area, as they rely primarily on precipitation, in the form of rain and snowmelt, for their water supply. The exception is black ash, which grows in wetlands and may be fed by both surface and groundwater sources in addition to precipitation and snowmelt.

Summary

The quality of precipitation falling on the CGC Conservation Area will not be affected by the Project and will not affect species reliant on precipitation for their water supply. The Project will not affect surface or ground water quality in the CGC Conservation Area, and therefore will not have an impact on black ash.

3.3.7 Acid Rain and Air Quality

Most plants and lichen species rely on precipitation (rain, snow, and fog) as a supply of water. Normal, unpolluted rainfall is moderately acidic, having a pH of around 6 due to the effect of carbon dioxide in the air which combines with water to form carbonic acid (USEPA, online). The effect of this acidity is usually negligible, as it is neutralised in the soil by alkaline materials, like limestone. The combustion of fossil fuels, however, results in the emission of sulphur dioxide to the atmosphere. Sulphur dioxide combines with moisture in the atmosphere to form sulphurous acid (H_2SO_3) or sulphuric acid (H_2SO_4), which leads to the creation of acid rain, defined as precipitation with a pH < 5.3 These forms of sulphur are harmful to lichens and plants, by causing physiological damage to plant cells as well as geochemical shifts in soils and soil waters that impede plant growth. Since acid rain develops high in the atmosphere, it tends to fall a considerable distance away form where the sulphur was emitted. Nova Scotia rainfall currently exhibits an average pH of 4.5 (as does rainfall in most of eastern North America) due to the acidifying effects of industrial air pollution. In Nova Scotia, much of this air pollution is due to emission sources in the Great Lakes region, Ohio River Valley, and Midwest region of the USA (Environment Canada 2004).

The flora species at risk in the CGC Conservation Area rely primarily on precipitation and surface runoff for their water supply. Vascular plants are generally not affected by decreased air quality, though they can be affected when decreased air quality results in the creation of acid rain.

Acid rain deposits nitrates that can lead to increases in nitrogen in forests, which can then lead to a unnatural surplus of this nutrient in forests (USEPA, online). Nitrates can also remove calcium and magnesium from soils. Continued nitrogen deposition may alter other aspects of the nutrient balance in sensitive forest ecosystems and alter the chemistry of nearby lakes and streams (USEPA, online). Thus, the effects of acid rain on terrestrial plants tend to be indirect rather than direct. The waxy cuticle layer possessed by all terrestrial vascular plants acts to minimize direct absorption of atmospheric pollutants. However, very acid rain (pH<3) has been shown to cause physiological damage to plant tissues, such as increased foliar leaching, loss of chlorophyll, and disruption of chloroplast structure (Wood & Bormann, 1975; Hindawi *et al.* 1980, Chia *et al.* 1984) Precipitation with a pH value this low does not occur in Nova Scotia.

Lichens rely primarily on rain and humidity for their water supply and are very susceptible to air pollution, particularly acidifying or fertilizing sulfur and nitrogen-based pollutants. They do not have root systems and absorb water from their environment directly through the thallus wall. Most lichens prefer water that is neutral to slightly alkaline (pH 7 to 8), as the photosynthetic algal partner is damaged by acidic conditions (Gilbert 1986, Hallingback 1989, Hawksworth and Rose 1970, Sigal and Johnston 1986). Nitrogen fixation, essential for lichen survival, is also very sensitive to acid rain (Gries 1996). The effect of acid rain on lichens depends primarily on the pH of the substrate, the surface on which the lichen grows. The main impact of acid rain on lichens is acidifying their environment, causing leaching of important nutrients from lichen thalli or changes in the buffering capacity of bark and soil (Richardson 1992). Sensitive lichen species growing in areas exposed to acid rain have become restricted to substrates that have high pH and better buffering capacity, such as the bark of certain deciduous trees or calcareous rock outcrops, or may be absent entirely (Richardson 1988).

Regions which contain calcareous soils, such as the Project site, have an abundant natural supply of acid-neutralizing bases, and a larger capacity to neutralize acid rain than do other regions. While acid rain continues to be an issue in Atlantic Canada, it has less potential impact to vascular plant and lichen species in the CGC Conservation Area, due to the modifying influence of soils rich in gypsum (pH=7) on acidic precipitation.

Summary

The proposed Project will not affect air quality or the pH of precipitation within the CGC Conservation Area. Sulphur dioxide emissions from this project will be minimal, given that sulphur content in diesel fuel is regulated. In addition, the existing Miller's Creek Mine east of Ferry Road will reduce production as the new quarry is developed. It is not anticipated that the Project will increase emissions of sulphur dioxide compounds from heavy equipment above currently existing levels in the region. There will be no cumulative air quality or acid rain impacts from the Project.

3.3.8 Temperature

Temperature plays a crucial role in determining local climate and, subsequently, the distribution and abundance of plant species. Warmer temperatures increase the rate of photosynthesis in plants, to a point. Once temperatures get too warm, plants may begin to lose more water faster than they can take it up, due to increased transpiration in an attempt to lower temperatures before tissue damage occurs. Cold temperatures slow photosynthesis, resulting in slower growth. In temperate areas, plants stop growing entirely once winter arrives, and many temperate and polar species require a cold period of dormancy in order to trigger flowering in the subsequent season.

All plant species have a range of temperature which they can tolerate. Different parts of plants also show different levels of temperature tolerance. Roots of vascular plants are less tolerant of extreme temperatures than are the above-ground portions of plants, since the soil layer insulates roots from extreme cold in winter and heat in summer. Lichens do not have underground roots, and the whole specimen is exposed year-round. Lichen species in general have evolved to be very tolerant of temperature extremes, and some species are the dominant vegetation in parts of the Arctic and in some of the hottest deserts (Brodo *et al.* 2001).

The tolerance of a plant species to temperature extremes is referred to as its degree of hardiness. This is defined by a series of hardiness zones. In the United States, plant hardiness zones are geographically defined zones within North America in which specific categories of plant life are capable of growing, based on the minimum winter temperatures of the zone. The United States Department of Agriculture (USDA) hardiness zone map divides North America into 11 hardiness zones, with zone 1 (northern Alaska) being the coldest. Some species are tolerant of cold winters, but intolerant of hot summers. For this reason, USDA hardiness levels for a specific species are usually provided as a range of zones which the species can tolerate.

However, this does not fully reflect all of the environmental factors which determine where a species can survive. For this reason, the Canadian system of hardiness zones is based on a mathematical calculation which incorporates factors such as the length of the frost-free period, summer rainfall and winter snowfall amounts, maximum temperatures, January rainfall and maximum wind speed, in addition to the minimum winter temperatures. Canadian hardiness zones therefore may differ from US hardiness zones, and are much less easily defined (and have not been determined for the US). As this section deals primarily with data from US sources discussing geographic ranges within North America, hardiness zones in this document follow the US system.

Distribution data for the vascular plant species-at-risk were obtained from the Lady Bird Johnson Native Plant database (www.wildflower.org) and the Flora of North America (www.efloras.org), and compared with the USDA Hardiness Zone map (www.usna.usda.gov/Hardzone/ushzmap.html).

Hardiness zones were developed with a bias towards agriculture and horticulture, and so focus on vascular plant species. As this system was designed for vascular plants, it does not apply to non-vascular plants species or lichens. Hardiness zones for the vascular plant species-at-risk occurring within the CGC Conservation Area are provided in Table 2.

Table 2. United States Department of Agriculture Hardiness Zones for Vascular Plant Species at Risk Occurring within the Proposed CGC Conservation Area.

Species	Lower USDA Hardiness Zone (minimum winter temperature)	Upper USDA Hardiness Zone (minimum winter temperature)
Ram's-head lady's-slipper	Zone 2a (-42.8 to -45.5°C)	Zone 6a (-20.6 to -23.3°C)
Round-lobed hepatica	Zone 5 (-28.9 to -23.3°C)	Zone 8 (-12.3 to -6.6°C)
Yellow lady's-slipper	Zone 1 (< -45.6°C)	Zone 7b -12.3 to -14.9°C)
Wood anemone	Zone 2b (-40.0 to -42.7°C)	Zone 7b -12.3 to -14.9°C)
Eastern leatherwood	Zone 1 (< -45.6°C)	Zone 7b (-12.3 to -14.9°C)
Canada buffaloberry	Zone 1 (< -45.6°C)	Zone 6a (-20.6 to -23.3°C)
Black ash	Zone 2b (-40.0 to -42.7°C)	Zone 6b (-17.8 to -20.5°C)

While the hardiness zone system is inapplicable to lichens, an examination of their geographic distribution provides a general idea of their cold tolerance levels. All three lichen species-at-risk occurring in the CGC Conservation Area also occur in more northern areas of North America (Brodo *et al.* 2001) and, therefore, are very tolerant of cold temperatures. Lichens lack the waxy cuticle found in vascular plants which minimizes evaporative losses, and so prefer cooler temperatures, which maximize water retention. Dry lichens are incapable of photosynthesis. Lichens can survive very long periods (years, in some cases) completely dry, and so can tolerate warm, dry spells.

The CGC Conservation Area falls within USDA hardiness zone 6a, meaning it has an average minimum winter temperature of -20.6 to -23.3°C (www.usna.usda.gov/Hardzone/ushzmap.html). The average annual temperature of the Avon Peninsula is 6.9°C, with monthly average temperatures ranging from -2.5°C to 19.4°C. Temperature extremes can range from -31.1°C to 37.8°C, and there is an average of 306 days per year with an average temperature above 0°C. This data was obtained from the Summerville climate station (MSC ID# 8205650) operated by Environment Canada. The Summerville data was used because of its length of record, geographic location and proximity to the site. As seen in Table 2, the CGC Conservation Area falls well within the range of zones suitable for the vascular species-at-risk known from the site. The CGC Conservation Area is also located in a region well within the observed geographic ranges of the lichen species.

Within the USDA hardiness zones, small areas where the climate differs from the surrounding area may occur, due to factors such as exposure, elevation, aspect, and proximity to water bodies. These areas are known as microclimates, and may consist of areas as small as a few square metres (such as a sheltered garden) or as large as many square kilometres (such as a valley). Such microclimates are often too small to be mapped, but can allow more cold-sensitive species to survive within a zone considered too cold for them (and vice-versa). For example, cool soils seem to play an important part in defining the range of ram's-head lady's-slipper, as it is found in cold bogs or cool, north-facing bluffs in the southern part of its range (Penskar and Higman 1999, Brzeskiewicz 2000). Soil temperatures over 25°C are considered detrimental to survival of this species (Correll 1950, Cash 1991).

Summary

The proposed Project will not result in changes in soil, substrate, or air temperatures in the CGC Conservation Area because it will not affect local weather patterns in the area encompassing the CGC Conservation Area. The Project will not affect the moderating influence of the nearby Bay of Fundy on the CGC Conservation Area, nor the effect of the Atlantic Ocean on the province as a whole. It will not affect the amount of solar irradiation received by the CGC Conservation Area, nor will it affect precipitation levels. The project cannot affect the latitude or altitude of the project site, two of the major factors determining local temperatures.

On a small scale, logging can increase local soil and air temperatures due to the increased solar exposure following removal of the tree layer. No logging will occur within the CGC Conservation Area.

While climate change may have an effect on temperatures within the CGC Conservation Area in the future, these effects are unrelated to the proposed Project and so are not discussed in this document.

3.3.9 Soil Physical Characteristics

Soil is the naturally occurring, unconsolidated or loose material covering the Earth's surface. It is composed of particles of broken rock that have been altered by chemical and environmental processes, such as weathering and erosion, combined with organic materials. Most terrestrial plant species use soils of some type as a substrate or growing medium, using their root systems to anchor themselves within the soil and to absorb soil-borne water and associated nutrients. Soil particles pack together loosely, resulting in a soil structure filled with pore spaces. The larger the soil particles, the faster drainage a soil has. Organic materials and small soil particles like clay and silt retain water and slow drainage of soils. Gases and solutions are found within the pore spaces, leading to complex chemical, geochemical and biochemical interactions within the soil structure.

Soil types vary widely depending on a host of factors, including the nature of the bedrock geology and till deposits, the local climate, biological activity, soil chemistry, local hydrology patterns, and past glacial activity. Soils are generally classified based on the relative proportion of particles within a sample in set size classes (gravel, sand, silt, and clay). Loam is soil composed of sand, silt, and clay in relatively even concentration (about 40-40-20% concentration respectively), and is considered optimal for agricultural uses. Loam soils generally contain more nutrients and organic material (humus) than sandy soils, have better infiltration and drainage than silty soils, and are easier to work than clay soils.

The majority of soils in Hants County are developed from glacial till (Cann and Hilchey 1954). Soils within the CGC Conservation Area are represented by the Falmouth series of the Queens catena of soils. The Queens catena (or hierarchy) of soils consists of reddish-brown clay loam till derived from fine-textured reddish-brown and gray shale till (till is unsorted glacial sediment) (Cann and Hilchey 1954). Within this catena, soils are either well-drained (Falmouth series) or imperfectly-drained soils (unnamed series). Soils of the CGC Conservation Area are of the well-drained Falmouth Series. Within Hants County, this series occurs principally in the Windsor district where the till has been mixed with, and deposited over, gypsum. Under forest cover the Falmouth soils have a thin surface layer of semi-decomposed leaf litter and debris (the A_0 or O horizon) under which is a one inch layer of fairly well-decomposed organic matter mixed with mineral material (the A_1 horizon). A typical pH for this layer is 5.0. This surface layer is underlain by a pinkish-grey sandy loam A_2 horizon that varies in depth from a trace thickness to two inches (five cm), with a slightly higher pH (5.2). Beneath that is the B_1 horizon, composed in this case of yellowish-red sandy loam and occurring at a depth of 2.5 to 14 inches, with a pH value of 5.2. The B_1 horizon is underlain by the B_2 horizon at a depth of 14 to 23 inches, and consisting of reddish brown clay loam with a coarse blocky structure and a pH of 5.5. Below this level is the C horizon, which overlies the bedrock layer. A typical C horizon of the Falmouth series is dark reddish brown clay loam with a firm structure, bits of gypsum and a pH of 6.0. The till rests on the bedrock at a depth of 2.4 to 4.5 m below the surface (Cann and Hilchey 1954).

Loam is an older agricultural term which is not recognized by the currently-accepted Unified Soils Classification System (ASTM International 2006). Soil samples were obtained from the top 10 cm of the soil layer in the CGC Conservation Area in October 2008, in areas supporting ram's-head lady's-slipper and yellow lady's-slipper. A laboratory grain size analysis was performed on each sample and the results used to classify each sample according to the Unified Soils Classification System. The sample from the ram's head location was determined to be silt and clayey sand, while the sample from the yellow lady's-slipper patch was classified as silty sand with some clay. Soil classified as silt and clayey sand is equivalent to loam, while silty sand with some clay is equivalent to sandy loam. These soil types are prevalent within the CGC Conservation Area.

Yellow lady's-slipper

In Nova Scotia, yellow lady's-slipper is strongly associated with calcareous soils occurring with gypsum and/or limestone deposits (Zinck 1998). It is reported to prefer soils that are rich in nutrients and organic material, with a pH of 6.0 to 7.0. (http://www.gardensoftheblueridge.com/native_orchids.htm). The species is known to occur in peaty soils in other parts of its range (Flora of North America., online). Soils have been described as loam or sandy loam (www.illinoiswildflowers.info), or as a mix of humus, loam and sand (Cullina 2000). These soil types are all found within the CGC Conservation Area, as the surface layers of the Falmouth soil series consist of sandy loams (Cann and Hilchey 1954). Soils high in sedge peat also likely exist in Wetland 1, where some yellow lady's-slippers occur.

Ram's head lady's-slipper

Throughout its geographic range, populations of ram's-head lady's-slipper are known from both mineral-rich and mineral-poor sites, with soils of clay, loam

(Smith 1981, cited in Blaney and Mazerole 2007) or sand (Case 1964) in upland sites and nutrient-poor peat in lowland sites (Ostlie 1990). Blaney and Mazerole (2007) state that in Nova Scotia, ram's-head lady's-slipper prefers sandy loam soil. This soil type is abundant within the CGC Conservation Area, as the surface layers of the Falmouth soil series (within which ram's-head lady's-slipper roots would occur) consist of sandy loams (Cann and Hilchey 1954).

Eastern leatherwood

The Lady Bird Johnston Native Plant Database (www.wildflower.org) states that eastern leatherwood prefers moist, well-drained, organic soils, but do not mention particle size distribution. In South Carolina, Ward and Horn (1998) found that eastern leatherwood grew primarily in well-drained sandy to sandy loam soils. The surface layers of the Falmouth soil series, which occurs throughout the CGC Conservation Area, consist of sandy loams (Cann and Hilchey 1954).

Round-lobed hepatica

Round-lobed hepatica is said to prefer a deep, light alkaline soil containing leaf mould (Huxley 1992, Bown 1995). Another report says that this species grows best in a deep loam or clay soil (Grieve 1984), while Slattery *et al*. (2003) state that round-lobed hepatica prefers sandy to loamy soils. Sandy to loamy soils are found within the CGC Conservation Area as the surface layers of the Falmouth soil series consist of sandy loams (Cann and Hilchey 1954).

Canada buffaloberry

The Lady Bird Johnson Native Plant Database (www.wildflower.org) states that Canada buffaloberry grows on calcareous soils, but does not mention particle size distribution. The Evergreen Native Plant Database (www.evergreen.ca/nativeplants/about/index.php) states that this species grows in clay, sand, or loam soils, and is a calciphile species. Other sources state that this species generally prefers sandy, gravelly, or rocky soils, and is able to thrive on nutrient poor soils due to its nitrogen-fixing ability (Wei and Kimmins 1998). Thus, it appears that this species is not particular about soil grain size composition or organic matter content. In the CGC Conservation Area, this species occurs in areas disturbed by historical mining activities, where the topsoil is nutrient poor.

Wood anemone

Wood anemone is noted to prefer damp, rich, mucky soils (www.rook.org). Mucky soils are generally fine-grained sediments (a mixture of silt and clay) which drain poorly. Mucky soils are usually relatively high in organic matter. These soil types are mostly associated with intervale and wetland areas where the organic matter input into the soil is high. These soils likely occur patchily throughout the CGC Conservation Area, near watercourses and wetlands. Small patches of such soils are too small to show up on the available soil mapping for the area encompassing the CGC Conservation Area (Cann and Hilchey 1954).

Black ash

Black ash most commonly grows in moist to wet muck or shallow organic soils, especially in swamps, floodplains, terraces, ravines, and on small, poorly drained upland pockets. It occurs most frequently on peat and muck soils, but also grows on fine sands underlain by sandy till, on sands and loams underlain by lake-washed clayey till (Eyre 1980, Niering 1953) or on sands and loams with high water tables (Anderson and Nesom 2007). Sandy to loamy soils are found within the CGC Conservation Area as the surface layers of the Falmouth soil series (within which most herbaceous plant roots would occur) consist of sandy loams (Cann and Hilchey 1954). Black ash in the Conservation Area occurs within wetlands where the water table is at or very near the surface, and where organic matter content is likely enriched relative to nearby non-wetland soils.

Cyanolichens

As cyanolichens generally grow on substrates other than soils, a discussion of soil characteristics is irrelevant and they are not discussed in this section.

Summary

The proposed Project will not affect any physical characteristics of soils within the CGC Conservation Area. There will be no removal, reworking, or disturbance of soils of any kind. Particle size distribution of soils present in the CGC Conservation Area will not be affected by the Project. No logging will occur within the CGC Conservation Area, and the ground and rock outcrops will not be disturbed. There will be no activities which could potentially lead to changes in soil organic material content, particle size distribution, or pH levels.

3.3.10 Substrate Physical Characteristics

A substrate is simply the material or object that a lichen grows on or within. Thus this section is limited to a discussion of lichen substrates. Lichens do not have root or vascular systems and do not rely on their substrate for water or nutrient uptake. As they do not rely on their substrate for nutrients or water, the substrate primarily serves in an anchoring capacity. Three factors determine whether a substrate is suitable for a particular lichen: its texture; its ability to absorb and retain moisture; and its chemistry, particularly the ability to buffer sudden changes in pH. Different lichen species can grow on substrates such as the soil surface, bare rock, tree trunks or twigs, and even other lichens.

Solorina saccata

The cyanolichen *Solorina saccata* is said to grow on calcareous soil or rock, and in moist situations on tundra (Nearing 1947, Brodo *et al.* 2001). This species occurs on vertical faces of exposed gypsum outcrops on the proposed Project site.

Collema cristatum* var. *cristatum

The substrate for *Collema cristatum* var. *cristatum* is usually bare calcareous rock, but it may also occur on limy soil or among mosses (Brodo *et al*. 2001). Degelius (1954) states this species is mainly saxicolous (living on rock) but is practically restricted to calcareous rocks which are periodically wetted. It may also occur on periodically wet soil, especially var. *cristatum*, sometimes bare soil (even fine sand and gypsum), but usually among other plants (Degelius 1954). Occasionally, it has been found on lignum (dead wood) and bark (Degelius 1954).

Leptogium. lichenoides

Brodo *et al.* (2001) lists the habitat for *L. lichenoides* as mossy calcareous rock. This species usually grows on calcareous rocks, generally among mosses or, rarely, on the bases of trees having basic bark (Brodo *et al.* 2001, Sierk 1964).

Summary

The three lichen species-at-risk which occur within the CGC Conservation Area occur primarily on calcareous rock or the bark of certain deciduous trees. The proposed Project will not remove any potential lichen substrates such as bare earth, rock, tree bark, or dead wood from the CGC Conservation Area. Nor will the Project affect any physical characteristics of these potential lichen substrates within the CGC Conservation Area. No logging will occur within the CGC Conservation Area, and the ground and rock outcrops will not be disturbed. There will be no removal, reworking, or disturbance of substrates of any kind.

3.3.11 Soil and Substrate pH values

Soil and substrate pH is a measure of the soil/substrate acidity or alkalinity, and is measured on a scale from 1 to 14. The pH of a soil or substrate is estimated by measuring the pH of a soil or substrate extract solution. Acid soils exhibit pH values greater than 7, while alkaline (also called basic) soils exhibit pH values above 7. A pH of 7 is neutral. Soil pH plays a large role in determining distribution and abundance of vegetation because most plant species tolerate a limited pH range. The pH of a substrate directly affects the availability of many plant nutrients, especially micronutrients. At pH values of 5.5 to 7.5, nutrients and micronutrients are most easily available for uptake by plants. Below 5.5, nutrients such as phosphorus, sulphur, calcium, magnesium and molybdenum are converted with chemical forms which are less available for uptake by plants. Above a pH of 7, iron, boron, copper, and zinc are less available to plants.

As discussed in the Acid Rain and Air Quality section, unpolluted rainwater has a pH of around 6.0. The effect of the addition of acidic rainwater to soils is usually negligible, as it is neutralized in the soil by alkaline materials like limestone. Solid substrates such as alkaline tree bark or rock can neutralize acidic rainwater and allow lichens to survive. Many epiphytic, acid-sensitive lichen species occur primarily on tree species with alkaline bark, such as maple or elm. Acid-sensitive epilithic species grow preferentially on alkaline rock such as limestone.

Soils within the CGC Conservation Area are typically slightly more acidic than those described above, as the Falmouth soil series present in the area is typified by a near-surface pH of 5.2, increasing to 6 at about 60 cm depth. However, localized outcrops of gypsum may decrease the acidity of surface soils.

Yellow lady's-slipper

Yellow lady's-slippers are strongly linked with calcareous soils associated with gypsum and/or limestone deposits (Zinck 1998, Munden 1997) and, therefore, are tolerant of the slightly acid to slightly alkaline pH of such soils. A soil pH range of 6.5 to 7.0 is considered by commercial growers to be optimal for this species and the related *C. reginae* (White Flower Farm, undated document). While the Falmouth soil series present on the CGC Conservation Area typically exhibits surface soil pH values around 5.2, local surface soil pH values are affected by surface outcrops of gypsum (a neutral mineral), which can bring local soil pH values close to neutral. Yellow lady's-slippers on the CGC Conservation Area are found primarily around exposed gypsum outcrops.

Ram's-head lady's-slipper

Ram's-head lady's-slipper is strongly associated with the calcareous soils associated with gypsum and/or limestone deposits and, therefore, is well adapted to the slightly acid to slightly alkaline soils. A soil pH range of 6.5 to 7.0 is considered by commercial growers of lady's-slippers to be optimal for the related yellow lady's-slipper (*C. parviflorum* var. *pubescens)* and showy lady's-slipper, *C. reginae* (White Flower Farm, undated document), and it is likely that ram's-head lady's-slipper also prefers a soil pH in this range. Studies of populations in Quebec have shown that soil in ram's-head lady's-slipper habitat exhibits an average pH of 6.8 (Sabourin *et al*. 1999). It has also been observed in this habitat that the uppermost soil horizons are acidified by accumulation of acidic conifer needles, while the lower soil horizons tend to be more alkaline due to underlying calcareous rock (Sabourin *et al*. 1999). A propagation study by Cribb (1997) found that the best results were obtained at a slightly acidic pH of 6.0. A surface (0-10 cm depth) soil sample obtained near a ram's head lady's-slipper patch in the GC Conservation Area in October 2008 yielded a pH value of 5.98. Ram's head lady's-slippers are described as occurring "in the rough country of gypsum sinkholes" (Munden 1997). Sinkholes occur patchily within CGC Conservation Area and may lead to very localized patterns in soil pH.

Eastern Leatherwood

Eastern leatherwood is said to prefer soils approaching neutrality (pH 6.8 to 7.2) (Lady Bird Johnston Native Plant Database, www.wildflower.org). However, Ward and Horn (1998) found that eastern leatherwood grew in soils which were strongly to slightly acidic, with pH values ranging from 4.2-6.7. Soils within the CGC Conservation Area fall within the latter range, as the Falmouth soil series present in the area is typified by a near-surface pH of 5.2, increasing to 6 at about 60 cm depth.

Round-lobed hepatica

Round-lobed hepatica appears to prefer acidic soils. Commercial growers of round-lobed hepatica state that this species requires acidic soil, with a pH of 4 to 6 (Prairie Moon Nursery, online). Other sources state it requires a soil pH below 6.8 (Lady Bird Johnson Native Plant Database, www.wildflower.org). Soils within the CGC Conservation Area fall within this range, as the Falmouth soil series present in the area is typified by a near-surface pH of 5.2, increasing to 6 at about 60 cm depth, and so would be of suitable pH for round-lobed hepatica.

Canada buffaloberry

Canada buffaloberry is associated with calcareous soils (Zinck 1998) with neutral pH, usually over 7.2 (Lady Bird Johnston Wildflower Centre Native Plant Database, www.wildflower.org). While the Falmouth soil series present on the CGC Conservation Area typically exhibits surface soil pH values around 5.2, local surface soil pH values are affected by surface outcrops of gypsum (a neutral mineral), which can bring local soil pH values close to neutral. Canada buffaloberry on the CGC Conservation Area is found primarily around exposed gypsum outcrops.

Wood Anemone

No specific information on soil pH requirements for wood anemone is available. This species is said to prefer moist peaty soils (Phillips and Rix 1991), which are likely to be somewhat acidic. Soils within the CGC Conservation Area fall within this range, as the Famouth soil series present in the area is typified by a near-surface pH of 5.2, increasing to 6 at about 60 cm depth.

Black ash

Black ash is tolerant of a wide range of pH values, from strongly acid soils (pH 4.4) to those with moderate alkalinity (pH 8.2) (Godman and Mattson 1976). Soils within the CGC Conservation Area fall within this range, as the Famouth soil series present in the area is typified by a near-surface pH of 5.2, increasing to 6 at about 60 cm depth.

Solorina saccata

Cyanolichen species in general prefer neutral (pH=7) to alkaline (pH>7) substrates (Brodo *et al*. 2001). McCune and Geiser (1997) and Seward (1977) state that the cyanolichen *S. saccata* is very specific to calcareous substrates, which have neutral to alkaline pH values. Gypsum has a neutral pH value, and all of the *S. saccata* specimens known from the CGC Conservation Area occur on gypsum outcrops.

Collema cristatum* var. *cristatum

Suitable substrate for *C. cristatum* var. *cristatum* is usually bare calcareous rock, but it also occurs on limy soil or among mosses (Brodo *et al*. 2001). Degelius (1954) states this species is restricted to calcareous rocks which are periodically wetted. The variety *cristatum* may also occur on periodically wet soil, sometimes-bare soil, such as fine sand and gypsum (Degelius 1954). All of these substrates are neutral to alkaline. Substrates exhibiting these requirements occur throughout the CGC Conservation Area.

Leptogium lichenoides

Brodo *et al.* (2001) list the habitat for *L. lichenoides* as mossy calcareous rock. Rarely, this species may also grow on the bases of trees having alkaline (basic) bark (pH>7) (Brodo *et al.* 2001, Sierk 1964). Both mossy calcareous rock (gypsum) and trees with alkaline bark, such as maple, apple, and elm, occur within the CGC Conservation Area.

Summary

The proposed Project will not affect soil or substrate pH levels for any species or habitats in the CGC Conservation Area. Mining of gypsum in the area surrounding the CGC Conservation Area cannot affect the impact of the gypsum on soils in the CGC Conservation Area. There will be no changes to substrate pH values due to acidification from acid rain above what is currently occurring due to transboundary sources (see Acid Rain and Air Quality section for additional discussion).

3.3.12 Successional Stage

Ecological succession is the more-or-less predictable and orderly changes in the composition or structure of an ecological community over time. As time passes, natural vegetation communities become more complex and diverse, modifying local conditions and creating microclimates for additional species to colonize. In most temperate forest areas, an area of bare soil, if left undisturbed, will naturally progress from: (1) annual grasses and forbs (broadleaf plants); to (2) perennial grasses and forbs; then to (3) shrubs, vines and briars; followed by (4) young forest tree species; and finally (5) a mature/climax forest.

Ecological succession is usually initiated by a natural disturbance of some type. Natural disturbances are infrequent natural events which cause large changes in ecosystems. This is usually on a short-term basis, but the impacts may be of much longer duration. Fire, flooding, windstorms, and falling trees are all types of natural disturbances. The scale of natural disturbances varies widely. A single tree falling creates an opening in the forest canopy, while hundreds of square kilometres of forest may be removed by a wildfire. Both situations cause changes in habitat parameters and allow new species to colonize, initiating the successional process.

Biological diversity is therefore dependent on natural disturbances. In forests, many shade-intolerant plant species rely on disturbance for successful establishment and to limit competition. Without this perpetual thinning, diversity of forest flora can decline, which in turn affects the animal species dependent on those plants.

The majority of the species-at-risk occurring within the CGC Conservation Area are species which grow primarily in forested areas. Canopy closure in forests tends to increase as a forest matures, so that mature forests usually have a closed canopy. Natural senescence of trees, leading to small openings in the canopy, ensures that forests generally have patches of forest habitat at various maturity levels.

Yellow lady's-slipper

Yellow lady's-slipper grows in a wide range of habitats, ranging from open bogs to forested areas (Flora of North America, online). In the CGC Conservation Area, it grows primarily in previously disturbed areas which receive full sunlight for part of the day. It also grows in open forested areas (B. Cameron, pers. obs.) The yellow lady's-slipper population appears to be temporarily elevated on the site due to the creation of suitable habitat by the previous disturbance of mining and logging activities.

Ram's-head lady's-slipper

Ram's-head lady's-slipper is said to prefer mid-successional forests formed from old disturbances such as wind throw or fire, but also grows in stands of varying ages (Brzeskiewicz 2000). In the CGC Conservation Area, ram's-head lady's-slipper occurs primarily in areas of mid-successional forests (B. Cameron, pers.obs.)

While orchid species may be described as preferring successional forests of a particular stage, the reliance of orchids on mychorizal fungi complicates the issue greatly. Despite their reputation as 'fussy' species with very particular habitat requirements, orchids are sometimes among the first species to colonize disturbed areas. For example, some species of *Spiranthes* orchids are often abundant along old roads and dry disturbed areas in Nova Scotia, while yellow lady's-slippers have been observed growing on gypsum waste rock piles within the province (B. Cameron, pers.obs). A recent study (Shefferson *et al.* 2008) noted that in mining areas of Estonia, several rare orchid species are often among the first species to colonize oil shale mining tailing piles. Investigation of fungal associates revealed that in some species, the same fungal species were associated with plants growing in both pristine and mine tailing habitats. Some of the mychorizal fungi species associated with these orchids were members of the *Tulasnellaceae* group (Shefferson *et al.* 2008), members of which are known associates with lady's-slipper orchids in North America (Shefferson *et al.* 2005).

Round-lobed hepatica

Round-lobed hepatica typically grows in dry mixed or hardwood forest (Zinck 1998). In hardwood or mixed forests, the degree of canopy closure is of less importance to round-lobed hepatica, as it blooms, forms new leaves, and does most of its photosynthesizing in spring, before the canopy has leafed out (Skidmore and Heithaus 1988). Thus this species is likely tolerant of forests in a broad range of maturity levels. In the CGC Conservation Area, the round-lobed hepatica grows on elevated knolls within a relatively mature forested area.

Eastern leatherwood

Eastern leatherwood occurs in rich deciduous or mixed woods (Zinck 1998). This species has been observed to grow primarily under closed forest canopy conditions (Ward and Horn 1998), suggesting that it prefers relatively mature forests. On the site, it is found in relatively mature areas where logging has not occurred, due to the prevalence of sinkholes.

Canada buffaloberry

Canada buffaloberry is often one of the first shrubs to colonize disturbed areas (Jones 1999). It is also called a "feeder species" because of its symbiotic relationship with a soil bacterium, which fixes atmospheric nitrogen and increases the levels of available nitrogen compounds in the vicinity (Huxley 1992). Species of nitrogen-fixing bacteria infecting Canada buffaloberry have been shown to be more abundant in soils from drier, earlier successional sites (Batzli *et al.* 2004), and Canada buffaloberry has been shown to be responsible for the production of significant amounts in newly-formed habitats (Rhoades *et al.* 2008) and regenerating habitats (Hendrickson and Burgess 1989). Further evidence of the pioneering nature of this species comes from the fact that Canada buffaloberry is used in western Canada for mine land reclamation (Jones 1999). Mine soils are often coarse textured materials with high coarse fragment content and low nutrient status. Canada buffaloberry is often selected for such sites due to its ability to improve the nutrient content of soils and provide food for wildlife (Jones 1999). Thus, Canada buffaloberry can be considered a pioneer species. In the CGC Conservation Area, Canada buffaloberry is found primarily in unforested gypsum areas disturbed by previous mining and logging activities.

Wood anemone

Wood anemone is known to grow in open woods, thickets, clearings, along stream sides, and occasionally swampy areas (Flora of North America, www. efloras.com). A study of forest stands of varying ages in New Brunswick found wood anemone only in mature natural stands (Ramovs and Roberts 2005). Wood anemone in the CGC Conservation Area occurs within a moderately mature forested area.

Black ash

Black ash is classed as intolerant of shade (Martin and Gower 1996). As such, it requires forest with a relatively open canopy in which to grow. This indicates it prefers patches of forest in the earlier successional stages, before the forest matures and the canopy closes over.

Cyanolichens

Cyanolichen species tend to grow in forested areas where the trees provide shade and shelter. *Solorina saccata* grows primarily in shaded moist areas, while the other two species occurring within the CGC Conservation Area (*L. lichenoides* and *C. cristatum*) can tolerate direct sun for a few hours each day. The maturity level of forests in their vicinity is likely of little importance, given that shade and protection from drying winds is sufficient.

Summary

Landscapes within the CGC Conservation Area are in various stages of succession. Some areas of mature forest exist, while much of the site is in various stages of regrowth due to natural senescence and/or historic logging activities. Other smaller areas are in the recolonization stage, due to removal of vegetation cover by historic quarrying activities. Natural disturbances in the CGC Conservation Area are likely of small scale. The most frequent short-term disturbance is likely falling trees, though flooding may cause infrequent disturbances in small, localized areas. On a longer time scale, insect infestations (both native and non-native species), fire, and the development of new sinkholes in karst areas may cause disturbances.

The proposed Project will not affect natural patterns in ecological succession in the region encompassing the Conservation Area. Natural disturbance regimes in the Conservation Area will not be suppressed by anthropogenic means. While historic logging may have interfered with natural disturbance regimes in some areas of the CGC Conservation Area, logging will not occur in the Conservation Area in the future.

Forest in suitable successional stages for the species-at-risk will persist in the CGC Conservation Area for some time due to natural ecological succession. While many areas may mature over the next several decades, natural disturbances in the form of falling trees will ensure that patchy areas of forest in various stages of succession exist within the CGC Conservation Area, allowing continued persistence of the species-at-risk within the CGC Conservation Area

3.3.13 Species Interactions

All species on Earth interact with other species to some extent. The term symbiosis is used to describe close and often long-term interactions between different biological species. Plant species interactions span a wide range of possible relationships, ranging from relationships with soil fungi which aid in plant nutrition, to relationships with animal species which play important roles in pollination and seed dispersal. Lichens are the epitome of species interactions, where two widely differing species cooperate to create a totally different species.

Four broad classes of species interactions are discussed in the following paragraphs

- Plant symbioses with mycorrhizal fungi;
- Plant symbioses with nitrogen-fixing soil bacteria;
- Roles of animal species in pollination and seed dispersal; and
- Lichens

Each of these species interactions is discussed in the following paragraphs in relation to the species-at-risk occurring in the CGC Conservation Area.

Plant Symbioses With Mycorrhizal Fungi

Plants can develop microbial symbioses with soil fungi which can result in significant nutritional advantages to the plant. The most widespread and well-known microbial symbiosis is the mycorrhiza. A mycorrhiza (Greek for fungus roots) is a symbiotic association between a fungus and the roots of a plant. It is an important part of soil life. This plant-fungus symbiosis provides most plants with the majority of their nutrients, including those limiting their growth (Smith and Read 1997). Most plants respond mutually to such gains by allowing the fungus a share of photosynthetically-fixed carbon, which limits fungal growth

(Smith and Read 1997). Mycorrhizal symbioses are of significant importance for plant growth and persistence in many ecosystems and are utilized by 92% of plant families (80% of species) (Wang and Qui 2006).

While the majority of plant species utilize mycorrhizal symbioses, some plants, including the entire orchid family (Orchidaceae), have evolved a different kind of mycorrhizal relationship in which carbon is not supplied to the fungus (Taylor *et al.* 2002). Orchids have also taken reliance on mycorrhizal relationships a step farther than most plants. Infection by an appropriate mycorrhizal fungus is required for the germination and growth of all orchid seeds in the wild (Bernard 1904, Rasmussen 1995).

Lady's-slippers produce large amounts of 'dust seeds', which contain no food reserves for the embryo and are so small as to be almost microscopic (Curtis 1943, Rasmussen 1995, Kull 2002). Actual recruitment rates from seed, however, are very low. For example, recruitment has been estimated to be less than 0.06% in the European yellow lady's-slipper (*C. calceolus*) (Kull 2002). This is primarily because lady's-slipper seeds require very specific conditions to germinate. First, a microscopic fungus must invade the seed. If the soil nutrient levels and pH are correct, the fungus develops a symbiotic relationship with the growing seed (protocorm), providing it with carbohydrates (Rasmussen 1995). The symbiotic relationship is a very delicate process whereby the fungus infiltrates the growing orchid seed via filaments, and then the orchid seed defensively responds by producing chemicals that dissolve the fungal filaments. After having its filaments dissolved, the fungus will then reattempt to invade the protocorm and supply more carbohydrates and the protocorm will grow again ever so slightly.

This process, known as the myco-heterotrophic phase, is repeated until the protocorm has grown large enough to produce a small dormant eye bud and root system (seedling). This process can often take more than a decade (Rasmussen 1995, Kull 1999). Once the eye bud and root system are produced, the following spring the protocorm will produce its first green leaf and begin to photosynthesize (Rasmussen 1995).

Some orchids are known to retain the fungal mycorrhizae after they have reached maturity. This is thought to allow them to remain dormant. On occasion, as adults, *Cypripedium* species undergo 'adult dormancy', periods of one or more years during which no sprouts are produced and no photosynthesis takes place (Lesica and Steele 1994, Shefferson *et al.* 2003). This suggests that these plants may retain myco-heterotrophy into adulthood (Gill 1989).

Shefferson *et al.* (2005) found evidence of fungal structures in all adult *Cypripedium* specimens sampled, including *C. parviflorum*, in their study.

A recent study by Shefferson *et al.* (2005) found that the primary mycorrhizal symbionts of many *Cypripedium* species are within the fungal family *Tulasnellaceae*. This family of basidiomycete fungi includes many known orchid mycorrhizal fungi (Warcup and Talbot 1967, Warcup and Talbot 1971, Rasmussen 1995). Sheffeson *et al.*(2005) found that *Cypripedium* mycorrhizal specificity appears generally high. In addition, some species of *Cypripedium*, such as *C. calceolous*, are known to be capable of mychorizal symbioses with more than one species of fungus (Shefferson *et al.* 2005).

It has been suggested that distribution of *Cypripedium*s may be limited by the distribution of appropriate mycorrhizal fungi. This is partly because soil microbial diversity is known to play important roles in determining plant abundance (Klironomos 2002), and because seed germination in some orchids has been observed to occur only near adults (Batty *et al.*2001). However, it appears more likely that the specific conditions enabling the heterotrophic stage are limiting recruitment, not absence of a suitable *Cypripedium* mycorrhizal fungus (Shefferson *et al.* (20075). Shefferson *et al.* (2005) suggested that habitat characteristics are just as important as mycorrhizal fungi in limiting *Cypripedium* distribution. The heterotrophic phase of growth occurs only when all the habitat and soil conditions are suitable, and this is considered the primary reason for the natural rarity of lady's-slipper orchids (Rasmussen 1995). Under many soil conditions, the fungus that the orchid requires can become a pathogen and destroy the orchid seed. Shefferson *et al.* (2007) found that most clades of *Cypripedium*-mycorrhizal fungi are found throughout much of the northern hemisphere, suggesting that lack of appropriate *Cypripedium* mycorrhizal fungi is not an issue in limiting *Cypripedium* distributions, at least at larger scales.

While the majority of plant species are known to utilize mycorhizal fungi, information on the specific species used by a particular plant species is difficult to find, and the available information generally targets agricultural species of orchids. Geographic distributions of soil fungi are also not available for the majority of species.

Yellow lady's-slipper

Yellow lady's-slipper is known to utilize at least two species of *Tulasnellaceae* fungi (Shefferson *et al.* 2005). The mycorhizal fungus *Rhizoctonia subtilis* has also been isolated from *C. parviflorum* as well as other *Cypripedium* species (Curtis 1939).

Ram's-head lady's-slipper

Although data on the specific mycorrhizal fungus utilized by ram's-head lady's-slipper are lacking, this species most likely has a symbiotic relationship with a member of the *Tulasnellaceae* family, as most species of *Cypripedium* orchids do (Shefferson *et al.* 2005).

Round-lobed hepatica

Round-lobed hepatica has recently been found to have mychorizal associations with several species of *Glomeromycota* fungi in coniferous temperate forests (Opik *et al.* 2008).

No data on species of mychorizal fungi utilized by eastern leatherwood, black ash, wood anemone, or Canada buffaloberry could be found, though it is most likely these species utilize mychorizal symbioses to some degree.

Plant Symbioses With Nitrogen Fixing Soil Bacteria

Biological nitrogen fixation is the process that changes inert atmospheric nitrogen to biologically useful ammonia (NH_3). All organisms use the ammonia form of nitrogen to manufacture amino acids, proteins, nucleic acids and other nitrogen-containing components. Biological nitrogen fixation can be accomplished by several taxa in nature, including blue-green algae (a bacterium), lichens and free-living soil bacteria. Nitrogen is often limited in natural ecosystems, and nitrogen fixation by organisms can contribute significant quantities of ammonia to such ecosystems.

Some vascular plant species have developed symbiotic relationships with nitrogen-fixing soil bacteria. In this symbiosis, a soil bacterium invades the root and multiplies within the cells, forming nodules. Within these nodules, nitrogen fixation is done by the bacteria, and the ammonia produced is absorbed by the plant. The most well-known example of this is the legume family, which forms associations with a species of *Rhizobium* bacteria. This is why legumes species are often grown in agricultural fields, to supply nitrogen and other nutrients to subsequent crops.

Canada buffaloberry

One of the species-at-risk occurring within the CGC Conservation Area, Canada buffaloberry, is known to utilize nitrogen-fixing bacteria. A species of *Frankia* bacteria is the nitrogen-fixing partner in this symbiosis, which allows Canada buffaloberry to colonize nutrient poor, disturbed sites, where nitrogen is often limiting. Some of the nitrogen created by the symbiosis is used by the shrub, but some can also be used by other plants growing nearby, leading to 'islands of fertility" (Huxley 1992). The possible utility of this species in returning nitrogen to areas where levels of this nutrient have been diminished by fire or other means is discussed in Wei and Kimmins (1998). Strains of *Frankia* bacteria are also known to establish a nitrogen-fixing symbiosis with alder (*Alnus* spp.) and myrtle (*Myrica* spp.), two pioneer plant genera of temperate regions often found in areas where nitrogen is the limiting factor (Genoscope, online).

None of the other species-at-risk occurring within the CGC Conservation Area are known to utilize symbioses with nitrogen-fixing bacteria.

Role Of Animals In Pollination And Seed Dispersal

For plants, symbioses with other organisms are particularly important for sexual reproduction, in which animals act as pollinators or seed dispersers in return for nectar or a portion of the seed crop (Jordano 1993, Pellmyr *et al.*. 1996, Kawakita and Kato 2004).

While some plant species are self-fertile or pollinated by wind, others must rely on insects to transfer pollen and allow pollination. This usually occurs when an insect is enticed to visit a flower by the promise of nectar. Floral structure is usually designed to maximize contact of the visiting insect with the pollen-bearing anthers and/or pollen-receiving stigma. Dispersal of seeds by animals is accomplished by two different methods: ingestion and hitch-hiking. Animals consume a wide variety of fruits, and in so doing disperse the seeds in their droppings. Seeds with hooks or sticky surfaces may become attached to animals when they brush against the seeds, often resulting in the seed being transported a considerable distance from the parent plant before falling off or being removed by the animal.

Yellow Lady's-slipper

Throughout its range, yellow lady's-slipper flowers from mid-June to mid-July and is an obligate out-breeder. The flowers attract small bees and various flies. Little carpenter bees (*Ceratina* spp.) have been observed visiting the flowers, although whether they actually aide in pollination is unclear (Stoutamire 1967). According to Stoutamire (1967), plants are pollinated by a number of different species of small bees, primarily adrenid and halictid bees. Andrenid bees have been observed pollinating the flowers of *Cypripedium calceolus* in Europe (Illinois Wildflowers, online). (The North American yellow lady's slipper, *C. parviflorum,* was formerly considered to be the same species as *C. calceolus*). North American yellow lady's-slippers are also visited and sometimes pollinated by a variety of *Diptera*, or flies (Stoutamire 1967).

The tiny dust-like seeds of yellow lady's-slipper contain no stored food reserves, and are too small to act as a food source for fauna. Yellow lady's-slipper in the CGC Conservation Area most likely relies on wind for seed dispersal.

Ram's-head Lady's-slipper

All species of lady's-slippers rely on insects for pollination, though they do not produce any nectar. Lady's-slippers are characterised by the slipper-shaped pouches (modified labellums) of the flowers. This pouch is designed to trap insects visiting the flower, so that they are forced into contact with the reproductive structures. This contact results in the visiting insect being dusted with pollen, and also depositing pollen if it has already been dusted by a previous flower. In this way, insects enable increased transfer of pollen among plants, leading to higher seed production and increased gene flow within populations.

Throughout its range, ram's-head lady's-slipper flowers from mid-May to mid-June and is an obligate out-breeder, pollinated by small and mid-sized bees. Known pollinators of ram's-head lady slipper and the similarly sized sparrow's-egg lady's-slipper (*C. passerinum*) include bees in the genera *Dialictus* (*Lasioglossum*, Stoutamire 1967) and *Megachile* (Van der Pijl and Dodson 1966, Keddy *et al.* 1983, Brackley 1985). Stoutamire (1967) observed pollen-covered *Dialictus caeruleus* and *Dialictus* sp. bees exiting ram's-head lady's-slipper blossoms in Ontario. Flies and other insects visit ram's-head lady's-slipper flowers as well, but do not effectively contribute to pollination (Stoutamire 1967). Nothing has been published regarding pollinators of ram's-head lady's-slipper in Nova Scotia, but nine species of *Megachile* bees and 15 species of *Dialictus* bees which could be potential pollinators are known from the province (Sheffield *et al.* 2003). Blaney and Mazerolle (2007) noted that two dozen or more potential pollinators, insects from families documented as visiting *C. arietinum* in other jurisdictions, are present in Nova Scotia.

The tiny dust-like seeds of ram's-head lady's-slippers contain no stored food reserves and are too small to act as a food source for fauna. No organisms are known to directly contribute to seed dispersal of this species, although white-tailed deer and beaver have been suggested to modify environmental conditions around ram's-head lady's-slipper patches via grazing, which may influcence wind dispersal patterns (Sabourin *et al.*1999). Ram's-head lady's-slipper in the CGC Conservation Area most likely relies on wind for seed dispersal.

Eastern leatherwood

Leatherwood also has separate male and female flowers (Zasada *et al.* 2008). Flowering occurs in April or May, usually two to three weeks before the overstory leaves are out and generally before the spring ephemeral species flower (Zasada *et al.* 2008). For early spring flowering species pollinated by insects, low spring temperatures may limit pollination success by limiting insect activity (*e.g.*, Willson and Schemske 1980). It is possible that pollination of eastern leatherwood may be limited by this environmental factor. Williams (2004) identified small bodied bees (*Halictidae and Andrenidae*) as important pollinators of this species. However, Williams (2004) has also suggested that *D. palustris* is self-compatible (self-fertile) or perhaps capable of producing seed without fertilization (apomictic), as the related *D. mexicana* is known to be (Graves 2008). Thus, it is unclear how strong a role insect pollinators play in successful reproduction of this species. No data on known insect pollinators in Nova Scotia could be found.

The fruits of eastern leatherwood are thin-fleshed with large seeds. Rodents are apparently voracious consumers of the seeds (Kahl and Schulz, personal observation, cited in Zadas *et al.* 2003). Nevling (1962) suggested that fruits of leatherwood are eaten by birds. No published data on known seed dispersal agents in Nova Scotia could be found, though rodents and birds may play roles.

Round-lobed hepatica

Round-lobed hepatica is self-fertile and does not require pollinating insects to produce seed. However, seed set is increased when insect visitors enhance pollen transfer (Motten 1982). Motten (1982) also suggested that solitary bees are the main pollinating insects active in very early spring when round-lobed hepatica is in bloom. Small bees such as honeybees, small carpenter bees, Andrenid bees, or Halictid bees have been observed collecting pollen from flowers of the very closely-related sharp-lobed hepatica (*H. acutiloba,* syn. *Hepatica nobilis* var. *acuta*) (Illinois Wildflowers, online).

Murphy and Vasseur (1995) found that the vast majority of all visits to a monitored population of *H. acutiloba* in northern Ontario were from the red-necked false blister beetle (*Asclera ruficollis*) which was virtually the only insect active during the flowering period. This beetle is present in Nova Scotia (www.BugGuide.net) and it is possible it may act as a pollinator of round-lobed hepatica within the province.

Round-lobed hepatica is known to be a myrmeecochorus species, meaning that it utilizes ants to disperse its seeds. Seeds of myrmecochorus plants have a lipid-rich food body (known as an elaiosome) attached to the outside of the seed. Some ant species take the seeds back to their nest and feed the elaiosomes to their larvae. The seeds are abandoned, unharmed, within the nest or just outside in small heaps of 'garbage', which are often high in organics (Gomez and Bas 2005). Plants which bloom early in spring often use this method of dispersal, and there are several possible benefits to the plant, such as increasing seed dispersal distances, increasing dispersal to potentially suitable microsites, and decreased predation on seeds by seed-eating predators such as rodents (Giladi 2006). Seeds of round-lobed hepatica are rather large (~5 mm x 2 mm). Ants, such as the rough harvester ant (*Pogonomyrmex rugosus*) are thought to play a role in their dispersal in the southern United States (Skidmore and Heithaus 1988). A species of ant occupying a similar ecological role as *P. rugosus* is likely involved in dispersal of round-lobed hepatica seed within Nova Scotia and the CGC Conservation Area. *Aphaenogaster picea* is a common species of ant which is present in Nova Scotia and has been implicated in myrmeecochory elsewhere (Philip, Ward, University of California, pers. comm. 2009). It is possible this species, or one of several *Formica* species known to be present, might play roles in dispersal of round-lobed hepatica seed in Nova Scotia.

Canada buffaloberry

Canada buffaloberry blooms in very early spring, and possesses separate male and female flowers (Stephens 1973, Huxley 1992). Pollinators are therefore required to transfer pollen from male to female flowers. A study of pollination of Canada buffaloberry found that insect visitors to this species were primarily flies from the families *Syrphidae* and *Empididae* (Borkent and Harder 2007).

The seeds of Canada buffaloberry are produced within a red or yellow fleshy fruit. No data regarding dispersal of Canada buffaloberry seeds in Nova Scotia could be found. The berries are one of the most important berries in the diet of grizzly bears in Alberta (Kansas 2002), Black bears are also known to make substantial use of them in late summer and fall in Idaho and the Yukon (Unsworth *et al*. 1989, MacHutchon and Grant 1989) and it is possible that black bears also consume these berries in Nova Scotia. Dispersal via ingestion by bears or other mammals may play a role in dispersal of Canada buffaloberry seeds within Nova Scotia. Quinlan and Cuccarese (2004) stated that this species has low value as a food source for terrestrial birds, although grouse are also known to eat Canada buffaloberry fruits. Seed dispersal via ingestion by mammals may be important in dispersal of Canada buffaloberry seed within Nova Scotia and the CGC Conservation Area.

Wood anemone

Wood anemone is said to be pollinated chiefly by solitary bees attracted to its white color (Great Smoky Plains All Taxa Biodiversity Inventory, online). While no published information is available regarding pollinators of this species in Nova Scotia, there are at least 151 species of solitary bees present in the province (Packer *et al.* 2007), many of which are likely suitable pollinators.

Many species of *Anemone* are myrmeecochorus, meaning that they utilize the collection and dispersal of their seeds by ants (see discussion in round-lobed hepatica section). Mitchell *et al. (*2002) refer to this species as a myrmeecochorus species in the southern Applachain Highlands region of the USA. No published information is available regarding seed dispersing ants utilized by this species in Nova Scotia.

Black Ash

Black ash is primarily a wind-pollinated species (Wallander 2001), so it does not rely on any animal interactions to aid in seed production. Ash trees also rely on wind to disperse their seeds, which are known as keys or samaras (Wallander

2001). A samara is a type of seed with a rigid or membranous, slightly angled wing at one end, which causes the seed to spin as it falls from the tree, potentially increasing dispersal distance. Ash seeds do not have a fleshy coat to attract fruit-eating species which might ingest the fruit and aid in seed dispersal (Wallander 2001). Black ash trees in the CGC Conservation Area do not rely on any animals to aid in seed dispersal.

Cyanolichens

Cyanolichens do not produce seed, and so do not rely on other species for seed dispersal. There is no published data regarding the potential role of fauna species in the dispersal of lichen spores.

Lichen symbioses

Lichens are complex symbiotic organisms which consist of a fungal and an algal partner, which combine to create a lichen thallus. The fungal partner, known as the mycobiont, is an ascomycete or basidiomycete fungus which absorbs nutrients, provides structural support to the lichen and is responsible for respiration. The algal partner, or photobiont, consists of one (or sometimes both) of two main types of algae which are responsible for carbohydrate production via photosynthesis. Most lichens (approximately 90% of total species), contain a green alga (often *Trebauxia*) as the photobiont. The remaining species, known as cyanolichens, contain a blue-green alga (cyanobacterium) instead of (or in addition to) a green alga, as the photobiont. This is often a species of *Scytonema* or *Nostoc*.

All of the lichen species-at-risk occurring in the CGC Conservation Area are cyanolichens. Cyanolichens contain cyanobacteria, which enables them to utilize ('fix') atmospheric nitrogen by converting it to a useable form. They are the only group of lichens which have been given status rankings by NSDNR.

Solorina saccata

All *Solorina* species utilize a species of green algae (*Coccomyxa* sp.) as the primary photosynthesizing partner. They also contain a cyanobacterium (*Nostoc s*p.) as a secondary photosynthesizing partner. The fungal partner is a species of *Ascomycetes* fungus (Brodo *et al.* 2001).

Leptogium lichenoides

All species of Leptogium utilize a species of cyanobacterium (*Nostoc* sp.) as the photosynthesizing partner. The fungal partner is a species of *Ascomycetes* fungus (Brodo *et al.* 2001).

Collema cristatum

All species of *Collema* utilize a species of cyanobacterium (*Nostoc* sp.) as the photosynthesizing partner. A species of *Ascomycetes* fungus acts as the fungal partner (Brodo *et al.* 2001).

Summary

The proposed Project will not have an impact on symbiotic relationships within the CGC Conservation Area. Plant symbioses with mycorrhizal fungi will not be affected. Soil conditions within the CGC Conservation Area (such as pH, soil types, moisture level, grain size, and organic content) will not be affected by the proposed Project, so soil fungi will not be impacted. No logging or spraying of fungicides which might affect fungal communities will occur.

Plant symbioses with nitrogen-fixing soil bacteria will not be affected. As outlined in the preceding paragraphs on soil fungi, soil conditions will not be impacted, and so soil bacteria will not be impacted.

The roles of animal species in pollination and seed dispersal will not be affected. Populations of pollinating insects such as bees, beetles, and flies within the CGC Conservation Area will not be impacted by the proposed Project. Species of mammals potentially playing roles in seed dispersal will not be significantly affected, as no hunting or trapping will occur within the CGC Conservation Area. Mammal habitat within the CGC Conservation Area will not be affected.

The proposed Project will not have an impact on lichen symbioses. The component species of the lichen species-at-risk occurring within the CGC Conservation Area will not be affected by the proposed Project.

Table 3. Summary Table of Ecological Requirements of Species-at-Risk Occurring in the Conservation Area. See text for further details.

Species	Parameter											
	Landscape Position	**Proximity to Forest Edges/Exposure**	**Climate**	**Soil Moisture**	**Humidity**	**Ground and Surface Water Quality**	**Acid Rain and Air Quality**	**Temperature (Min to Max)**	**Soil and Substrate Physical Characteristics**	**Soil and Substrate pH Values**	**Species Interactions**	**Successional Stage**
Yellow lady's-slipper	Open and forested areas .Near gypsum or limestone deposits in NS .	High tolerance of edges and exposure	Warm summer subgroup (b) of the humid continental climate zone (Df).	Facultative wetland (FACW) species	Low to High humidity	Not applicable, species relies primarily on precipitation for water supply	No data available	Zone 2a (-42.8 to -45.5°C) To Zone 6a (-20.6 to -23.3°C)	Strongly associated with calcareous soils. Soils rich in nutrients and organics, though also occurs on poor soils.	Slightly acid to slightly alkaline pH (pH around 7)	o Utilizes at least two species of Tulasnellaceae fungi, also *Rhizoctonia subtilis*. o Pollinated by small bees and various flies. o Seed dispersed by wind.	Wide range of habitats. On proposed Project site, it is most abundant in previously disturbed areas.
Ram's head lady's-slipper	Thin soils in mixed hardwood /conifer forests over calcareous soils, karst areas	Moderate tolerance of edges and exposure	Warm summer subgroup (b) of the humid continental climate zone (Df).	Facultative wetland (FACW) species. Occurs in uplands in NS	Low to High humidity	Not applicable, species relies primarily on precipitation for water supply	No data available	Zone 5 (-28.9 to -23.3°C) to Zone 8 (-12.3 to -6.6°C)	Sandy loam soil in NS.	Average pH of 6.8.	o Likely utilizes a Tulasnellaceae fungus, (most *Cypripedium* orchids do). o Pollinated by small and mid-sized bees. o Seed dispersed by wind	Mid-successional forests formed from old disturbances.
Eastern leatherwood	Mesic, relatively rich, mature hardwood forests or mixed conifer-hardwood forests, also dry uplands.	Shaded closed forest canopy conditions Low tolerance of edges, and exposure	Warm summer subgroup (b) of the humid continental climate zone (Df).	Facultative wetland (FACW) species	Moderate to High humidity	Not applicable, species relies primarily on precipitation for water supply .Tolerant of hard surface water in calcareous areas.	No data available	Zone 1 (< -45.6°C) To Zone 7b (-12.3 to -14.9°C)	Well-drained, sandy to sandy loam soils., often calcareous in Nova Scotia.	Approaching neutrality (pH 6.8 to 7.2)	o No published data on mychorizal associations available, though likely utilizes mychorizal symbioses to some degree. o May be pollinated by Halictidae and Andrenidae bees. o Rodents and birds may ploy role in dispersal.	Relatively mature forests with closed canopies.
Round-lobed hepatica	Shady wooded areas with little other ground vegetation and dry acidic soils,	Shaded/ partly shaded conditions. Moderate tolerance of edges and exposure	Warm summer subgroup (b) of the humid continental climate zone (Df).	Non-wetland species	Low to High humidity	Not applicable, species relies primarily on precipitation for water supply	No data available	Zone 5 (-28.9 to -23.3°C) to Zone 8 (-12.3 to -6.6°C)	Deep loam or clay soil containing leaf mould, Also sandy to loamy soils.	Acidic soils, pH below 6.8	o Mychorizal associations with several Glomeromycota fungi species. o Pollinated by solitary bees, possibly blister beetles. o Relies on forest ants for seed dispersal.	Occurs in forests of a range of maturity levels.
Wood anemone	Intervales, along streams with calcareous and slate ledges, shores and thickets in clearings and streamsides.	Shaded/ partly shaded conditions. Moderate tolerance of edges and exposure	Warm summer subgroup (b) of the humid continental climate zone (df).	Facultative upland species (FACU)	Low to High humidity	Not applicable, species relies primarily on precipitation for water supply	No data available	zone 2b (-40.0 to -42.7°C) To zone 7b (-12.3 to -14.9°c)	Sai damp, rich, mucky soils	No published information on soil pH available	o No specific data available, though likely utilizes mychorrizal associations. o Pollinated by solitary bees. Relies on forest ants for seed dispersal	Reported to occur only in mature natural stands in New Brunswick.
Canada buffaloberry	Gypsum outcrops, waste rock piles and slopes	Along edges, such as gypsum or talus slopes and along coasts. High tolerance of edges and exposure	Warm summer subgroup (b) of the humid continental climate zone (Df).	Obligate upland species (UPL)	Low to moderate humidity	Not applicable, species relies primarily on precipitation for water supply	No data available	Zone 1 (< -45.6°C) to Zone 6a (-20.6 to -23.3°C)	Sandy, gravelly, or rocky soils,.	Calcareous soils with neutral to alkaline pH, usually over 7.2	o Utilizes nitrogen-fixing *Frankia* bacteria. o Pollinated by Syrphidae and Empididae flies. Seeds possibly dispersed by mammals.	One of first woody shrubs to colonize disturbed areas in NA. Used in mine reclamation in western NA
Black ash	Typically grows in bogs and swamps, along streams, or poorly drained areas which flood seasonally.	Shade-intolerant species. High tolerance of edges and exposure	Warm summer subgroup (b) of the humid continental climate zone (df).	Facultative wetland (FACW) species	High humidity	Not applicable, species relies primarily on precipitation for water. Tolerant of hard surface water in calcareous areas.	No data available	Zone 2b (-40.0 to -42.7°c) to zone 6b (-17.8 to -20.5°c)	Peat and muck soils, sands and loam underlain by sandy or clayey till,	Strongly acid (pH 4.4) to moderately alkaline(ph 8.2) soils	o No data available, likely utilizes mychorrizal symbioses to some degree. o Does not rely on other organisms for pollination or seed dispersal.	Relatively young forest with rather open canopy in which to grow. Pioneer species which colonizes disturbed areas.
Solorina saccata	Calcareous soil or rock , moist areas on tundra	Shaded areas, with high humidity. Low tolerance of edges, and exposure	Warm summer subgroup (b) of the humid continental climate zone (df).	Not applicable, species primarily grows on rock	High humidity	Not applicable, species relies primarily on precipitation as a water source	No data available, cyanolichens negatively affected by acid rain.	Tolerant of very cold temperatures, occurs in northern NA.	Calcareous rock or soil.	Neutral (pH=7) to alkaline substrates (pH>7).	o A green alga (*Coccomyxa* sp.); and a cyanobacterium (*Nostoc* sp.) are photosynthesizing partners . o Fungal partner is an Ascomycetes fungus.	No specific data, but cyanlichens tend to occur in mature forests
Collema cristatum var cristatum	Bare calcareous rock, also limy soil, among mosses	Partly exposed sites, Low to moderate tolerance of edges, and exposure	Warm summer subgroup (b) of the humid continental climate zone (Df).	Not applicable, as this species primarily grows on rock	No specific information available, though cyanolichens prefer high humidity.	Not applicable, species relies primarily on precipitation as a water source	No data available, cyanolichens negatively affected by acid rain.	Tolerant of very cold temperatures, occurs in northern NA.	Bare calcareous rock, also occur on limy soil or among mosses	Neutral (pH=7) to alkaline substrates (pH>7).	o Photosynthesizing partner is a cyanobacterium (*Nostoc* sp.). o Fungal partner is an Ascomycetes fungus.	No specific data, but cyanlichens tend to occur in mature forests
Leptogium lichenoides	Calcareous rocks, among mosses, on bases of trees having basic bark	Partly exposed sites, Low to moderate tolerance of edges, and exposure.	Warm summer subgroup (b) of the humid continental climate zone (Df).	Not applicable, as this species primarily grows on rock	No specific information available, though cyanolichens prefer high humidity.	Not applicable, species relies primarily on precipitation as a water source	No data available, cyanolichens negatively affected by acid rain.	Tolerant of very cold temperatures, occurs in northern NA.	Calcareous rocks, among mosses or on the bases of trees with basic bark	Calcareous rock with neutral to alkaline ph (pH 7 or more), also bases of trees with alkaline bark	o Photosynthesizing partner is a species of cyanobacterium (*Nostoc* sp.). o Fungal partner is an Ascomycetes fungus.	No specific data, but cyanlichens tend to occur in mature forests

3.4 Conclusion

The CGC Conservation Area is a large, continuous expanse of calcareous habitat, which supports considerable populations of vascular plant and cyanolichen species of concern. None of the environmental conditions discussed in the previous subsections will be negatively affected by the development of a gypsum mine to the north of the proposed Conservation Area

- Landscape position will not be affected;
- Proximity to forest edges/exposure will not be affected;
- Local climate will not be affected;
- Soil moisture levels will not be affected;
- Humidity regime will not be affected;
- Ground and surface water quality will not be affected;
- Acid rain and air quality will not be affected;
- Temperatures will not be affected;
- Soils and substrates physical characteristics will not be affected;
- Soil and substrate pH values will not be affected;
- Natural patterns in forest succession will not be affected;
- Air quality will not be affected; and
- Species interactions will not be affected.

The Conservation Area will be undisturbed by the proposed Project, and will be protected by CGC to ensure it remains undisturbed. It will never be logged, nor will further anthropogenic disturbances be permitted, unless required to protect species at risk.

Until recently, *C. parviflorum* var. *pubescens* was considered a subspecies of the European yellow lady's-slipper, *C. calceolus.* Population viability analysis modeling has shown that *C. calceolus* can persist in a protected area where there are only slow changes in habitat through secondary forest succession (Nicolè *et al*. 2005). No changes in habitat are predicted to occur in the CGC Conservation Area, aside from natural succession. As succession tends to occur patchily in forests such as that on the CGC Conservation Area, there should always be suitable habitat available for yellow lady's-slipper within the CGC Conservation Area.

Nicolè *et al.*'s (2005) population viability analysis also indicated the importance of habitat versus individual conservation for the protection of *C. calceolus* populations. Over 40 ha of potentially suitable habitat will be preserved and protected within the CGC Conservation Area, and over 3230 stems, representing several hundred plants ranging from seedlings to large established clumps, will remain undisturbed.

The current abundance of yellow lady's-slipper on the Project site near disturbed areas indicates that the yellow lady's-slipper population in this area is temporarily elevated above 'normal' levels (*ie*., what the level would be if historic mining had not occurred). It is unclear why the yellow lady's-slipper is so abundant in some disturbed areas, though it is likely due to reduced competition on gypsum-rich soils. The heavy reliance of yellow lady's-slipper on mychorrhizal relationships early in the life history may give this species an advantage on these nutrient-poor gypsum-rich soils, on which other species may have trouble becoming established. As these disturbed areas continue to be naturally revegetated, approaching pre-disturbance conditions, the resulting higher soil nutrient levels and vegetation diversity will likely result in the yellow lady's-slipper population decreasing to pre-disturbance levels.

The dominant ecological characteristics currently present within the CGC Conservation Area, such as elements of composition, structure, function, and ecological processes are not predicted to be affected beyond the limits of their expected natural ranges of variation. The ecosystem of the CGC Conservation Area will remain resilient to most perturbations imposed by natural environmental dynamics.

The Conservation Area will support detailed monitoring plans and/or research plans on species-at-risk occurring within its boundaries. Protection plans for species-at-risk known from the Project site are discussed in the following section.

4.0 FRAMEWORK OF PROTECTION PLAN FOR SPECIES-AT-RISK IN THE EXTRACTION AREA

Over the life of the Project, some specimens of flora species-at-risk will be removed, due to their location within the planned extraction area of the proposed Project. Species-at-risk present in the planned extraction area are yellow lady's-slipper, black ash, Canada buffaloberry, and the lichens *S. saccata* and *C. cristatum*. To protect species of concern which will lose specimens growing in the extraction area, CGC will develop a Flora Species of Concern Protection Plan to ensure all specimens of species of concern located elsewhere on the site are protected**.** This policy will supplement the Environmental Protection Plan (EPP), which will be developed prior to development. In addition, a detailed habitat assessment will be conducted for each location of species-at-risk prior to removal.

Proposed protection measures to be incorporated into CGC's Flora Species of Concern Protection Plan are briefly discussed in the following subsections. While targeting flora species at risk, many of these measures will protect other valued ecological resources as well. CGC's final Flora Species of Concern Protection Plan will be developed once the Project receives regulatory approval and prior to development.

Once operational, CGC will continually evaluate these protective measures and modify approaches as required to ensure impacts to flora species-at-risk which are represented within the extraction area are minimized

4.1 Exclusion Zones

The Policy will include establishing 'no-go' zones in areas where flora species of concern are known to occur. Employees will be required to stay out of these areas, which will be marked in the field. CGC will also encourage employees to stay on existing trails wherever possible. Persons on foot will be encouraged to watch their footing when traveling near known locations of species of concern.

4.2 Buffer Zones and Minimal Habitat Disturbance

For species of concern located in the vicinity of approaching mining activity, known specimens will be protected by a buffer zone of undisturbed habitat until they must be removed. Very little published information is available regarding buffer zones established in other jurisdictions around the species of concern occurring on the proposed Project site. Some data on buffers zones enacted around ram's head lady's-slipper is available (OMNR 2004, Brzeskiewicz 2000), however this is not applicable as no ram's head lady's-slipper occurs within the proposed extraction area. These buffer zones will remain intact until clearing of the area is absolutely necessary for extraction purposes. Delaying the removal of these specimens until absolutely necessary will maximize their lifespan and reproductive potential. For species such as black ash, for which transplantation may be possible, this may result in production of additional seedlings which may then be transplanted to suitable habitat in the Conservation Area. Minimizing disturbance of specimens of species-at-risk to be removed until absolutely necessary increase the opportunities for these species to recruit naturally to areas outside of the planned extraction footprint.

4.3 Motorized vehicle restrictions

To further protect species-at-risk on the proposed Project site, CGC will restrict all motorized vehicles to established trails on the site. If, for exploration purposes, any motorized vehicle must travel off-road on the site, a qualified terrestrial ecologist will flag an appropriate route during the appropriate season, prior to any off-road activities. This will minimize disturbance of specimens to be removed until absolutely necessary and will increase their chances of recruiting naturally to areas outside of the planned extraction footprint.

4.4 Training of staff to recognize and report species

CGC will encourage employees to familiarize themselves with the flora species of concern present on site to further minimize disturbance to these species. Posters depicting the identifying features of each species of concern known from the site will be posted in common areas of the CGC mine office. Familiarizing CGC employees and in some cases contractors who work in karst areas to identify species associated with such habitat may result in the discovery of additional occurrences of these species.

4.5 Seed Collection/Transplantation

CGC is working with the Confederacy of Mainland Mi'kmaq to develop a monitoring program for black ash at the site. The program will involve monitoring for general health, possible seed harvesting and more detailed survey work in the general area for additional specimens. Some specimens of black ash may also be transplanted into areas of the Conservation Area where the species already occurs.

Transplantation is generally not planned for most species, particularly the lady's-slippers, because they are known to have poor long-term survival rates post-transplantation. NSDNR generally does not recommend this option as mitigation for the loss of flora species of concern. Some experimental transplantation of species-at-risk specimens from areas to be disturbed to protected areas may possibly be conducted early in the life of the mine. Depending on the long-term success of these transplants (> three years for yellow lady's-slipper, two years for other species), additional transplantation may be attempted.

4.6 Report Illegal Collection or Picking

Illegal harvesting of wild species is a major threat to many plant species, particularly slow-growing species with long periods to maturity and low rates of reproduction, such as orchids. In Nova Scotia, the ram's-head lady's-slipper is protected under the *NSESA* and persons caught harming this species or its habitat are subject to fines. CGC employees will be alert for evidence of illegal collecting of ram's-head lady's-slipper and will report any such evidence to the NSDNR.

4.7 Collection of Additional Species Knowledge

For species with poorly-known life histories, or which are in general poorly-known within Nova Scotia (such as the lichen *Solorina saccata*), additional habitat assessments may be undertaken to increase the knowledge of these species. Surveys in other areas of potentially suitable habitat elsewhere in the province will also be considered.

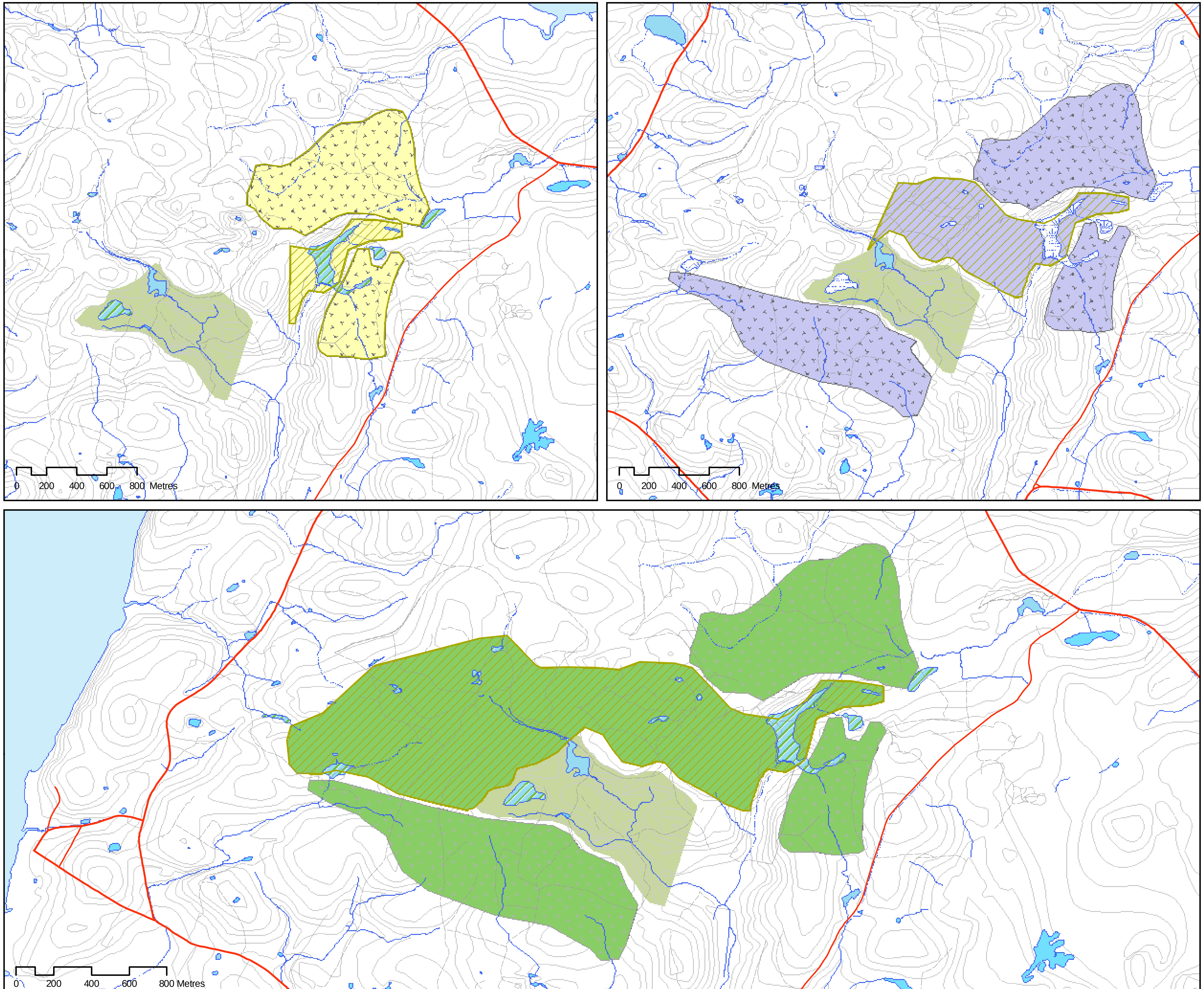
4.8 Maximize Use of Native Species in Reclamation

To minimize the environmental effects of the Project on local plant communities, CGC will use native seed mixes or mixes recommended by the province whenever possible during the reclamation phase. All seed mixes will be free of noxious weed species, which potentially could compete with the species-at-risk occurring on the Project site or within the CGC Conservation Area. If native seed mixes cannot be obtained, seed mixes containing species which are already well established in Nova Scotia and which are not known to be aggressive weeds in any habitat types known to occur in the vicinity of the Project will be used. All trees to be planted shall be native species known to occur in the vicinity of the Project site.

5.0 OPERATIONS MANAGEMENT

A detailed Mine Development Plan, detailing the phased schedule of extraction for the proposed mine, will be prepared by CGC once the Project receives regulatory approval. This plan will take into account species-at-risk affected by each extension phase and will outline mitigation activities required for Project approval.

Figure 4 depicts the planned extent of the proposed Project at 20, 40 and mine life (~70 year) intervals. Table 4 depicts the current populations of flora species-at-risk within the extraction area and their approximate date of removal. A draft framework for a Protection Plan for species-at-risk occurring within the proposed extraction and stockpile areas was provided in Section 4.0 of this document. Reclamation of the proposed Project is discussed in Section 6.0.



LEGEND:

20 Yr Mine Extent
- Extraction Area - 20 yr
- Stockpiles - 20 yr

40 Yr Mine Extent
- Extraction Area - 40 yr
- Stockpiles - 40 yr

Mine Extent - Full Mine Life
- Extraction Area
- Stockpiles
- Proposed Conservation Area
- Contours (topo)

SOURCE:
Nova Scotia Topographic Database (SNS&MR - NS Geomatics Centre)
Field Surveys: CRA Ltd.
Mine Layout: CGC Inc.

N

PROJECTION:	DRAWN / CHECKED BY:	MAP ANGLE:
UTM z20 NAD83	JJP / PO	0° North
SCALE: 1:25,000 1:20,000	DATE: October 6, 2009	PROJECT NO: 820677K

820677K (09) GIS_DA004_SAR_Project Phase.mxd

figure 4
CONCEPTUAL PLANNED EXTENT OF PROJECT
20, 40 YEARS & FULL MINE LIFE
Miller's Creek Extension Project
CGC Inc. - Windsor Plant
Hants County, Nova Scotia

CONESTOGA-ROVERS & ASSOCIATES

Table 4. Summary of Extraction Schedule as it Relates to Species-at-Risk Locations

Species	Current Total Number of specimens[1] known on Project site	Years 0- 20		Years 20-40		Year 40-70	
		# to be removed[2]	Location of Specimens	# to be removed[2]	Location of Specimens	# to be removed[2]	Location of Specimens
Yellow lady's-slipper	7936	1877	Wetland 1m northeastern southeastern edges of proposed Pit	1571	Centre of Project site, near historically mined areas	300	Along Shaw Brook, above Dump Pond
Black ash	37	19	Wetlands 1 and 2	0	N/A	5	Wetlands 8 and 10
Canada buffalo-berry	447	0	N/A	195	Centre of Project site, near historically mined areas	0	N/A
Solorina saccata	303	53	West of Wetland 1	0	N/A	0	N/A
Collema cristatum var. cristatum	3 locations (each <9m²)	1 location (<9m²)	West of Wetland 1	0	N/A	0	N/A

[1] Number of stems for yellow lady's-slipper
[2] Numbers of each species within extraction area may fluctuate naturally over time, numbers provided are based on most recent counts (2008)
N/A = Not applicable

6.0 RECLAMATION

Reclamation of land disturbed by past or ongoing surface mining is an essential component of mitigating impacts to terrestrial flora. Where reclamation is not completed and a landscape remains disturbed, terrestrial habitat may be impacted in the long term. The goal of reclamation is to produce a landscape that is safe, stable and compatible with the surrounding landscape and final land use. This is generally achieved by grading, contouring, capping with soil, revegetating, flooding mined areas, and allowing nature to recolonize. CGC has been turning previously mined or disturbed land back to a natural state for decades – land that is now used for wildlife, farming and recreation.

Reclamation of the proposed Project site will involve both natural and progressive reclamation. Each of these processes is discussed in the following subsections.

6.1. Natural Reclamation

Natural reclamation of a site involves allowing natural revegetation processes to reclaim a disturbed site. Natural revegetation relies upon the establishment of plants growing from three primary sources:

1) those already present on the site;
2) plants lying dormant in the soil as seeds or roots (propagules); and
3) seeds from nearby plants, carried by the wind or deposited by wildlife.

Natural reclamation relies on natural plant succession, which is the predictable, gradual, and sequential change in plant communities over a given period of time. As time passes, natural vegetation communities become more complex and diverse, creating microclimates for additional species to colonize. In most temperate forest areas, an area of bare soil, if left undisturbed, will naturally progress from: (1) annual grasses and forbs (broadleaf plants); to (2) perennial grasses and forbs; then to (3) shrubs, vines and briars; followed by (4) young forest tree species; and finally (5) a mature/climax forest. While a mature forest will obviously not be present immediately following cessation of disturbance, local vegetation will begin to colonize a disturbed area within just a few weeks to months.

Natural reclamation has already been proven to be quite effective at revegetating several old quarry sites in Hants County. Many active and inactive CGC properties show considerable natural revegetation today. These sites include Meadow Pond, Miller's Creek, Major King Quarry, Baxter Marsh, Hunter Quarry, Eagle Swamp, and the proposed Miller's Creek Mine Extension site. An excellent example of natural reclamation on a gypsum quarry site is CGC's Meadow Pond Quarry, which was last mined in the early 1930s. As site reclamation was not a regulatory requirement at that time, reclamation of this site has occurred entirely naturally, to the extent that the majority of the site is vegetated today. Areas which were covered by grasses and forbs in the 1950s (as evidenced by aerial photographs) today support forests approaching maturity. Trees include red maple, white and red spruce (*Picea alba, P. rubens*), balsam fir, American beech, largetooth aspen (*Populus grandidentata*), trembling aspen (*P. tremuloides*) and white birch. Shrubs established in the area include dogwoods (*Cornus rugosa, C. alterniflora*), speckled alder (*Alnus incana*), possum-haw viburnum (*Viburnum nudum*), Virginia rose (*Rosa virginiana*) and American fly honeysuckle (*Lonicera canadensis*). The ground vegetation layer contains wild lily-of-the-valley (*Maianthemum canadense*), dwarf dogwood, yellow clintonia, bracken fern, and various aster and fern species. The quarry pits at Meadow Pond are now filled with water and support an active wetland complex over 20 ha in size. This wetland supports a variety of waterfowl and aquatic species and is used by a local wildlife group for fishing and other recreational uses.

In addition to the above-listed native vegetation, the Meadow Pond property today supports large numbers of both yellow and ram's-head lady's-slippers, within and adjacent to areas which have been previously disturbed. Both of these species have rather specific habitat requirements. Canada buffaloberry has also colonized previously disturbed areas of this site. It is very encouraging to note that habitat for both ram's-head lady's-slipper and yellow lady's-slipper has persisted on the site post-mining, and that suitable habitat for yellow lady's-slipper and Canada buffaloberry has since developed naturally in disturbed areas without the benefit of reclamation.

The proposed Miller's Creek Mine Extension site also displays abundant evidence of historic mining activities and natural reclamation, particularly near the centre of the site. The pond known as Dump Pond or Beaver Pond, located in the northern portion of the planned Conservation Area, is in fact a man made pond which supports edge habitat with plans found in wetland area. A built-up road runs north to south past the eastern edge of this pond, and travels over an old stockpile which is now forested. Canada buffalo-berry is very abundant on this road, and yellow lady's-slipper is abundant on the western slope leading down to the pond. Ram's-head lady's-slipper has also been found growing just a few metres off this road, in areas that have likely been disturbed within the last several decades. Many other native species occur around Dump Pond, including red maple, balsam fir, hawthorn (*Craetagus* sp), white spruce, alder , cherry, white birch, and juniper (*Juniperus communis*). Ground vegetation includes various asters, sedges (*Carex spp*.), and dwarf dogwood. Hemlock saplings have been observed growing around other old quarry pits on the site.

All but one of the CGC sites which supported historical mining activities and was surveyed in 2008 support considerable populations of yellow lady's-slipper and Canada buffaloberry today. These species are relatively common at the Major King site, the existing Miller's Creek site, Meadow Pond, Eagle Swamp, Baxter Marsh, and the proposed Miller's Creek Mine Extension site. (Hunter Quarry, the only historically-mined site surveyed which did not support yellow lady's-slipper or Canada buffaloberry, has also been extensively grazed by livestock). None of these sites have received any progressive reclamation. The fact that yellow lady's-slipper and Canada buffaloberry are still present around the exposed outcrops, after they have been disturbed by surface mining, is strong evidence of the resiliency of these populations. In fact, one might go so far as to note that yellow lady's-slipper and Canada buffaloberry appear to be more abundant in previously disturbed gypsum areas, as they are most common around old mine workings on the CGC sites. Some vascular plant species are more common in disturbed areas because the disturbance caused a shift in the ecological balance and allows them to become established and spread. Slow-growing species with specific habitats, such as yellow lady's-slipper and Canada buffaloberry, generally do not fall into this category. These species are present near the exposed outcrops because they prefer the calcareous soils. It may be that quarrying activity has removed the overburden and increased surface exposure of the underlying gypsum, thereby creating suitable habitat for these gypsum-loving species. St Croix, the only site with no evidence of historic quarrying activity, had no Canada buffaloberry and the relatively small numbers of yellow lady's-slipper present were mostly limited to exposed gypsum outcrops.

It is particularly encouraging to note that yellow lady's-slipper has naturally colonized stockpiles on at least two CGC sites. These stockpiles are estimated to have been last used in the 1950s and 1960s, so these piles have been undisturbed for no more than 50 to 60 years. Yellow lady's-slipper specimens are known to have very long life spans and usually take 10-15 years to reach blooming size. Specimens of the closely related *C. calceolus* are known to live more than 100 years (Kull 1988). Thus, yellow lady's-slipper has succeeded in colonizing these stockpiles within just a few generations, without benefit of progressive reclamation. Canada buffalo0berry has also been observed growing on these stockpiles, as well as in an area disturbed at recently as 12 years ago. Progressive reclamation of the stockpiles to be created on the proposed Miller's Creek Mine Extension site will no doubt decrease the time frame required for yellow lady's-slipper and Canada buffalo-berry to become established in reclaimed areas.

6.2. Progressive Reclamation

Progressive reclamation is a process which essentially helps to speed up the process of natural revegetation, by assisting in providing suitable growing conditions, seeds, and saplings. Progressive reclamation and revegetation of the site will help to mitigate the long-term effects of deforestation on the project site and restore non-critical habitat for flora. As the mine progresses westward over the next several decades, the previously mined area will undergo progressive reclamation. Dozers and excavators regrade and contour the side slopes of piles to ensure that they are stable. Rock lined ditches are constructed as necessary, to control run-off and prevent erosion of the exposed soils.

Topsoil and root mat from the site will be stockpiled during the development period for use in reclamation. These materials will act as a growing medium and as a source of seeds and propagules of existing local species and will aid greatly in re-establishment of these species. The existing scrub plant material and debris will also be re-used in the reclamation as a growing medium, placed as the final layer on top of the contoured lands. This will decrease erosion and provide a range of microclimates to enhance natural establishment of vegetation. Some of the stockpiled material will be redistributed, seeded with native grasses and wildflowers and planted with a mix of native deciduous and hardwood trees. As the reclaimed and reforested areas mature, much of this structural complexity of the original forest will be regained and additional flora habitat will be created. Thus, natural revegetation processes combined with an active reclamation plan should result in the reclamation period being significantly shorter than it would be if left to nature alone.

CGC will develop a detailed reclamation plan in consultation with NSDNR and NSE with input from other stakeholders, including the community. The progressive reclamation plan will be based on the natural seral stages of reforestation. It will be integrated with the mine plan and will address the key areas of land use, water resources, restructuring and recontouring, revegetation, restoration of services, aesthetics and safety, and future land use.

6.3 Progressive Reclamation Options

As the mine extends westward across the planned footprint, progressive reclamation activities will occur in its wake. CGC will consider many options for creation of effective and functional wildlife habitat.

Prior to initiation of mining activities or creation of stockpiles in an area, the area will be cleared of merchantible timber and grubbed. The topsoil and root mat will be stockpiled for later use in reclamation. The area will then be mined or a stockpile created. Once mining activities have been completed in an area, the area will be backfilled (pits) or contoured (stockpiles) to ensure all slopes are stable and safe. Deep pits will be allowed to flood, and wetland habitat will develop around the edges of these lakes. Wetland native seed mixtures may be utilized to aid in establishment of vegetation in these new wetlands. Topsoil and root mat stockpiled from recently-cleared areas will then be spread over the area to allow establishment of native vegetation. These materials will act both as a growing medium and an excellent source of seeds and propagules of suitable local plant species and will aid greatly in natural re-establishment of these species. Small knolls, ridges and depressions may also be created, to create additional habitat complexity and mimic the previously existing landscape of gypsum ridges and sinkholes. Some areas of exposed gypsum may be left bare to recreate gypsum outcrops for calciphile plant species such as yellow lady's-slipper and Canada buffalo-berry, which have been shown to naturally recolonize disturbed calcareous areas without benefit of reclamation. Comparison of non-reclaimed areas with those subject to progressive reclamation practices will allow examination of the role of competition in the successful colonization of yellow lady-slipper and Canada buffaloberry.

In addition to the natural reclamation discussed above, CGC will consider additional revegetation practices to aid in reclamation of the site. Progressive reclamation activities will include seeding of reclaimed areas to establish ground cover vegetation and minimize erosion due to runoff. Seed mixes to be used will include a number of agronomic and native species. Agronomic species to be used are those that are already well established throughout the Province. These species should be available though a number of seed suppliers, such as Halifax Seed, Pickseed, Veseys Seeds, and perhaps others.

Consideration may be given to having all seed coated (prilled). Prilled seed has been coated with a thin layer of fertilizer, lime, and/or inoculant. This optimizes the chances of successful germination and establishment of the seed. While prilled seed is more expensive than non-prilled seed, the price may be roughly equivalent to non-prilled seed in the end, as less prilled seed is required. Seed will be applied at the rate recommended by the supplier or as recommended by local resource managers.

Once the ground vegetation is well established, shrubs and trees will begin to colonize. CGC will aid in reestablishment of woody species by planting a mixture of native trees and shrubs on the site. In addition, Canada buffaloberry may be planted to aid in soil fertility. CGC may investigate collaborating with local wild flora nurseries to provide a supply of local flora species, particularly Canada buffalo-berry, for establishment on the reclaimed areas.

CGC will also investigate the feasibility of transplanting patches of vegetation, via specially modified front-end loader, which can remove a 3m x 3m section of topsoil and root mat for immediate placement elsewhere, effectively transplanting it. These vegetation 'grafts' have been shown to be reasonably effective on other mine sites within Nova Scotia. This would likely work best in vegetated areas to be cleared which are in the early stages of regrowth, when trees present are still quite small and shallow-rooted. Grafts would be planted at the same depth as they were originally situated, and would be watered well upon initial placement. Large patches of yellow lady's slipper could be transplanted in this way, with much less disturbance to plant roots than if they were transplanted individually. This would also increase the chances of successfully transplanting the root mycorrhizal fungi this species relies on, as a larger volume of soil would be transplanted along with the plants. Placing a mosaic of these grafts on an area to be revegetated would greatly increase the speed at which local species would colonize these areas.

CGC will also develop monitoring plans to monitor the success and rate of revegetation activities. An outline of a suggested monitoring plan is provided in Section 7.2. Fauna surveys may also be conducted on a regular basis on the reclaimed areas to document use of the reclaimed habitat by wildlife.

As the reclaimed and revegetated areas mature, much of the structural complexity of the original forest will be regained and additional flora habitat will be created. Thus, natural revegetation processes combined with an active reclamation plan should result in the reclamation period being significantly shorter than it would be if left to nature alone.

6.4 Reclamation Schedule

A detailed Mine Reclamation Plan, detailing the phased schedule of reclamation for the proposed mine, will be prepared by CGC once the Project receives regulatory approval. The framework of the reclamation schedule for the proposed Project is provided below. The timeline is approximate, as unforeseen events may affect the progression of scheduled activities and cause deviations from the proposed timeline.

Table 5. Framework of Reclamation Schedule for Proposed Project. Areas depicted on Figure 5 .

Area	Conceptual Cessation of Mining/ Stockpiling Activities	Backfilling and/or Contouring and Grading	Seeding	Planting of Trees and Shrubs	Initiation of Reclamation Monitoring	Other Reclamation Activities
1	Year 20	Year 15	Year 17	Year 22-23	Year 21	o Transplantation of vegetation grafts, including yellow lady's slipper o Creation of wetland habitat for black ash
2	Year 40	Year 35	Year 37	Year 42-43	Year 41	o Transplantation of vegetation grafts, including yellow lady's slipper o Creation of wetland habitat for black ash
3	Year 70	Year 65	Year 67	Year 72-73	Year 71	o Continuation of reclamation activities

Note 1: Actual year that activity will be completed is dependent on production volumes and the amount of material moved annually.

Note 2: Some of these activities will be ongoing throughout the development of the mine.

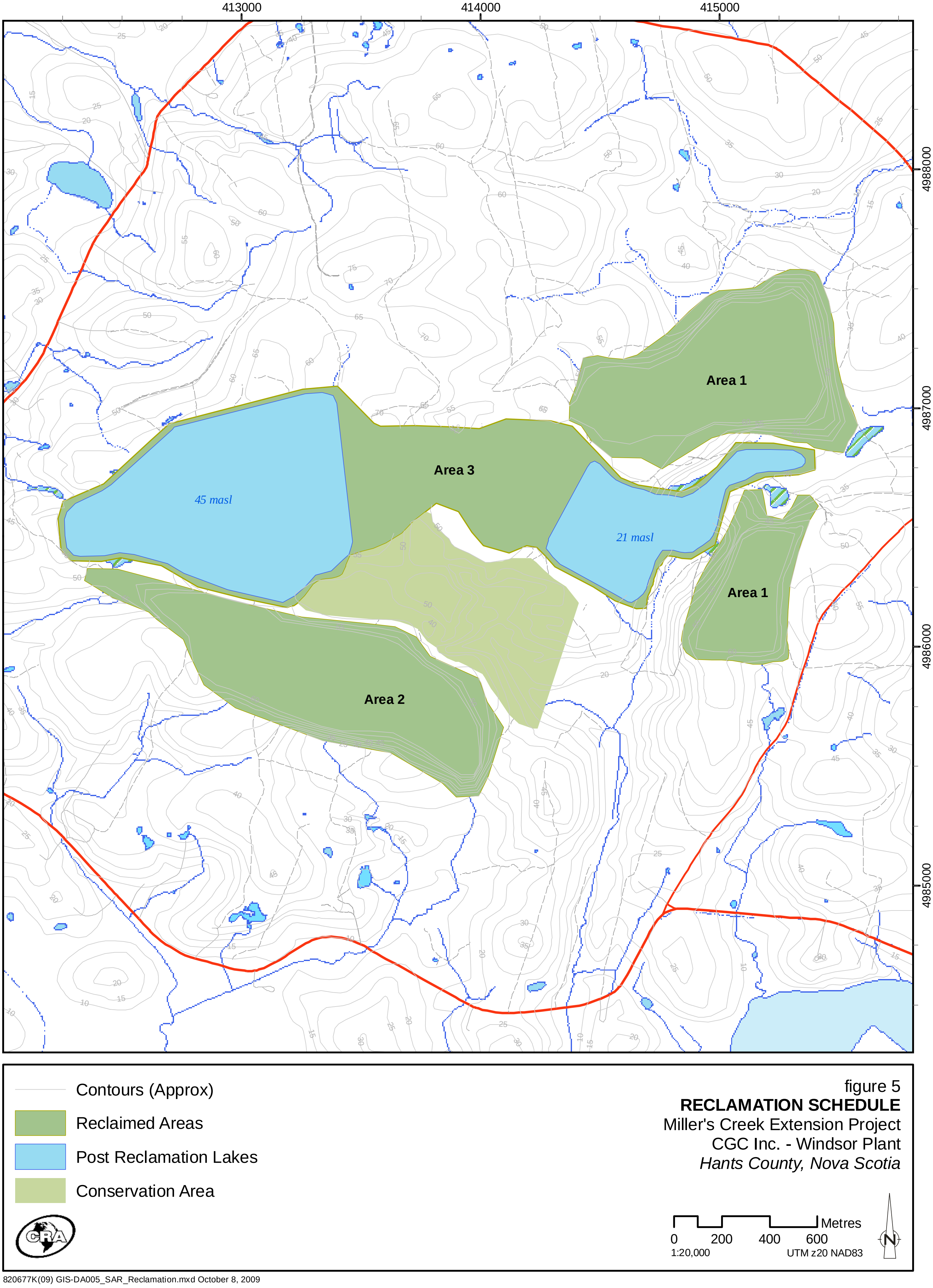


figure 5
RECLAMATION SCHEDULE
Miller's Creek Extension Project
CGC Inc. - Windsor Plant
Hants County, Nova Scotia

820677K(09) GIS-DA005_SAR_Reclamation.mxd October 8, 2009

As with any mitigative activities, knowledge deficiencies exist regarding the potential outcome. These knowledge deficiencies, and steps proposed to correct them, are summarized in Table 6.

Table 6. Knowledge Deficiencies Regarding Species-at-Risk and Mitigative Actions for the Miller's Creek Extension Project.

Knowledge Deficiency	Possible Steps to Correct	Will/Has Project Address(ed) Deficiency?	Rationale
Time required for ram's-head lady's-slipper to colonize reclaimed areas	Monitoring of vegetation of reclaimed areas	Project will address deficiency	A project-specific Reclamation will be been developed. Results to be provided in Project Monitoring Reports
Time required for yellow lady's-slipper to colonize reclaimed areas (See further discussion in Section 6.1)	Monitoring of vegetation of reclaimed areas	Project will address deficiency	A project-specific Reclamation Monitoring Plan which monitors revegetation will be developed. Results to be provided in Project Monitoring Reports.
Time required for Canada Buffalo-berry to colonize reclaimed areas (See further discussion in Section 6.1)	Monitoring of vegetation of reclaimed areas	Project will address deficiency	A project-specific Reclamation Monitoring Plan which monitors revegetation, as well as a Wetlands Monitoring Plan, will be developed. Results to be provided in Project Monitoring Reports.
Time required for black ash to colonize created wetlands	Monitoring of vegetation of reclaimed areas and created wetlands	Project will address deficiency	A project-specific Reclamation Monitoring Plan which monitors revegetation will be developed. Results to be provided in Project Monitoring Reports.
Impact of drawdown on soil moisture levels in CGC Conservation Area	Modelling, and monitoring of Soil Moisture Levels	Project will address deficiency	
Impacts to Wetlands 12 -16 resulting from mine activities.	Monitoring of water levels and vegetative communities	Project will address deficiency	A project-specific Monitoring Plan for Wetlands will be developed. Results to be provided in Project Monitoring Reports
Appropriate widths of buffer zones around Conservation Area required to maintain habitat for species –at-risk	Research and monitoring to identify appropriate widths of buffer zones. Details in Section 3.3.	Project has addressed deficiency, and will continue to do so.	

7.0 Research and Monitoring

The TOR supplied by NSE for the proposed Miller's Creek Mine Extension Project requested details on research and monitoring of species-at-risk in the CGC Conservation Area and the reclamation activities. These details are provided in the following subsections.

7.1 Conservation Area Monitoring of Species at Risk

Prior to mine development, a detailed long-term research and monitoring program for the vascular plant and lichen species-at-risk in the CGC Conservation Area will be developed in consultation with NSDNR, academia and the Confederacy of Mainland Mi'kmaq (CMM). A draft monitoring plan for black ash, developed in collaboration with CMM, is provided in Appendix __. A draft table of contents for a Research and Monitoring Plan for rare flora species occurring in the CGC Conservation Area is provided at the end of this section. The research and monitoring program will be specifically aimed at benefiting the species-at-risk by providing information on habitat requirements and reproduction to facilitate long-term survival in the CGC Conservation Area. Collaboration with experienced botanists and lichenologists will help to clearly define limitations on current knowledge surrounding the resilience, population ecology, and life history of the vascular plant and lichen species-at-risk occurring within the CGC Conservation Area. As requested in the TOR, the long-term monitoring plan will be defined in ten-year intervals and will include annual counts or surveys of the individual rare plants and lichens. The monitoring program will begin with a preliminary survey, which will provide updated baseline habitat data on the species-at-risk. During the baseline surveys, specimens may be marked to allow tracking throughout the monitoring program. Annual monitoring surveys will follow. Collection of at least two years of baseline data prior to Project activities will provide knowledge of the natural year-to-year variation in population demographics of the species at risk.

The vascular plant and lichen species-at-risk occurring on the site fall within three groups: woody plants, herbaceous plants, and lichens. As these groups differ in physical form and life histories, baseline and annual monitoring of these species will involve measuring a list of physical characteristics specific to each group. These are outlined below.

Woody plants (eastern leatherwood, black ash, Canada buffaloberry)

- Number of specimens
- Population demographics (% mature, % blooming, % producing seed),
- Height
- Diameter at breast height (dbh) (black ash only),
- % vegetation cover in each strata (e.g., ground vegetation layer, shrub layer, tree layer
- Degree of canopy closure,
- Associated species,

Herbaceous plants (ram's-head lady's-slipper, yellow lady's-slipper, round-lobed hepatica, wood anemone)

- Number of specimens
- Population demographics (% mature, % blooming, % producing seed),
- Active/dormant state (for species potentially exhibiting non-seasonal dormancy, i.e. lady's-slippers),
- Bloom status
- Number of stems/blooms per plant,
- Height
- % vegetation cover in each strata (e.g., ground vegetation layer, shrub layer, tree layer
- Degree of canopy closure,
- Soil moisture ,
- Associated species,

Lichens (*Solorina saccata, Collema cristatum* var. *cristatum, Leptogium lichenoides*)

- Number of specimens
- Size of each specimen (longest and widest axis, in mm)
- Aspect (compass direction) of each specimen
- Height above ground
- Reproductive state of each specimen
- Number of reproductive structures per specimen (for species with large apothecia)
- Co-occurring species of lichens
- General condition of each specimen (evidence of herbivory, wind or ice damage, and dead patches).
- Associated species,
- % vegetation cover in each strata (*e.g*., ground vegetation layer, shrub layer, tree layer
- Degree of canopy closure,
- Detailed photographs of each specimen, showing a scale and a unique identification number, will be taken.

For research purposes, additional environmental parameters such as temperature, relative humidity, and light intensity will be recorded on a long-term basis via data loggers to provide additional knowledge of habitat requirements of ram's-head lady's-slipper and possibly the lichen *Solorina saccata*.

As discussed in the Ecological Integrity section of this document, the proposed Project is predicted to have very little, if any, impact on species and habitats within the CGC Conservation Area. The one parameter which might potentially be affected is soil moisture levels in the northern portion of the CGC Conservation Area, as the slope providing runoff to Wetland 12 is mined away. As ram's-head lady's-slipper occur near the base of this slope, soil moisture levels in this area should be monitored to determine if there is a significant effect. These moisture levels would then be compared with measurements obtained from another ram's-head lady's-slipper patch within a drainage basin within the Conservation Area which has not been affected. Thus, for ram's-head lady's-slipper, soil moisture levels may be monitored in the long-term using permanently installed soil moisture meters. CGC proposes to install piezometers and water level loggers near the ram's-head lady's-slippers in the Conservation Area to collect data on water table levels near this species before and after initiation of the Project.

Piezometers and water level loggers may also be installed to monitor moisture levels near black ash, a primarily wetland species which occurs in wetlands within the CGC Conservation Area.

Environmental parameters to be determined include:

- Soil pH;
- Soil organic matter content;
- Soil grain size analysis; and
- Soil nutrients

All field monitoring, data review, and analysis will be conducted by CRA on behalf of CGC and results of annual monitoring will be provided to NSDNR. Final details of the Conservation Area monitoring plan will be determined once the Project receives regulatory approval.

A suggested draft table of contents for the Conservation Area Species at Risk monitoring plan is provided below.

SUGGESTED DRAFT TABLE OF CONTENTS FOR MONITORING PLAN FOR RARE FLORA SPECIES OCCURING IN CGC CONSERVATION AREA

7.2. Reclamation Monitoring

An experimental framework to monitor natural revegetation of the disturbed areas (stockpiles) will be established. This plan will involve setting up permanent monitoring stations (quadrats) at several locations on the new stockpiles shortly after they are created. Once the stockpiles reach full capacity, they will be surveyed and baseline data, such as aspect exposure, soil type, slope, etc. will be recorded. The topography of each stockpile will be mapped and the resulting maps used to examine hydrological patterns on each stockpile.

Botanical surveys of vegetated areas near the monitoring stations will be conducted. All plants growing within a specific area will be recorded, and the percent cover of each will be determined. These quadrats will be surveyed on a regular basis (annually or biannually) during the growing season to document changes in plant species composition and percent cover over time. The data will be compared with the list of species growing in the vicinity of the stockpiles.

A photo-point station at each monitoring station will also be established. At each station, photographs will be taken to record the general appearance of the monitoring station, in such a way that similar photographs may be taken in following survey years. These photo point stations are a useful tool for documenting changes in vegetation, which may not be detected via statistical methods or quadrat surveys. The quadrats themselves may also be photographed in this manner for comparison between survey years.

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E-1 BLACK ASH (WISQOQ)
DRAFT MONITORING REPORT

Black Ash (Wisqoq) Monitoring Plan

FGC recognizes the importance of black ash (*Fraxinus nigra*) to the Province and Mi'kmaq and has developed a monitoring program to provide benefit to the species. Some black ash, or Wisqoq, will be removed as part of the mine development's 50 year life and FGC has sought to develop a program that gains as much information on the species as possible prior to each individual's removal. We have also provided information on what may be done with individuals at the time of removal. FGC recognizes the need to continue to work with NSDNR and the Confederacy of Mainland Mi'kmaq (CMM) to finalize a program that is beneficial to all. The program described here provides detail that is intended to meet the EA needs. FGC recognizes that, should the project receive approval, additional detail and discussions may need to occur as part of the application for an Industrial approval.

The following section provides a monitoring plan for the management of black ash within the Miller's Creek Mine Extension Project. In Nova Scotia, Black Ash (or Wisqoq) is distributed from Digby to central Lunenburg counties to northern Cape Breton, scattered throughout the northern portions of the mainland, and limited elsewhere. This species prefers damp woods, low ground, and swamps. Black ash is yellow-listed by NSDNR and is of particular importance to Nova Scotia's First Nations communities due to its use in basket weaving. Black ash's sub-national rank in Nova Scotia in S3 (sensitive), while nationally is listed as secure based on large populations in Ontario, New Brunswick and Quebec. Globally this species is listed as G5, or common with secure populations.

From environmental baseline data collected for the Environmental Assessment Registration Document (EARD) for Miller's Creek Mine Extension, black ash was identified in several wetlands in and around the Project area. Within the Project area, a single mature black ash, 24 saplings and four seedlings were detected in the summer of 2007. An additional seven saplings were identified outside the Project footprint and measures to avoid disturbance to these individual specimens were addressed in the EARD. The avoidance measures have resulted in roughly 25% of the specimens found being in areas where the mine development will not disturb them.

The proposed plan involves the black ash being assessed yearly to obtain information on populations within the Miller's Creek Mine Extension Project area. Based on conversations with CMM, baseline assessments, monitoring, and management options for healthy trees impacted by the project will be evaluated. Field studies will commence in mid- to late summer when potential seed sources are present.

Baseline Assessment

Baseline information is critical to the management of black ash within the Project area. A significant amount of baseline information on locations and health of individuals are known. This information will be upgraded and the additional assessments will include:

- Further searching and investigations for additional black ash in the area surrounding existing populations.
- Documenting the existing geological and hydrogeological conditions for each area where black ash are located.
- Identification of wildlife attributes associated with black ash.
- Assessing soil and wetland characteristics at black ash location.

Monitoring

Appropriate monitoring strategies are imperative to the understanding of black ash population and habitat requirements of black ash in Nova Scotia. Monitoring of black ash will include:

- Each black ash specimen will be marked with a unique identification code and monitored yearly.
- Complete yearly data collection on each black ash specimen will be collected based on a field checklist provided by CMM (see Table below).
- Identification of seed sources. Good seed crops occur at irregular intervals and up to 7 years apart. Due to the biology of the species, seeds will be collected when possible.

Management Options

FGC will provide advice and guidance on management options for healthy trees to be impacted by the project. Management options include:

- Determine suitable locations for black ash transplantations in the surrounding landscape for trees scheduled to be removed by the Project development.
- FGC will coordinate with CMM to determine the appropriate course of action for any trees that can not be transplanted.

Wisqoq Research Field Sheet		
Site:		Date:
GPS Location:		
Data Collector(s):		
1. Macrotopography		
2. Tree Number		
3. DBH (Diameter at Breast Height)		
4. Height		
5. Dominance (D,C,I, or S)		
6. Tree Type		
7. Basket Quality		
8. Stem Form (0,2,3,4,5)		
9. Main Stem Bending (1 to 5)		
10. Dieback (%)		
11. Anthracnose (diseases of hardwood trees)		
12. Stem Fungus (1 to 5)		
13. Leaf Insect Damage (%)		
14. Woody Tissue Damage	Type	
	Location	
	Level	
15. Soil Drainage Class	Terrain Position	
	Horizon depth, colour and texture	
16. Wildlife Attributes		
17. Associated Soils		
18. Associated Vegetation		

APPENDIX F

DFO CORRESPONDENCE

Fisheries and Oceans Canada | Pêches et Océans Canada

P.O. Box 1006
Dartmouth, Nova Scotia
B2Y 4A2

Your file *Votre référence*

August 26, 2009

Our file *Notre référence*
05-HMAR-MA7-00285

Mr. Derek McDonald
Senior Program Officer
Canadian Environmental Assessment Agency
1801 Hollis Street
Suite 201
Halifax, Nova Scotia
B3J3N4

Dear Mr. McDonald:

Subject: Proposal not likely to result in impacts to fish and fish habitat.

Fisheries and Oceans Canada - Fish Habitat Management Program (DFO) received the proposal on October 17, 2005. Please refer to the file number and title below:

DFO File No.: **05-HMAR-MA7-00285**
Title: **Avon River and tributaries to - gypsum mine expansion**

The proposal has been reviewed to determine whether it is likely to result in impacts to fish and fish habitat which are prohibited by the habitat protection provisions of the *Fisheries Act* or those prohibitions of the *Species at Risk Act* that apply to aquatic species.*

Our review consisted of: A review of a fish habitat study conducted by Conestoga Rovers and Associates dated September 12, 2008 (see attached) and a site visits completed on August 21 2009.

We understand that the proponent plans to: Proposed gypsum mine site expansion.

Provided that the plans are implemented as described DFO has concluded that the proposal is not likely to result in impacts to fish and fish habitat.

The proponent will not need to obtain a formal approval from DFO in order to proceed with the proposal.

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*Those sections most relevant to the review of development proposals include 20, 22, 32 and 35 of the *Fisheries Act* and sections 32, 33 and 58 of the *Species at Risk Act*. For more information please visit www.dfo-mpo.gc.ca.

.../2

If the plans have changed or if the description of the proposal is incomplete the proponent should contact this office to determine if the advice in this letter still applies.

Please be advised that any impacts to fish and fish habitat which result from a failure to implement this proposal as described could lead to corrective action such as enforcement.

If you have any questions please contact the undersigned at (902) 426-7818, by fax at (902) 426-1489, or by email at deviner@mar.dfo-mpo.gc.ca.

Yours sincerely,

Richard Devine
Habitat Assessment Biologist

Copy: Fundy Gypsum Company
Helen MacPhail
Conestoga-Rovers and Associates

APPENDIX G

WETLANDS

APPENDIX G

MONITORING PROTOCOLS TO ASSESS THE ADEQUACY OF MITIGATIVE OPTIONS

INTRODUCTION

The development of a well-designed monitoring plan aimed at assessing the adequacy of mitigative options for reducing Project-related impacts on wetlands is an important component of the Environmental Assessment process. Since no provincial or federal monitoring protocols for wetland mitigation currently exist, monitoring plans are developed on a project-by-project basis to address the specific mitigative options proposed by the Proponent. Monitoring plans are generally long-term, and aim to provide regulatory agencies with information regarding the success of mitigative options for future decision–making procedures. Accordingly, the purpose of this section is to provide monitoring plans to ensure impacts to avoided wetlands (Wetland 12 to 16) are effectively mitigated, and to determine the capability of created wetlands to successfully replace the form and function of removed wetlands. In addition, wetlands in the conservation area (*e.g.*, Wetland 12) will be assessed and monitored as part of the Conservation Area Monitoring Plan. The monitoring of avoided wetlands will allow for the development of adaptive mitigation options, if required, and the monitoring of created wetlands will allow for suitable application of the wetland compensation ratio.

As described in Section 4.4.5, the purpose of monitoring avoided wetlands is to ensure the control of sediment discharge from surrounding areas and to maintain the hydrological, biogeochemical, and biotic functions of each wetland. Table 4.4-2 provided a summary of mitigative options for Wetlands 12 to 16. In addition, Section 4.4.5 describes the application of "wetland banking" as a means of compensating for wetland loss. For this Project, wetland banking involves creating wetlands on the existing mine site in advance of the removal of wetlands.

APPROACH

The ecological factors that define wetlands (hydrology, soils, and biota) are the critical components for monitoring wetland condition and function. The ecological factors of a wetland, therefore, define its ecological integrity. From an ecological standpoint, wetland functions perform in a hierarchical manner, with ecological integrity, the function that encompasses all ecosystem structure and processes, at the top (Smith *et al*. 1995). The link between function and condition lies in the assumption that if ecological integrity of the wetland is intact, the functions typical of that wetland type (hydrology, soil, and biota), will also occur at reference levels (Smith *et al*. 1995). For that reason, the monitoring plan will focus on assessing the impacts of mining activities on hydrological features, soil characteristics and biotic communities of Wetlands 12 to 16 through comparison with nearby reference wetlands.

The approach for design and monitoring of created wetlands is different than the approach for monitoring existing wetland. Prior to monitoring, project goals and objectives (*i.e.*, how to ensure that the lost functions are to be replaced), and Project design and preparation (*i.e.*, the location of created wetlands to ensure proper hydrologic regime, soils, terrain, saturation level and topography to ensure the wetland performs the same functions as well or better than the wetlands it replaces) must be developed. The most critical consideration at this stage is achieving the hydrological and soil development objectives of the Project design. Once the site performs the desired hydrologic functions, the next critical step is establishing the proper types of plant life in the wetland in the proper numbers and proportion. Despite careful planning, the site may not perform exactly as intended, or it may be initially successful but fail later. For that reason, monitoring must be applied to determine whether or not the wetland is functioning properly and continues to do so.

METHODOLOGY

Multiple methods for assessing wetland function have been developed, and are recommended by Environment Canada, including landscape level assessments (Level 1), rapid assessments (Level 2) and detailed assessments (Level 3). For the purpose of this monitoring plan, detailed assessments will be applied to determine the adequacy of mitigative options. The United States Environmental Protection Agency (US EPA) has developed a series of reports for assessing wetland condition using the Index of Biological Integrity (IBI). The US EPA reports are largely applicable in Canada and allows for the development of a Project specific IBI. Four methods developed by the US EPA will be used for monitoring vegetation, soils and hydrology, including:

- *Methods for Evaluating Wetland Condition: Using Vegetation To Assess Environmental Conditions in Wetlands* (US EPA 2002)
- *Methods for Evaluating Wetland Condition: Biogeochemical Indicator* (US EPA 2008)
- *Methods for Evaluating Wetland Condition: Wetland Hydrology* (US EPA 2008)
- *Methods for Evaluating Wetland Condition: Developing Metrics and Indexes of Biological Integrity* (US EPA 2002)

Although metrics of ecological integrity should be based on sound ecological theory, the IBI is intended to be adaptive and must be tested, as metrics can vary among wetlands.

In order to provide a defensible argument for Project-related impacts to wetlands, if any, statistically rigorous multimetric models must be applied to indices of wetland condition. Multimetric indexes integrate several biological metrics that can be designed to be sensitive to a range of factors (physical, chemical, and biological) that stress biological systems (Karr and Chu 1999). The Before-After Control-Impact (BACI) design will be applied to statistically assess the ecological integrity of mitigated wetlands (Wetlands 12-16). The BACI design allows for temporal comparisons of wetlands in similar systems to determine the impact of mining activities, if any, on the avoided wetlands. To statistically test the success of created wetlands, a multivariate approach (*e.g.*, PCA, CCA) will be applied. The multivariate approach allows for statistical and graphical interpretation of created wetlands through time in comparison to natural wetlands.

In order to ensure all aspects of wetland components, processes and functions are examined, the monitoring plan will be developed in consultation with NSDNR and NSE; the monitoring plan will be conducted over the full Project area and over a shorter approval period; and may be adapted over time to account for uncertainties associated with impacts to wetlands and ecosystems. The schedule and study design for the monitoring plan (*i.e.*, placement of transects, number of replicates, sample sizes, sampling frequency) will be developed in consultation with NSDNR and NSE and provided at the Industrial Approval stage of the Project.