DE BEERS SNAP LAKE MINE
LAKE DISCHARGE AND LAKE ELEVATION MONITORING PROGRAM

2012 ANNUAL REPORT

Submitted to:

De Beers Canada Inc.
Yellowknife, Northwest Territories

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EXECUTIVE SUMMARY

The De Beers Canada Inc. Snap Lake Mine (Mine) is a diamond mine located in Canada's Northwest Territories, about 220 kilometres (km) northeast of Yellowknife, 30 km south of MacKay Lake, and 100 km south of Lac de Gras. Snap Lake water inflows and outflows are measured and estimated throughout the year to calculate the annual Snap Lake water balance. Water elevations and lake discharges are measured at Snap Lake as well as at three other lakes in the region: North Lake, Northeast Lake, and 1999 Reference Lake. North Lake and Northeast Lake are hydraulically connected to Snap Lake whereas 1999 Reference Lake is in a different drainage basin, is not hydraulically connected to Snap Lake, North Lake, or Northeast Lake, and is used as an indicator of whether water elevation trends at Snap Lake, North Lake, and Northeast Lake are due to Mine effects or to regional environmental trends.

This report summarizes the 2012 Snap Lake water balance and the water elevation and lake discharge trends at Snap Lake, North Lake, Northeast Lake, and 1999 Reference Lake. The Snap Lake water balance predicted a decrease in the water elevation of Snap Lake of 65 millimetres (mm), whereas surveyed elevation changes from September 2011 to September 2012 and October 2011 to October 2012 were an increase of 79 mm and a decrease of 11 mm, respectively. These differences may be due to uncertainty in the drainage area inflow data and the Snap Lake outflow data.

Snap Lake water elevation trends were similar to Northeast Lake, North Lake, and 1999 Reference Lake during 2012, showing an increase in May followed by a decrease through September. The water elevations of Snap Lake, 1999 Reference Lake, Northeast Lake, and North Lake increased by 0.079 m, 0.043 m, 0.049 m, and 0.050 m, respectively, between September 2011 and September 2012, indicating a similar trend in water elevations at all measured lakes. Between 2002 and 2012, water elevations at Snap Lake, North Lake, and Northeast Lake followed similar trends, but tended to exhibit a lower range of elevation changes than 1999 Reference Lake. This indicates that Mine activities are having negligible effects on water elevations at Snap Lake, North Lake, and Northeast Lake. The 2002 Environmental Assessment Report (EAR) predicted an increase of 5.3 centimetres (cm) in the mean water elevation of Snap Lake and decreases of 1.6 cm and 3.0 cm in the mean water elevations of Northeast Lake and North Lake respectively, as a result of the mining operations. However, to date, the predicted changes have been of a much lower magnitude than the annual variation due to environmental factors observed at all the study lakes, and all four lakes have exhibited similar elevation trends.

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ACRONYMS

AEMP	Aquatic Effects Monitoring Program
De Beers	De Beers Canada Inc.
EAR	Environmental Assessment Report
EMP	Environmental Monitoring Program
Golder	Golder Associates Ltd.
ln	natural logarithm
Mine	Snap Lake Mine
NAD	North American Datum
QA/QC	quality assurance / quality control
SNP	Surveillance Network Program
TWTP	temporary water treatment plant
UTM	Universal Transverse Mercator
WMP	water management pond
WTP	water treatment plant

UNITS

%	Percent
cm	Centimetre
km	Kilometre
km^2	square kilometre
m	Metre
m^3	cubic metre
m^3/s	cubic metres per second
$m^3/s/km^2$	cubic metres per second per square kilometre
m^3/yr	cubic metres per year
masl	metres above sea level
mm	Millimetre

1 INTRODUCTION

The Snap Lake Mine (Mine) is a diamond mine owned and operated by De Beers Canada Inc. (De Beers). The Mine is located about 220 kilometres (km) northeast of Yellowknife, Northwest Territories, 30 km south of MacKay Lake, and 100 km south of Lac de Gras. Final regulatory approvals for construction and operation of the Mine were granted in May 2004, and construction began in April 2005. The first diamonds were recovered in August 2007, and commercial production was achieved in early 2008. The Mine officially opened on July 25, 2008.

Water elevations and lake discharges are monitored near the Mine to meet three objectives:

- evaluate Environmental Assessment Report (EAR) predictions (De Beers 2002) related to changes in lake water elevations and lake discharges;
- provide flow and water elevation information for fish habitat compensation monitoring, and annual water balance and lake elevation data for water quality monitoring; and
- fulfill requirements of the Water Licence MV2011L2-0004 (MVLWB 2012) and the Environmental Agreement (De Beers 2004).

The lake discharge and lake elevation monitoring program addresses the requirements in the Water Licence as follows:

- *Part B, Section 5a, ix – Conduct a surface hydrology program to provide data for components of the overall project water balance, specifically estimates and measurements of precipitations, and runoff.*
- *Part B, Section 5b – Monitor water elevations in Snap Lake during the open water season.*
- *Part B, Section 5n – Provide flow or water elevation data for selected locations under Parts A, B, and C of the Surveillance Network Program (SNP). Specific Station numbers are 02-02, 02-03, 02-04, 02-05, 02-06, 02-07, 02-08, 02-09, 02-10, and 02-21.*
- *Part B, Section 8 – Provide quality assurance/quality control (QA/QC) for selected equipment used for flow or water elevation measurements.*
- *Part G, Section 2 – Support the Aquatic Effects Monitoring Program (AEMP) in evaluating Mine impacts to Snap Lake by monitoring outflow from Snap Lake.*

The Environmental Agreement requires that hydrology data be collected to provide input to other environmental monitoring programs, which include the hydrogeology program and the AEMP. This report provides the results of the 2012 lake discharge and lake elevation monitoring program along with comparisons to data from previous years.

2 MONITORING LOCATIONS

2.1 SNAP LAKE DRAINAGE AREA

The Snap Lake water elevation at Station H3, the inflow elevation and discharge at Station H4, and the outflow elevations and discharges at Stations H1 and H2 were measured during 2012 (Figure 2-1). Data were collected using a combination of rod and level surveys, lake discharge measurements, and data loggers. Logger data were collected every 30 minutes during the open water period at the outflow stations and every 30 seconds during the peak flow period at the inflow station. The locations of the monitoring stations are as follows:

- Station H1 – Snap Lake outflow (north channel) - Universal Transverse Mercator (UTM) 512098E, 7054100N (North American Datum [NAD] 83, Zone 12).
- Station H2 – Snap Lake outflow (south channel) - UTM 512223E, 7053929N (NAD 83, Zone 12).
- Station H3 – Snap Lake water elevation - UTM 506811E, 7051483N (NAD 83, Zone 12).
- Station H4 – Snap Lake inflow (representative tributary) - UTM 506805E, 7051461N (NAD 83, Zone 12).

Snap Lake drains through the adjacent north and south outlet channels located on the eastern end of the southeast arm of Snap Lake. The channels are approximately 200 metres (m) apart and flow sub-parallel over most of their 400 m length before discharging to a small lake east of Snap Lake. The H1 and H2 monitoring stations are located at these outlets.

Snap Lake water elevation monitoring Station H3 is located along the western shore of the main body of Snap Lake (Figure 2-1).

Snap Lake inflow was measured at Station H4, within Stream 1, one of the larger streams where flow volumes are sufficient for measurement during the open water period. This stream is located near Station H3 on the western shore of Snap Lake and drains an area of approximately 7 square kilometres (km^2). It collects runoff from an area south of the Mine footprint (Figure 2-1). Flow from this stream is used to estimate flow into Snap Lake from the entire Snap Lake watershed.

On July 28 and 29, 2010, wooden box flumes were installed at the outlet channels by Fracflow Consultants Inc. One flume was installed at H1, and two parallel flumes were installed at H2. The flumes are designed to capture all water flowing through the Snap Lake outlet so that flow measurements can be accurately recorded throughout the year.

LEGEND

- HYDROLOGICAL MONITORING LOCATION
- WATERCOURSE
- WATERBODY
- MINE FOOTPRINT

2 0 2

SCALE 1:125,000 KILOMETRES

NOTE

DSL1 = First lake downstream of Snap Lake.

REFERENCE

Base Data: Canvec 1:50000 downloaded from Geogratis
DATUM: NAD83 PROJECTION: UTM ZONE 12

PROJECT

DE BEERS
GROUP OF COMPANIES

TITLE

HYDROLOGICAL MONITORING LOCATIONS, 2012

Golder Associates

PROJECT		13-1328-0007	FILE No.	
DESIGN	KM	09 Apr. 2013	SCALE AS SHOWN	REV. 0
GIS	KM	09 Apr. 2013	FIGURE: 2-1	
CHECK	RB	29 Apr. 2013		
REVIEW	BT	29 Apr. 2013		

N:\Active\GIS\2013\Misc_Request\Snap_SurroundingLakes

2.2 OTHER MONITORING LOCATIONS

A lake water elevation and outflow discharge monitoring station was established at 1999 Reference Lake, located about 7 km southwest of the Mine at UTM 496863E, 7042216N (NAD 83, Zone 12) (Figure 2-1). The purpose of monitoring lake elevations and outflows from 1999 Reference Lake is to provide reference parameters for a nearby watershed unaffected by mining operations.

Water elevations and outflows from North Lake and Northeast Lake are also monitored to verify predicted changes in these parameters as indicated in the EAR (De Beers 2002). The North Lake and Northeast Lake monitoring locations are located at UTM 507672E, 7056635N (NAD 83, Zone 12), and 510207E, 7063652N (NAD 83, Zone 12), as shown in Figure 2-1. The EAR predicted that, as the Mine develops, North Lake and Northeast Lake may be subject to reductions in water elevations of 3.0 and 1.6 centimetres (cm), respectively. Water elevation and discharge measurements from all monitoring stations are collected on or about the same date to allow data comparisons.

3 METHODS

A summary of methods and protocols used for water elevation and stream discharge monitoring is provided below. Detailed information on water measurement practices and specific equipment used in collecting the data are provided in the Surface Water Monitoring Program Manual, prepared by Golder Associates Ltd. (Golder) for De Beers (Golder 2005).

3.1 LAKE DISCHARGE

Lake outflow velocities for all monitoring locations were measured using a Swoffer Model 2100 current metre or a Marsh McBirney Flo-Mate model 2100 flow metre attached to a top setting wading rod. A tag line marked at 0.2 m intervals was used to measure the width of all channels. The tag line was attached to sections of rebar driven into the stream banks. The channels were divided into vertical segments of approximately 5 percent (%) of the channel width.

Velocity and depth were measured at the centre of each segment. For water depths less than or equal to 0.7 m, the velocity was measured at a depth of 60% of the total depth from the surface. For water depths greater than 0.7 m, the velocity was measured at 80% and 20% of depth, and the measured velocities were averaged.

The product of the mean of the depths and the mean of the velocities observed at adjacent segments was multiplied by the width between the centre points of segments to determine the discharge for each segment. This method was repeated for each consecutive segment across the stream and the total discharge for the stream was then calculated by summing the partial discharges.

Flume discharge measurements at H1 and H2 were taken by collecting velocity and depth measurements every 0.10 m across the flumes.

3.2 SURVEY BENCHMARKS

At each monitoring station, water elevation was measured relative to an established benchmark to ensure continuity between yearly data sets. The current benchmark locations and their geodetic elevations are listed in Table 3-1. Benchmarks consist of an embedded pin in bedrock.

Table 3-1 Benchmark Locations and Elevations

Station Designation	UTM (NAD 83, Zone 12)		Geodetic Elevation [masl]
	Northing	Easting	
H1 – Snap Lake Outflow	7054115	512105	444.341
H2 – Snap Lake Outflow	7053946	512231	443.842
H3 – Snap Lake Elevation[a]	7051483	506811	444.840
H4 – Snap Lake Inflow[a]	7051483	506811	444.840
SAS 14 – Snap Lake Elevation[b]	7053175	507089	453.018
2005 Benchmark – Snap Lake Elevation[c]	7053075	507193	445.392
North Lake	7056652	507682	440.720
Northeast Lake	7063614	510192	433.641
1999 Reference Lake	7042237	496879	441.492

(a) H3 and H4 surveyed from same benchmark location.

(b) Survey benchmark for Snap Lake Elevation Surveys used by Nampcy Solutions Ltd.

(c) Benchmark used during 2012.

Notes: UTM = Universal Transverse Mercator; NAD = North American Datum; masl = metres above sea level.

Initially, water elevations were measured relative to nearby large stable boulders or bedrock outcrops. During June 2007 the geodetic elevations of the existing benchmarks were established. Previous water elevations were then converted into geodetic elevations using the surveyed relationship between the new and old benchmarks.

Each time stream discharge was assessed at a monitoring station, the water elevation was measured relative to the established benchmark using an engineer's rod and level. Over time, the relationship between water elevation (stage) in the channel and flow (discharge) was established, and described by a stage-discharge rating curve. The stage-discharge curve can be used to calculate the discharge based on the elevation of the water at the monitoring station.

Discharge measurements along with surveyed water elevations provide input to the stage-discharge rating curve, and also provide information on channel stability. However, changes in channel characteristics can alter the relationship between stage and discharge, making the developed stage-discharge rating curve obsolete. The installation of the outlet flumes at H1 and H2 in July 2010 caused the open-channel stage-discharge curve at H1 to become obsolete. Both curves were updated during 2012 to more accurately reflect the flow conditions through the flumes.

Snap Lake water elevation was first surveyed from the control point named SAS-14, located at UTM 507089E, 7053175N (NAD 83, Zone 12). The elevation at SAS-14 is 453.018 m above sea level (masl). In 2005, a second benchmark was established about 200 m downslope of SAS-14 and close to the lakeshore to simplify water elevation measurements. This benchmark is referred to as the 2005 Benchmark in Table 3-1, and is at 445.392 masl. The geodetic elevation of a second benchmark located near monitoring stations H3 and H4 was established in 2007 and is used to reference both stream depth at H4, and lake elevation at H3.

3.3 CONTINUOUS WATER ELEVATION RECORDING

Water elevations were measured every 30 minutes using a Levelogger Gold 3001 (manufactured by Solinst Canada Ltd.) during the open-water period at lake discharge monitoring stations H1 and H2, year-round at Station H3, and during the peak discharge period at H4. Water elevations at the 2005 Benchmark were surveyed at least monthly by Nampcy Solutions Ltd. using a rod and level.

Total pressure measured by the Leveloggers is the sum of air pressure and water pressure, and is measured at each monitoring station. Air pressure is subtracted from the total pressure through a software program that combines data from the Levelogger with data from a Barologger Model 3001 F5/M1.5 (a separate sensor which measures air pressure only) to provide water elevation data at each of the monitoring stations. The Barologger is installed in a 1 m long buried polyvinyl chloride pipe located near the shore of Snap Lake near the intake vent raise located at UTM 507180E, 7053065N (NAD 83, Zone 12). The Barologger is used to correct for barometric pressure, and these data are then used to calculate the actual water elevation above the Levelogger pressure sensors. The water elevation data and the stage-discharge rating curves are then used to produce a record of discharges for each corresponding water elevation.

Since the surveyed values from the benchmark and the first pressure sensor reading each year are collected only a few minutes apart, these two values represent the same elevation. For example, if the water elevation is measured at 99.50 m relative to the benchmark and the first data record from the sensor is 0.25 m, the water elevation (0.25 m) can be considered equal to 99.50 m. The absolute value of any change in water elevation can then be applied to the benchmark water elevation reading. If the water elevation increases 0.005 m over the next 30 minutes, the increase should also be applied to the benchmark elevation (99.505 m). This correction allows the stage data as measured from the pressure sensor to be converted to elevations relative to the benchmark. Because the benchmark values are used with the stage-discharge rating curves, the pressure sensor data can be readily converted to relative benchmark values and then to discharge values.

At the stream stations (H1 and H2), the Leveloggers are mounted to brackets that are installed in the streambed. At the Snap Lake station (H3), the Levelogger is located in approximately 1.2 m of water, and about 5 m from shore. The H3 logger data began to drift away from the surveyed data during summer 2012, and therefore the H3 logger data are considered unreliable.

3.4 WATER BALANCE

An approximate water balance for Snap Lake in 2012 was calculated based on measured and estimated inflows to and outflows from the lake, and included both natural inflows and water management data from the Mine operations records. Sources of data for water loss and gain are as follows:

- **Losses from Snap Lake:**
  - Water pumped from Snap Lake: provided in Snap Lake Mine operations records (De Beers 2012).
  - Pumped water truck volume: provided in Snap Lake Mine operations records (De Beers 2012).
  - Losses from Snap Lake via groundwater recharge: this volume is assumed to be equal to minewater pumped from the underground workings to the water treatment plant (WTP) and is provided in Snap Lake Mine operations records (De Beers 2012).
  - Outflow from Snap Lake: this volume is based on the De Beers Environmental Department stage, discharge, and Levelogger measurements at H1 and H2. Discharges between January and May 2012 and between September and December 2012 were estimated based on measured 2011 data since logger data were not available. Discharges between May and September 2012 were based on stage, discharge, and Levelogger measurements and represent most of the annual flow.
  - Evaporation from Snap Lake was calculated using the Meyer formula from 2012 site meteorological data collected at the Lake Station.
- **Gains to Snap Lake:**
  - Inflow from water management pond (WMP) seepage: seepage from the WMP as presented in the EAR (De Beers 2002) was estimated to be 12,000 cubic metres per year (m^3/yr).
  - Inflow from domestic waste water plant outflow of treated effluent: provided in Snap Lake Mine operations records (De Beers 2012).
  - Inflow from the WTP: treated releases provided in Snap Lake Mine operations records (De Beers 2012).
  - Inflow from drainage areas: this amount is estimated based on unit flow rates of cubic metres per second per square kilometre ($m^3/s/km^2$) from inflow stream H4 with a drainage area of 7.04 km^2 and applied for the entire watershed draining to Snap Lake (50.8 km^2). The annual inflow volumes from the H4 watershed in 2012 were measured during freshet in May and once each in August and September. Since H4 is a seasonal stream, and is dry or frozen to the streambed during the winter, flows are estimated to be zero between October and May.
  - Precipitation was based on measured Snap Lake precipitation data for May to October, and precipitation data from the Environment Canada Yellowknife “A” meteorological

station for January to May, and October to December (Environment Canada 2012). To account for Snap Lake conditions, Yellowknife snowfall data were corrected by a factor of 0.97 as described in the EAR (De Beers 2002).

- Uncontained Site Runoff: runoff from Mine facilities as detailed in the EAR (De Beers 2002).

3.5 DATA QUALITY ASSURANCE/QUALITY CONTROL

The quality assurance / quality control (QA/QC) analysis identified several data gaps and data quality issues for the 2012 hydrology component. Specific data quality issues for 2012 were:

1) Snowfall data used for the water balance were estimated based on the adjusted 2012 Environment Canada Yellowknife “A” meteorological station data (Environment Canada 2012) since the snowfall gauges at the Lake Station and Hill Station do not accurately record snowfall.
2) The barometric loggers installed in the vent raise did not record data and therefore the meteorological station barometric data were used; these loggers have since been replaced.
3) H1 and H2 logger (Snap Lake outflow) data were collected between May 10 and September 7, 2012; all discharge values outside of these months was estimated to be equal to the monthly discharges measured during 2011.
4) The H3 (Snap Lake elevation) logger drifted out of range and the data were not used.
5) The H4 (Snap Lake inflow) logger data were not used since data were only recorded for the freshet peak and field survey data were available for this time period.
6) The elevation survey data for 1999 Reference Lake, North Lake, and Northeast Lake contained errors, and therefore the elevations were back-calculated using the measured discharges and the stage-discharge rating curves.

Based on the QA/QC analysis, the inflow data, outflow data, precipitation data, and lake elevation data are considered to be estimates only.

4 RESULTS

Discharges and elevation monitoring for H1 and H2 started on May 10, 2012 and continued until September 7, 2012 when monitoring equipment was removed for the winter. Snap Lake elevations were measured twice in May, once in June, twice in July, twice in September, and once in October. Discharge estimates at H4 were conducted on May 9, May 14 and May 15; water elevations and discharge measurements at H4 were conducted on May 17 to 22, 24, 26, 28, August 5, and September 8, 2012. The following section details discharge measurements and water elevation readings for the Snap Lake outflows (H1 and H2), Snap Lake (H3), Snap Lake inflow (H4), North Lake, Northeast Lake, and 1999 Reference Lake.

4.1 SNAP LAKE OUTLET (STATIONS H1 AND H2)

Snap Lake has two outlets which carry flow about 400 m downstream to the next lake. Station H1 is located on the north channel and Station H2 is located on the south channel (Figure 2-1). Stage measurements were recorded on both channels throughout the open water season.

Stage-discharge rating curves for the H1 and H2 flumes were developed in 2012 using water elevation data, discharge measurements, and the Aquarius hydrologic software package (Aquatic Informatics 2013).

Direct instantaneous discharge measurements at H1, collected from 2001 to 2012 using a current meter, are provided in Table 4-1.

Station H2 is the southern channel and carries about two-thirds of the total outflow from Snap Lake. Discharge measurements from 2001 to 2012 for H2 are provided in Table 4-2.

Table 4-1 Measured Discharge at Station H1

Date	Discharge [m^3/s]
29-May-2001	0.185
09-Jun-2002	0.123
11-Aug-2002	0.113
01-Oct-2002	0.083
26-Jun-2004	0.043
21-Sep-2004	0.005
18-Jun-2005	0.102
20-Sep-2005	0.034
19-May-2006	0.209
04-Aug-2006	0.091
03-Oct-2006	0.053
03-Jun-2007	0.137
15-Aug-2007	0.108
12-Sep-2007	0.045
09-Jun-2008	0.091
13-Aug-2008	0.032
18-Sep-2008	0.047
02-Jul-2009	0.135
24-Aug-2009	0.085
19-Sep-2009	0.068
23-Jun-2010	0.066
31-Jul-2010	0.069
16-Sep-2010	0.014
28-May-2011	0.142
31-Jul-2011	0.055
18-Sep-2011	0.017
28-May-2012	0.084[(a)]
3-Aug-2012	0.055[(a)]
7-Sep-2012	0.023[(a)]

(a) Average of two discharge surveys conducted.
Notes: m^3/s = cubic metres per second.

Table 4-2 Measured Discharge at Station H2

Date	Discharge [m^3/s]
29-May-2001	0.413
9-Jun-2002	0.292
12-Aug-2002	0.252
1-Oct-2002	0.167
26-Jun-2004	0.131
21-Sep-2004	0.038
18-Jun-2005	0.308
20-Sep-2005	0.111
19-May-2006	0.449
3-Aug-2006	0.188
3-Oct-2006	0.136
3-Jun-2007	0.379
15-Aug-2007	0.169
12-Sep-2007	0.157
9-Jun-2008	0.222
13-Aug-2008	0.083
18-Sep-2008	0.117
2-Jul-2009	0.346
24-Aug-2009	0.173
19-Sep-2009	0.152
23-Jun-2010	0.145
31-Jul-2010	0.113
16-Sep-2010	0.021
28-May-2011	n/a[a]
31-Jul-2011	0.073
18-Sep-2011	0.015
28-May-2012	0.254
3-Aug-2012	0.129[b]
7-Sep-2012	0.064[b]

(a) Not measured due to ice blocking the measurement area.
(b) Average of two discharge surveys conducted.
Notes: m^3/s = cubic metres per second; n/a = not available.

The total H1 and H2 daily calculated outflow discharge from Snap Lake from May 10, 2012 to September 7, 2012 is provided in Appendix I, Table I-1. The January 1 to May 10, and September 7 to December 31 2012 discharges were estimated based on measured monthly 2011 values. The May 10 to September 7 discharges were calculated using the Levelogger data and the H1 and H2 stage-discharge rating curves. The estimated monthly mean and seasonal mean outflow discharge based on flows calculated from the H1 and H2 stage-discharge curve for January 1, 2012 to December 31, 2012 was 0.150 m^3/s, as shown in Table 4-3.

Table 4-3 Summary of Discharges at Snap Lake Outflow, 2012

Month[(a)]	Total Outflow (Sum of H1 and H2 discharges) [m^3/s]
January	0.092
February	0.063
March	0.038
April	0.046
May	0.172
June	0.565
July	0.298
August	0.136
September	0.098
October	0.098
November	0.098
December	0.098
Annual mean	**0.150**

(a) January 1 to May 10, and September 7 to December 31, 2012 discharges are estimated based on 2011 flows. May 10 to September 7, 2012 discharges were calculated using the Levelogger data, and the stage-discharge rating curves.

Note: m^3/s = cubic metres per second.

Monthly mean discharge values for Snap Lake total outflow for the years 1999 to 2012 during the peak flow season are presented in Table 4-4. The outflow hydrographs from 1999, 2000, 2002, and 2004 to 2012 are provided in Figure 4-1. All flow data recorded in 2012 remained within the range of previously recorded flow values.

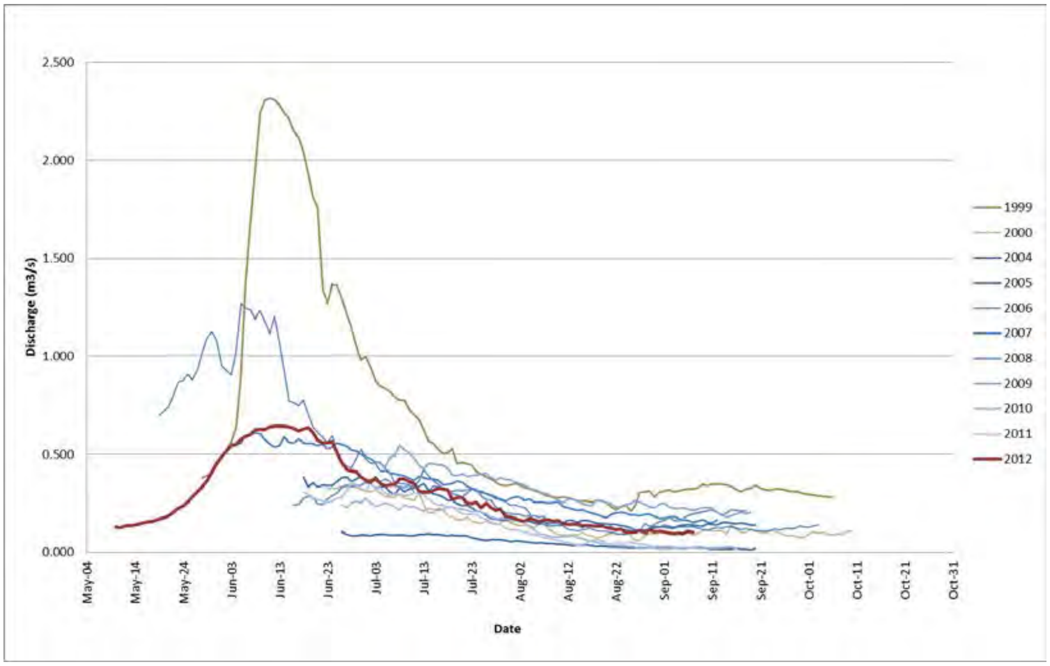
Table 4-4 Monthly Mean Discharges for Snap Lake Outflow (Stations H1 and H2)

Month	1999	2000	2002	2004	2005	2006	2007	2008	2009	2010	2011	2012
June	1.541	0.331	n/a	0.090	0.300	0.836	0.557	0.300	n/a	0.246	0.353	0.565
July	0.592	0.220	0.290	0.081	0.272	0.336	0.363	0.308	0.432	0.219	0.241	0.298
August	0.279	0.102	0.266	0.036	0.145	0.132	0.220	0.144	0.273	0.068	0.058	0.136
September	0.324	0.101	0.273	0.019	0.140	0.123	0.165	0.197	0.224	0.024	0.032	0.098[(a)]

(a) Estimated using recorded data from September 1 to 7 and estimated data for September 8 to 30.

Note: Values are all in cubic metres per second (m^3/s).

Figure 4-1 Daily Mean Outflow Discharge[(a)] From Snap Lake (Stations H1 and H2)



(a) Discharge values estimated using Levelogger data and stage-discharge rating curves.
Note: m^3/s = cubic metres per second.

4.2 SNAP LAKE (STATION H3)

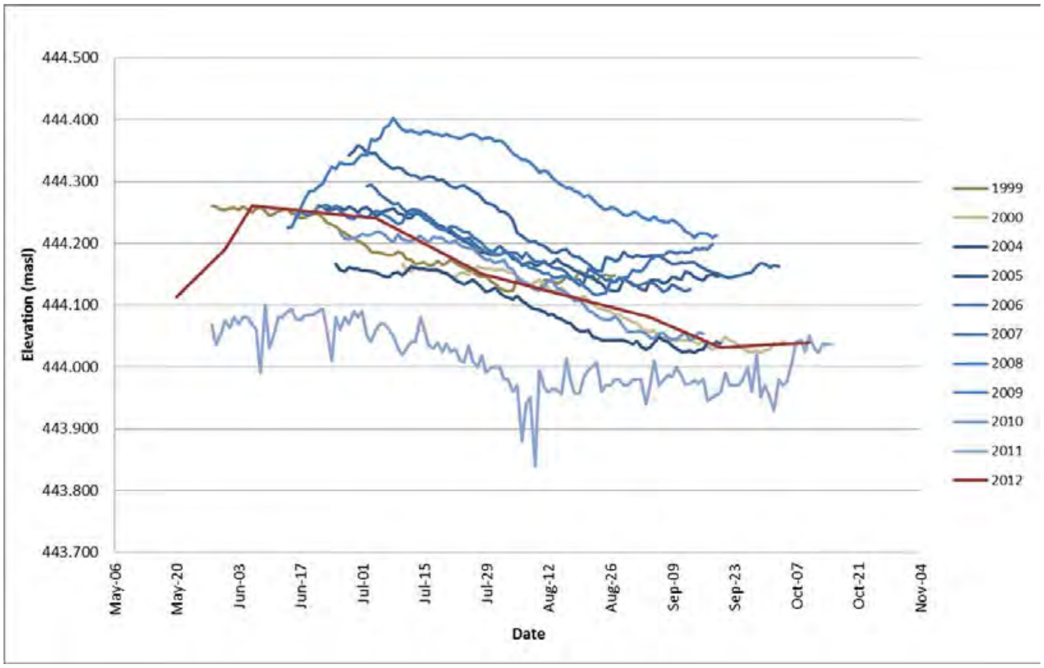
Daily mean water elevation data from the H3 Levelogger for Snap Lake during the open-water season were not considered reliable since the recorded logger data drifted approximately 0.45 m from the surveyed elevations. Surveyed elevation data are shown in Appendix I, Table I-2. The surveyed water elevation data collected during the open-water period from 1999, 2000, and 2004 to 2012 are summarized in Table 4-5 and Figure 4-2. During 2012, Snap Lake water elevations peaked in June, consistent with data from previous years.

Table 4-5 Summary of Water Elevation for Snap Lake (Station H3)

Month	1999 EA	2000 EA	2004	2005	2006	2007	2008	2009	2010	2011[(a)]	2012[(b,c)]
June mean	444.108	n/a	444.159	444.255	444.412	n/a	444.247	444.302	444.210	444.071	444.260
July mean	444.002	443.782	444.147	444.227	444.306	444.239	444.228	444.375	444.201	444.035	444.240
August mean	443.875	443.693	444.074	444.156	444.192	444.159	444.149	444.297	444.113	443.967	444.080[(d)]
September mean	443.897	443.696	444.034	444.141	444.163	444.129	444.181	444.228	444.051	443.975	444.030

(a) Nampcy Solutions Ltd. survey data used since H3 logger not retrieved at time of reporting due to lake ice conditions.
(b) Nampcy Solutions Ltd. survey data used since H3 logger drifted out of range during 2012.
(c) 2012 water elevations surveyed monthly and are not mean values.
(d) No water elevations were surveyed during August; this elevation was collected on September 4, 2012.
Notes: Values are all in metres above sea level (masl); n/a = not available; EA = Environmental Assessment.

Figure 4-2 1999 and 2000 Environmental Assessment, and 2004 to 2012 Snap Lake Water Elevation[(a)] (Station H3)



(a) Nampcy Solutions Ltd survey data used for 2012 and data points between surveys interpolated.
Note: masl = metres above sea level.

Snap Lake water elevations for 2012 were measured twice in May, once in June, twice in July, twice in September, and once in October by Nampcy Solutions Ltd. from the 2005 Benchmark survey location. Snap Lake water elevations were higher in 2012 than in 2011, but lower than most recorded years between 2004 and 2011. Figure 4-2 also illustrates that lake elevations measured in 2012 are generally consistent with those measured in other years, including pre-development measurements.

To compare water elevations among lakes in the region water elevations at Snap Lake, 1999 Reference Lake, North Lake, and Northeast Lake were surveyed approximately three times on or about the same date in each year from 2002 to 2012. The surveyed water elevation for each lake is listed in Table 4-6 and a graphical presentation of the changes in surveyed water elevations for each lake relative to their August 2002 elevations is shown in Figure 4-3. August 2002 was chosen since it was the first date for which survey elevations were available for all four lakes.

Over the period from September 2011 to September 2012, water elevations increased at Snap Lake, 1999 Reference Lake, North Lake, and Northeast Lake (Figure 4-3). The range of minimum and maximum water elevations between 2002 and 2012 for the lakes is also listed in Table 4-6. Snap Lake, North Lake, and Northeast Lake have exhibited similar elevation trends to 1999 Reference Lake, but tend to exhibit a lower range of elevation changes than 1999 Reference Lake, which is located in a different watershed. This indicates that the Mine is having negligible effects on lake water elevations compared to natural factors. Snap Lake, North Lake, and Northeast Lake show similar water elevation trends to 1999 Reference Lake. Although the EAR (De Beers 2002) predicted a decrease in Northeast Lake elevation of 1.6 cm, a decrease in North Lake elevation of 3.0 cm, and an increase in Snap Lake elevation of 5.3 cm, these trends have not been observed, and would be difficult to differentiate from the normal annual lake water elevation fluctuations resulting from changes in precipitation, evaporation, and other environmental factors.

Table 4-6 Surveyed Water Elevations for Snap Lake, 1999 Reference Lake, North Lake, and Northeast Lake

Year	Month	Snap Lake [masl]	1999 Reference Lake [masl]	North Lake [masl]	Northeast Lake [masl]
2002	Average[(a)]	444.297	440.841	439.839	433.074
2004	Average[(a)]	444.112	440.711	439.718	432.935
2005	Average[(a)]	444.151	440.776	439.766	432.972
2006	May	444.404	440.966	439.909	433.057
2006	August	444.247	440.789	439.755	432.924
2006	September	444.163	440.746	439.702	432.861
2007	June	444.293	441.077	439.865	433.043
2007	August	444.159	440.703	439.723	432.909
2007	September	444.125	440.702	439.696	432.885
2008	June	444.225	440.803	439.817	433.108
2008	August	444.145	440.661	439.645	n/a
2008	September	444.199	440.692	439.695	n/a
2009	July	444.342	440.880	439.962	432.911
2009	August	444.289	440.732	439.960	432.771
2009	September	444.213	n/a	439.661	n/a
2010	June	444.217	440.729	439.852	432.760
2010	July	444.168	440.662	439.708	432.719
2010	September	444.054	440.343	439.584	432.607
2011	May	444.068	440.689	439.695	432.985
2011	July/August	444.000	440.593	439.592	432.899
2011	September	443.951	440.575	439.585	432.767
2012	May	444.11[(b)]	440.790[(d)]	439.695	432.985
2012	July	444.24[(b)]	n/a	439.818[(d)]	n/a
2012	August	444.08[(b,c)]	440.711[(d)]	439.754[(d)]	432.851
2012	September	444.03 [(b)]	440.634[(d)]	439.634[(d)]	432.817[(d)]
Year-on-year change, 2011 to 2012 (m)	September 2011 to September 2012	+0.079	+0.043	+0.049	+0.050
Range between maximum and minimum surveyed water levels, 2002 to 2012 (m)	All months	0.453	0.734	0.378	0.501

(a) Average of the spring, summer, and fall surveyed water elevations.

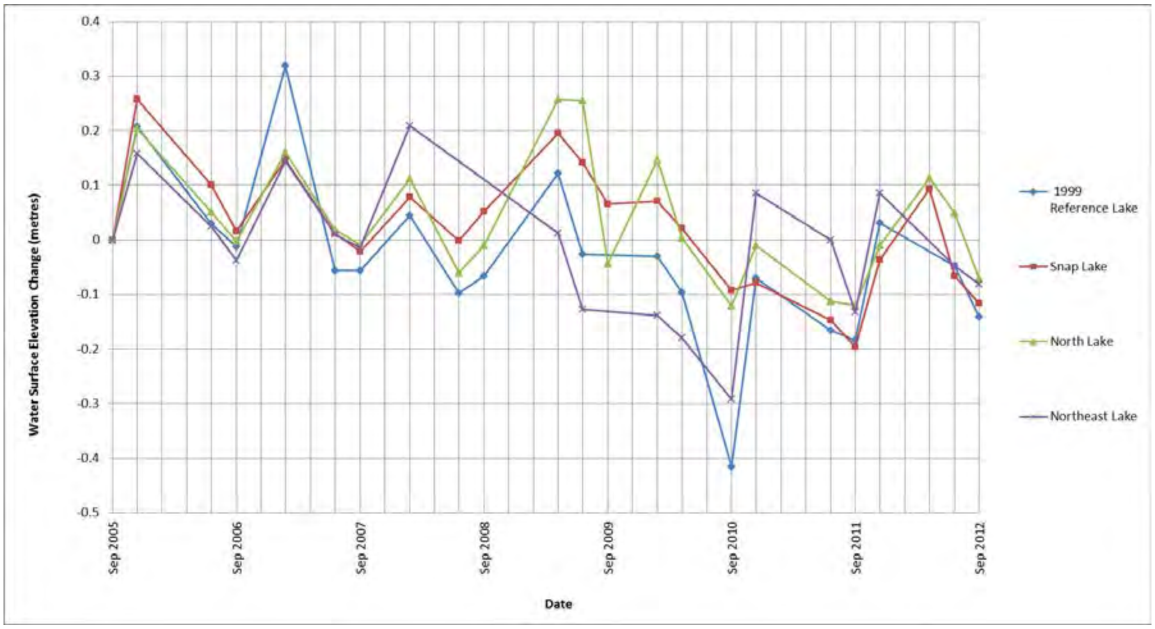
(b) Nampcy Solutions Ltd. survey data used since H3 logger drifted out of range during 2012.

(c) No water elevations were surveyed during August; this elevation was collected on September 4, 2012.

(d) Elevations calculated using stage-discharge rating curve and measured discharge flows since survey data were incorrect.

Notes: m = metre; masl = metres above sea level; n/a = not available.

Figure 4-3 Surveyed Water Elevations for 1999 Reference Lake, North Lake, Northeast Lake, and Snap Lake, Relative to September 2002 Elevation Surveys



(a) Data for 2005 are from September only; data points from all other years are from surveyed months in May, June, August and September (connecting lines are interpolated).

4.3 SNAP LAKE INLET (STATION H4)

Visual estimates were conducted on May 9 (zero discharge), May 14 (discharge estimated from digital video record), and May 15 (discharge estimated based on photographic record), 2012. In-stream discharge measurements were conducted using a velocity meter and depth gauge prior to and during freshet peak at Station H4 from May 17 to May 22, 2012 and on May 24, 26, and 28, 2012. In-stream discharge measurements were also taken using a velocity meter and depth gauge during the low flow period on August 5 and September 8, 2012. All discharges between measured dates are interpolated. The freshet peak was captured during 2012. Levelogger data were also collected during freshet but were not used since the snow and ice conditions rendered the stage-discharge relationship inaccurate and manual field survey data were available. A field error resulted in elevation logger data being recorded every 30 seconds rather than every 30 minutes; consequently the H4 data logger stopped recording on May 28. The measured discharges and corresponding water elevations are listed in Table 4-7.

Table 4-7 Measured Water Elevations and Discharge at Station H4, Snap Lake Inflow, 2001, 2002, and 2004 to 2012

Date	Geodetic Elevation [masl]	Discharge [m^3/s]
29-May-2001	444.769	0.514
09-Jun-2002	444.635	0.046
11-Aug-2002	444.650	0.049
01-Oct-2002	444.660	0.055
25-Jun-2004	444.660	0.071
20-Sep-2004	444.561	0.004
17-Jun-2005	444.700	0.151
25-Aug-2005	444.488	0.007
20-Sep-2005	444.663	0.069
19-May-2006	444.757	0.339
04-Aug-2006	444.594	0.011
03-Oct-2006	444.653	0.039
03-Jun-2007	n/a	0.385
15-Aug-2007	n/a	0.006
12-Sep-2007	444.614	0.041
09-Sep-2008	444.665	0.066
13-Aug-2008	444.562	0.006
18-Sep-2008	444.695	0.060
02-Jul-2009	444.671	0.081
16-Aug-2009	444.615	0.019
19-Sep-2009	444.645	0.024
23-Jun-2010	444.620	0.050
31-Jul-2010	444.598	0.011
15-Sep-2010	444.570	0.002
29-May-2011	444.693	0.121
01-Aug-2011	444.556	0.007
17-Sep-2011	444.612	0.021
28-May-2012	444.763	0.173
5-Aug-2012	445.075	0.003
8-Sep-2012	444.040	0.007

Note: masl = metres above sea level; m^3/s = cubic metres per second; n/a = not available.

The mean monthly discharge record for Station H4 between 1999 and 2012 is presented in Table 4-8. There are no recorded water elevation, and hence corresponding discharge data for 2005 due to sensor malfunction following installation. Daily mean discharges for the years 1999, 2000, and 2004 to 2012 are shown graphically in Figure 4-4. The 2012 peak discharge was estimated to have occurred on May 28, 2012. The seasonal mean discharge at H4 was estimated to be 0.067 m^3/s.

Table 4-8 Monthly Mean Discharges for Station H4

Month	1999	2000	2004	2005	2006	2007	2008	2009	2010	2011	2012[(d)]
May	n/a[(a)]	n/a[(a)]	n/a[(a)]	n/a[(a)]	n/a[(a)]	n/a[(a)]	n/a[(a)]	n/a[(a)]	n/a[(a)]	0.028	0.113
June	0.280	0.056[(b)]	0.033[(b)]	n/a[(c)]	0.085	0.134[(b)]	0.060[(b)]	n/a	0.115[(b)]	0.091	0.123
July	0.051	0.019	0.012		0.040	0.020	0.019	0.089	0.031	0.013	0.051
August	0.046	0.007	0.003		0.028	0.011	0.008	0.035	0.006	0.002	0.004
September	0.094	0.026	0.003[(b)]		0.058	0.022[(b)]	0.046[(b)]	0.026[(b)]	0.002[(b)]	0.002	0.002

(a) Data not recorded for this month.

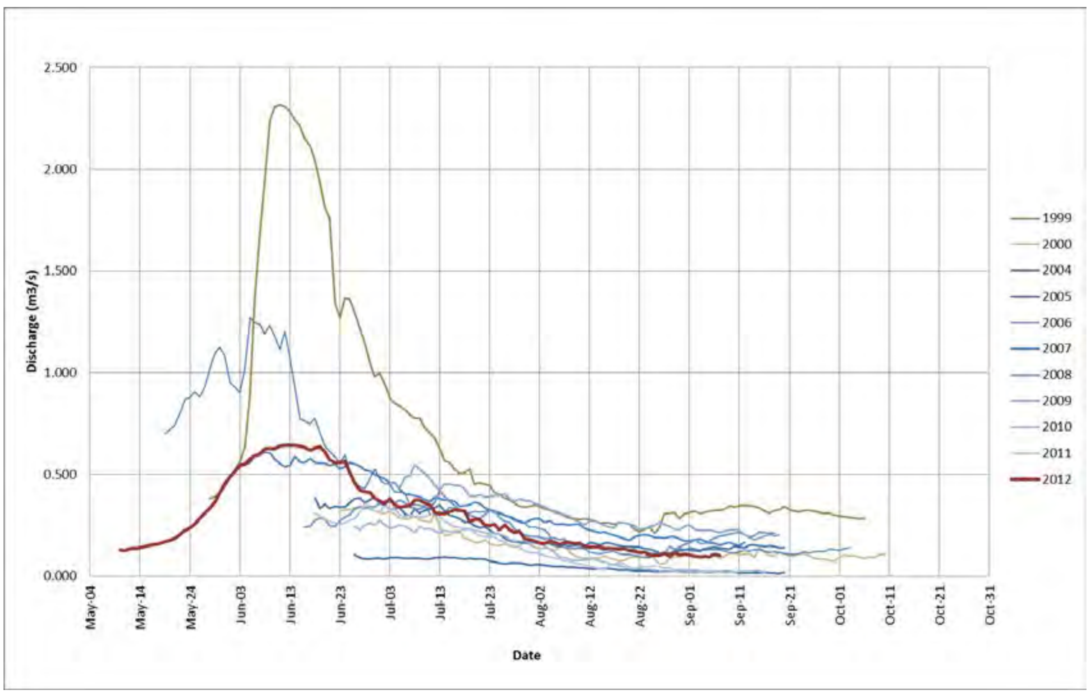
(b) Mean based upon a partial monthly flow record.

(c) Data for 2005 do not exist due to sensor malfunction.

(d) Estimated data based on visual surveys for May 9, 14, and 15. In-stream velocity and depth measurement data for May 17 to 22, 24, 26, 28, August 5, and September 8, 2012. All other discharge values are visual estimates or are interpolated and are estimates only.

Notes: Values are all in cubic metres per second (m^3/s); n/a = not available.

Figure 4-4 Daily Mean Discharge at Station H4, Snap Lake Inflow, 1999 to 2012[(a)]



(a) 2012 data collected May 17 to 22, 24, 26, 28, August 5, and September 8. Visual estimates conducted on May 9, 14, and 15. All other 2012 discharge values are interpolated and are estimates only.

Note: m^3/s = cubic metres per second.

4.4 1999 REFERENCE LAKE

Lake discharge monitoring and lake water elevation measurements at 1999 Reference Lake began in 2002. Lake water elevations were originally surveyed to an arbitrary benchmark with an assigned value of 100.000 m. During 2007, a geodetic benchmark was established consisting of an embedded pin in bedrock, and the corresponding elevations were updated. Surveyed elevations and outflow discharge measurements from 2002 to 2012 are provided in Table 4-9.

Surveyed elevations for 1999 Reference Lake were determined to be erroneous during 2012 since the elevations and discharge measurements did not correspond with the stage-discharge rating curve or monthly elevation and discharge measurements from previous years. The discharge measurements were considered to be more reliable, and therefore the elevations were back-calculated using the established natural logarithmic (ln) stage-discharge rating curve equation:

Calculated elevation (m) = 0.1005 * ln(discharge) + 440.91 *[equation 1]*

Based on these calculations, the water surface of 1999 Reference Lake was estimated to have increased by approximately 0.043 m between 2011 and 2012.

Table 4-9 Measured Water Elevation and Outflow Discharges for 1999 Reference Lake

Date	Geodetic Elevation [masl]	Discharge [m^3/s]
07-Jul-2002	440.839	0.423
11-Aug-2002	440.846	0.340
30-Sep-2002	440.839	0.311
27-Jun-2004	440.770	0.160
21-Sep-2004	440.652	0.060
18-Jun-2005	440.869	0.667
25-Aug-2005	440.699	0.086
19-Sep-2005	440.759	0.199
20-May-2006	440.966	1.443
03-Aug-2006	440.789	0.250
02-Oct-2006	440.746	0.138
02-Jun-2007	441.077	0.815
14-Aug-2007	440.703	0.191
12-Sep-2007	440.702	0.131
09-Jun-2008	440.803	0.691
13-Aug-2008	440.661	0.073
17-Sep-2008	440.692	0.103
02-Jul-2009	440.880	0.925
17-Aug-2009	440.732	0.178
09-Sep-2009	n/a	0.129
24-Jun-2010	440.729	0.193
31-Jul-2010	440.662	0.080
15-Sep-2010	440.343	0.012
28-May-2011	440.689	0.290
01-Aug-2011	440.593	0.033
18-Sep-2011	440.575	0.023
28-May-2012	440.790[a]	0.302
5-Aug-2012	440.711[a]	0.138
8-Sep-2012	440.618[a]	0.055

(a) Calculated using stage-discharge equation.

Notes: masl = metres above sea level; m^3/s = cubic metres per second; n/a = not available.

4.5 NORTH LAKE

North Lake water elevations are surveyed against an established geodetic benchmark. Prior to 2007, water elevations were surveyed to an arbitrary benchmark with an assigned value of 100.000 m. During June 2007, the current benchmarks were established. Previous water elevations were then converted into geodetic elevations using the surveyed relationship between the new and old benchmarks.

Outflow from North Lake passes through a large boulder field before discharging into a small lake downstream, and most flow passes along a bedrock wall where measurements are collected. In winter, outflow is spread across a broad channel area, and ice builds up to a thickness of several metres. The accumulated ice requires an extended period to melt, and therefore it is not possible to measure early summer discharges from the outlet of North Lake. Surveyed elevations and outflow discharge measurements from 2002 to 2012 are provided in Table 4-10.

During May 2012, De Beers personnel surveyed the elevation of North Lake but were unable to collect a discharge measurement due to ice conditions.

Surveyed elevations for North Lake for July, August, and September were determined to be erroneous during 2012 since the elevations and discharge measurements did not correspond with the stage-discharge rating curve or monthly elevation, or with discharge measurements from previous years. The discharge measurements were considered to be more reliable and the elevations were back-calculated using the established stage-discharge rating curve equation:

$$\text{Calculated elevation (m)} = 0.0986 * \ln(\text{discharge}) + 440.11 \qquad \text{[equation 2]}$$

Based on these calculations, the water surface of North Lake was estimated to have increased by approximately 0.049 m between 2011 and 2012.

Table 4-10 Measured Water Elevation and Outflow Discharges for North Lake

Date	Geodetic Elevation [masl]	Discharge [m^3/s]
08-Jul-2002	439.865	0.087
11-Aug-2002	439.846	0.072
30-Sep-2002	439.807	0.046
25-Jun-2004	439.784	n/a
21-Sep-2004	439.652	0.012
17-Jun-2005	439.865	n/a
25-Aug-2005	439.727	n/a
19-Sep-2005	439.705	0.022
20-May-2006	439.909	0.128
03-Aug-2006	439.755	0.046
02-Oct-2006	439.702	0.025
03-Jun-2007	439.870	0.093
14-Aug-2007	439.723	0.026
12-Sep-2007	439.696	0.018
09-Jun-2008	439.817	n/a
13-Aug-2008	439.645	0.021
17-Sep-2008	439.695	0.020
01-Jul-2009	439.962	0.146
17-Aug-2009	439.960	0.078
18-Sep-2009	439.661	0.011
23-Jun-2010	439.852	0.055
31-Jul-2010	439.708	0.034
15-Sep-2010	439.584	0.005
28-May-2011	439.695	n/a
01-Aug-2011	439.592	0.007
18-Sep-2011	439.585	0.002
28-May-2012	439.695	n/a
6-Jul-2012	439.818[(a)]	0.052
5-Aug-2012	439.754[(a)]	0.027
8-Sep-2012	439.634[(a)]	0.008
8-Sep-2012	n/a	0.010 [(b)]

(a) Calculated using stage-discharge equation.

(b) Second survey location at North Lake outlet (downstream of first survey location).

Notes: masl = metres above sea level; m^3/s = cubic metres per second; n/a = not available.

4.6 NORTHEAST LAKE

Northeast Lake water elevations were originally surveyed to an arbitrary benchmark with an assigned value of 100.000 m until 2007, when a geodetic benchmark was established consisting of an embedded pin in bedrock. Previous water elevations were then converted into geodetic elevations using the surveyed relationship between the new and old benchmarks.

Outflow from Northeast Lake was measured using a current meter each time water elevation was surveyed. Surveyed water elevations and corresponding outflow discharges are listed in Table 4-11. Elevation data for May and August were provided by De Beers and were considered accurate since they were consistent with the stage-discharge rating curve, and with elevation measurements from previous years. The surveyed elevation for Northeast Lake for September was determined to be erroneous during 2012 since the elevations and discharge measurements did not correspond with the stage-discharge rating curve or monthly elevation and discharge measurements from previous years. The discharge measurements were considered to be more reliable and the elevations were back-calculated using the established stage-discharge rating curve equation:

Calculated elevation (m) = 0.0707 * ln(discharge) + 433.02 *[equation 3]*

Based on these calculations, the water surface of Northeast Lake was estimated to have increased by approximately 0.050 m between 2011 and 2012.

Table 4-11 Measured Water Elevations and Outflow Discharges for Northeast Lake

Date	Geodetic Elevation [masl]	Discharge [m^3/s]
08-Jul-2002	433.117	1.373
11-Aug-2002	433.068	0.754
30-Sep-2002	433.037	0.526
25-Jun-2004	432.993	0.107
21-Sep-2004	432.877	0.080
18-Jun-2005	433.102	1.592
25-Aug-2005	432.917	0.228
20-Sep-2005	432.897	0.227
20-May-2006	433.057	1.055
03-Aug-2006	432.924	0.251
03-Oct-2006	432.861	0.137
02-Jun-2007	433.043	0.653
14-Aug-2007	432.909	0.242
11-Sep-2007	432.885	0.160
08-Jun-2008	433.108	1.349
13-Aug-2008	n/a	0.187
17-Sep-2008	n/a	0.142
01-Jul-2009	432.911	1.582
17-Aug-2009	432.771	0.378
18-Sep-2009	n/a	0.243
23-Jun-2010	432.76	0.322
30-Jul-2010	432.719	0.119
15-Sep-2010	432.607	0.022
28-May-2011	432.985	0.238
31-Jul-2011	432.899	0.035
18-Sep-2011	432.767	0.041
28-May-2012	432.985	0.241
5-Aug-2012	432.851	0.232
8-Sep-2012	432.817[(a)]	0.057

(a) Calculated using stage-discharge equation.

Notes: masl = metres above sea level; m^3/s = cubic metres per second; n/a = not available.

4.7 WATER BALANCE

The water balance for Snap Lake was estimated in 2012 to assess predictions of changes in water quality and quantity in Snap Lake as part of the AEMP (Golder 2005). The results of the water balance calculations summarized in Table 4-12 indicate that Snap Lake water losses were greater than inputs by 1,085,000 cubic metres (m^3). The estimated loss in volume suggests a decrease in water elevation of 65 mm over the previous year. However, Snap Lake surveyed water elevations showed an increase of 79 mm between September 2011 and 2012, and a decrease of 11 mm between October 2011 and 2012. These differences may be due to uncertainty in the inflow and outflow data for Snap Lake.

Table 4-12 Approximate Annual Snap Lake Water Balance 2012

Losses from Snap Lake [m^3]	
Pumped from Snap Lake	40,134
Pumped water truck volume	0
Loss from Snap Lake due to groundwater recharge	10,918,484
Outflow from Snap Lake	4,745,110
Net precipitation / evaporation loss from Snap Lake	5,788,220
Sum of Losses	**21,491,948**
Gains to Snap Lake [m^3]	
Inflow from WMP seepage	12,000
Inflow from domestic waste water plant outflow	28,406
Inflow from WTP	10,627,762
Inflow from TWTP	29,563
Inflow from drainage areas	5,570,005
Precipitation	4,135,488
Uncontained site runoff	3,825
Sum of Gains	**20,407,049**

Notes: m^3 = cubic metres; WMP = water management pond; WTP = water treatment plant; TWTP = temporary water treatment plant.

5 DISCUSSION AND CONCLUSIONS

Lake water elevations and outflows from Snap Lake, and discharge monitoring of one representative Snap Lake inflow tributary were monitored during the spring, summer, and fall of 2012. These monitoring data were collected to assess EAR predictions that Snap Lake Mine operations would have a negligible effect on water elevations and outflow (De Beers 2002).

The annual change in the Snap Lake water elevation, measured September 2011 to September 2012, was similar for Snap Lake, 1999 Reference Lake, North Lake, and Northeast Lake (increase of 79 mm, 43 mm, 49 mm and 50 mm respectively), indicating negligible effects of Mine and site water management on Snap Lake, North Lake, and Northeast Lake water elevations. The water balance calculations indicated that a decrease of 63.1 mm would be observed in Snap Lake, and lake survey elevation data showed an increase of 79 mm between September 2011 and 2012, and a decrease of 11 mm between October 2011 and 2012. These differences may be due to incomplete Snap Lake inflow and outflow data sets.

6 RECOMMENDATIONS

The following actions should be taken to improve the data quality for subsequent hydrological monitoring programs:

1) Barometric loggers in the vent raise should be replaced.
2) Monthly discharge monitoring should be conducted at H1 and H2, and the water level loggers should be installed at H1 and H2 as early as possible each year.
3) The H3 water level logger should be replaced and re-installed as soon as possible.
4) Discharge measurements should be taken at H4 throughout freshet, and the water level logger installed after freshet to record the remaining annual flows.
5) Elevation survey field procedures should be reviewed by crews conducing elevation surveys.

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8 CLOSURE

We trust this report meets your present requirements. If you have any questions or require additional details, please contact the undersigned.

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APPENDIX I

2012 DAILY DISCHARGE AND WATER ELEVATION DATA FOR STATIONS H1, H2, H3, AND H4

Table I-1 Snap Lake Recorded Outlet Discharges (Stations H1 and H2)

Date	H1 Discharge [m³/s]	H2 Discharge [m³/s]	H1+H2 Discharge [m³/s]
10-May-2012	0.047	0.084	0.130
11-May-2012	0.046	0.081	0.127
12-May-2012	0.049	0.088	0.137
13-May-2012	0.047	0.089	0.136
14-May-2012	0.048	0.092	0.140
15-May-2012	0.048	0.096	0.145
16-May-2012	0.051	0.101	0.151
17-May-2012	0.052	0.104	0.156
18-May-2012	0.053	0.107	0.160
19-May-2012	0.055	0.114	0.169
20-May-2012	0.058	0.119	0.178
21-May-2012	0.060	0.126	0.186
22-May-2012	0.065	0.140	0.205
23-May-2012	0.071	0.153	0.224
24-May-2012	0.075	0.164	0.239
25-May-2012	0.079	0.178	0.257
26-May-2012	0.084	0.201	0.285
27-May-2012	0.087	0.221	0.308
28-May-2012	0.089	0.245	0.335
29-May-2012	0.092	0.277	0.369
30-May-2012	0.095	0.316	0.411
31-May-2012	0.098	0.359	0.457
1-Jun-2012	0.100	0.385	0.485
2-Jun-2012	0.100	0.415	0.516
3-Jun-2012	0.100	0.446	0.546
4-Jun-2012	0.098	0.454	0.552
5-Jun-2012	0.098	0.476	0.575
6-Jun-2012	0.098	0.496	0.593
7-Jun-2012	0.098	0.502	0.600
8-Jun-2012	0.101	0.525	0.625
9-Jun-2012	0.103	0.525	0.627
10-Jun-2012	0.102	0.525	0.627
11-Jun-2012	0.102	0.538	0.640
12-Jun-2012	0.102	0.541	0.644
13-Jun-2012	0.103	0.541	0.644
14-Jun-2012	0.103	0.541	0.644
15-Jun-2012	0.102	0.539	0.641
16-Jun-2012	0.103	0.531	0.635
17-Jun-2012	0.101	0.519	0.620
18-Jun-2012	0.106	0.525	0.631
19-Jun-2012	0.105	0.531	0.636
20-Jun-2012	0.103	0.509	0.612
21-Jun-2012	0.100	0.472	0.572
22-Jun-2012	0.101	0.458	0.559
23-Jun-2012	0.102	0.456	0.557
24-Jun-2012	0.109	0.455	0.564
25-Jun-2012	0.107	0.405	0.512
26-Jun-2012	0.102	0.358	0.459

Table I-1 Snap Lake Outlet Discharges (Stations H1 and H2) (continued)

Date	H1 Discharge [m³/s]	H2 Discharge [m³/s]	H1+H2 Discharge [m³/s]
27-Jun-2012	0.097	0.326	0.423
28-Jun-2012	0.096	0.321	0.416
29-Jun-2012	0.093	0.318	0.411
30-Jun-2012	0.092	0.292	0.384
1-Jul-2012	0.092	0.277	0.370
2-Jul-2012	0.093	0.264	0.356
3-Jul-2012	0.113	0.268	0.382
4-Jul-2012	0.100	0.250	0.350
5-Jul-2012	0.088	0.253	0.341
6-Jul-2012	0.098	0.246	0.343
7-Jul-2012	0.101	0.247	0.348
8-Jul-2012	0.123	0.250	0.373
9-Jul-2012	0.125	0.251	0.376
10-Jul-2012	0.122	0.239	0.361
11-Jul-2012	0.092	0.259	0.351
12-Jul-2012	0.082	0.230	0.311
13-Jul-2012	0.071	0.235	0.305
14-Jul-2012	0.078	0.227	0.305
15-Jul-2012	0.099	0.218	0.317
16-Jul-2012	0.104	0.224	0.328
17-Jul-2012	0.087	0.237	0.324
18-Jul-2012	0.082	0.239	0.321
19-Jul-2012	0.057	0.212	0.269
20-Jul-2012	0.069	0.208	0.277
21-Jul-2012	0.082	0.198	0.280
22-Jul-2012	0.062	0.189	0.251
23-Jul-2012	0.067	0.181	0.247
24-Jul-2012	0.081	0.173	0.254
25-Jul-2012	0.058	0.171	0.229
26-Jul-2012	0.084	0.167	0.251
27-Jul-2012	0.068	0.161	0.229
28-Jul-2012	0.056	0.159	0.215
29-Jul-2012	0.074	0.147	0.221
30-Jul-2012	0.045	0.138	0.183
31-Jul-2012	0.052	0.129	0.181
1-Aug-2012	0.051	0.122	0.172
2-Aug-2012	0.048	0.116	0.164
3-Aug-2012	0.047	0.114	0.161
4-Aug-2012	0.050	0.124	0.174
5-Aug-2012	0.050	0.117	0.167
6-Aug-2012	0.045	0.111	0.156
7-Aug-2012	0.048	0.120	0.168
8-Aug-2012	0.048	0.117	0.165
9-Aug-2012	0.048	0.112	0.160
10-Aug-2012	0.050	0.114	0.164
11-Aug-2012	0.046	0.100	0.146
12-Aug-2012	0.044	0.098	0.142
13-Aug-2012	0.042	0.100	0.141

Table I-1 Snap Lake Outlet Discharges (Stations H1 and H2) (continued)

Date	H1 Discharge [m³/s]	H2 Discharge [m³/s]	H1+H2 Discharge [m³/s]
14-Aug-2012	0.042	0.104	0.146
15-Aug-2012	0.038	0.099	0.137
16-Aug-2012	0.037	0.097	0.134
17-Aug-2012	0.037	0.098	0.135
18-Aug-2012	0.040	0.094	0.134
19-Aug-2012	0.040	0.096	0.137
20-Aug-2012	0.038	0.089	0.127
21-Aug-2012	0.037	0.084	0.122
22-Aug-2012	0.037	0.079	0.116
23-Aug-2012	0.040	0.077	0.118
24-Aug-2012	0.034	0.069	0.102
25-Aug-2012	0.032	0.070	0.103
26-Aug-2012	0.033	0.069	0.102
27-Aug-2012	0.038	0.072	0.110
28-Aug-2012	0.035	0.063	0.098
29-Aug-2012	0.037	0.077	0.115
30-Aug-2012	0.029	0.077	0.106
31-Aug-2012	0.033	0.076	0.109
1-Sep-2012	0.033	0.073	0.106
2-Sep-2012	0.032	0.067	0.099
3-Sep-2012	0.031	0.064	0.095
4-Sep-2012	0.032	0.065	0.097
5-Sep-2012	0.031	0.063	0.095
6-Sep-2012	0.035	0.072	0.107
7-Sep-2012	0.033	0.068	0.101

Note: m^3/s = cubic metres per second.

Table I-2 2012 Snap Lake Recorded Water Elevations (Station H3)

Date	Nampcy Survey Daily Water Elevation [masl]
20-May-2012	444.110
31-May-2012	444.190
6-Jun-2012	444.260
4-Jul-2012	444.240
28-Jul-2012	444.150
4-Sep-2012	444.080
20-Sep-2012	444.030
10-Oct-2012	444.040

Note: masl = metres above sea level.

Table I-3 Snap Lake Inlet Discharge Surveys and Estimates (Station H4)

Date	Daily Discharge[(a)] [m^3/s]
09-May-2012	0.000[(b)]
14-May-2012	0.030[(c)]
15-May-2012	0.030[(d)]
17-May-2012	0.180
18-May-2012	0.388
19-May-2012	0.387
20-May-2012	0.265
21-May-2012	0.249
22-May-2012	0.221
24-May-2012	0.196
26-May-2012	0.202
28-May-2012	0.173
5-Aug-2012	0.003
8-Sep-2012	0.007

(a) All other daily data interpolated or estimated.

(b) Snow covering stream was excavated, no water found.

(c) Discharge estimated based on digital video footage.

(d) Discharge estimated based on photograph to be similar to 14-May-12 discharge.

Note: m^3/s = cubic metres per second.