APPENDIX E.3

STREAMFLOW DATA FOR TYPE A WATER LICENCE MONITORING LOCATIONS

MEMORANDUM

To:	Mr. James (Jim) Millard	Date:	March 12, 2015
Copy To:		File No.:	NB102-181/34-A.01
From:	Dale Klodnicki	Cont. No.:	NB14-00597
Re:	Stream Flow Data for Type A Water Licence Sites		

1 – INTRODUCTION

A monitoring requirement of the Type A Water Licence #2AM-MRY1325 issued to Baffinland Iron Mines Corporation (Baffinland) for the Mary River Project is to measure the flow and the water quality of surface discharge at locations established as part of the Surveillance Network Program (SNP). The data collected from these stations will help inform the evaluation of effects to be conducted as part of the Aquatics Effects Monitoring Plan (AEMP). The SNP stations at the Milne Port and Mine Site subject to this assessment are summarized in Table 1 and shown on Figure 1 and Figure 2.

Table 1 SNP Surface Water Monitoring Stations

SNP Station	Description	Monitoring Frequency	Source
MP-C-A	Locations where there is surface discharge from construction areas at the Milne Port Site	During periods of flow and following precipitation events on a monthly basis	Table 13 of Schedule I of the Water Licence
MP-C-B			
MP-C-C			
MP-C-D			
MP-C-E			
MP-C-F			
MP-Q1-01	Locations where there is surface discharge from the quarry at the Milne Port Site	During periods of flow and following precipitation events on a monthly basis	Established by Baffinland to monitor downstream water discharge from the quarry operations
MP-Q1-02			
MS-MRY-09	Surface water drainage from the bulk sample open pit	Monthly during summer	Table 14 of Schedule I of the Water Licence
MS-MRY-10	Surface water drainage from the bulk sample weathered ore stockpile		
MS-MRY-13a	Surface water drainage from the non-hazardous waste landfill	Daily	Table 14 of Schedule I of the Water Licence
MS-MRY-13b	Surface water drainage from the non-hazardous waste landfill		
MQ-C-A	Locations where there is surface discharge from mine site construction areas downstream of construction areas and/or the QMR2 quarry	During periods of flow and following precipitation events on a monthly basis	Established by Baffinland to monitor downstream water discharge from the quarry operations at the mine site
MQ-C-B			
MQ-C-D			
MS-C-A	Locations where there is surface discharge from mine site construction areas	During periods of flow and following precipitation events on a monthly basis	Table 14 of Schedule I of the Water Licence
MS-C-B			
MS-C-C			
MS-C-D			
MS-C-E			
MS-C-F			

2 – MEASUREMENT OF SURFACE WATER DISCHARGE

Site visits were made to all of the SNP stations during the spring freshet period in June 2014. Hydrometric monitoring stations were installed to measure surface water discharge at or near each of the SNP stations where possible. The measurement techniques used were based on the characteristics of each site. On larger flowing channels, or in streams considered to be fish habitat, the natural channel was used as a control section and discharge was measured using the velocity-area method. In smaller channels, channels without stable flow conditions, and/or without a natural control, it was not possible to establish a reliable relationship between stage and discharge. In these cases, V-notch thin plate weirs were used as flow control structures to provide a reliable means of estimating flow. The V-notch weirs were installed during site visits in July 2014. At all of the hydrometric stations, pressure transducers with data loggers were installed to record water level (stage) in a gauge pool upstream of the control section or weir. A relationship was established between stage and discharge at each site and rating curves were developed to produce a long-term flow record from the water level data.

At stations with little or intermittent flow, or unsuitable channel conditions, it will not be practical to obtain a reliable long-term record of flow. The sites where the long-term measurement of flow was not practical are shown in Table 2.

Table 2 Stations Where Measuring Discharge Was Not Practical

SNP Station	Observations	Follow-up
MP-C-A MP-C-D MP-C-E MP-C-F MP-C-G	Measuring surface water flow at these sites on a regular basis was not possible as there was little or no flow observed during site visits.	The sites were visited on a regular basis and following precipitation events to determine if flow was present.
MS-C-C MS-C-D	Flow was observed at these sites but the channels were not conducive to reliable long-term monitoring.	Flow was measured at these sites during water quality sampling and is monitored on a long-term basis downstream at MS-C-E.
MS-MRY-09 MS-MRY-10	Measuring flow at these sites was not possible as there was no channelized flow present.	The condition of these sites was assessed during water quality sampling.

2.1 STATIONS WITH NATURAL CHANNEL CONTROL

The stations that utilized natural stream controls are shown in Table 3.

Table 3 Stations Using Natural Channel Controls

SNP Station	Hydrometric Station Type	Data Collected
MQ-C-B MQ-C-D MS-C-A MS-C-B	Hydrometric station installed using natural channel control and pressure transducer with data logger.	Discharge and water level measured during weekly sampling events to establish stage-discharge relationship. Data loggers downloaded monthly.

Suitable locations for hydrometric stations were not found at MS-C-A or MS-C-B due to the poorly defined and rocky channels. A single hydrometric station was installed between MS-C-A and MS-C-B at a location with a good control section (MS-C-A/B). The data from the MS-C-A/B station is considered to be more representative of flows at MS-C-B and is expected to slightly underestimate flows at MS-C-A, which is located approximately 100 m downstream.

2.2 STATIONS WITH A WEIR

The stations where a V-notch weir was installed to measure flow are shown in Table 4.

Table 4 Stations Using Weirs

SNP Station	Hydrometric Station Type	Data Collected
MP-Q1-01 MP-Q1-02 MP-C-B MS-MRY-13a MS-MRY-13b MQ-C-A MS-C-E	Thin plate V-notch weir flow measurement structures installed. Pressure transducer with data logger installed to measure height of water.	Manual measurements of water level obtained weekly. Data loggers downloaded monthly.

A suitable location for a flow control structure was not found at MS-MRY-13b. The station at MS-MRY-13a is located approximately 120 m upstream of MS-MRY-13b and there are no channelized inputs of flow between the two sites. As such, the flow measured at MS-MRY-13a weir is considered to be reasonably representative of flow at both stations.

At the MP-Q1-01 station, flow was measured for a three day period, after which water began running under the weir and the water level data recorded after this point was not considered reliable. The pattern of flow recorded during the concurrent periods of record at MP-Q1-01 was similar to MP-Q1-02. The flow at MP-Q1-01 was approximately 1.8 times greater than at MP-Q1-02.

3 – DAILY DISCHARGE DATA

Water level data were recorded at each site on 15 minute intervals and daily discharge values were calculated by averaging the 15 minute data on a daily basis. The daily discharge data recorded for June and July are shown in Table 5 and for August and September in Table 6. The daily discharge record is summarized in hydrographs for the Milne Port SNP Stations on Figure 3 and for the Mine Site SNP Station on Figure 4.

Prepared:

Dale Klodnicki, C.E.T. - Environmental Technologist

Reviewed:

Richard Cook, P.Geo. (Ltd.) - Senior Scientist

Approval that this document adheres to Knight Piésold Quality Systems:

Attachments:

Table 5 Rev 0	SNP Station Daily Average Discharge - June and July
Table 6 Rev 0	SNP Station Daily Average Discharge - August and September
Figure 1 Rev 0	Mine Site Surveillance Network Program (SNP)
Figure 2 Rev 0	Milne Port Surveillance Network Program (SNP)
Figure 3 Rev 0	2014 Daily Average Discharge - Milne Port SNP Stations
Figure 4 Rev 0	2014 Daily Average Discharge - Mine Site SNP Stations

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TABLE 5

BAFFINLAND IRON MINES CORPORATION
MARY RIVER PROJECT

SNP STATION DAILY AVERAGE DISCHARGE
JUNE AND JULY

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Date	Daily Average Discharge (l/s)								
	MP-C-B	MP-Q1-02	MQ-C-A	MQ-C-B	MQ-C-D	MRY-13a	MS-C-AB	MS-C-E	MS-C-D
25-Jun-14			8.26	29.7	50.0		66.9	20.8	5.2
26-Jun-14				29.4			75.6		
27-Jun-14				21.1			55.4		
28-Jun-14				19.8			54.7		
29-Jun-14				21.5			64.9		
30-Jun-14				22.7			84.5		
1-Jul-14				20.6			86.8		
2-Jul-14				17.5			80.7		
3-Jul-14				17.3			79.8		
4-Jul-14				15.3			77.7		
5-Jul-14				12.0			67.0		
6-Jul-14				10.6			60.3		
7-Jul-14				10.7			54.4		
8-Jul-14				9.1			48.5		
9-Jul-14				7.1			42.7		
10-Jul-14				6.3			38.0		
11-Jul-14				7.7			34.5		
12-Jul-14				6.3			31.1		
13-Jul-14				4.8			26.1		
14-Jul-14				3.8			21.5		
15-Jul-14				3.7			17.1		
16-Jul-14				3.5			15.2		
17-Jul-14				3.3			13.4		
18-Jul-14				7.6			21.6		
19-Jul-14				31.9			84.0		
20-Jul-14				30.8			159.4		
21-Jul-14				28.0			98.6		
22-Jul-14				23.6			105.8		
23-Jul-14			0.69	15.9			75.7		
24-Jul-14			0.54	12.9			57.0		
25-Jul-14			0.41	10.8			43.7	8.4	
26-Jul-14			0.40	9.8		0.18	34.9	8.5	
27-Jul-14	2.7	0.90	0.35	8.5		0.17	29.0	11.4	
28-Jul-14	2.6	0.83	0.35	7.9	11.9	0.36	24.8	10.5	2.9
29-Jul-14	2.6	0.75	0.33	6.8	13.3	0.31	22.3	9.9	
30-Jul-14	2.9	0.81	1.18	12.3	23.1	0.24	23.6	14.5	
31-Jul-14	3.3	0.75	0.67	8.9	19.6	0.33	21.3	11.4	

I:\1\02\00181\34\A\Correspondence\NB14-00597 - 2014 Hydrology at Water License Sites\Final\Figures and Tables\[Table 5 and 6 - Flow Records.xlsx]Table 5 (June-July)

REV	DATE	DESCRIPTION	PREP'D	REV'D
0	12MAR'15	ISSUED WITH MEMO NB14-00597	ALR	DKK

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TABLE 6

BAFFINLAND IRON MINES CORPORATION
MARY RIVER PROJECT

SNP STATION DAILY AVERAGE DISCHARGE
AUGUST AND SEPTEMBER

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Date	Daily Average Discharge (l/s)								
	MP-C-B	MP-Q1-02	MQ-C-A	MQ-C-B	MQ-C-D	MRY-13a	MS-C-AB	MS-C-E	MS-C-D
1-Aug-14	3.2	0.67	0.57	7.8	16.7	0.13	19.7	9.9	
2-Aug-14	3.1	0.61	0.54	6.8	14.1	0.11	18.7	9.0	
3-Aug-14	3.1	0.55	0.51	6.5	14.3	0.05	17.5	8.6	
4-Aug-14	3.0	0.46	0.46	5.9	13.0	0.06	15.5	7.7	
5-Aug-14	3.4	0.37	1.51	13.5	26.0	0.34	17.9	14.9	9.0
6-Aug-14	3.1	0.31	0.92	9.6	21.9	0.18	15.3	11.7	
7-Aug-14	6.9	0.77	8.62	42.2	71.1	0.88	50.1	34.7	
8-Aug-14	8.0	0.69	8.57	46.8	82.7	0.63	111.7	40.5	
9-Aug-14	6.7	0.69	8.18	50.2	89.5	0.77	122.9	39.0	
10-Aug-14	9.5	0.99	10.67	63.1	100.6	0.92	143.6	47.2	
11-Aug-14	11.2	1.24	6.52	53.8	97.3	0.44	155.2	42.7	
12-Aug-14	10.0	1.10	3.47	32.4	67.6	0.63	109.2	33.4	14.0
13-Aug-14	8.1	0.86	2.62	24.1	54.3	0.87	83.4	28.7	
14-Aug-14	6.5	0.64	1.93	18.2	42.8	0.67	68.5	23.8	
15-Aug-14	5.0	0.45	1.40	13.5	34.5	0.38	54.8	18.8	
16-Aug-14	3.8	0.31	1.07	9.9	26.1	0.19	43.1	14.7	
17-Aug-14	2.9	0.21	0.94	8.4	23.1	0.06	33.5	12.2	
18-Aug-14	2.3	0.14	0.87	8.7	25.0	0.05	25.8	10.8	6.9
19-Aug-14	4.2	0.52	1.64	9.1	33.3	0.15	22.8	12.2	
20-Aug-14	4.6	0.54	1.90	9.1	25.0	0.12	21.6	12.2	
21-Aug-14	4.0	0.42	1.77	10.0	30.4	0.09	19.0	11.2	
22-Aug-14	3.9	0.27	1.60	8.8	27.7	0.04	17.9	9.9	
23-Aug-14	3.4	0.15	1.09	6.4	22.1	0.02	16.3	8.0	
24-Aug-14	2.8	0.12	0.86	5.3	19.2	0.01	15.2	7.1	
25-Aug-14	4.8	0.49	4.13	18.6	38.9	0.27	24.9	14.8	
26-Aug-14	6.4	0.75	2.18	13.8	40.9	0.17	33.2	15.0	
27-Aug-14	5.6	0.63	1.45	9.7	30.2	0.06	41.3	11.3	1.5
28-Aug-14	5.6	0.50	1.14	7.3	24.4	0.03	39.0	9.4	
29-Aug-14	5.1	0.36	0.93	6.2	20.3	0.02	33.1	8.0	
30-Aug-14	4.1	0.24	0.67	3.3	13.7	0.00	26.1	6.2	
31-Aug-14	3.2	0.19	0.62	3.1	12.3	0.00	20.8	5.8	
1-Sep-14	2.8	0.18	0.57	2.9	12.1	0.00	16.5	5.4	
2-Sep-14	2.5	0.16	0.53	2.8	11.8	0.00	13.5	5.0	1.4
3-Sep-14	2.0	0.22	0.49	2.8	11.4	0.00	11.6	4.7	
4-Sep-14	1.6	0.14	0.45	2.4	10.3	0.00	9.6	4.3	
5-Sep-14	1.4	0.13	0.41	2.2	10.1	0.00	7.9	4.0	
6-Sep-14	1.2	0.13	0.39	1.9	7.0	0.00	6.9	3.7	
7-Sep-14	0.9	0.19				0.00			
8-Sep-14	0.70	0.13							

I:\1\02\00181\34\A\Correspondence\NB14-00597 - 2014 Hydrology at Water License Sites\Final\Figures and Tables\[Table 5 and 6 - Flow Records.xlsx]Table 6 (Aug-Sept)

REV	DATE	DESCRIPTION	PREP'D	REV'D
0	12MAR'15	ISSUED WITH MEMO NB14-00597	ALR	DKK

559 500 E
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QUARRY QMR2
MQ-C-D
MQ-C-B
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RAW WATER INTAKE PIPELINE
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CONSTRUCTION
LAYDOWN AREA
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AERODROME RUNWAY
AND APRON EXTENSION
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EXPLORATION CAMP
SEWAGE DISCHARGE
PIPELINE
MS-MRY-11 (MRY-11)
MS-C-A
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CAMP INFRASTRUCTURE
MS-C-B
MS-C-E
MS-C-D
MS-01
MS-C-F
MS-C-C
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TRUCK WEIGH SCALE BUILDING
FUTURE ORE
CRUSHING
SEDIMENTATION
POND
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EXISTING LANDFILL ROAD
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UTILITY BERM
MS-MRY-13b (MRY-13b)
MS-MRY-13a (MRY-13a)
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EXISTING LANDFILL
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ᐅᓇᐃᓕᒪᓂᖅ ᐊᒻᒪᓗ ᓄᓇᕗᑎᓄᑦ
FUTURE EXPLOSIVES
MAGAZINE STORAGE AND
ACCESS ROAD
ᓄᓇᕗᑎᓄᑦ ᖃᓄᐃᓕᓴᕐᓂᓕᕐᓂᑦ ᐊᑐᕐᑎᓂᒃ
FUTURE EMULSION PLANT

grQ/ q5

LEGEND:

- wu6 WATER
- kN Wdtf=4 w[1 os3t lQ5 LAYDOWN AREA (CONSTRUCTION PHASE)
- ᐊᑐᓕᐅᖅᓱᒃᑲᐃᓇᓕᓂᒃ ᐃᓂᓱᐅᓄᑦ (2013 ᐅᑯᑎᓇ Q10C3001) BORROW AREAS (2013 UNDER Q10C3001)
- ᐅᔨᕐᑕᕐᓴᖅᑎᑦ ᐃᓂᓱ (ᐱᑕᕐᑲᓂᑐᒥ ᐅᖅᓂ Q13C301) QUARRY AREA (EXISTING UNDER Q13C301)
- fig6FfZMig6Ff==sJ6 RIVER/STREAM/DRAINAGE
- x3dt ROAD
- ᐱᓕᓇᖅᓴᓗᒃ ᐱᖅᓯᓪᓕᐊᑕᐅᓂᑦᓯᑦ ᐃᓂᓱᓗᒃ PROJECT DEVELOPMENT AREA
- X?8M8f5 kNu4 xg6gx6bz5 wkw5 kNdtzi BAFFINLAND'S COMMERCIAL LEASE ON INUIT OWNED LAND
- ᓴᓴᕐᓂᓗᑦ ᐃᓕᓴᕐᑐᒥ ᒥᓕᓕᓂᓗᒃ ᓯᓚᓕᖅᑎᑦ RAW WATER INTAKE PIPELINE
- ᐃᓕᓕᓇᓂᓪᓚᑦ ᐱᓕᓇᖅᓴᓕᒥᑦ ᐃᓕᐅᑦ ᐱᐅᓂᖅᓴᓗᓂ ᐅᓴᖅᓴᐃᓂᓪᓚᑦ ᐃᓂᓱᓗᒃ WATER LICENCE WATER QUALITY MONITORING LOCATION

NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 17N.
2. TOPOGRAPHY PROVIDED BY EAGLE MAPPING (2005).
3. PLAN BASED ON INFORMATION PROVIDED BY HATCH, DATED (JAN 31, 2014).
4. CONTOUR INTERVAL IS 2.5 METRES.
5. ALL SAMPLE ID'S SHOWN IN BRACKETS REPRESENT THE TYPE B WATER LICENCE(S) MONITORING POINTS. ALL OTHERS ARE MONITORING POINTS AS PER THE TYPE A WATER LICENCE (2AM-MRY1325).

c spm/4nw5:

1. kNax3 tt3ymiz mo4g6 UTM NAD83 ZONE 17N.
2. kNaxoEp5 EAGLE MAPPING (2005).
3. ᐸᑲᔪᑎᓪ/ᐃᓕᒥᓂᕆᓚᓕᑦ ᑐᖅᓚᐃᑦᓯᑎᑦ ᑐᓴᐅᒪᓕᒥᑎᓂᑦ ᑐᓂᔅᓴᒪᓕᓕᑦ ᐱᓪᓗᔨ, ᐅᓪᓗᓴᒪᓕᑎᑦ (ᓴᓄᐊᓇ 31, 2014).
4. tt3ymJ5 ub: xd8iqs szy4tQg5 @% ub
5. ᐃᓗᓯᓇᑎᒃ ᖃᐅᔨᓴᒥᑎᓂᓚᑦ ᑲᓂᓱᑎᑕᐅᓂᑦ ᐅᖃᓪᑕᖃᓄᐃᓗᓂᒃ ᐅᖃᓪᓚᕐᓗᓂᒃ ᐃᓗᓯᓇᑎᒃ B ᐃᒥᓪᓚᓂᓪᓚᑦ ᐱᓪᓚᓂᓇᑎᒥᑦ ᖃᐅᔨᓴᓐᓂᓪᓚᑦ ᐱᓪᓚᓂᓇᑎᒥᑦ ᐊᓪᓚᓂᓇᑎᒥᑦ ᐊᓪᓚᓂᓇᑎᒥᑦ ᐃᓗᓯᓇᑎᒃ ᖃᓄᐃᓕᓴᕐᓂᓗᒃ A ᐃᒥᓪᓚᓂᓪᓚᑦ ᐱᓪᓚᓂᓇᑎᒥᑦ (2AM-MRY1325).

x q i z 100 50 0 100 200 300 400 500 m
SCALE A

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

MINE SITE SURVEILLANCE NETWORK PROGRAM (SNP)

Knight Piésold CONSULTING

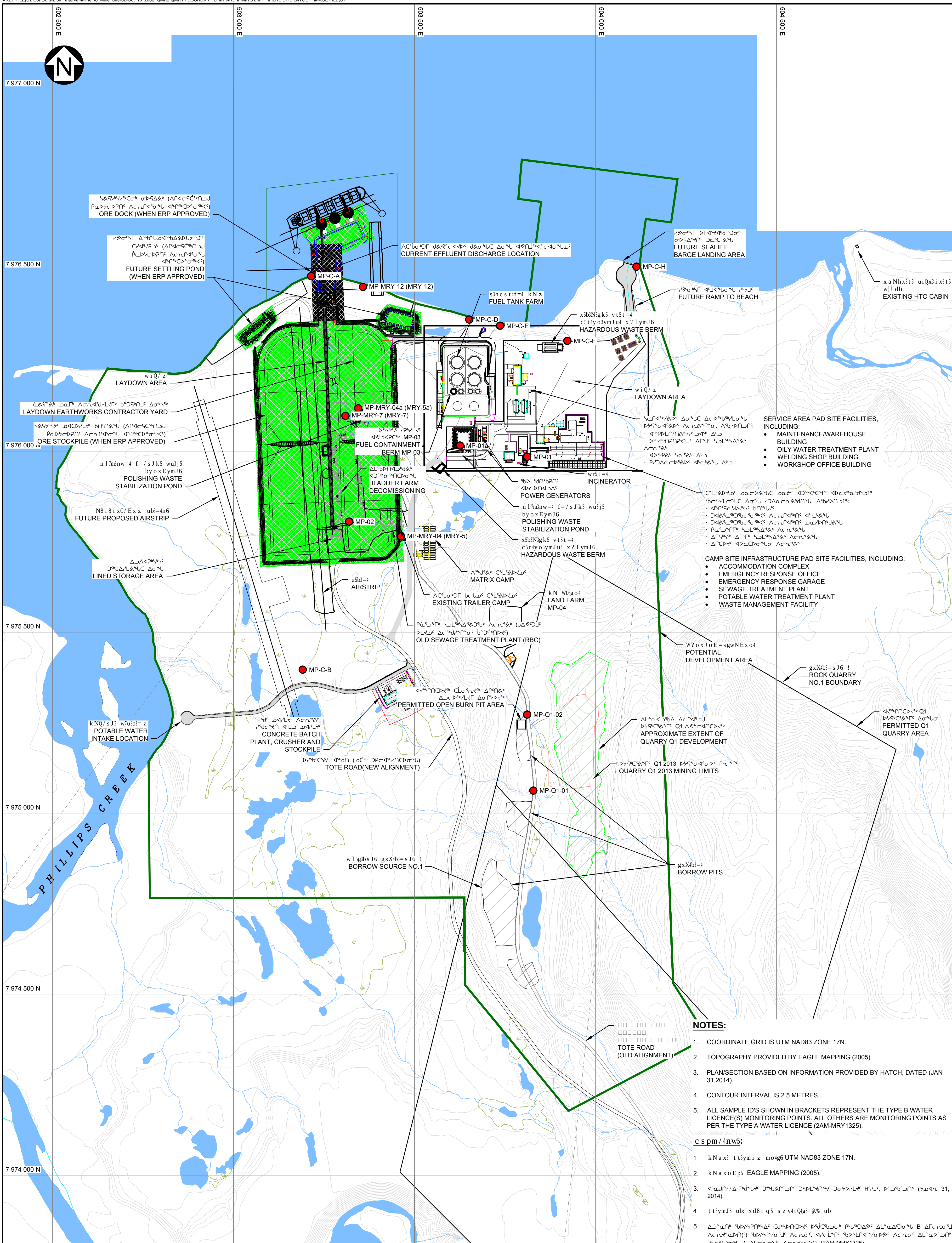
P/A NO. NB102-181/34 | REF NO. NB14-00597

FIGURE 1 | REV 0

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	12MAR'15	ISSUED WITH MEMO	DKK	SWK	RAC

SAVED: I:\1102\20\181134\Acad\FIGS\B24_r0_3/12/2015 3:11:18 PM, SKOZMICK PRINTED: 3/12/2015 3:15:32 PM, Layout1, SKOZMICK
XREF FILE(S): Contours-2.5m_Interval-Mine_Is_Mine_Site-dGCol_16_2008, QMR2 QMR1 - BOUNDARY LIMIT AND MINING LIMIT, MINE SITE LAYOUT IMAGE FILE(S)

SAVED: I:\1\02\00181\34\A\Acad\FIGS\B25_r0, 3/12/2015 3:01:47 PM , SKOZMICK PRINTED: 3/12/2015 3:05:56 PM, Layout1, SKOZMICK
XREF FILE(S): Contours-2.5m_Interval-Milne_to_Mine_Site-02-Oct_16_2008; QMR2 QMR1 - BOUNDARY LIMIT AND MINING LIMIT; MILNE SITE LAYOUT IMAGE FILE(S):



NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 17N.
2. TOPOGRAPHY PROVIDED BY EAGLE MAPPING (2005).
3. PLAN/SECTION BASED ON INFORMATION PROVIDED BY HATCH, DATED (JAN 31,2014).
4. CONTOUR INTERVAL IS 2.5 METRES.
5. ALL SAMPLE ID'S SHOWN IN BRACKETS REPRESENT THE TYPE B WATER LICENCE(S) MONITORING POINTS. ALL OTHERS ARE MONITORING POINTS AS PER THE TYPE A WATER LICENCE (2AM-MRY1325).

LEGEND:

- WATER
- LAYDOWN AREA (CONSTRUCTION PHASE)
- BORROW AREAS (2013 UNDER Q10C3001)
- QUARRY AREA (EXISTING UNDER Q13C301)
- EARLY REVENUE PHASE (ERP) WORK SUBJECT TO REGULATORY APPROVAL
- RIVER/STREAM/DRAINAGE
- ROAD
- POTENTIAL DEVELOPMENT AREA
- WATER LICENCE WATER QUALITY MONITORING LOCATION

SCALE A 100 50 0 100 200 300 400 500 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	12MAR'15	ISSUED WITH MEMO	DKK	SWK	RAC

BAFFINLAND IRON MINES CORPORATION

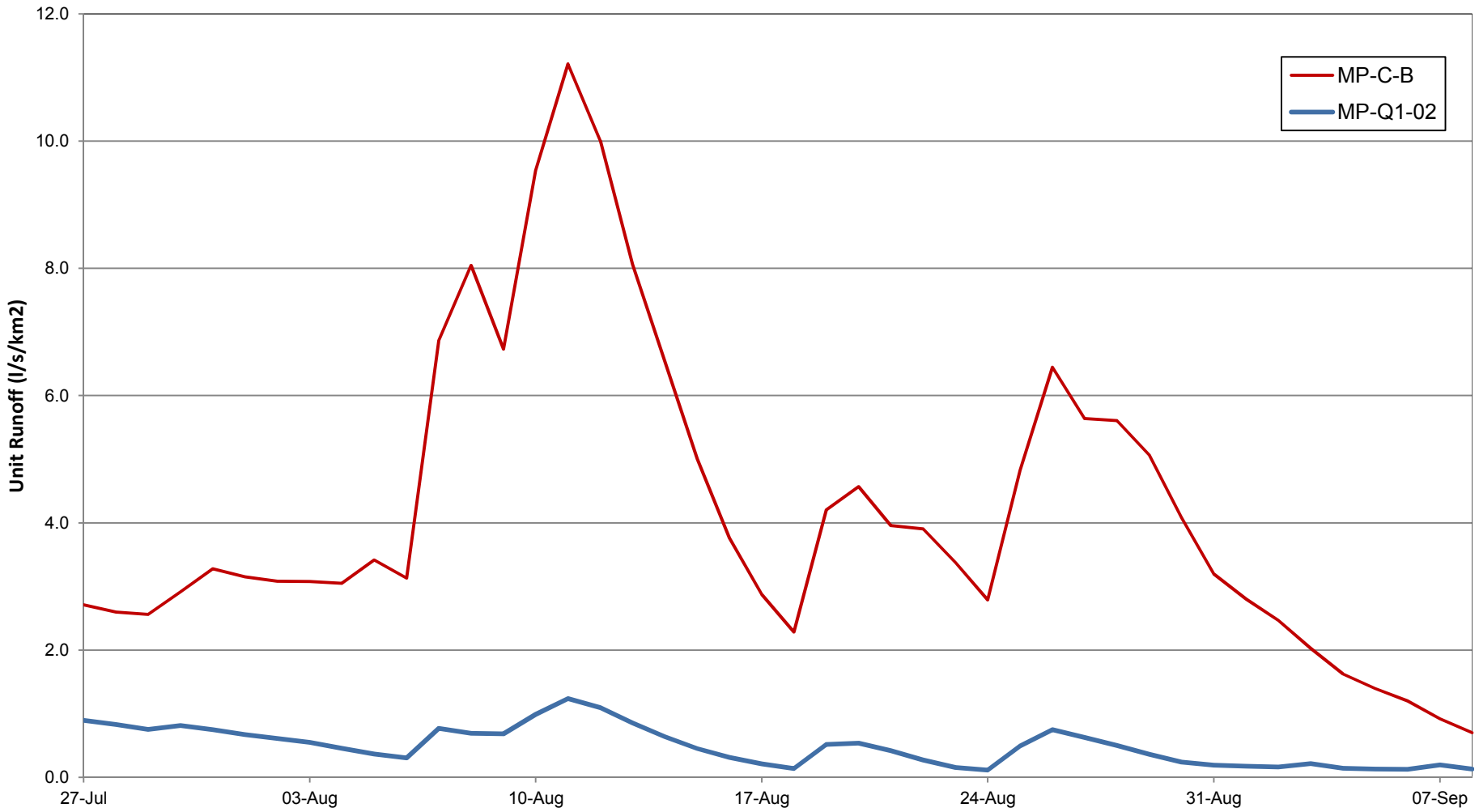
MARY RIVER PROJECT

MILNE PORT SURVEILLANCE NETWORK PROGRAM (SNP)

Knight Piésold CONSULTING

P/A NO. NB102-181/34 | REF NO. NB14-00597

FIGURE 2 REV 0



REV	DATE	DESCRIPTION	PREP'D	REV'D
0	12MAR'15	ISSUED WITH MEMO	ALR	DKK

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

2014 DAILY AVERAGE DISCHARGE
MILNE PORT SNP STATIONS

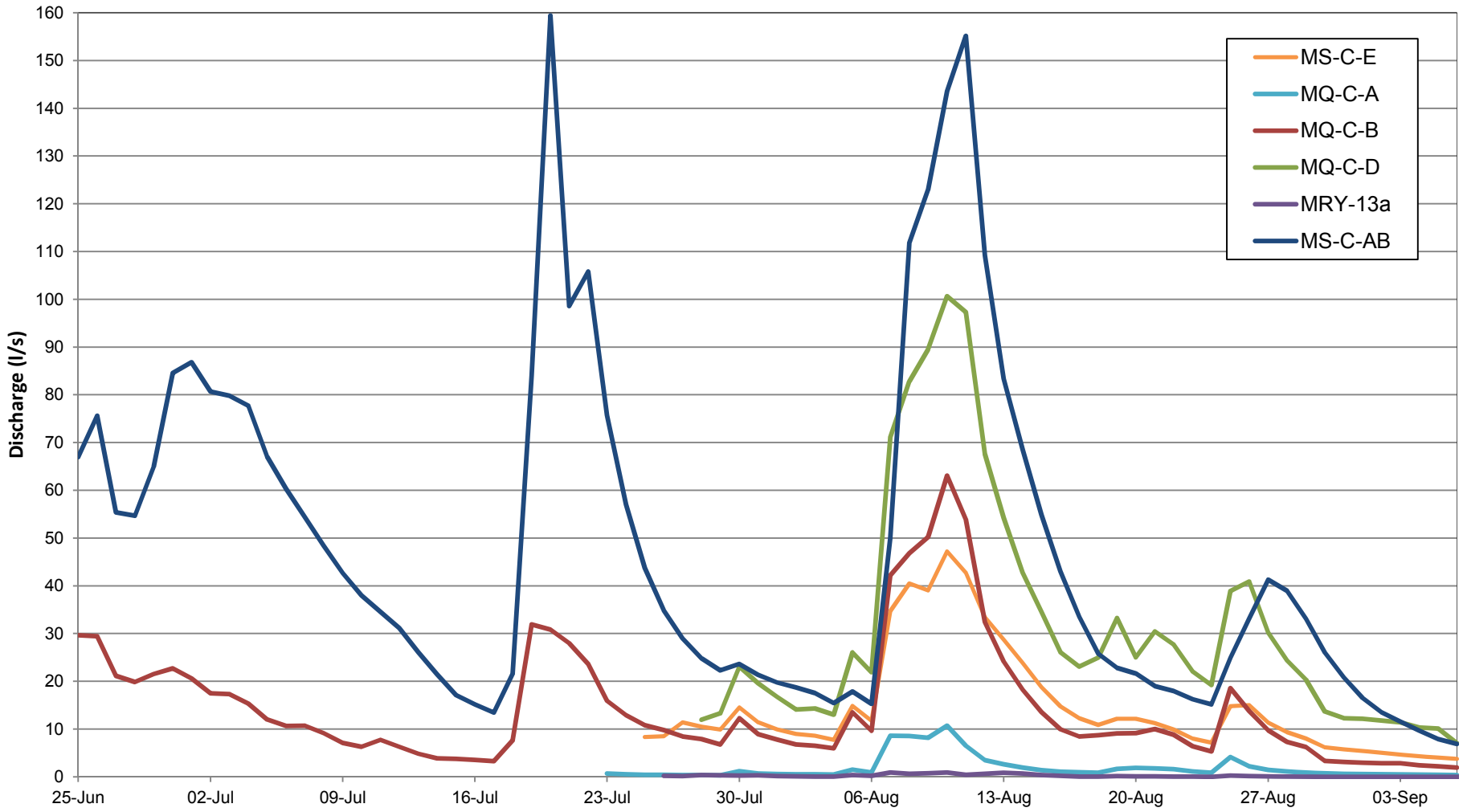
Knight Piésold CONSULTING

P/A NO. NB102-181/34

REF NO. NB14-00597

FIGURE 3

REV 0



REV	DATE	DESCRIPTION	PREP'D	REV'D
0	12MAR'15	ISSUED WITH MEMO	ALR	DKK

BAFFINLAND IRON MINES CORPORATION

MARY RIVER PROJECT

2014 DAILY AVERAGE DISCHARGE
MINE SITE SNP STATIONS

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REF NO. NB14-00597

FIGURE 4

REV 0