SNC·LAVALIN

Water Management Plan - Howse

CONCEPTUAL ENGINEERING FOR HOWSE WATER MANAGEMENT PLAN

MINING & METALLURGY – SUSTAINABLE MINE DEVELOPMENT

05 | 11 | 2015

Report Number : 622834-4000-40ER-0005_03

	TECHNICAL NOTE Conceptual Engineering for Howse Water Management Plan	Prepared by: Patrick Scholz Reviewed by: Marie-Hélène Paquette		
SNC·LAVALIN		Rev.	Date	Page
	622834-4000-40ER-0005	03	November 5, 2015	i

Title of document: **CONCEPTUAL ENGINEERING FOR HOWSE WATER MANAGEMENT PLAN**

Client: **HOWSE MINERALS LIMITED**

Project: **WATER MANAGEMENT PLAN - HOWSE**

Prepared by: Patrick Scholz, Eng., M. Eng. (Hydrology) <Original signed by>

Geneviève Beaudoin-Lebeuf, Eng. (Water Treatment) <Original signed by>

Reviewed by: Marie-Hélène Paquette, Eng. M. Env. <Original signed by>

Anh-Long Nguyen, Eng. M.Sc. <Original signed by>

REVISION INDEX

Revision				Pages Revised	Remarks
#	Prep.	App.	Date		
PA	PS	MHP	Aug 17, 2015		For internal review
PB	PS	MHP	Nov. 14, 2014	All	Includes only section 2.0 Hydrological Data. Other sections to come
PC	PS/GBL	MHP/ALN	Dec. 12, 2014	All	Issued for Preliminary Environmental Impact Study
00	PS/GBL	MHP/ALN	Jan. 16, 2015	All	Final document
01	PS/GBL	MHP/ALN	Aug. 26, 2015	All	New layout
02	PS/GBL	MHP/ALN	Oct. 19, 2015	All	Final document
03	PS/GBL	MHP/ALN	Nov. 5, 2015	Appendix B	New Site Infrastructure Location

NOTICE TO READER

This document contains the expression of the professional opinion of SNC-Lavalin Inc. (“SNC-Lavalin”) as to the matters set out herein, using its professional judgment and reasonable care. It is to be read in the context of the agreement dated May 27th 2014 (the “Agreement”) between SNC-Lavalin and Howse Minerals Canada Limited (the “Client”) and the methodology, procedures and techniques used, SNC-Lavalin’s assumptions, and the circumstances and constraints under which its mandate was performed. This document is written solely for the purpose stated in the Agreement, and for the sole and exclusive benefit of the Client, whose remedies are limited to those set out in the Agreement. This document is meant to be read as a whole, and sections or parts thereof should thus not be read or relied upon out of context.

SNC-Lavalin has, in preparing estimates, as the case may be, followed accepted methodology and procedures, and exercised due care consistent with the intended level of accuracy, using its professional judgment and reasonable care, and is thus of the opinion that there is a high probability that actual values will be consistent with the estimate(s). Unless expressly stated otherwise, assumptions, data and information supplied by, or gathered from other sources (including the Client, other consultants, testing laboratories and equipment suppliers, etc.) upon which SNC-Lavalin’s opinion as set out herein are based have not been verified by SNC-Lavalin; SNC-Lavalin makes no representation as to its accuracy and disclaims all liability with respect thereto.

To the extent permitted by law, SNC-Lavalin disclaims any liability to the Client and to third parties in respect of the publication, reference, quoting, or distribution of this report or any of its contents to and reliance thereon by any third party.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 Context

Howse Minerals Canada Ltd (HML) plans to mine iron ore within the Howse deposit (Direct-Shipping Ore Howse Property Project) located near the border between the provinces of Quebec and Newfoundland and Labrador, approximately 25 km north of the community of Schefferville, Quebec. One open pit is planned and the anticipated mining period is from 2016 to 2024. Two waste dumps, including one in-pit dump, an overburden stockpile, a site infrastructure pad, and a topsoil stockpile are also planned for the site (see Map 1 in Appendix B). No tailings will be generated in this area since the majority of the ore will only be crushed and screened on-site, with the ore then being directly shipped for secondary processing.

The Howse property sits on three different watersheds leading to Pinette Lake, Burnetta Creek and Goodream Creek (see Map 2 in Appendix B). The water management strategy aims to manage surface runoff water and pit dewatering water with less impact possible on these three watersheds. In order to maintain a good water quality around Howse property, runoff water on site and dewatering water from the pit will all be managed through several sedimentation ponds before being released to the environment. In order to address local stakeholders concerns, no water will be discharged into Pinette Lake, even after sedimentation through a pond. The infrastructures planned for water management are the following (see Map 1 in Appendix B):

- Runoff on the west part of the in-pit waste rock dump and on the topsoil stockpile and from surrounding area on the south-west side of the site will be collected by a ditch leading to sedimentation pond HOWSEA and then discharged to Burnetta Creek;
- Runoff on the waste rock dump, the site infrastructure pad, and the overburden stockpile will be collected by ditches leading to sedimentation pond HOWSEB and then discharged to Goodream Creek;
- Underground water will seep into Howse pit and will then be pumped and diverted to a ditch on the north-east side of the pit, leading to sedimentation pond HOWSEB, and then discharged into Goodream Creek. The portion of the ditch receiving the dewatering water along the pit will be waterproofed to avoid infiltration of water directly back into the pit;
- Approximately two third of surface runoff from Howse pit will be pumped into existing Timmins 4 sedimentation pond 3, to take advantage of its full sedimentation capacity, and then discharged into Goodream Creek. The remaining third, like the underground water, will be pumped to a ditch on the north-east site of the pit leading to sedimentation pond HOWSEB and then discharged into Goodream Creek.

1.2 Content

This technical note summarizes the conceptual design of the Howse project water management infrastructures. First, baseline hydrology data will be presented. Comments on water quality and information on hydrogeology will then be discussed. The water management plan concept will be presented and options studied before the selection of the preferred option will be discussed. Design of ditches, ponds and water balances will be presented. Potential impacts on natural watersheds will be presented. Finally, data needing to be collected before the next phase of engineering will be discussed.

Intensity-duration-frequency curves are presented in Appendix A, maps and drawings are presented in Appendix B and design criteria are presented in Appendix C. Water quality results from Timmins 4 project are presented in Appendix D.

2.0 HYDROLOGY

2.1 Meteorological Data Sources

Data recorded at Environment Canada meteorological stations, located close to the Howse mine site, was used to develop a data set representative for the Howse mine site. Data from the following stations was used:

Table 2-1: Environment Canada Meteorological Stations

Station		Latitude	Longitude	Elevation	Available Data
Number	Name	North	West	[m]	
7117825	Schefferville A	54°48'00"	66°49'00"	521.8	1948-2010
7117823	Schefferville A	54°48'19"	66°48'19"	520.9	2012-present
7117827	Schefferville	54°48'00"	66°48'00"	517.2	2005-present
704BC70	Fermont	52°48'00"	66°05'00"	594.4	1976-2004

The Schefferville stations, called Schefferville hereafter, are located approximately 24 km South-East from Howse. Fermont is located approximately 240 km South from Howse. Data from this station was used during the period between October 1993 and December 1995, to fill in some missing data from Schefferville.

2.2 Temperature

Average monthly temperature data was computed based on daily data from the Schefferville station for the period of 1949 to 2013 (65 years) and is presented in Table 2-2. During the period between October 1993 and December 1995, no temperature data is available for Schefferville. To fill this gap, data from Fermont was used, with an adjustment of -1.6 C corresponding to the average temperature difference between both stations during their period of concomitant data (July 1976 to September 1993).

Schefferville monthly temperature is above freezing during the months of May to September. July is the warmest month with an average temperature of 12.7 C and the coldest month is January with an average temperature of -23.3 C.

Table 2-2: Schefferville Monthly Average Temperature (1949-2013)

Month	Average Temperature [°C]
Jan	-23.3
Feb	-21.7
Mar	-15.3
Apr	-6.9
May	1.5
Jun	8.8
Jul	12.7
Aug	11.3
Sep	5.9
Oct	-0.9
Nov	-9.0
Dec	-18.5
Year	**-4.6**

An average temperature colder by a degree or two is expected for the Howse mine site as it is located at an elevation approximately 140 m higher than Schefferville.

2.3 Precipitation

A daily total precipitation data series, including rainfall and snowfall, was obtained for the period of 1949 to 2013 (65 years). During the period between October 1993 and December 1995, no precipitation data is available for Schefferville. To fill this gap, data from Fermont was used. First cumulated precipitation data from both stations, during their period of concomitant data (July 1976 to September 1993, and January 1996 to December 2013), was compared on a double mass curve. As both stations recorded similar amounts of precipitation, without any jump in the double mass curve, data from Schefferville was filled with data from Fermont, corrected by a factor of 0.96, the ratio of cumulated precipitations between both stations over their concomitant period. Due to the proximity between Howse and Schefferville, the obtained precipitation series is assumed representative for the Howse mine site.

As shown in Table 2-3, the average annual precipitation during the period of 1949-2013 is 782 mm. July is the wettest month averaging 101 mm of precipitation, and February is the driest month with 37 mm of precipitation.

Table 2-3: Monthly Total Precipitation (1949-2013)

Month	Total Precipitation [mm]
Jan	45
Feb	37
Mar	45
Apr	50
May	52
Jun	73
Jul	101
Aug	96
Sep	91
Oct	75
Nov	68
Dec	49
Year	**782**

Annual precipitation varied between 523 mm in 1953 and 1038 mm in 1983. However, over the 65 years period (1949-2013) of available precipitation data, annual precipitation remained relatively stable (Figure 2-1).

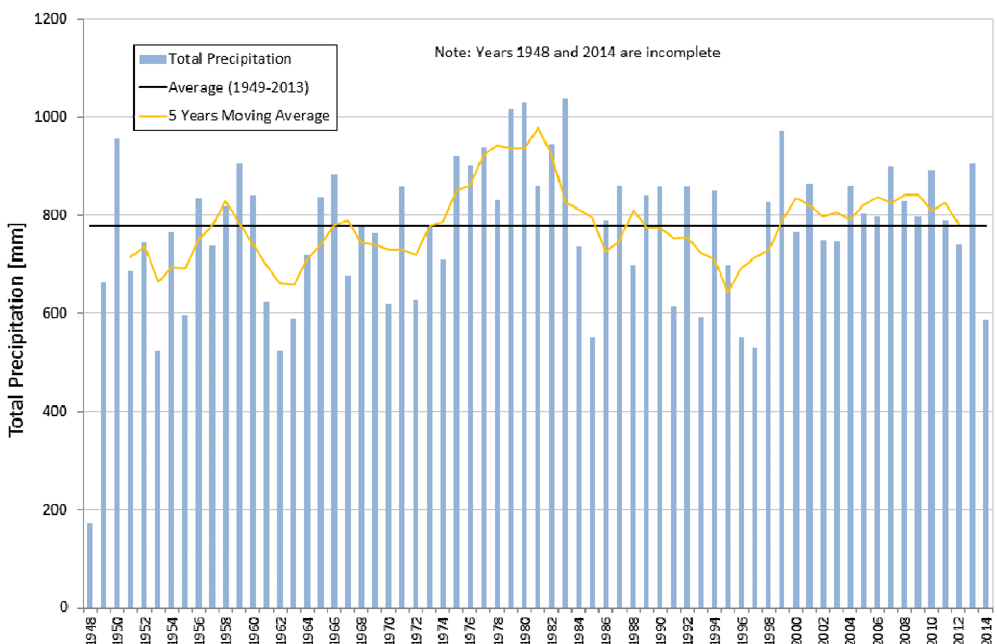


Figure 2-1: Total Precipitation (1948-2014)

A frequency analyses was performed, using the Pearson type 3 probability distribution with the method of moments, to determine annual precipitation for different return periods presented in Table 2-4:

Table 2-4: Annual Precipitation for Different Return Periods

Return Period [year]	Total Precipitation [mm]
1000	1130
100	1050
50	1030
25	994
10	942
5	891
2	787

2.3.1 Rainfall

Daily rainfall data is available for the period of 1948-1993 from the Schefferville station. To extend the data set to 65 full years (1949-2013), rainfall was derived from total precipitation. Comparing the average annual recorded rainfall with the average annual derived rainfall, during the period 1949-1992, it was determined that precipitation falling during days with an average temperature higher than 1.2 °C would fall in the form of rain. Average monthly rainfall values are presented in the following table:

Table 2-5: Average Monthly Rainfall (1949-2013)

Month	Rainfall [mm]
Jan	0
Feb	0
Mar	0
Apr	5
May	28
Jun	69
Jul	101
Aug	96
Sep	81
Oct	28
Nov	3
Dec	0
Year	**411**

Rainfall hyetographs can be derived from intensity-duration-frequency (IDF) curves. Environment Canada developed an IDF curve for Schefferville based on annual rainfall data for the period 1965-1992. It is assumed that the shape of this curve is representative of rainfall in the Schefferville and Howse area.

To transform the annual IDF curve into spring and summer-fall IDF curves, the following steps were followed. First, the spring season was assumed to happen between May 15th, the approximate date when the average air temperature is over 2 °C, and June 10th, the approximate date when the snow cover is completely melted. Then, frequency analyses were performed for daily spring and daily summer-fall rainfalls presented respectively in Table 2-6 and Table 2-7. In both cases, the Pearson type 3 probability distribution with the method of moments was adopted. Then, daily rainfall values were transformed into 24 h rainfall, by applying a correction factor of 1.13 (WMO, 2009). Then, spring and summer-fall IDF curves were obtained by using the shape of the annual IDF curves and the ratio between annual and seasonal 24 h rainfall for each return period considered. Because it was found that annual values for the 24 h rainfall were larger than the computed summer-fall 24 h rainfall, annual values were retained for summer-fall rainfalls. Finally, daily hyetographs were constructed for different return periods between 2 and 100 years. The central part of these hyetographs is presented in Figure 2-2 and Figure 2-3.

Table 2-6: Spring Rainfall Depth for Different Return Periods

Duration	Return Period [year]					
	2 years	5 years	10 years	25 years	50 years	100 years
	Spring Rainfall Depth [mm]					
5 min	1.4	2.6	3.3	4.3	5.0	5.7
10 min	2.0	3.4	4.3	5.5	6.3	7.1
15 min	2.3	3.9	4.9	6.2	7.1	8.0
30 min	2.8	4.7	5.9	7.4	8.5	9.5
1 h	3.8	5.9	7.3	9.0	10.1	11.3
2 h	5.0	7.5	9.0	10.9	12.2	13.4
6 h	8.4	12.3	14.7	17.5	19.5	21.4
12 h	10.9	16.5	20.0	24.3	27.3	30.2
24 h	13.8	21.8	26.9	33.1	37.5	41.8

Table 2-7: Summer-Fall Rainfall Depth for Different Return Periods

Duration	Return Period [year]					
	2 years	5 years	10 years	25 years	50 years	100 years
	Summer-Fall Rainfall Depth [mm]					
5 min	3.7	5.8	7.2	9.0	10.3	11.6
10 min	5.2	7.7	9.4	11.4	13.0	14.5
15 min	6.1	8.8	10.6	12.9	14.6	16.3
30 min	7.5	10.7	12.8	15.5	17.4	19.4
1 h	10.1	13.5	15.8	18.7	20.8	22.9
2 h	13.4	17.1	19.6	22.7	25.0	27.3
6 h	22.3	28.0	31.8	36.5	40.0	43.5
12 h	29.0	37.7	43.4	50.6	56.0	61.4
24 h	36.8	49.7	58.3	69.1	77.1	85.0

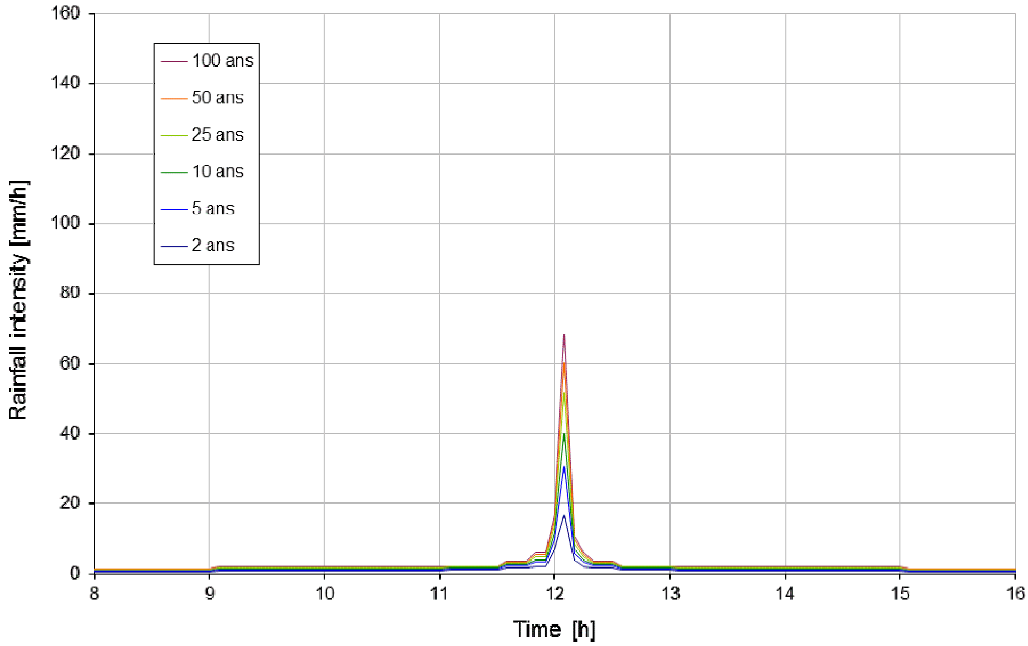


Figure 2-2: Spring Rainfall Hyetographs

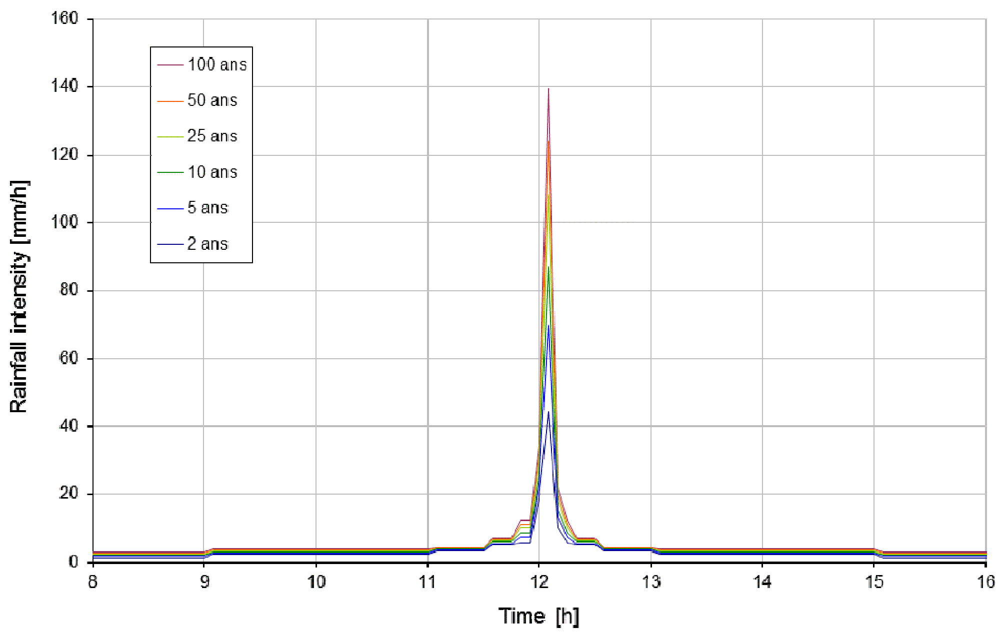


Figure 2-3: Summer-Fall Rainfall Hyetograph

2.3.2 Snowfall

Daily snowfall data is also available for the period of 1948-1993 from the Schefferville station. To extend the data set to 65 full years (1949-2013), snowfall was derived from total precipitation, by considering only precipitations that happened when the average daily temperature was lower than 1.2 °C. Average monthly snowfall values are presented in the following table:

Table 2-8: Average Monthly Snowfall (1949-2013)

Month	Snowfall [mm]
Jan	45
Feb	37
Mar	44
Apr	45
May	24
Jun	4
Jul	0
Aug	1
Sep	10
Oct	47
Nov	65
Dec	49
Year	**370**

On average, during the period 1949-2013, precipitation in the form of snow represented approximately 47 % of total precipitation.

Snow on the ground data is also available from the Schefferville station for years 1955 to 1993 and 2013 to 2014. Historical annual maximum snow cover depth varied between 43 cm in 1958 and 190 cm in 1977. A frequency analysis, using the Pearson type 3 probability distribution and the method of moments, was performed on snow cover depth to determine the values corresponding to different return periods. To compute the amount of water produced by snowmelt, snow density needs to be assessed. Snow density varies with time and from one year to another. According to Maidment (1993), typical values for settled snow density are 2 to 3 mm of water equivalent/cm of snow. Based on experience with other projects in the same area, a snow cover density of 2.5 mm of water equivalent/cm of snow was estimated for Howse. Those results are shown in Table 2-9.

Table 2-9: Maximum Annual Snow Cover Depth for Different Return Periods

Return Period [year]	Snow Cover [cm]	Snow Cover [mm]
2	100	250
5	128	320
10	144	360
25	163	408
50	175	438
100	187	468

It was determined that snow cover would melt between approximately 20 and 60 days, with an average around 35 days. The average melting time of 35 days was adopted to select a typical snow cover melting sequence, as illustrated for a 25 years return period snow cover on the following figure:

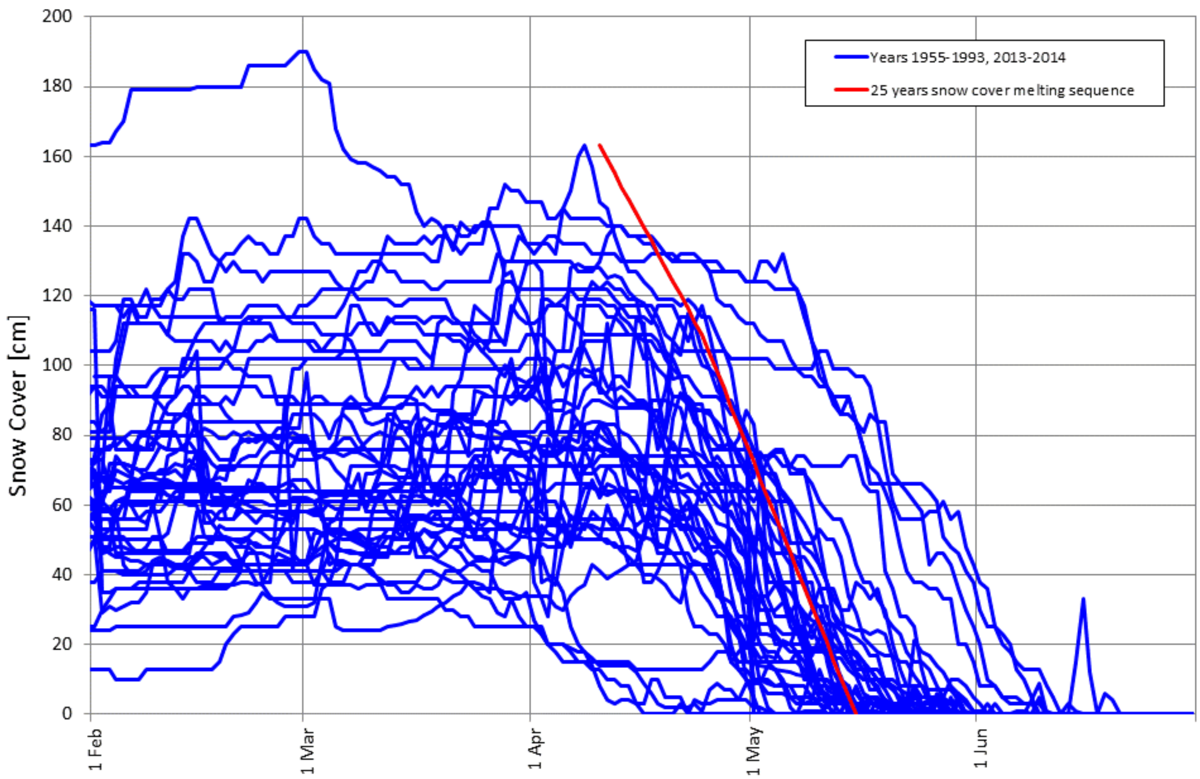


Figure 2-4: Snow Cover Melting Sequence

2.4 Lake Evaporation and Evapotranspiration

Some monthly lake evaporation data is available for the Schefferville meteorological station. This data was compiled from measurements made during the period 1951 to 1980 (Rollings, 1997). This data was compared with the Churchill Falls lake evaporation data from HML (2014) and with potential evapotranspiration computed using the Thornthwaite equation (Maidment, 1993).

The yearly lake evaporation from Churchill Falls (288 mm) is approximately 9 % lower than lake evaporation values for Schefferville (318 mm), and Schefferville annual computed potential evapotranspiration (393 mm) is approximately 24 % higher than lake evaporation values for Schefferville (318 mm). Lake evaporation data from Rollings (1997) was selected as the most representative data set for Howse. Monthly Lake Evaporation data from the three collecting points are presented in Table 2-10:

Table 2-10: Monthly Lake Evaporation

Month	Schefferville Rollings (1997) Adopted for Howse [mm]	Schefferville Thornthwaite Equation [mm]	Churchill Falls HML (2014) [mm]
Jan	0.0	0.0	0.0
Feb	0.0	0.0	0.0
Mar	0.0	0.0	0.0
Apr	0.0	0.0	0.0
May	0.0	24.5	0.0
Jun	104.0	96.4	99.0
Jul	98.0	123.3	105.4
Aug	70.0	100.2	83.7
Sep	46.0	48.9	0.0
Oct	0.0	0.0	0.0
Nov	0.0	0.0	0.0
Dec	0.0	0.0	0.0
Year	**318.0**	**393.2**	**288.1**

Evapotranspiration is another component of the hydrological cycle that needs to be estimated, in particular for water balance computations. Based on experience with other similar projects, evapotranspiration is assumed to be equal to 35 % of lake evaporation for the Howse mine site.

2.5 Infiltration and Runoff

When water, in the form of rainfall or snowmelt, reaches the ground, part of it might infiltrate the ground, if it is not frozen or already saturated with water, and part of it will be runoff.

To obtain relatively accurate values of infiltration and runoff volumes, hydrological modeling of one or more representative watersheds in the Howse area should be undertaken. However, such modelling requires a large amount of data, typically a minimum of five complete years of stream flow data, to perform a proper model calibration.

Another way to estimate infiltration and runoff is to use a runoff coefficient. This coefficient should be representative of average conditions, when used for water balance computations, or it should be representative of conditions during a particular flood, when used for the design of hydraulic structures like ditches, culverts, and sedimentation basins.

Available data to estimate runoff coefficients for Howse are:

- Hydrometric data recorded on small creeks on the Howse mine site (GH, 2011, GH 2014a);
- Values estimated for larger watersheds (Rollings, 1997);
- Typical values sited in the literature (MTQ, 2006).

The hydrometric data collected during one summer campaigns is representative of the conditions during this particular summer. However, they don't permit statistical analyses and the derivation of values for different return periods because the duration of the campaigns was too short. For this reason, this data was not considered in the present study.

Based on regional analyses, runoff and precipitation maps are available for Labrador (Rollings, 1997). According to these maps, for the Howse area, the mean annual total precipitation is in the order of 800 mm, a number similar to the 782 mm obtained in section 2.3, and the mean annual runoff is in the order of 650 mm. The ratio of these numbers leads to an annual runoff coefficient of approximately 0.8.

Typical runoff coefficient values cited in the literature are given for peak flow function of soil type, watershed slope and land use. For example, gravel roads and roadsides, or a cultivated soil with a medium porosity, and a watershed slope between 3 and 8 % would have a peak flow runoff coefficient between 0.4 and 0.6.

For Howse, the following assumptions were made:

- A runoff coefficient of 1.0 is assumed for water balance computations for the winter months, between October and April, due to frozen ground, and for the month of May, when most of the snowmelt occurs and the ground is saturated with water;
- A runoff coefficient of 0.4 is used for water balance computations during the summer months between June and September;
- A runoff coefficient of 1.0 is assumed during spring floods combining snow melt and spring rainfall, and for 100 year return period floods;
- A runoff coefficient of 0.5 is assumed for the 25 year return period summer-fall flood.

3.0 EFFLUENT QUALITY, TYPE AND TREATMENT STRATEGY

3.1 Effluent Quality

Water quality analytical results sampled at the current mining operation DSO3 were used to evaluate the expected water quality that could be observed on the Howse property since they are located close to each other. The water quality results from Sedimentation ponds 2 and 3 (sampling COA-SW11 and COA-SW12) were reviewed since they are the most representative of the effluent that is expected on the Howse property. The water quality results taken from Sedimentation ponds 2 and 3 are presented in Appendix D (HML, 2014c).

The water is of good quality and generally meets the requirements of the Certificate of Approval (CofA) (GNL, 2012) for all parameters except for suspended solids, where the concentration in the water tested is slightly above 30 mg/L. The Certificate of Approval is based on the Metal Mining Effluent Regulations (MMER) 2002 (Government of Canada, 2002). The concentration of total iron, which is not currently regulated by the MMER, was tested once and the result was high. This parameter should be closely monitored in the future, but it is assumed that iron is present as a suspended solid form and should settle out in the Sedimentation pond, thus possibly lowering the concentration to an acceptable limit. It is important to note that the MMER is currently under review and iron could be included in its next edition.

Consequently, for the purpose of this study, and assuming that any effluent collected on the Howse DSO property will have a similar water quality as observed on the Timmins 4 site, the main parameters of concern is assumed to be limited to suspended solids.

3.2 Type of Effluent

There are three types of effluent that will need to be managed on the Howse DSO property:

1) **Natural site runoff:** the main parameter of concern with the natural site runoff will be suspended matter, specifically during heavy rainfall event and snowmelt event. It is assumed that suspended solids will mainly consist of silt, sand and grit.

2) **Runoff from overburden and waste rock dump:** the overburden at the Howse DSO property is expected to be mainly composed of silt, sand and gravel. The waste rock is expected to be composed of fine rock particles. The waste rock is also expected to be non-acid generative. The main parameter of concern is assumed to be with fine suspended matter.

3) **Pit Dewatering:** the pit dewatering water will consist mainly of groundwater that infiltrate into the pit, as well as surface runoff that flows into the pit:

   a. **Groundwater:** the groundwater is expected to be of similar quality to the natural site runoff. The groundwater pumped from the wells around the pit is expected to have very little suspended solids.

   b. **Sump Water:** the main parameter of concern in the sump water from the pit is assumed to be limited to only fine suspended matters. Total suspended solids of the sump water are expected to be high due to the mining activity in the pit.

   The sump water could also be contaminated with ammonia, nitrate, and diesel coming from un-exploded explosive residues, and oil and hydrocarbon spills from the machinery. In order to minimize the load of ammonia and nitrate that could migrate into the sump water, proper explosive management shall be implemented. The objective of the explosive management will be the leaching of ammonia and nitrate from the explosive into the water column. The explosive management could include the following:

I. Proper selection of a water resistant based emulsion explosive.

II. Monitoring blasting performance based on explosive quantities, blast design and surface water quality.

III. Proper explosive handling in combination with proper spillage control in order to promptly remove explosive spills around the blast holes.

IV. Proper blast design to minimize incomplete detonation of explosive.

To manage any oil and hydrocarbon spills from the machinery, once a spill is detected, it will be promptly contained and removed through the use of absorbing pads. Furthermore, to manage any diesel that could be present in the sump water, an oil/water separator system will be used to remove the diesel before the surface runoff is transferred to the sedimentation pond

3.3 Treatment Strategy

Sedimentation ponds are proposed on the Howse DSO property to manage and remove the suspended solids before the water is returned to the natural receiving streams. All the sedimentation ponds are sized to provide the required settling area to allow for the smallest design particle size to settle out in the pond.

The sedimentation ponds will not be lined with any impervious material to prevent or reduce water infiltration into the ground. Ammonia and nitrate residues are expected in effluent water, but at such a low concentration that it should not require any specific treatment. Effluent monitoring will be conducted on a regular basis and specific treatment will be considered if ammonia and nitrate blasting residues concentration are above the criteria. The only parameter of concern is suspended matters. Consequently, if some of the runoff water does infiltrate into the ground, it will not have a negative impact on the groundwater quality.

An allowance of 0.5 m is provided at the bottom of the sedimentation pond for sediment storage. The frequency at which the sediments will need to be removed from the pond and properly managed following all applicable regulations during the life of the mine will be evaluated in the next phase of the project.

The sediments that are expected to settle out are silt, sand, gravel, grits and a small amount of hydroxide metals. As mentioned above, iron could be a source of contamination, but assuming the water quality will be similar to the one at Timmins 4 pond B & C, it will be in negligible quantities. Depending on the quantity of sediments to manage, that will be estimated in the next phase of the project, and the duration of operation, dredging of the sediments could be considered if the sediment storage area is full. Dredging of the sediments will involved excavating or pumping of the accumulated sediments out of the pond and transferring them for final disposal in the in-pit dump. However, based on the current information available from site, no dredging is anticipated since the quantity of sediments to be managed during the life of mine should fit in the sedimentation pond. At closure, the sedimentation pond will be covered to avoid any leaching of iron.

Based on the surface runoff water quality information available to date from the Timmins 4 site, a chemical treatment dosing system is not required. Thus, a similar surface runoff quality is anticipated at the Howse mine site. However, a review of more recent data will be conducted and compared with the required discharge criteria. If runoff water from the overburden, waste rock dumps, or pit exhibits water quality issues other than suspended solids, such as color issues due to the presence of fine iron oxide and hydroxide particles, the necessary equipment to dose treatment chemicals, such as a coagulant, could be added as a contingency measure at the entrance of sedimentation ponds with manual dosing pumps, and mixed naturally by the turbulence action of the incoming flow. The inorganic coagulant could be aluminum sulfate, iron salts or lime. The treatment chemicals will help destabilize the fine particles and help them co-precipitate out with the floc formed by the addition of a coagulant. Alternatively, an organic polyamide cationic flocculant could also be used to destabilize the fine iron oxide particles. An anionic flocculant could be added to enhance the settling rate of the coagulated particles if required.

Please refer to sections 6 and 7 for more details on the design of the sedimentation ponds planned for the Howse DSO project.

4.0 HYDROGEOLOGY

An overview of historical mine dewatering at Knob Lake is given in Stubbins & Munro (1965). Wishart, Gagnon, French and Ruth mines were studied. It was found that dewatering was significantly correlated with pit depth. Table 4-1 summarizes these results. The range of dewatering rates varied from approximately 16 900 to 86 500 m^3/d for those mines. This wide range of dewatering rates is due to several factors for which data is unavailable. Such factors are pit dimensions, hydraulic conductivities of geological units, fault zones, proximity to water bodies, permafrost, and mining and dewatering operations.

More recently, dewatering simulations were conducted for two mine sites projects: Timmins 3, located about 5 km northeast form Howse deposit, and LabMag, located west from Howse deposit. Obtained dewatering rates (Table 4-1) for these two mines are similar to the ones measured at Wishart and Gagnon mines (between 13 000 and 23 000 m^3/d).

Hydraulic conductivities for Howse iron ore units were estimated from pumping tests by Geofor in 2014. Very similar results were obtained for Howse, Timmins 3 and LabMag deposits. Therefore, Howse dewatering rate is expected to be similar to Timmins 3 and LabMag dewatering rates.

Recent groundwater flow modeling results for Howse deposit (SNC-Lavalin, January 2015) confirmed this assumption as a dewatering rate of approximately 14 000 m^3/d was estimated for a base case scenario considering a safety factor of 1.5. However, this flow rate could reach higher values, ranging from approximately 17 700 to 31 000 m^3/d, when considering slightly higher hydraulic conductivities values for the geological units surrounding the pit, and a slightly higher recharge rate. At the time of writing, field work is ongoing to obtain a more precise estimation of Howse dewatering rate.

Consequently, a dewatering rate of 22 000 m^3/d was adopted for the present study. This value is relatively conservative and corresponds to an average value between 14 000 and 31 000 m^3/d.

Howse deposit water table was found to be between 64 and 90 m deep (Geofor, 2015 and Golder, 2014). Dewatering rate is expected to be lower during the first years of mining operations than for the final pit. During the first years of mining operations, dewatering will be limited to water from direct precipitations and infiltration through the unsaturated geological units. Later, when pit depth reaches water table depth, dewatering rate will increase gradually, and reach a maximum value when the pit reaches its final depth. Therefore, there will be no dewatering until the pit reaches a certain depth. Dewatering will be ongoing all year long once the water table depth will be reached.

Table 4-1: Summary of Hydrogeological Data

Type of Data	Mine Site	Floor Depth (m)	Dewatering (m^3/d)	Data References
Historical data of DSO mines	Wishart	69	16 874	Stubbins, J. B. and P. Munro. 1965. Historical information on mine dewatering of DSO (Knob Lake). The Canadian Institute of Mining and Metallurgy Bulletin, 58:814-822.
	Gagnon	83	20 412	
	French	116	84 370	
	Ruth	144	86 547	
Simulation results on new mines	Timmins 3	80	12 960	Groupe Hémisphères, March 2010. Hydrological and hydrogeological study: survey season 2009, DSOP. Final technical report.
	LabMag	150	22 262	SNC-Lavalin, in preparation. Hydrogeology and mine pit dewatering modeling - LabMag site. New Millenium Iron – TATA Steel
Assumption	Howse	160	22 000(*)	Geofor, personnal communication, 2015
(*) Average value of the expected possible range.				

Water management infrastructures are designed based on the assumed dewatering flow rate of 22 000 m^3/d.

5.0 DESIGN CRITERIA FOR WATER MANAGEMENT INFRASTRUCTURES

A summary of the design criteria is presented in the following table. The complete design criteria document is presented in Appendix C.

Table 5-1: Design Criteria of the Planned Water Management Infrastructures

Type of criteria	Criteria	Value	Comments
Location criteria	Buffer zone between infrastructures and Irony Mountain	500 m	--
	Buffer strip between infrastructures and water course and wetlands	Minimum of 30 m	--
Environmental Criteria	Alteration of Pinette Lake	No alteration of Pinette Lake water quality is accepted	No surface water from Howse mine site can be discharged to Pinette Lake, even after treatment through a sedimentation pond.
	General location of infrastructures	Avoid building infrastructures on wetlands whenever possible.	--
	Quality of runoff water and dewatering water	The only issue is assumed to be total suspended solids	See section 3 for discussion on this issue.
	Pond and ditches waterproofing	No waterproofing	The only exception is the portion of the ditch receiving dewatering water along the pit to avoid infiltration of water directly back into the pit. See section 3 for discussion on this issue.
Hydrological criteria	Source of meteorological Data	Schefferville A meteorological station	Intensity-duration-frequency curves used for infrastructure design are presented in Appendix A
Ditches design criteria	Ditch longitudinal slopes	Minimum 0,5%	--
	Ditch transversal slopes	2H:1V	--
	Ditch excavation	Minimize volume of excavation	--
	Return period of design flow	100 years	--
Ponds design criteria	Infiltrations	No infiltration is considered	Pond bottom and sides assumed frozen during spring freshet.
	Dead storage for sediment	0.5 m	Frequency at which sediments will need to be removed from the pond during the life of mine will be evaluated in the next phase of the project. If sediment removal is required, it will be managed according to all applicable regulations

Type of criteria	Criteria	Value	Comments
	Vertical distance between dike crest and spillway invert	1 m	--
	Pond outflow structure	Permeable rockfill dike	--
	Return period of design flood for emergency spillway	100 years	According to Canadian Dam Association (CDA) recommendation for significant dam class. According to Newfoundland & Labrador Department of Environmental and Conservation, dams must meet the CDA Guidelines.
	Sedimentation pond design flood return period	25 years	--
	Sedimentation pond design flood	The most critical between : • Summer-fall 24-hour 25 year return period rainfall; • A combination of a 24-hour 25 year return period spring rainfall with the melting of a 25 year return period snowpack over 35 days.	--
	Ice cover during spring design flood	0.5 m	Sedimentation ponds will naturally drain by gravity at the end of fall. Thus, there will be no significant build-up of ice cover during winter. Sedimentation pond HOWSEB receives water continuously from pit dewatering operation, even during winter. Therefore, a 1.0 m ice cover is assumed during the spring design flood.
Sedimentation criteria	Design flow	24 hour design flood peak inflow	--
	Specific gravity of particle to settle	2.7	--
	Design particle size to settle for sedimentation ponds	0.01 mm (10 microns)	Particle size selected according to assumed particle size analysis for overburden and waste rock. Pond designed to ensure minimum area requirement is met and a minimum residence time of approximately 5 h.
	Length to width ratio of the sedimentation ponds	Minimum 3 to 1	--

6.0 WATER MANAGEMENT STRATEGY

The adopted water management strategy is based on the following concepts:

- Minimize impacts on environment;
- Use existing infrastructures as much as possible;
- Clean and contaminated water separation;
- Water treatment for suspended sediments.

Impacts on the environment need to be minimized by avoiding construction in sensitive areas such as wetlands as much as possible and by minimizing flow variations in existing natural creeks. Another way to mitigate impacts on the environment is to use existing infrastructures, like Timmins 4 sedimentation pond 3, as much as possible. Separation of clean water, collected by diversion ditches, from contaminated water, collected by collection ditches, allows for specific water treatment before release towards existing streams. Water treatment consists of removing suspended sediments by the means of sedimentation ponds (refer to section 3 for comments on water quality).

6.1 Proposed Site Layout

The site layout is presented on Map 1 (Appendix B). The layout was designed to minimize impacts on the natural watersheds on which the project will be constructed and to distribute the pit runoff and the pit dewatering water in the most suitable watershed. Map 2 (Appendix B) shows the natural watershed limits and Map 3 (Appendix B) presents the modified watershed boundaries. The future infrastructures watersheds are shown on Map 4 (Appendix B) and on Table 6-1.

Table 6-1: Planned Infrastructures Watershed Area (Mine End of Life)

Infrastructure	Watershed area
Sedimentation pond HOWSEA	59 ha
Sedimentation pond HOWSEB	178 ha

Water management infrastructures consist in a drainage network made of ditches, three sedimentation ponds, including the existing Timmins 4 sedimentation pond 3. Drawing 622834-40DD-0001 (Appendix B) shows the detailed plan view of ditches and ponds. The following figure schematically describes the water management plan infrastructures and water fluxes between them.

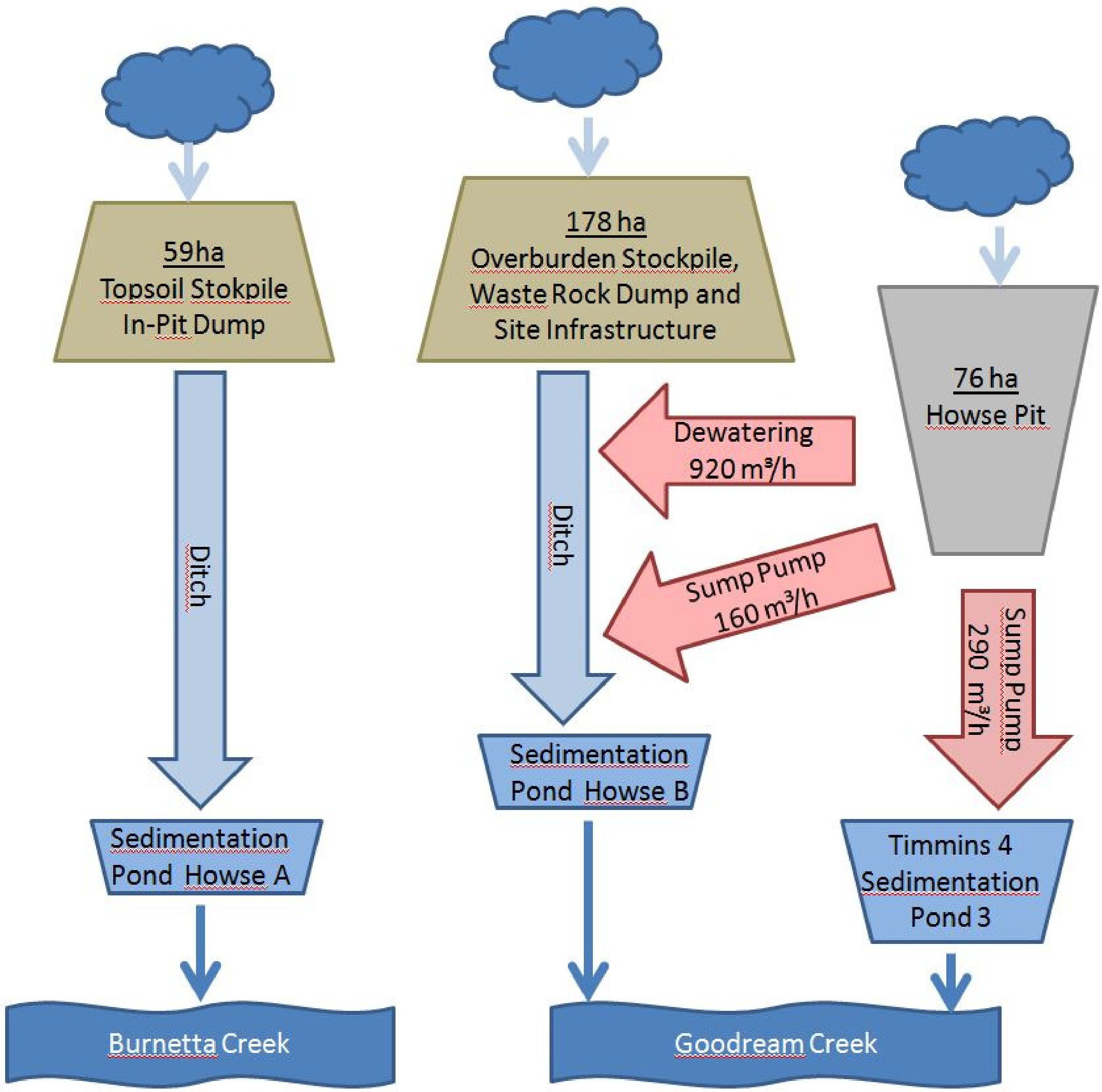


Figure 6-1: Water Management Plan Schematic

6.2 Designed Infrastructures

The following sections describe the different infrastructures designed for this project.

6.2.1 Sedimentation Pond HOWSEA

Sedimentation pond HOWSEA (see Drawing 622834-4000-40DD-0006 in Appendix B) is used to treat runoff water from the topsoil stockpile, part of the in-pit dump not flowing into the pit, and from the natural area located on the south-west side of Howse pit. This pond will be located on the west side of Howse pit and treated water will be discharged into Burnetta Creek. The pond will be located in a natural slope of about 5% and the downstream side of the pond will have to be confined with a dike. The design of sedimentation pond HOWSEA is documented in more details in Section 7.2.4. Note that it was decided to collect runoff from the natural area located on the south-west side of Howse pit and treat it in HOWSEA to avoid the construction of any ditch and/or sedimentation basin outside of the claim limit (Map 1), and to avoid having this water flowing into the Pit, resulting into more pumping towards HOWSEB and increasing the release of water between different natural watersheds.

6.2.2 Sedimentation Pond HOWSEB

Sedimentation pond HOWSEB (see Drawing 622834-4000-40DD-0005 in Appendix B) will receive runoff from the overburden stockpile, the waste rock dump, the site infrastructure pad, water pumped from the peripheral well used for Howse pit dewatering, and approximately one third of the pit runoff. This pond will be located on the north-west side of the overburden stockpile, in a natural slope, and the downstream side of the pond will have to be confined with a dike. Treated water will be discharged into Goodream Creek. The design of sedimentation pond HOWSEB is documented in more details in Section 7.2.5.

6.2.3 Timmins 4 Sedimentation Pond 3 (Existing)

Timmins 4 sedimentation pond 3 is an existing sedimentation pond located on the east side of Howse project. It will be used to treat approximately two third of the pit runoff water that will be pumped from the bottom of the pit.

6.2.4 Ditches

A network of collection ditches is used to collect contaminated runoff from the whole mine site, including haul road, site infrastructure pad, topsoil stockpile, part of In-Pit waste dump, waste dump, and overburden stockpile. The collected contaminated water is conveyed into sedimentation ponds HOWSEA and HOWSEB for treatment. Ditches plan view is presented on Drawing 622834-4000-4GGD-0001-0001 and Map 4 (Appendix B), and ditches profiles are presented on Drawing 622834-4000-40DD-0002. (Appendix B).

It was chosen to include the relatively small wetland area located between the overburden stockpile and waste dump in the area collected by the collection ditches and treated into sedimentation pond HOWSEB. This decision was based on the facts that:

- It will not be possible to avoid contamination of this area due to its close location between two stockpiles;
- It would be technically difficult to cross the outlet of this area with the collection ditch necessary to collect runoff from the most eastern part of the mine site.

6.2.5 Inlet and Outlet Structures

The water inlet structures of sedimentation ponds HOWSEA and HOWSEB will be designed to promote an even distribution of the flow over the pond width (see Drawing 622834-4000-40DD-0005 in Appendix B). Ditches will be widened at the sedimentation pond entrance, and water will flow into the pond via an impervious ditch section with the use of a HDPE plastic membrane. This impervious section will avoid the formation of preferential channels at the pond entrance.

The outflow structure for all sedimentation ponds will be made of a permeable rockfill dike sized to avoid any spill over the emergency spillway during the sedimentation ponds design flood (see Drawing 622834-4000-40DD-0005 in Appendix B). The emergency spillway will be integrated within the rockfill in a way allowing for the passage of vehicles when the spillway is not in use.

The outlet structure of existing Timmins 4 sedimentation pond 3 will have to be modified into a permeable rockfill dike and an emergency spillway similar to those for sedimentation ponds HOWSEA and HOWSEB. This is necessary to ensure the good functioning of the pond with the additional pumped discharge from the pit, based on the same design criteria as the new ponds.

Downstream of the permeable rockfill dike, treated water from the sedimentation ponds will be collected and conveyed toward the receiving stream with ditches. These ditches will have a small longitudinal slope to ensure low flow velocities at the entrance of the receiving streams. If needed, energy dissipation measures could also be put in place before the junction with natural streams to avoid unwanted disturbance to the existing creeks.

6.2.6 Dikes Construction Material

For the present project stage, it is assumed that the dikes on the downstream side of sedimentation ponds HOWSEA and HOWSEB will be built with compacted material, using overburden available on site (cut and fill). The suitability of this material for construction will be confirmed in the next phase of engineering, based on more detailed sieve analysis of the material and its percentage of fines. Permeable rockfill dike and riprap will be built using non-acid generating material.

7.0 WATER MANAGEMENT INFRASTRUCTURE DESIGN

The methodology, design criteria and detailed design of each infrastructure is presented in the next sections.

7.1 Ditches

Ditches are used to collect runoff water and convey it into sedimentation basins before being released towards existing natural streams.

7.1.1 Methodology

Ditches peak discharge is computed using the rational method:

$$Q = \frac{CIA}{360}$$

Where:

Q: Peak discharge [m^3/s].

C: Runoff coefficient [-].

I: Rainfall intensity corresponding to the watershed time of concentration [mm/h].

A: Drainage area [ha].

Ditches dimensions are determined using the Manning equation:

$$Q = \frac{1}{n} A R^{2/3} S^{1/2}$$

Where:

Q: Peak discharge [m^3/s].

n: Manning's coefficient [$s/m^{1/3}$].

A: Flow area [m^2].

R: Hydraulic radius [m]. R = A/P, where P is the wetted perimeter [m].

S: Ditch slope [%].

7.1.2 Design Criteria

The following design criteria were adopted for the ditches:

- A design flood return period of 100 years;
- A runoff coefficient of 1.0;
- Maximum drainage areas during the life of mine are considered (Table 7-1);
- A trapezoidal section is adopted. Typically ditches will be 1.5 m deep, have a 1.0 m base width, and 2H:1V side slopes;
- Ditches will be protected against erosion with a layer of riprap. If the required riprap layer exceeds 0.5 m, a gabion mattress will be used to replace the riprap;
- A Manning's n coefficient between 0.028 and 0.036 is used function of riprap mean diameter;
- A minimum longitudinal slope of 0.5 % is adopted;
- Culverts used for road crossings are assumed to be made of concrete with an inlet projecting from fill.

7.1.3 Results

Ditches location is presented on drawing 622834-4000-40DD-0001. The following table summarizes ditches and culvert characteristics:

Table 7-1: Ditches and Culvert Characteristics

		CD 1	CD 2	CD 3	CD 4	CD 5	CD 6	CD 7	CD 8	CD 9	CD 10	CD 11	Culvert 1
Drainage area	[ha]	7.6	13.5	22.6	42.7	118.8	25.2	30.0	69.7	196.7	87.3	12.5	13.4
Return period	[an]	100	100	100	100	100	100	100	100	100	100	100	100
Runoff coefficient	[-]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Peak discharge	[m³/s]	0.8	1.3	1.9	2.2	5.6	2.4	3.2	4.0	8.7	5.3	1.4	1.5
Culvert type		Concrete					Concrete	Concrete					Concrete
Culvert inlet type		Projecting from fill					Projecting from fill	Projecting from fill					Projecting from fill
Number of culverts	[-]	1					1	1					1
Min required diameter	[mm]	800					1400	1400					1000
Channel shape		Trapezoidal	Trapezoidal	Trapezoidal	Trapezoidal	Trapezoidal	Trapezoidal	Trapezoidal	Trapezoidal	Trapezoidal	Trapezoidal	Trapezoidal	
Channel lateral slope	H: 1V	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	
Channel base width	[m]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	3.00	1.00	1.00	
Channel depth	[m]	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	
Max channel longitudinal slope	[%]	2.3%	0.8%	2.4%	2.4%	4.3%	3.6%	4.4%	3.6%	2.5%	4.4%	3.9%	
Min channel longitudinal slope	[%]	0.5%	0.5%	0.5%	0.5%	0.5%	1.5%	0.5%	0.5%	0.5%	0.5%	0.5%	
Flow depth	[m]	0.41	0.54	0.66	0.72	1.15	0.59	0.88	0.97	1.03	1.13	0.59	
Minimum freeboard - Design	[m]	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	
Minimum freeboard - Actual (1)	[m]	1.09	0.96	0.84	0.78	0.35	0.91	0.62	0.53	0.47	0.37	0.91	
Maximum flow velocity	[m/s]	1.8	1.4	2.2	2.2	3.3	2.6	2.9	2.9	3.0	3.3	2.4	
Minimum riprap D_{50} (2)	[mm]	100	100	150	150	Gabion	200	Gabion	250	Gabion	Gabion	200	
Minimum riprap depth (2)	[mm]	300	300	300	300	Mattress	400	Mattress	500	Mattress	Mattress	400	

(1) Corresponds to the ditch section with minimum longitudinal slope.

(1) Minimum riprap D_{50} and depth correspond to the ditch section with maximum longitudinal slope and flow velocity.

7.2 Howse Pit

Maximal drainage area of the Howse pit is 76 ha. Water inflow in the Howse pit will come from seepage of the underground water and from runoff. The inflow rate of underground water adopted for design (dewatering rate) is 22 000 m^3/d, 920 m^3/h (see section 4).

It was estimated that a 450 m^3/h pumping capacity was necessary to pump runoff water out of the mine pit, assuming an area at the bottom of the pit developed to allow water accumulation when water inflow into the pit is higher than total pumping capacity for dewatering and runoff (1 370 m^3/h) based on the following assumptions:

Spring freshet:

- Snow is assumed to accumulate during the months of October to April and completely melt during the month of May;
- Pumping can only happen during the summer months. Therefore, inflow from October to May is pumped out of the mine pit in May

24 hour rainfall:

- This pumping capacity allows for the pumping of the entire volume of a 24h, 25 years return period annual rainfall (69 mm, see Appendix A) during less than 5 days, and more rapidly if the underground water inflow is not at its maximum.

The following table summarizes the required pumping capacity in the pit.

Table 7-2 : Required Pit Pumping Rate Capacity

	Required pumping capacity	Comments
Underground water	22 000 m^3/d (920 m^3/h)	See section 4
Runoff	10 800 m^3/d (450 m^3/h)	Allows for the pumping of an average year spring freshet during the month of May Allows for the pumping of a 24h, 25years return period annual rainfall in less than 5 days.
TOTAL	32 800 m^3/d (1 370 m^3/h)	

7.3 Sedimentation Ponds

Sedimentation ponds are used to treat runoff water by reducing their content of total suspended solids before releasing the treated water in an existing natural stream.

7.3.1 Methodology

First, the minimum basin area necessary for the proper settling of the design particles is computed based on the sedimentation basin inflow and Stokes law:

$$A_{min} = a\,\frac{Q}{V_s}$$

Where:

A_{min}: Minimum sedimentation basin area [m^2]. To be conservative, the sedimentation basins bottom area was selected to be equal or larger than Amin.

a: Safety factor for particle shape being different than perfect spheres: a = 1.2.

Q: Design discharge [m^3/s].

V_s: Settling velocity [m/s].

$$V_s = \frac{(d_s - d_f)g}{18v}D^2$$

Where:

d_s: Sediment density: d_s = 2700 kg/m^3.

d_f: Fluid density. For water at 4°C, d_f = 1000 kg/m^3.

g: Gravity: 9.81 m/s^2.

v: Fluid viscosity. For water at 4°C, v = 0.00157 kg/m*s.

D: Particle diameter [m].

Then, flood routing computations are used to determine the sedimentation basin volume and outlet capacity for the design flood. The adopted outlet, for all Sedimentation ponds, is a permeable dike made of rockfill. This choice was based on the good resistance to freezing of such rockfill dikes. Rockfill dikes discharge capacity was computed based on Hansen (1994) as follows:

$$Q = h * L * V$$

Where:

Q: Discharge [m^3/s].

h: Hydraulic head [m].

L: Rockfill dike length [m].

V: Flow velocity [m/s].

$$V = n * W * \sqrt{m} * {i_{eff}}^{0.54}$$

Where:

n: Porosity [-].

W: Williamson coefficient = 5.243.

m: Hydraulic mean radius [m].

i_{eff}: Effective hydraulic gradient [-].

With:

$$m = \frac{e * d}{6 * rsae}$$

Where:

e: Void ratio [-]. Note that n = e/(1+e).

d: Nominal particle diameter [m].

rsae: Relative particle surface area efficiency [-].

And:

$$i_{eff} = 0.8 * A_r^{-3/2} * \left(\frac{h}{H}\right)^{1.4}$$

Where:

A_r: Embankment aspect ratio [-].

H: Rockfill dike height [m].

With:

$$A_r = \frac{1}{H} * \left(B_u + B_c + \frac{B_d}{2}\right)$$

Where:

B_u: Base length of the upstream part of the rockfill dike [m].

B_c: Base length of the central part of the rockfill dike [m].

B_d: Base length of the downstream part of the rockfill dike [m].

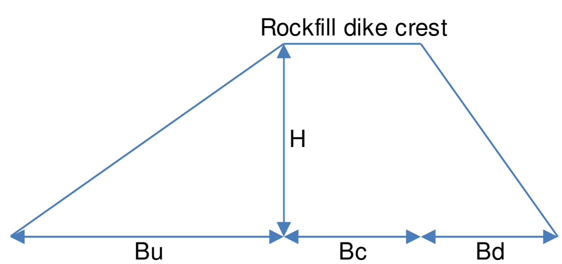


Figure 7-1: Rockfill Dike Cross-Section Sketch

7.3.2 Design Criteria

The following design criteria were adopted for the sedimentation basins:

- A design flood return period of 25 years was selected. A spring flood and a summer-fall flood were compared. A runoff coefficient of 0.5 was assumed for the summer-fall flood. For the spring flood, a runoff coefficient of 1.0 was assumed considering a frozen or water saturated ground. The spring flood, composed of a 24 h spring rainfall, occurring the last day of the melting of a 25 years snow cover over a 35 days period, resulted in the largest sedimentation basins volumes;
- The spring flood adopted equals to 33.1 mm of rain plus 407.5 mm of snowmelt, for a total of 440.6 mm over a 35 days period;
- Maximum drainage areas during the life of mine are considered;
- A rectangular shape, with a length to width ratio of 4, and 3H:1V side slopes were adopted;
- A design particle size of 0.01 mm was adopted for sedimentation basins HOWSEA and HOWSEB used to treat runoff water from the mine site;
- Design discharge for sedimentation is the average inflow during the 24 h design rainfall;
- A permeable rockfill dike section was adopted as outlet. The bottom of the rockfill is located 0.5 m above the basin bottom elevation. This dead storage is used to collect sediments, and it is assumed frozen during the flood routing computations involving spring floods;
- A void ratio of 1.0 (corresponding to a porosity of 0.5), a nominal diameter of 0.2 m, and a relative surface area efficiency of 1.8 were assumed for the rockfill stones;
- Rockfill dike side slopes are 3H:1V, and the dike crest, Bc, is 4.0 m wide;
- An emergency spillway was designed to safely pass a 100 years flood. A trapezoidal weir, assuming a discharge coefficient of 0.35, and side slopes of 10H:1V to allow traffic when the spillway is not in use, was adopted;
- Evaporation is not considered during floods;
- No infiltration is considered for the new ponds.

7.3.3 Existing Timmins 4 Sedimentation Pond 3

Timmins 4 sedimentation pond 3 is an existing sedimentation pond located on the east side of Howse project (Map 1).

This sedimentation pond has a top length of approximately 195 m, a top width of approximately 75 m, and a depth of 4.0 m. Water is conveyed into the pond by two ditches, draining approximately 82 ha, located on the upstream end of the pond. An outlet, made of a corrugated steel culvert with a 0.9 m diameter and an invert elevation of 660.6 m, is located on the downstream end of the pond. Treated water flows out of the pond through the spillway. Then, it is directed towards Goodream Creek through a small ditch.

To test the capacity of the existing pond, flood routing computations were performed considering natural runoff from the 82 ha watershed. It was found that this pond has an available area of approximately 10 600 m^2. This would allow for the treatment of an additional discharge of approximately 7 000 m^3/day, which is less than pit dewatering (22 000 m^3/day, 920 m^3/h) or pit runoff pumping (10 800 m^3/day, 450 m^3/h). Also, the minimum available freeboard during the design flood is too small to protect the surrounding dike against wave erosion. For these reasons, it was decided to use the existing pond, with a modified outlet structure, for the treatment of up to 7 000 m^3/day (290 m^3/h) of runoff water pumped from the pit. The remaining pit runoff and pit dewatering are treated in sedimentation pond HOWSEB.

To respect the maximum treatment capacity available at existing Timmins 4 sedimentation pond 3, a maximum pumping capacity of approximately 290 m^3/h will be used to pump pit runoff water into this pond. A second pumping station, with a capacity of approximately 1080 m^3/h (160 m^3/h for runoff plus 920 m^3/h for dewatering), will be used to pump the remaining pit runoff and dewatering water into a collection ditch flowing towards sedimentation pond HOWSEB.

The modified outlet structure of Timmins 4 Sedimentation pond 3 is a combination of a permeable rockfill dike, 30 m wide and 2.0 m high, and a trapezoidal weir spillway, with a 15 m wide crest and 1V:10H side slopes for allowing traffic when the spillway is not in use. The following table presents the existing sedimentation pond characteristics when used to treat approximately two third of the pit runoff water.

Table 7-3: Timmins 4 Sedimentation Pond 3 Characteristics

		Existing Timmins 4 sedimentation 3
Maximum drainage area	[ha]	82
Design discharge	[m^3/s]	0.52
Time of residence	[h]	16.3
Minimum required area	[m^2]	10 500
Basin bottom area	[m^2]	10 600
Basin top length	[m]	195
Basin top width	[m]	75
Basin depth	[m]	4.0
Basin side slopes	H:1V	2
Basin volume [(1)]	[m^3]	36 200
Outlet type		Rockfill dike
Outlet width	[m]	30
Spillway type		Trapezoidal weir
Spillway crest length	[m]	15

[(1)] Between pond bottom and spillway invert elevations.

The following figure presents the design flood routing, through the existing Timmins 4 sedimentation pond 3, during a three days period centered on the 24h spring rainfall happening during the last day of a 35 days snow melt.

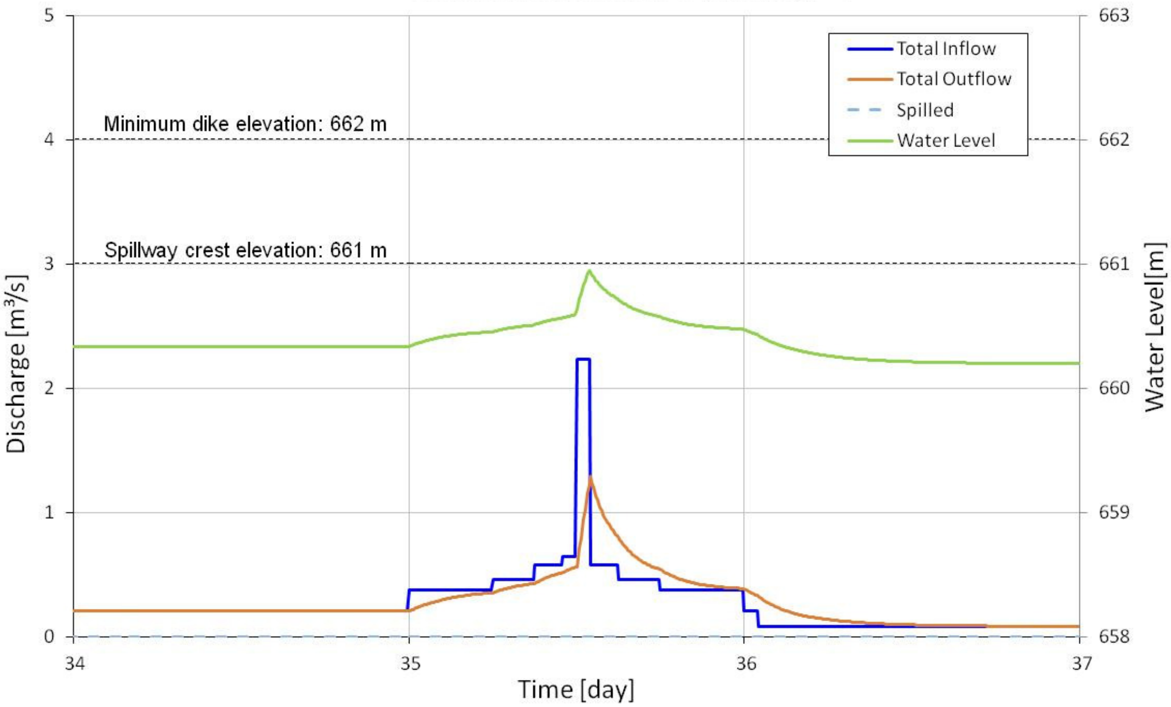


Figure 7-2: 25 Years Flood Routing through Timmins 4 Sedimentation Pond 3

7.3.4 Sedimentation Pond HOWSEA

Sedimentation pond HOWSEA (drawing 622834-4000-40DD-0006) is used to treat runoff water from the in-pit dump that does not flow into the pit, and from the topsoil stockpile, and water collected by a diversion ditch collecting runoff water from a maximum area of approximately 102 ha (maximum drainage area during the life of mine) located on the south side of the mine pit. Because this water will be in contact with small rock particles on the mine site, a sedimentation design particle size of 0.01 mm was adopted. The necessary pond dimensions are 280 m long by 70m wide by 3.5 m deep. Sedimentation pond HOWSEA characteristics are presented in Table 7-4.

A 10 m wide permeable rockfill dike is necessary to adequately pass the 25 years return period sedimentation design flood without any spill over the emergency spillway. An emergency spillway made of a trapezoidal weir with a 20 m wide crest, located 1.0 m below the elevation of the dike lowest point, will be necessary to protect adequately the dikes from a 100 years return period flood.

Table 7-4: Sedimentation Pond HOWSEA Characteristics

		Sedimentation pond HA
Maximum drainage area	[ha]	102
Design discharge	[m³/s]	0.54
Time of residence	[h]	11.9
Minimum required area	[m²]	11 100
Basin bottom area	[m²]	12 700
Basin top length	[m]	280
Basin top width	[m]	70
Basin depth	[m]	3.5
Basin side slopes	H:1V	3
Basin volume (1)	[m³]	37 800
Outlet type		Rockfill dike
Outlet width	[m]	10
Spillway type		Trapezoidal weir
Spillway crest length	[m]	20

(1) Between pond bottom and spillway invert elevations.

The following figure presents the design flood routing, through sedimentation pond HOWSEA, during a three days period centered on the 24h spring rainfall happening during the last day of a 35 days snow melt.

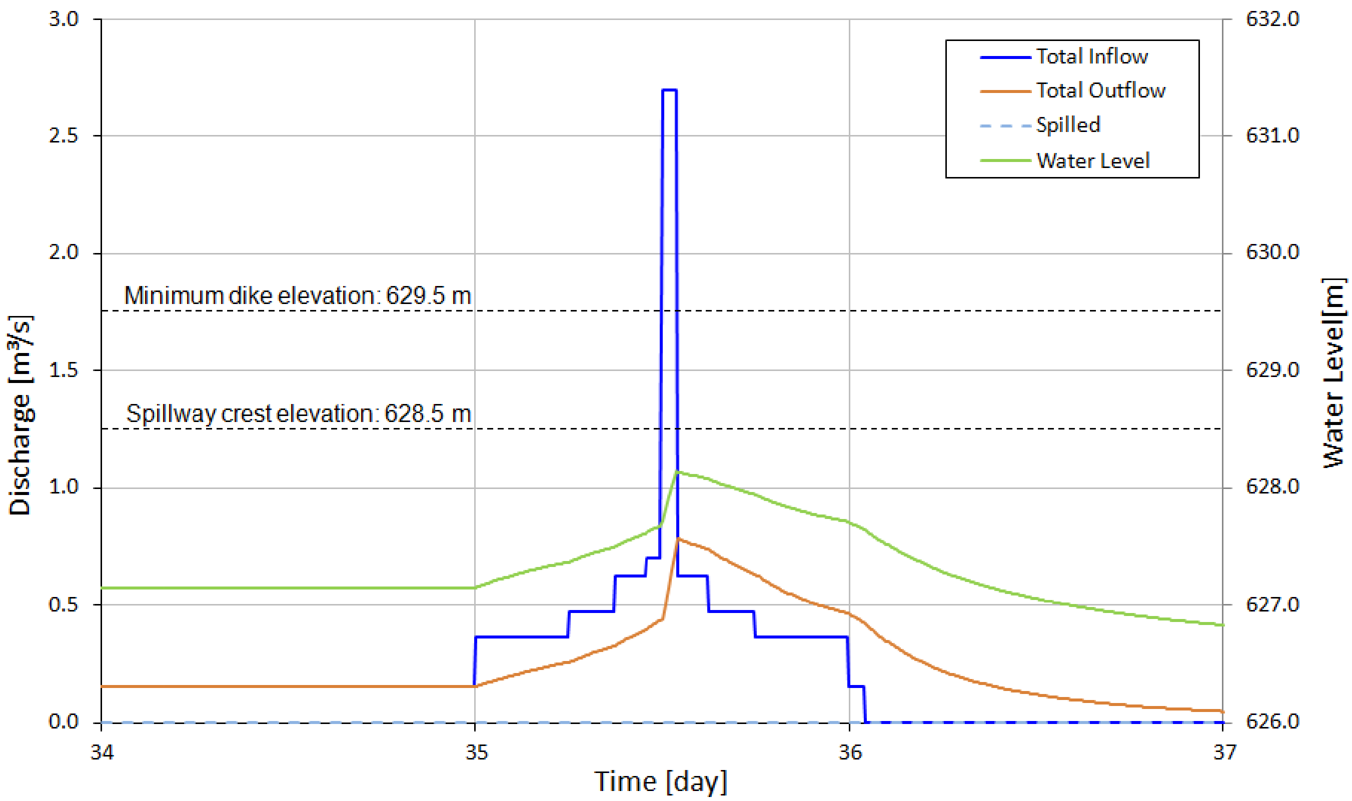


Figure 7-3: 25 Years Flood Routing through Sedimentation Pond HOWSEA

7.3.5 Sedimentation Pond HOWSEB

Sedimentation pond HOWSEB (drawing 622834-4000-40DD-0005-00) is used to treat runoff water from the overburden stockpile, the site infrastructure pad, and the waste dump. Pit dewatering (920 m^3/h, see section 4.0), and approximately one third (160 m^3/h) of pit runoff are also treated in sedimentation pond HOWSEB. This water is collected by a network of collection ditches covering a maximum area of approximately 204 ha. Because this water will be in contact with fine rock particles on the mine site, a sedimentation design particle size of 0.01 mm was adopted, resulting in a relatively large minimum area required for proper treatment.

The adopted sedimentation pond HOWSEB dimensions are: 420 m long by 105 m wide by 4.0 m deep. A 10 m wide permeable rockfill dike is necessary to adequately pass the 25 years return period sedimentation design flood without any spill over the emergency spillway. An emergency spillway made of a trapezoidal weir with a 40 m wide crest, located 1.0 m below the elevation of the dike lowest point, will be necessary to protect adequately the dikes from a 100 years return period flood. Characteristics of sedimentation Pond HOWSEB are described in Table 7-5.

Table 7-5: Sedimentation Pond HOWSEB Characteristics

		Sedimentation pond H2
Maximum drainage area	[ha]	204
Design discharge	[m³/s]	1.38
Time of residence	[h]	17.9
Minimum required area	[m²]	28 100
Basin bottom area	[m²]	32 100
Basin top length	[m]	420
Basin top width	[m]	105
Basin depth	[m]	4.0
Basin side slopes	H:1V	3
Basin volume (1)	[m³]	109 600
Outlet type		Rockfill dike
Outlet width	[m]	10
Spillway type		Trapezoidal weir
Spillway crest length	[m]	40

(1) Between pond bottom and spillway invert elevations.

The following figure presents the design flood routing, through sedimentation pond HOWSEB, during a three days period centered on the 24h spring rainfall happening during the last day of a 35 days snow melt.

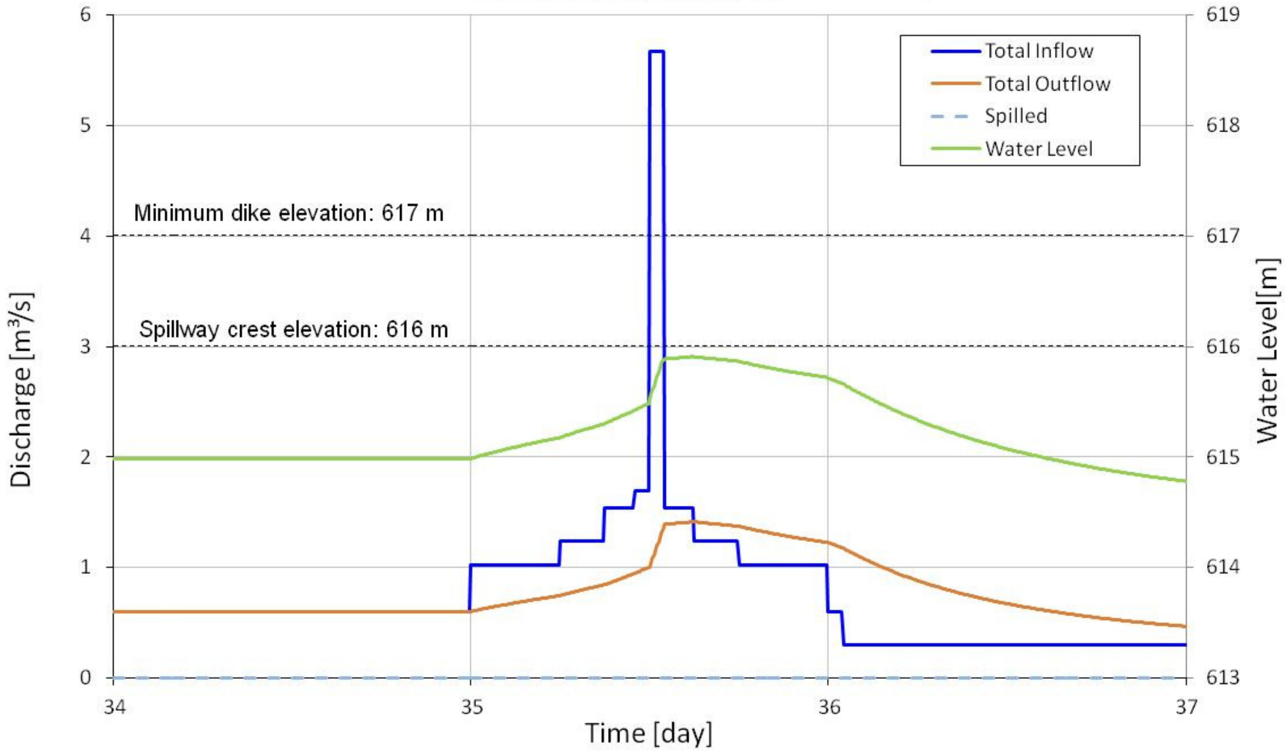


Figure 7-4: 25 Years Flood Routing through Sedimentation Pond HOWSEB

7.4 Water Management Infrastructures Main Characteristics Summary

The following table summarizes sedimentation ponds main characteristics:

Table 7-6: Sedimentation Ponds Characteristics

		Existing Timmins 4 sedimentation 3	Sedimentation pond HA	Sedimentation pond HB
Maximum drainage area	[ha]	82	102	204
Design discharge	[m³/s]	0.52	0.54	1.38
Time of residence	[h]	16.3	11.9	17.9
Minimum required area	[m²]	10 500	11 100	28 100
Basin bottom area	[m²]	10 600	12 700	32 100
Basin top length	[m]	195	280	420
Basin top width	[m]	75	70	105
Basin depth	[m]	4.0	3.5	4.0
Basin side slopes	H:1V	2	3	3
Basin volume (1)	[m³]	36 200	37 800	109 600
Outlet type		Rockfill dike	Rockfill dike	Rockfill dike
Outlet width	[m]	30	10	10
Spillway type		Trapezoidal weir	Trapezoidal weir	Trapezoidal weir
Spillway crest length	[m]	15	20	40

(1) Between pond bottom and spillway invert elevations.

Other key water management infrastructures characteristics are:

- Ditches typical dimensions: 1.0 m base width, 1.5 m depth, with 2H:1V lateral slopes. The only exception is ditch CD-9 with a 3.0 m base width. The location of all ditches is presented on Drawing 622834-4000-4GGD-0001-00 (Appendix B);
- Ditches are protected against erosion with riprap or gabions if the required riprap layer exceeds 0.5 m;
- Ponds emergency spillways have 10H:1V lateral slope to allow traffic when they are not in use.

8.0 WATER BALANCE

Water balance computations were made for an average year representative of average hydrological conditions.

8.1 Methodology and Assumptions

Monthly average values for snowfall, rainfall, lake evaporation and evapotranspiration are presented in Section 2.1. These values were used with the considered drainage areas to determine the corresponding monthly average volumes of water. The following assumptions were made:

- Snow is assumed to accumulate during the months of October to April and completely melt during the month of May;
- It is assumed that pumping can only happen during the summer months. Therefore, runoff from October to May is pumped out of the mine Pit in May;
- Actual evapotranspiration could be limited by water availability in the ground during the summer months. For this reason, actual evapotranspiration is computed as being the minimum between net runoff and evapotranspiration;
- A runoff coefficient of 1.0 is assumed for the months of October to May to take into account frozen or saturated ground conditions. A runoff coefficient of 0.4 is assumed for the months of June to September;
- Drainage areas corresponding to a time period close to the mine end of life are considered as shown on map 4;
- Pit dewatering occurs year long.

8.2 Water Management Infrastructures

Water balance computations were made for an average year for Howse mine pit (76 ha), Timmins 4 sedimentation pond 3 (82 ha), and sedimentation ponds HOWSEA (59 ha) and HOWSEB (178 ha) (Table 8-1 to Table 8-4:). Note that for sedimentation ponds Timmins 4 sedimentation pond 3 and HOWSEB, Pit area is not included because the runoff water on the Pit is indicated as pumped water in the following tables.

Table 8-1: Average Year Monthly Water Balance – Howse Mine Pit (76 ha)

Month	Snowfall [m³]	Rainfall [m³]	Infiltration [m³]	Net Runoff [m³]	Evapo-transpiration [m³]	Inflow [m³]	Inflow [l/s]
Jan	33 164	0	0	0	0	0	0.0
Feb	27 260	78	0	78	0	78	0.0
Mar	32 945	286	0	286	0	286	0.1
Apr	33 660	3 543	0	3 543	0	3 543	1.4
May	17 484	20 772	0	284 849	0	284 849	106.4
Jun	2 675	51 395	32 442	21 628	21 628	0	0.0
Jul	0	75 043	45 026	30 017	25 416	4 601	1.7
Aug	408	70 782	42 714	28 476	18 155	10 322	3.9
Sep	7 211	59 904	40 269	26 846	11 930	14 916	5.8
Oct	34 773	21 031	0	21 031	0	21 031	7.9
Nov	48 332	1 956	0	1 956	0	1 956	0.8
Dec	36 460	122	0	122	0	122	0.0
Year	274 371	304 912	160 451	418 832	77 129	341 703	10.8

Table 8-2: Average Year Monthly Water Balance – Sedimentation Pond HOWSEA (59 ha)

Month	Snowfall [m³]	Rainfall [m³]	Infiltration [m³]	Net Runoff [m³]	Evapo-transpiration [m³]	Inflow [m³]	Inflow [l/s]
Jan	26 361	0	0	0	0	0	0.0
Feb	21 668	62	0	62	0	62	0.0
Mar	26 187	227	0	227	0	227	0.1
Apr	26 756	2 816	0	2 816	0	2 816	1.1
May	13 898	16 511	0	226 418	0	226 418	84.5
Jun	2 126	40 853	25 787	17 192	17 192	0	0.0
Jul	0	59 649	35 790	23 860	20 203	3 657	1.4
Aug	324	56 263	33 952	22 635	14 431	8 204	3.1
Sep	5 732	47 616	32 009	21 339	9 483	11 856	4.6
Oct	27 640	16 717	0	16 717	0	16 717	6.2
Nov	38 418	1 555	0	1 555	0	1 555	0.6
Dec	28 981	97	0	97	0	97	0.0
Year	218 090	242 366	127 538	332 918	61 308	271 610	8.6

Table 8-3: Average Year Monthly Water Balance – Sedimentation Pond HOWSEB (178 ha)

Month	Snowfall [m³]	Rainfall [m³]	Infiltration [m³]	Net Runoff [m³]	Evapo-transpiration [m³]	Pit dewatering [m³]	Pumping from Pit [m³]	Inflow [m³]	Inflow [l/s]
Jan	80 334	0	0	0	0	682 000	0	682 000	254.6
Feb	66 032	188	0	188	0	616 000	0	616 188	254.7
Mar	79 804	693	0	693	0	682 000	0	682 693	254.9
Apr	81 538	8 583	0	8 583	0	660 000	0	668 583	257.9
May	42 353	50 317	0	690 006	0	682 000	101 865	1 473 870	550.3
Jun	6 479	124 498	78 586	52 391	52 391	660 000	0	660 000	254.6
Jul	0	181 781	109 068	72 712	61 567	682 000	1 503	694 648	259.4
Aug	989	171 460	103 469	68 979	43 977	682 000	3 371	710 374	265.2
Sep	17 468	145 108	97 546	65 030	28 899	660 000	4 872	701 003	270.4
Oct	84 232	50 944	0	50 944	0	682 000	0	732 944	273.6
Nov	117 077	4 739	0	4 739	0	660 000	0	664 739	256.5
Dec	88 318	295	0	295	0	682 000	0	682 295	254.7
Year	**664 624**	**738 606**	**388 669**	**1 014 560**	**186 834**	**8 030 000**	**111 611**	**8 969 337**	**284.4**

Table 8-4: Average Year Monthly Water Balance – Timmins 4 Sedimentation 3 (82 ha, Existing with Modified Outlet)

Month	Snowfall [m³]	Rainfall [m³]	Infiltration [m³]	Net Runoff [m³]	Evapo-transpiration [m³]	Pumping from Pit [m³]	Inflow [m³]	Inflow [l/s]
Jan	36 547	0	0	0	0	0	0	0.0
Feb	30 041	85	0	85	0	0	85	0.0
Mar	36 306	315	0	315	0	0	315	0.1
Apr	37 095	3 905	0	3 905	0	0	3 905	1.5
May	19 268	22 891	0	313 910	0	210 000	523 910	195.6
Jun	2 948	56 639	35 752	23 835	23 835	0	0	0.0
Jul	0	82 699	49 619	33 080	28 009	3 098	8 168	3.0
Aug	450	78 004	47 072	31 381	20 007	6 950	18 325	6.8
Sep	7 947	66 015	44 377	29 585	13 147	10 044	26 481	10.2
Oct	38 320	23 176	0	23 176	0	0	23 176	8.7
Nov	53 263	2 156	0	2 156	0	0	2 156	0.8
Dec	40 179	134	0	134	0	0	134	0.1
Year	**302 363**	**336 020**	**176 821**	**461 563**	**84 998**	**230 092**	**606 657**	**19.2**

8.3 Impacts on Natural Watersheds

Howse mine project is located on the upstream part of Goodream Creek, Burnetta Creek, and Pinette Lake watersheds. Construction of this project will have impacts on these natural watersheds, in terms of drainage area and flow pattern, due to:

- Ditches drainage network collecting runoff water and releasing it at particular points into the existing creeks (Goodream Creek and Burnetta Creek);
- Pumping of runoff water from the mine pit into sedimentation pond HOWSEB and Timmins 4 sedimentation pond 3, then releasing this water into Goodream Creek;
- Pumping of pit dewatering water, resulting in an additional amount of water (coming from deep water tables) released into Goodream Creek.

In the following sections, water balance computations results for the existing natural conditions and the future modified conditions are presented for Goodream Creek, Burnetta Creek, and Pinette Lake watersheds.

8.3.1 Goodream Creek

The drainage area difference between the existing (316 ha) and the modified (355 ha) Goodream Creek watershed, near the mine end of life, at the junction with Timmins 4 sedimentation pond 3 outflow is 39 ha (see maps 11 and 12). This represents an increase of approximately 12 % of the existing drainage area at this point, resulting in additional runoff downstream from Timmins 4 sedimentation pond 3.

Approximately two third of the pit runoff will be pumped into Timmins 4 sedimentation pond 3 for treatment. Then, this water will be released into Goodream Creek downstream from Timmins 4 sedimentation pond 3. At this location, Goodream Creek is mainly considered an intermittent Creek but still a fish habitat (HML, 2014). The upstream part of Goodream Creek watershed, located east from Timmins 4 sedimentation pond 3, will not be affected by the Project. Water flowing from this part of the watershed will ensure a minimum flow in the upstream portion of Goodream Creek.

The following table presents estimated monthly natural inflow values, corresponding to an average year representative of average hydrological conditions, for Goodream Creek at a point corresponding to the junction with Timmins 4 sedimentation pond 3 outflow.

Table 8-5: Goodream Creek Natural Inflow at Junction with Timmins 4 Sedimentation Pond 3 Outflow (316 ha)

Month	Snowfall [m³]	Rainfall [m³]	Infiltration [m³]	Net Runoff [m³]	Evapo-transpiration [m³]	Inflow [m³]	Inflow [l/s]
Jan	141 337	0	0	0	0	0	0.0
Feb	116 175	330	0	330	0	330	0.1
Mar	140 404	1 219	0	1 219	0	1 219	0.5
Apr	143 454	15 101	0	15 101	0	15 101	5.8
May	74 514	88 527	0	1 213 971	0	1 213 971	453.2
Jun	11 399	219 038	138 262	92 175	92 175	0	0.0
Jul	0	319 818	191 891	127 927	108 319	19 608	7.3
Aug	1 739	301 660	182 040	121 360	77 371	43 989	16.4
Sep	30 733	255 297	171 618	114 412	50 844	63 568	24.5
Oct	148 195	89 629	0	89 629	0	89 629	33.5
Nov	205 982	8 337	0	8 337	0	8 337	3.2
Dec	155 384	520	0	520	0	520	0.2
Year	**1 169 316**	**1 299 476**	**683 811**	**1 784 981**	**328 709**	**1 456 273**	**46.2**

The following table presents estimated monthly modified inflow values after construction of the water management infrastructures, corresponding to an average year representative of average hydrological conditions, for Goodream Creek at the junction with Timmins 4 sedimentation pond 3 outflow.

Table 8-6: Goodream Creek Modified Inflow at Junction with Timmins 4 Sedimentation Pond 3 Outflow (304 ha [(1)])

Month	Snowfall [m³]	Rainfall [m³]	Infiltration [m³]	Net Runoff [m³]	Evapo-transpiration [m³]	Pumping from Pit [m³]	Inflow [m³]	Inflow [l/s]
Jan	135 118	0	0	0	0	0	0	0.0
Feb	111 063	316	0	316	0	0	316	0.1
Mar	134 226	1 166	0	1 166	0	0	1 166	0.4
Apr	137 142	14 436	0	14 436	0	0	14 436	5.6
May	71 235	84 631	0	1 160 551	0	210 000	1 370 551	511.7
Jun	10 897	209 399	132 178	88 118	88 118	0	0	0.0
Jul	0	305 745	183 447	122 298	103 553	3 098	21 843	8.2
Aug	1 663	288 386	174 029	116 019	73 966	6 950	49 003	18.3
Sep	29 380	244 063	164 066	109 377	48 606	10 044	70 815	27.3
Oct	141 673	85 685	0	85 685	0	0	85 685	32.0
Nov	196 918	7 970	0	7 970	0	0	7 970	3.1
Dec	148 546	497	0	497	0	0	497	0.2
Year	**1 117 860**	**1 242 293**	**653 720**	**1 706 434**	**314 244**	**230 092**	**1 622 282**	**51.4**

[(1)] The drainage area of 304 ha corresponds to Goodream Creek modified drainage area at the junction with Timmins 4 Sedimentation pond 3 outflow (355 ha) from which the drainage area of approximately two third of the mine pit (51 ha) was subtracted.

Spring monthly maximum flow in Goodream Creek, at a point corresponding to the junction with Timmins 4 sedimentation pond 3, will increase by approximately 13 %.

The drainage area difference, between the existing (1068 ha) and the modified (1162 ha) Goodream Creek watershed, at the junction with HOWSEB outflow, is 94 ha (see Maps 5 and 6 in Appendix B). This represents an increase of approximately 9 % of the existing drainage area at this point, resulting in additional runoff downstream from sedimentation pond HOWSEB.

Pit dewatering will be treated in sedimentation pond HOWSEB, adding a constant discharge into Goodream Creek downstream from sedimentation pond HOWSEB as well. At this location, Goodream Creek is considered a permanent watercourse with fish habitat (HML, 2014a).

Dewatering water is assumed to reach 22 000 m^3/d at the final pit floor depth. Measurements in the boreholes within the Howse ore body indicate that the water table is relatively deep below the ground surface (between 64 m and 90 m in November 2013). This indicates that, at the beginning, dewatering will be mainly limited to pit runoff water and/or infiltration through the walls of the pit. The maximum pumping rate will occur when the deep water table is reached, and it will depend on the thickness and duration of mining of each lift. Then, the maximum impact on Goodream Creek will likely occur during a short period of time at the end of Howse pit exploitation.

The following table presents estimated monthly natural inflow values, corresponding to an average year representative of average hydrological conditions, for Goodream Creek at a point corresponding to the junction with sedimentation pond HOWSEB outflow.

Table 8-7: Goodream Creek Natural Inflow at Junction with HOWSEB Outflow (1068 ha)

Month	Snowfall [m³]	Rainfall [m³]	Infiltration [m³]	Net Runoff [m³]	Evapo-transpiration [m³]	Inflow [m³]	Inflow [l/s]
Jan	477 942	0	0	0	0	0	0.0
Feb	392 854	1 117	0	1 117	0	1 117	0.5
Mar	474 787	4 124	0	4 124	0	4 124	1.5
Apr	485 101	51 064	0	51 064	0	51 064	19.7
May	251 973	299 359	0	4 105 130	0	4 105 130	1 532.7
Jun	38 546	740 691	467 542	311 695	311 695	0	0.0
Jul	0	1 081 488	648 893	432 595	366 290	66 305	24.8
Aug	5 882	1 020 086	615 581	410 387	261 636	148 752	55.5
Sep	103 925	863 306	580 339	386 893	171 932	214 961	82.9
Oct	501 130	303 085	0	303 085	0	303 085	113.2
Nov	696 542	28 193	0	28 193	0	28 193	10.9
Dec	525 441	1 758	0	1 758	0	1 758	0.7
Year	**3 954 124**	**4 394 271**	**2 312 354**	**6 036 040**	**1 111 552**	**4 924 488**	**156.2**

The following table presents estimated monthly modified inflow values, corresponding to an average year representative of average hydrological conditions, for Goodream Creek at the junction with sedimentation pond HOWSEB outflow.

Table 8-8: Goodream Creek Modified Inflow at Junction with HOWSEB Outflow (1162 ha)

Month	Snowfall [m³]	Rainfall [m³]	Infiltration [m³]	Net Runoff [m³]	Evapo-transpiration [m³]	Pit dewatering [m³]	Inflow [m³]	Inflow [l/s]
Jan	519 251	0	0	0	0	682 000	682 000	254.6
Feb	426 809	1 214	0	1 214	0	616 000	617 214	255.1
Mar	515 824	4 480	0	4 480	0	682 000	686 480	256.3
Apr	527 029	55 478	0	55 478	0	660 000	715 478	276.0
May	273 752	325 233	0	4 459 942	0	682 000	5 141 942	1 919.8
Jun	41 877	804 710	507 953	338 635	338 635	660 000	660 000	254.6
Jul	0	1 174 962	704 977	469 985	397 949	682 000	754 036	281.5
Aug	6 390	1 108 253	668 786	445 857	284 249	682 000	843 608	315.0
Sep	112 908	937 923	630 498	420 332	186 792	660 000	893 540	344.7
Oct	544 444	329 281	0	329 281	0	682 000	1 011 281	377.6
Nov	756 745	30 629	0	30 629	0	660 000	690 629	266.4
Dec	570 856	1 910	0	1 910	0	682 000	683 910	255.3
Year	**4 295 884**	**4 774 074**	**2 512 214**	**6 557 743**	**1 207 625**	**8 030 000**	**13 380 118**	**424.3**

Goodream Creek spring monthly maximum flow, at the junction with sedimentation pond HOWSEB outflow, will increase by approximately 25 %, which is evaluated as a low magnitude impact by Groupe Hémisphère (GH, 2014b).

Map 13 (Appendix B) shows a comparison of Goodream Creek watershed area at the outlet of Triangle Lake with Howse Project (1706 ha) and without Howse Project (1659 ha). There is a 3% (47 ha) increase of Triangle Lake drainage area with Howse. This is a small increase that will not generate any noticeable water level variation for Triangle Lake. Similarly, the average flow increase in Goodream Creek, due to Howse mine pit dewatering, will not impact noticeably Triangle Lake water level as this flow increase is small in comparison with existing natural flow variations during floods.

8.3.2 Burnetta Creek

The drainage area difference, between the existing (83 ha) and the modified (143 ha) Burnetta Creek watershed at the junction with HOWSEA outflow, is 60 ha (see Maps 7 and 8 in Appendix B). This represents an increase of approximately 72 % of the existing drainage area at this point, resulting in additional runoff downstream from junction with sedimentation pond HOWSEA outflow.

Burnetta Creek does not host any fish habitat upstream from Burnetta Lake, which is located much downstream from the water release point (HML, 2014a). It is an intermittent creek with a relatively small natural flow.

The following table presents estimated monthly natural inflow values, corresponding to an average year representative of average hydrological conditions, for Burnetta Creek at a point corresponding to the junction with sedimentation ponds HOWSEA outflow.

Table 8-9: Burnetta Creek Natural Inflow at Junction with HOWSEA Outflow (83 ha)

Month	Snowfall [m³]	Rainfall [m³]	Infiltration [m³]	Net Runoff [m³]	Evapo-transpiration [m³]	Inflow [m³]	Inflow [l/s]
Jan	37 192	0	0	0	0	0	0.0
Feb	30 570	87	0	87	0	87	0.0
Mar	36 946	321	0	321	0	321	0.1
Apr	37 749	3 974	0	3 974	0	3 974	1.5
May	19 608	23 295	0	319 446	0	319 446	119.3
Jun	2 999	57 638	36 382	24 255	24 255	0	0.0
Jul	0	84 157	50 494	33 663	28 503	5 160	1.9
Aug	458	79 379	47 902	31 935	20 360	11 575	4.3
Sep	8 087	67 179	45 160	30 107	13 379	16 727	6.5
Oct	38 996	23 585	0	23 585	0	23 585	8.8
Nov	54 202	2 194	0	2 194	0	2 194	0.8
Dec	40 888	137	0	137	0	137	0.1
Year	**307 695**	**341 946**	**179 939**	**469 702**	**86 497**	**383 205**	**12.2**

The following table presents estimated monthly modified inflow values, corresponding to an average year representative of average hydrological conditions, for Burnetta Creek at the junction with sedimentation pond HOWSEA outflow.

Table 8-10: Burnetta Creek Modified Inflow at Junction with HOWSEA Outflow (143 ha)

Month	Snowfall [m³]	Rainfall [m³]	Infiltration [m³]	Net Runoff [m³]	Evapo-transpiration [m³]	Total Inflow [m³]	Inflow [l/s]
Jan	64 448	0	0	0	0	0	0.0
Feb	52 974	151	0	151	0	151	0.1
Mar	64 022	556	0	556	0	556	0.2
Apr	65 413	6 886	0	6 886	0	6 886	2.7
May	33 977	40 367	0	553 552	0	553 552	206.7
Jun	5 198	99 878	63 045	42 030	42 030	0	0.0
Jul	0	145 832	87 499	58 333	49 392	8 941	3.3
Aug	793	137 553	83 007	55 338	35 280	20 058	7.5
Sep	14 014	116 412	78 255	52 170	23 184	28 986	11.2
Oct	67 574	40 869	0	40 869	0	40 869	15.3
Nov	93 925	3 802	0	3 802	0	3 802	1.5
Dec	70 853	237	0	237	0	237	0.1
Year	**533 190**	**592 541**	**311 807**	**813 924**	**149 886**	**664 038**	**21.1**

After the construction of sedimentation pond HOWSEA, a relatively large area of Burnetta Creek watershed will be diverted. Rather than flowing naturally into Burnetta Creek some distance downstream from the junction with HOWSEA outflow, runoff from the diverted area will be collected then released punctually. Consequently, spring monthly maximum flow will increase of approximately 72 %, which corresponds to a moderate magnitude impact according to the scale used by Groupe Hémisphère (GH, 2014b).

However, the impact of the Howse project construction on Burnetta Creek is decreasing when the distance downstream from junction with HOWSEA outflow is increasing. When a point located approximately 600 m downstream from the junction with HOWSEA outflow is considered, the drainage area difference between actual and future conditions is only 36 ha. At this point, spring monthly maximum flow will increase by approximately 18 %, which corresponds to a low magnitude impact. Therefore, to keep the impact magnitude of Howse construction on Burnetta Creek low, this creek will be protected against erosion on a distance of approximately 600 m downstream from junction with HOWSEA outflow as a mitigation measure.

8.3.3 Pinette Lake

Pinette Lake watershed will be reduced by 9 ha following Howse project construction. This difference represents 4 % of the existing Pinette Lake watershed (237 ha) at the lake outlet (see Map 9 and Map 10 in Appendix B).

The following table presents estimated monthly natural inflow values, corresponding to an average year representative of average hydrological conditions, for Pinette Lake outlet.

Table 8-11: Pinette Lake Outlet Natural Inflow (237 ha)

Month	Snowfall [m³]	Rainfall [m³]	Infiltration [m³]	Net Runoff [m³]	Evapo-transpiration [m³]	Inflow [m³]	Inflow [l/s]
Jan	106 070	0	0	0	0	0	0.0
Feb	87 186	248	0	248	0	248	0.1
Mar	105 370	915	0	915	0	915	0.3
Apr	107 659	11 333	0	11 333	0	11 333	4.4
May	55 921	66 437	0	911 055	0	911 055	340.1
Jun	8 554	164 382	103 762	69 175	69 175	0	0.0
Jul	0	240 016	144 009	96 006	81 291	14 715	5.5
Aug	1 305	226 389	136 616	91 078	58 065	33 013	12.3
Sep	23 064	191 594	128 795	85 863	38 157	47 706	18.4
Oct	111 216	67 264	0	67 264	0	67 264	25.1
Nov	154 584	6 257	0	6 257	0	6 257	2.4
Dec	116 612	390	0	390	0	390	0.1
Year	**877 542**	**975 225**	**513 183**	**1 339 584**	**246 688**	**1 092 896**	**34.7**

The following table presents estimated monthly modified inflow values, corresponding to an average year representative of average hydrological conditions, for Pinette Lake outlet.

Table 8-12: Pinette Lake Outlet Modified Inflow (228 ha)

Month	Snowfall [m³]	Rainfall [m³]	Infiltration [m³]	Net Runoff [m³]	Evapo-transpiration [m³]	Inflow [m³]	Inflow [l/s]
Jan	102 266	0	0	0	0	0	0.0
Feb	84 059	239	0	239	0	239	0.1
Mar	101 591	882	0	882	0	882	0.3
Apr	103 798	10 926	0	10 926	0	10 926	4.2
May	53 915	64 054	0	878 380	0	878 380	327.9
Jun	8 248	158 487	100 041	66 694	66 694	0	0.0
Jul	0	231 407	138 844	92 563	78 376	14 187	5.3
Aug	1 259	218 269	131 717	87 811	55 983	31 829	11.9
Sep	22 237	184 723	124 176	82 784	36 789	45 995	17.7
Oct	107 228	64 852	0	64 852	0	64 852	24.2
Nov	149 040	6 032	0	6 032	0	6 032	2.3
Dec	112 429	376	0	376	0	376	0.1
Year	**846 069**	**940 248**	**494 778**	**1 291 540**	**237 840**	**1 053 699**	**33.4**

The decrease of Pinette Lake inflow is very small. Such a small decrease would have no measurable impact on Elross Lake inflow as Elross Lake watershed is very large (33 643 ha) compared to that from Pinette Lake, as shown on Map 14. Furthermore, the small reduction of Pinette Lake watershed corresponds to an equivalent augmentation of Goodream Creek watershed. As Goodream Creek eventually empties in Rosemarie Lake, located upstream from Elross Lake, the impact on Elross Lake is negligible.

9.0 ENVIRONMENTAL MONITORING PLAN

The environmental monitoring program will consist of three main types of sampling: real-time monitoring, effluent monitoring (sedimentation pond discharge), and water chemistry analysis of groundwater, surface water of natural water courses and drainage ditches.

The environmental monitoring program will be planned in accordance with the following protocols and regulations: Environmental Control Water and Sewage Regulations (2003); Protocols Manual for Real Time Water Quality Monitoring in Newfoundland and Labrador (2013); Metal Mining Effluent Regulations (Canada).

The environmental monitoring plan has been developed based on preliminary information, and should be considered a conceptual design only. The environmental monitoring plan is subject to change based on the final site plan, consultations, site visits, and feasibility. The monitoring plan presented in this section and on Map 15 is organized to be easily integrated to the TSMC DSO overall monitoring plan.

9.1 Real-Time Water Quality/Quantity Monitoring

The environmental monitoring program will provide effective real-time monitoring at the Howse Property Project Site (the Site) in accordance with the Canada-Newfoundland Water Quality Surveys Agreement. Real-time water quality (RTWQ) monitoring provides continuous water quality data, which can provide a better insight to the effect the mining operations are having on receiving waters than traditional grab samples alone.

Typical parameters measured by RTWQ stations are: temperature, pH, specific conductivity, dissolved oxygen and turbidity, which can be used to further calculate additional parameters such as total dissolved solids (TDS) and percent saturation. Additional sensors may be added to provide supplementary measured parameters, if needed. Water quantity data can also be measured by RTWQ stations (i.e., discharge, using stage height and velocity data).

Three monitoring stations currently exist within the area of interest and consideration will be given to implementing them into the environmental monitoring program for the site. The provincial and federal government will be responsible for the installation or relocation of real-time monitoring stations, as well as data collection and maintenance, as part of the Environment Canada/Government of Newfoundland and Labrador's Real-time Water Quality Monitoring Program. The stations and their intended use in the environmental monitoring program are listed below.

9.1.1 IHH1

Hydrometric station IHH1 monitors Burnetta Creek, downstream of the proposed sedimentation pond HOWSEA. This station currently only monitors water quantity and requires that manual readings be taken. Water quality should also be monitored at this location, to provide insight on any contaminates of concern present in Burnetta Creek caused by the discharge from sedimentation pond HOWSEA or other mining influences. The proposed surface water monitoring HSW1 located at IHH1 station will fulfill this function (see Table 9-4).

9.1.2 IHH3

Hydrometric station IHH3 is located at an intermittent stream flowing to Pinette Lake.. Currently IHH3 also requires that manual readings of stage height and velocity be taken. Surface water sampling for quality parameter is already taken with sampling location COA SW13, part of Timmins 4 project. Even if no water quality change is expected for Pinette Lake, this sampling should continue with the Howse project..

9.1.3 NF03OB0040

RTWQ monitoring station NF02OB0040 (Goodream Creek 2 km Northwest of Timmins 6) is already part of the Real-time Water Quality Monitoring Program in Newfoundland and Labrador. It is currently located upstream of sedimentation pond HOWSEB. This monitoring station could be moved downstream of the sedimentation pond in order to monitor contamination from both the Howse Property Project Site, and the HML DSO 3 site. If it is determined that the relocation of the monitoring station is not feasible or beneficial to the monitoring of both project sites, an additional monitoring station will be installed in Goodream Creek somewhere downstream of the sedimentation pond HOWSEB discharge point, ideally close to Triangle Lake where road access is available.

9.2 Effluent Monitoring

Effluent discharge criteria (EDC) parameters are usually tested weekly from the effluent grab samples. Acute lethality test (ALT) parameters are only required to be tested monthly. An overview of the effluent monitoring schedule, including monitoring locations is presented in Table 9-1.

Table 9-1: Effluent Monitoring Schedule

Monitoring Location	Parameters	Frequency
1. Sedimentation pond HOWSEA discharge into Burnetta Creek 2. Sedimentation pond HOWSEB discharge into Goodream Creek 3. Timmins 4 sedimentation pond 3 discharge into Goodream Creek	EDC (excluding ALT) See Table 9-2 for specific parameters and limits.	Weekly (minimum of 24 hours apart)
	ALT (conducted as per Environment Canada's Environmental Protection Service reference method EPS/1/RM-13	Monthly (minimum of 15 days apart)

Monitoring locations were chosen to ensure all effluent diverted to receiving waters is monitored regularly. All measured parameters will be compared to the Effluent Discharge Criteria specified by the Certificate of Approval from the Government of Newfoundland and Labrador. The expected parameters and concentrations are presented in Table 9-2 below, but may change after the Certificate of Approval is received.

Table 9-2: Effluent Discharge Criteria (EDC)

Parameter	Maximum Authorized Monthly Mean Concentration	Maximum Authorized Concentration in a Composite Sample	Maximum Authorized Concentration in a Grab Sample
Arsenic	0.50 mg/L	0.75 mg/L	1.00 mg/L
Copper	0.30 mg/L	0.45 mg/L	0.60 mg/L
Lead	0.20 mg/L	0.30 mg/L	0.40 mg/L
Nickel	0.50 mg/L	0.75 mg/L	1.00 mg/L
Zinc	0.50 mg/L	0.75 mg/L	1.00 mg/L
TSS	15.00 mg/L	22.50 mg/L	30.00 mg/L
Radium 224	0.37 Bq/L	0.74 Bq/L	1.11 Bq/L
pH	Allowable Range 5.5 – 9.0 units		
ALT	Toxic pass		

Sampling frequency decrease or increase depending on the results of previous consecutive tests, as specified by the Certificate of Approval. The expected conditions leading to sampling frequency changes are outlined in Table 9-3 below.

Table 9-3: Changes in Sampling/Testing Frequency

Parameter	Test results	New testing frequency
Arsenic	Parameter's monthly mean concentration in the effluent is less than 10% of the maximum authorized mean concentration for the 12 months immediately preceding the most recent test	Once per calendar quarter
Copper		
Lead		
Nickel		
Zinc		
Radium 224	Concentration of radium 226 is less than 0.037Bq/L in 10 consecutive tests	

Parameter	Test results	New testing frequency
ALT	Effluent is not determined to be acutely lethal over a period of 12 consecutive months.	
pH	Parameter testing frequency cannot be reduced.	
TSS	Parameter testing frequency cannot be reduced.	

The Department of Environment and Conservation will be notified in writing at least 30 days in advance of a reduction in the frequency of testing for any parameter. If during the next testing event, these test results are no longer met for a certain parameter, the parameter must be tested at the original frequency shown in Table 9-3.

If ALT determines that any sample is acutely lethal, a grab sample must be collected from the final discharge point of the failing site. An ALT must be performed, and an aliquot of the failing sample must be analyzed for the parameters in Table 9-3. Samples should then be collected twice per month until three consecutive tests determine that the effluent is no longer acutely lethal. After the third consecutive non-acutely lethal test, the ALT's must be conducted following the original testing frequency.

If three consecutive ALT's are performed and the results determine the effluent is acutely lethal, a Toxicity Identification Evaluation (TIE) must be performed to determine the specific toxin causing the problem. A report outlining the measures to prevent or reduce the toxin must then be submitted to the Director within 60 days of the third consecutive failed test.

Flow measurements at the effluent discharge of each sedimentation pond will be monitored through the installation of a Parshall flume located in the ditches downstream of the permeable rockfill dikes of the pond. A reading of the measurement from the Parshall flume will be taken at the same time when a water sample is collected.

9.3 Water Chemistry Analysis (Surface and Groundwater)

In addition to the real-time monitoring system and effluent monitoring, groundwater and surface water grab samples will be collected four times per year and analyzed by a laboratory that has been certified by the Canadian Association for Environmental Analytical Laboratories. Monitoring locations and parameters to be tested are presented in Table 9-4. As the monitoring program continues, it may be appropriate to relocate, add, or remove monitoring locations as needed.

Table 9-4: Water Chemistry Analysis Program

Sample Type	Station number	Monitoring Locations	Parameters
Surface Water	HSW1	Burnetta Creek, downstream of sedimentation pond HOWSEA	General Parameters: temperature, dissolved oxygen (DO), nitrate + nitrite, nitrate, nitrite, pH, TSS, colour, sodium,
	HSW2	Burnetta Creek, upstream of sedimentation pond HOWSEA	

Sample Type	Station number	Monitoring Locations	Parameters
	HSW3	Goodream Creek, downstream of sedimentation pond HOWSEB	potassium, calcium, sulphide, magnesium, ammonia, alkalinity, sulphate, chloride, turbidity, reactive silica, orthophosphate, phenolics, carbonate (CaCO2), hardness (CaCO3), bicarbonate, TPH Metals Scan: aluminium, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, mercury, nickel, selenium, silver, strontium, thallium, tin, titanium, uranium, radium, vanadium, zinc.
	HSW4	Goodream Creek, northeast of waste rock dump 2	
	COA SW12 (Timmins)	North of Timmins 4 sedimentation pond 3 (COA SW12 from Timmins Site)	
	HSW5	GDR3 stream between overburden stockpile and waste rock dump 2	
	HSW6	GDR4 stream northeast of Timmins 4 sedimentation pond 3	
	HSW7	GDR2 stream flowing into Goodream Creek, northeast of sedimentation pond HOWSEB	
	HSW8	Drainage ditch north of overburden stockpile	
	COA SW8 (Timmins)	Goodream Creek, northeast of overburden stockpile (COA SW8 - Timmins Site)	
	COA SW13	Stream north of Pinette Lake (COA SW13 -Timmins Site)	
	HSW9	Drainage ditch north of waste rock dump 2	
Groundwater	HGW1	northwest of Howse pit	
	HGW2	East of overburden stockpile and Goodream Creek	
	HGW3	West of topsoil stockpile	
	COA GW5 (Timmins)	Southeast of Timmins 4 sedimentation pond 3 (COA GW5 -Timmins Site)	
	HGW3	West of Howse pit	
		TSS analysis not required for groundwater samples. TPH analysis to be performed on sedimentation pond samples.	

Groundwater will be accessed using monitoring wells. Monitoring wells location will be selected not only to obtain groundwater samples, but also to monitor the depth to groundwater and fluctuation of the water table and changes in groundwater flow direction that could be caused by pit dewatering, changes in surface drainage, and permafrost melting. The installation of additional monitoring wells may be required if it is discovered that the current wells are not suitable for the purposes of groundwater sampling/monitoring based on hydrogeologic/geologic data, well depth, and well condition. Monitoring wells will be chosen and installed in areas that may be impacted by potential mine influences and also in areas that will allow background sample collection. A minimum of one monitoring well will be required as a reference well up-gradient within each watershed of concern and away from all potential mine influences.

The number of surface water sampling sites required and their locations was determined based on the hydrological and geological characteristics of the area, the characteristics of the expected contaminants, anthropologic influences, and ease of access. Sampling sites are to be established downstream of contamination points, and reference sites will also be established upgradient of potential contamination points.

9.4 Quality Assurance / Quality Control (QA/QC)

QA/QC samples will be taken regularly to ensure proper field and laboratory techniques have been followed and to ensure the integrity of the results. A minimum of 10% of the samples submitted will be QA/QC samples, such as field duplicates, split samples, trip blanks, and/or field blanks. Before each sampling event, discussions with the laboratory analyzing the samples will help determine the QA/QC protocols to be followed.

10.0 DISCUSSION

10.1 Data Needed for Next Phase of Engineering

The following tasks should be performed in the next phase of engineering to optimize the water management infrastructure layout presented in this document, to optimize the infrastructures size, and to refine the characterization of the expected effluent quality on Howse property:

- Actualize HOWSEB pond design with final hydrogeological modeling, which should confirm pit dewatering flow. Actual design is based on a relatively conservative assumption;
- Perform particle size distribution analysis of the overburden and waste rock expected at the Howse property;
- Perform settling test to assess the settling rate of the suspended solids from surface runoff coming from the waste rock dump, the overburden, and the pit dewatering water at Timmins 4;
- Timmins 4 sedimentation pond 3 sedimentation capacity should be checked once more data on sediment size distribution is available;
- Perform a complete water quality assessment, including total and dissolved metals, chloride, sulfate, pH, alkalinity, ammonia, nitrate, etc., once per week or every 2 weeks on the following samples:
- Surface runoffs on the Timmins 4 property coming from the waste rock pile and overburden pile;
- Pit surface runoffs and pit dewatering water from the Timmins 4 property.
- Perform a wind analysis to determine wind setup and wave run-up and validate the minimum freeboard for all the ponds build with a dike;
- Design outlet channels for sedimentation ponds HOWSEA and HOWSEB, and bring all ponds inlet structures to the level of engineering required for the next phase of the project.

10.2 Geotechnical Infrastructure Design

Presently, no waterproofing measures are planned at the bottom of the sedimentations ponds because the only expected environmental issue is the amount of total suspended solid. However, depending on the nature of the soil on which pond HOWSEA will be built, a sealing material may be required to avoid leakage of the water back into the pit, as these ponds will be located beside the pit. If the till in place is made of about 10-15% fine particles, the ponds would be impervious enough and this would not be an issue.

The suitability of the excavated material to be used for dike construction will have to be addressed. For ponds HOWSEA and HOWSEB dike construction, stability issues due to seepage could occur if the material used is too pervious. Geotechnical investigations at the pond location will have to be performed to assess this material. Standard geotechnical tests such as sieve analysis and Proctor tests will be required. If the material in place is too permeable, it will be possible to cover the bottom and slopes of the ponds with suitable compacted silty material available on site, or to use a geosynthetic membrane to seal the ponds.

11.0 CONCLUSION

SNC-Lavalin Inc. (SLI) was mandated by Howse Minerals Canada Ltd to conceive, at a conceptual engineering level, Howse project's water management plan. The adopted water management strategy is based on the following concepts:

- Minimize impacts on environment;
- Use existing infrastructures as much as possible;
- Clean and contaminated water separation;
- Water treatment for suspended sediments.

The necessary water management infrastructures consist in clean water derivation ditches, contaminated water collection ditches, and several sedimentation ponds. Different options were analyzed for the collection and treatment of water from the site runoff and pit dewatering.

The adopted layout is made of a network of collection ditches, one diversion ditch, and two new sedimentation ponds. Sedimentation pond HOWSEA is used to treat runoff water from the topsoil stockpile and part of the in-pit dump not flowing into the pit, and water collected on the south-west side of the mine pit, before releasing treated water into Burnetta Creek. Runoff water from the remaining of the mine site as well as pit dewatering and one third of pit runoff are collected and conveyed by a network of collection ditches into sedimentation pond HOWSEB for treatment. Once treated, this water is released into Goodream Creek. Timmins 4 sedimentation pond 3 is an existing sedimentation pond used to treat approximately two third of pit runoff water before releasing it into Goodream Creek.

A few options were studied, and the adopted layout is the option that has the least impact on the environment. Overall, existing watershed drainage areas are the least modified, and the release of treated water is split between Goodream Creek and Burnetta Creek to minimize impacts on their respective flow patterns and water quality.

The water management infrastructures were designed, at a conceptual level, based on a series of design criteria approved by HML, and a series of assumptions. These assumptions will need to be validated in the project next engineering phases. The validation of several assumptions related to water quality and available material for pond construction will need to be based on a series of data that will need to be collected on Howse mine future site or on existing nearby sites.

12.0 REFERENCES

Groupe Hémisphères (GH), 2010. Hydrological and hydrogeological study: survey season 2009, DSOP. Final technical report.

Groupe Hemispheres (GH), 2014b. BASTIEN, Julie (jbastien@hemis.ca): *Howse EIS: biophysical impact of the WMP* [Courrier électronique à Loic Didillon et Marie-Hélène Paquette] (loic.didillon@tatasteelcanada.com, mariehelene.paquette@snclavalin.com), 26 novembre 2012. Message original : Howse EIS: biophysical impact of the WMP par Daniel Néron

Government of Newfoundland and Labrador (GNL), 2012. Department of Environment and Conservation. Certificate of Approval for Direct Shipping Ore Project – Timmins, AA12-085571A, August 2012.

Government of Newfoundland and Labrador (GNL), 2011. Department of Environment and Conservation. *Dam Safety Program*, http://www.env.gov.nl.ca/env/waterres/damsafety/index.html#consequences, Consulted October 4th, 2015.

Government of Canada. 2002. Metal Mining Effluent Regulations. SOR 2002 - 222.

Hansen, 1994: David Hansen, Vinod K. Garga, and Ronald Townsend, Selection and application of a one-dimensional non-Darcy flow equation for two-dimensional flow through rockfill embankments, Can. Geotech. J. 32, 223-232, 1995.

Howse Minerals Limited (HML), 2014a. Howse Minerals Limited, Groupe Hémisphère, Project Registration / Project Description for the DSO – Howse Property Project, Final, March/April 2014.

Howse Minerals Limited (HML), 2014c. Data tables-Water Monitoring. September 2014

Maidment, 1993: David R. Maidment, Handbook of Hydrology, McGraw-Hill, Inc., ISBN 0-07-039732-5, 1993.

MTQ, 2006: Ministère des transports du Québec, Manuel de conception des Ponceaux, Guides et manuels techniques, May 2006.

Rollings, K., 1997. The Hydrology of Labrador, Hydrologic Modelling Section, Water Resources Management Division, Department of Environment and Labour, Government of Newfoundland and Labrador, June 1997.

SNC-Lavalin, 2014 (in preparation). Hydrogeology and mine pit dewatering modeling. LabMag site. New Millenium Iron.

Stubbins, J. B. and P. Munro. 1965. Historical information on mine dewatering of DSO (Knob Lake). The Canadian Institute of Mining and Metallurgy Bulletin, 58:814-822.

WMO, 2009: World Meteorological Organization, Manual on Estimation of Probable Maximum Precipitation (PMP), WMO-No.1045, ISBN 978-92-63-11045-9, 2009.

Geofor Environnement, 2015. Hydrogeological Campaign results on Howse deposit. (included in : Groupe Hémisphères, 2015. EIA Howse property project report)

SNC-Lavalin, 2015. Hydrogeology modelling for the Howse deposit. Howse Minerals Limited. Technical memorandum prepared for Geofor environment.

13.0 BIBLIOGRAPHY

AECOM, 2012a. DSO Timmins Project, Design Criteria Drainage and Design Brief, no.0521500 DSO DC 4310-CI-0001 revPB. Montreal, Canada, June 2012.

AECOM, 2012b. DSO Timmins Project, Detailed Engineering, Sedimentation Pond-Timmins 4, no.0521500 DSOT-DW 4310-CI-0004. Montreal, Canada, June 2012.

AECOM, 2012c. DSO Timmins Project, Flow Measurement- General Location, no.0521500 DSOT-DW 4310-CI-0001. Montreal, Canada, June 2012.

Crossman, T., 2014. Managing mining water- The federal regulatory framework. Presentation offered by Miller Thomson Lawyer.

Garga, V. K., Townsend, R., and Hansen, D., A Method for Determining the Surface Area of Quarried Rocks, *Geotechnical Testing Journal,* GTJODJ, Vol. 14, No. 1, March 1991, pp.35-45

Groupe Hémispheres (GH), 2011. Hydrological Campaign 2011: DSO3 and DSO4, Technical Report, PR185-07-11, February 2013.

Groupe Hemispheres (GH), 2014a. 2013-2014 Hydrological Campaign for the Howse Property, Field Report for Howse Minerals Limited, PR185-18-13, October 2014.

Golder, 2014. Technical Memorandum, Howse Pit Hydrogeological Investigation- Summary of factual data in support of environmental impact assessment process, 011-13-1221-0104 MTA Rev. A. February 2014

Golder Associés, February 2014. Howse pit hydrogeological investigation – Summary of factual data in support of environmental impact assessment process. Technical memorandum. Reference no. 011-13-1221-0104 MTA RevA.

Government of Newfoundland and Labrador (GNL), 2011. Department of Environment and Conservation. Real Time Water Quality Report, Tata Steel Minerals Canada-Elross Lake Network Annual Deployment Report.

Howse Minerals Limited (HML), 2014b. Howse Layout (December 5th, Option 3)

TATA Steel Minerals Canada, 2012. Water Monitoring Stations, no. GIS-ML-19-03. Canada, December 2012.

APPENDIX A

Schefferville A Intensity-Duration-Frequency Data

Environment Canada/Environnement Canada

Short Duration Rainfall Intensity-Duration-Frequency Data
Données sur l'intensité, la durée et la fréquence des chutes de pluie de courte durée

Gumbel - Method of moments/Méthode des moments

2011/05/17

===

SCHEFFERVILLE A QC 7117825

Latitude: 54 48'N Longitude: 66 49'W Elevation/Altitude: 521 m

Years/Années : 1965 - 1992 # Years/Années : 23

===

****

Table 1 : Annual Maximum (mm)/Maximum annuel (mm)

****

Year Année	5 min	10 min	15 min	30 min	1 h	2 h	6 h	12 h	24 h
1965	3.6	4.1	4.1	4.3	8.4	13.2	17.8	23.6	24.9
1966	2.8	4.1	4.6	7.1	10.2	17.3	29.5	30.5	30.5
1967	4.8	8.1	8.6	9.1	10.9	15.2	35.1	43.2	47.2
1969	3.6	5.3	6.1	6.3	8.4	10.4	11.7	17.3	22.1
1972	4.1	5.3	5.8	7.1	8.6	11.2	20.1	22.6	25.9
1973	6.6	10.2	12.4	14.5	14.5	16.5	20.6	20.6	21.3
1974	2.3	3.6	4.8	5.1	6.1	8.6	16.8	24.1	39.1
1975	11.4	12.4	14.0	17.8	22.1	22.6	27.7	34.0	40.1
1976	6.1	8.6	8.9	10.4	10.4	10.4	17.3	29.2	42.2
1978	2.6	3.5	4.4	5.8	9.8	10.5	20.0	23.2	32.8
1979	8.6	9.0	9.0	9.0	9.8	15.0	22.5	23.7	30.7
1980	5.4	8.9	11.2	13.7	17.9	22.2	28.5	42.5	56.6
1981	-99.9	-99.9	-99.9	7.9	9.8	10.1	18.3	29.7	37.9
1982	2.8	4.4	4.4	5.4	9.9	12.7	18.1	22.1	29.4
1983	5.1	6.8	7.3	8.9	12.9	16.6	26.4	33.1	38.8
1984	5.6	7.3	7.8	8.2	8.2	11.0	23.8	26.4	31.5
1985	1.3	2.0	2.4	2.6	4.0	6.6	13.1	18.7	20.7
1986	2.5	3.0	3.8	4.8	9.1	13.1	21.8	25.5	35.1
1987	3.5	5.3	5.5	5.5	8.6	13.5	30.1	45.5	47.7
1988	2.0	3.2	3.3	5.5	7.8	11.1	20.2	26.1	50.1
1989	2.9	5.5	8.0	12.4	17.2	17.7	32.2	47.8	59.1
1990	1.3	2.4	3.7	7.1	13.0	21.2	33.9	53.3	83.4
1991	1.9	2.9	4.1	6.0	9.1	16.3	27.8	33.8	37.0
1992	3.7	5.8	7.1	8.9	9.7	14.7	27.5	37.9	56.2

# Yrs. Années	23	23	23	24	24	24	24	24	24
Mean Moyenne	4.1	5.7	6.6	8.1	10.7	14.1	23.4	30.6	39.2
Std. Dev. Écart-type	2.4	2.8	3.1	3.6	3.9	4.2	6.4	9.8	14.6
Skew. Dissymétrie	1.50	0.76	0.92	1.15	1.34	0.50	0.12	0.82	1.24
Kurtosis	5.91	3.23	3.57	4.49	5.45	3.09	2.49	3.07	5.45

*-99.9 Indicates Missing Data/Données manquantes

****

Table 2a : Return Period Rainfall Amounts (mm)
Quantité de pluie (mm) par période de retour

****

Duration/Durée	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans	#Years Années
5 min	3.7	5.8	7.3	9.0	10.4	11.7	23
10 min	5.3	7.7	9.3	11.4	12.9	14.4	23
15 min	6.1	8.8	10.6	12.8	14.5	16.2	23
30 min	7.5	10.6	12.7	15.4	17.3	19.3	24
1 h	10.0	13.5	15.8	18.8	20.9	23.1	24
2 h	13.4	17.1	19.5	22.6	24.9	27.2	24
6 h	22.3	28.0	31.7	36.5	40.0	43.5	24
12 h	29.0	37.7	43.4	50.7	56.1	61.5	24
24 h	36.8	49.7	58.2	69.0	77.1	85.0	24

****

Table 2b :

Return Period Rainfall Rates (mm/h) - 95% Confidence limits
Intensité de la pluie (mm/h) par période de retour - Limites de confiance de 95%

****

Duration/Durée	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans	#Years Années
5 min	44.5	70.1	87.1	108.5	124.3	140.1	23
	+/- 10.9	+/- 18.3	+/- 24.7	+/- 33.3	+/- 39.9	+/- 46.4	23
10 min	31.6	46.2	55.9	68.1	77.2	86.2	23
	+/- 6.2	+/- 10.4	+/- 14.1	+/- 19.0	+/- 22.7	+/- 26.5	23
15 min	24.3	35.1	42.2	51.3	58.0	64.6	23
	+/- 4.6	+/- 7.7	+/- 10.4	+/- 14.0	+/- 16.8	+/- 19.6	23
30 min	14.9	21.3	25.5	30.7	34.7	38.6	24
	+/- 2.6	+/- 4.4	+/- 6.0	+/- 8.1	+/- 9.6	+/- 11.2	24
1 h	10.0	13.5	15.8	18.8	20.9	23.1	24
	+/- 1.4	+/- 2.4	+/- 3.3	+/- 4.4	+/- 5.3	+/- 6.2	24

2 h		6.7	8.5	9.8	11.3	12.5	13.6	24
	+/-	0.8 +/-	1.3 +/-	1.8 +/-	2.4 +/-	2.8 +/-	3.3	24
6 h		3.7	4.7	5.3	6.1	6.7	7.3	24
	+/-	0.4 +/-	0.7 +/-	0.9 +/-	1.2 +/-	1.4 +/-	1.7	24
12 h		2.4	3.1	3.6	4.2	4.7	5.1	24
	+/-	0.3 +/-	0.5 +/-	0.7 +/-	0.9 +/-	1.1 +/-	1.3	24
24 h		1.5	2.1	2.4	2.9	3.2	3.5	24
	+/-	0.2 +/-	0.4 +/-	0.5 +/-	0.7 +/-	0.8 +/-	1.0	24

****

Table 3 : Interpolation Equation / Équation d'interpolation: R = A*T^B

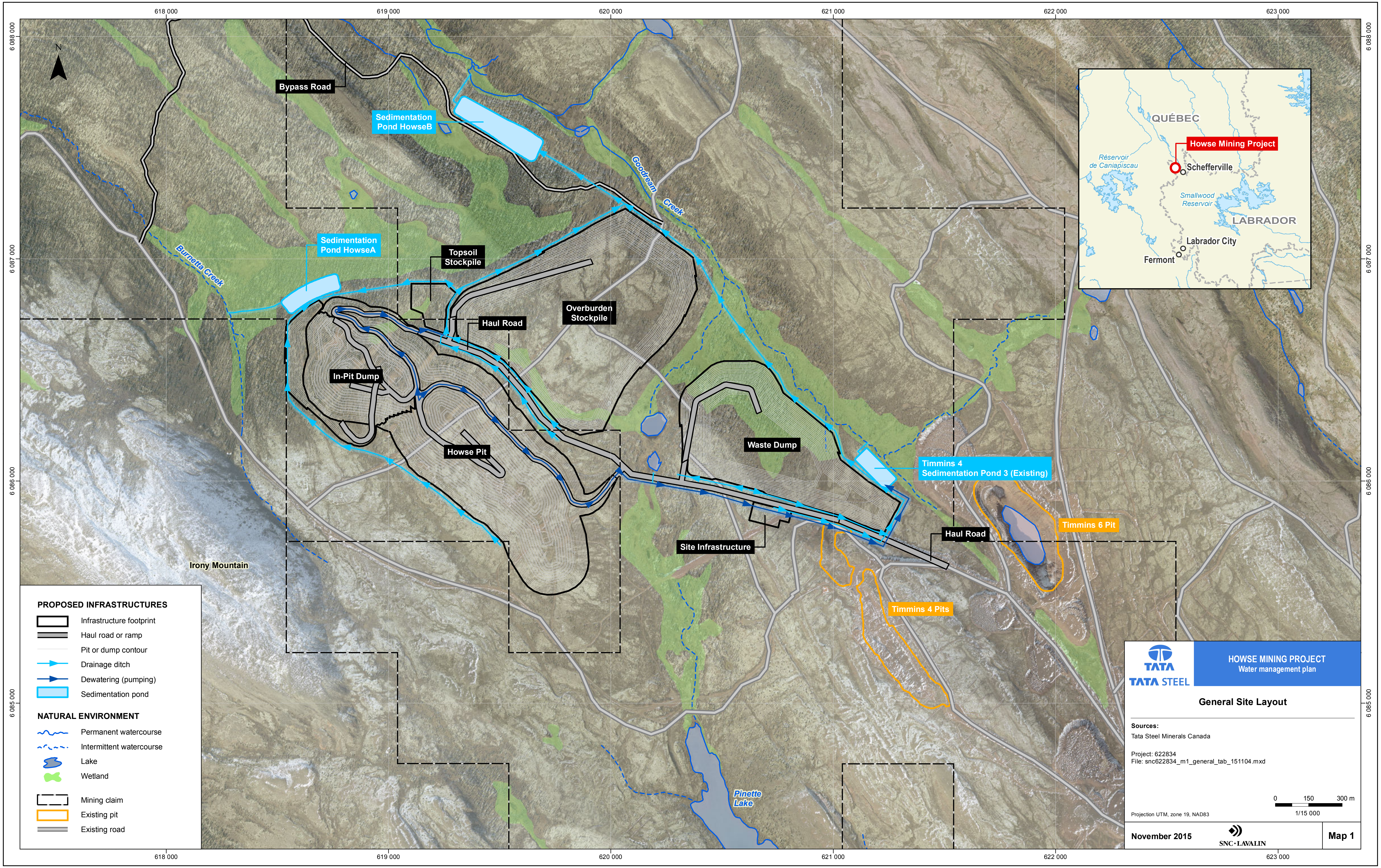
R = Interpolated Rainfall rate (mm/h)/Intensité interpolée de la pluie (mm/h)
RR = Rainfall rate (mm/h) / Intensité de la pluie (mm/h)
T = Rainfall duration (h) / Durée de la pluie (h)

****

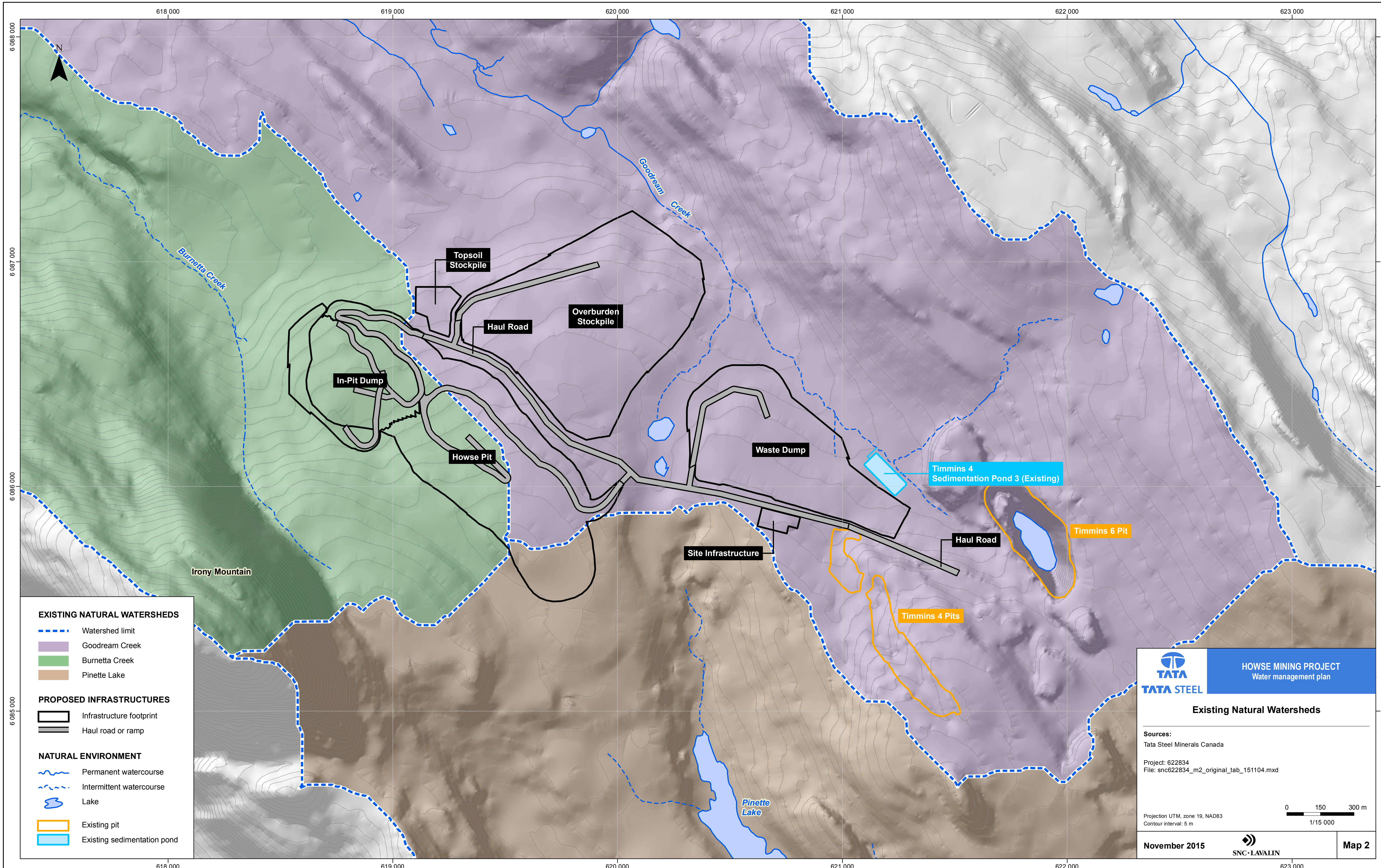
Statistics/Statistiques	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans
Mean of RR/Moyenne de RR	15.5	22.7	27.5	33.5	38.0	42.5
Std. Dev. /Écart-type (RR)	15.0	23.4	29.0	36.1	41.3	46.5
Std. Error/Erreur-type	0.8	1.3	2.1	3.1	3.9	4.6
Coefficient (A)	10.4	14.4	17.0	20.3	22.7	25.2
Exponent/Exposant (B)	-0.595	-0.625	-0.637	-0.648	-0.654	-0.659
Mean % Error/% erreur moyenne	3.2	4.3	5.5	6.5	7.1	7.6

APPENDIX B

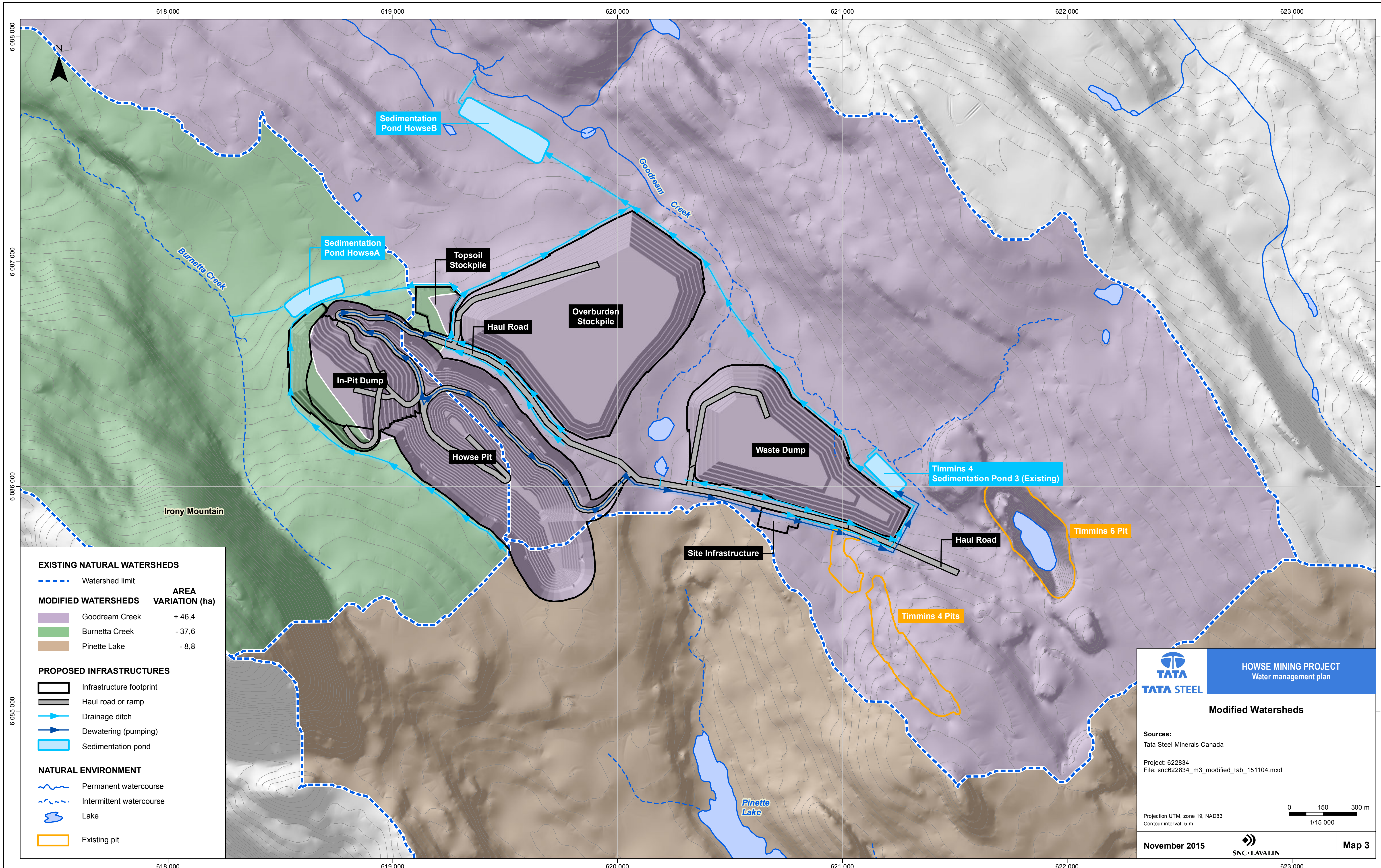
Maps and Drawings



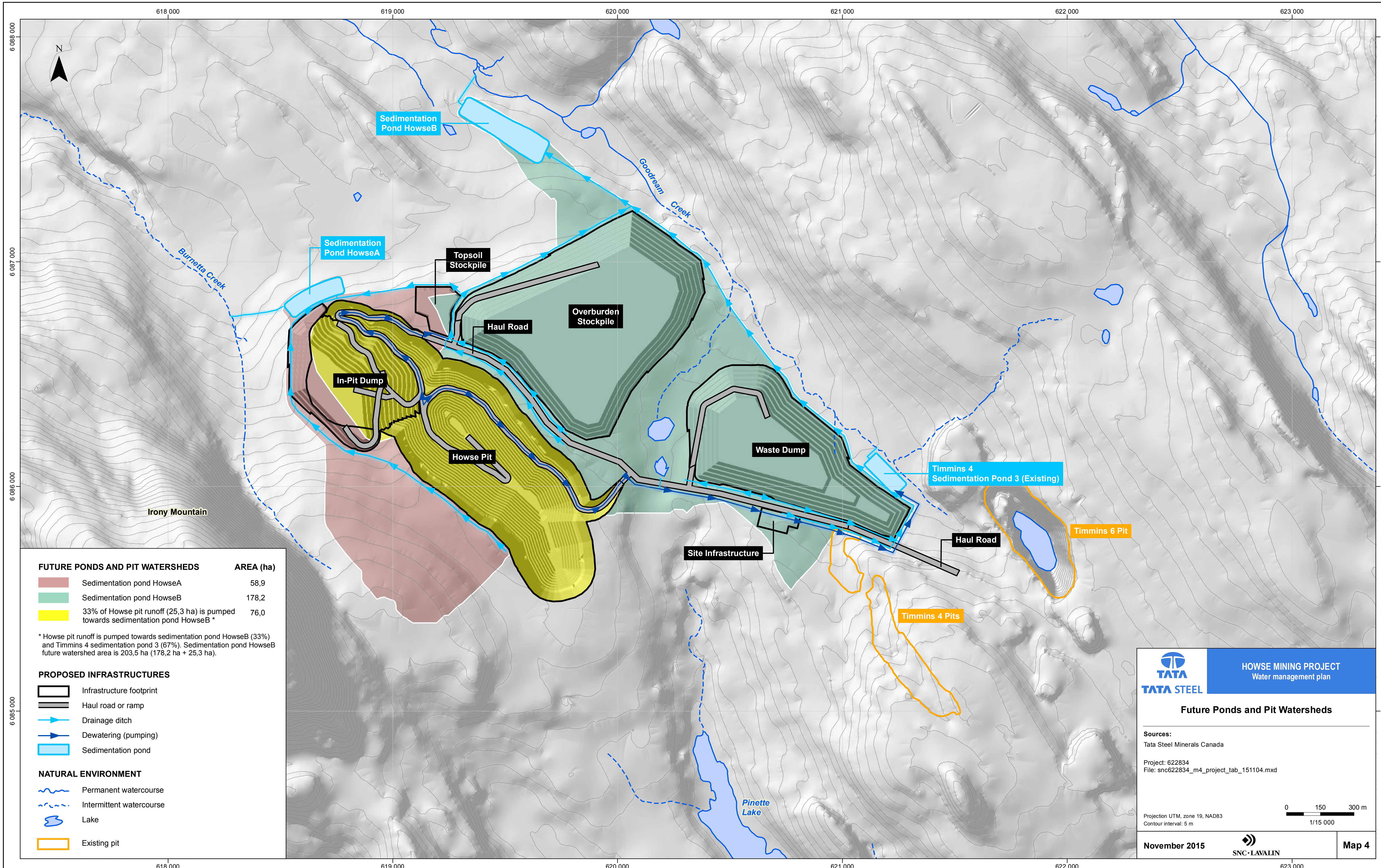
C:\Projets\622834 Howse\interne\diffusion\produit\note_technique_2015\snc622834_m1_general_tab_151104.mxd



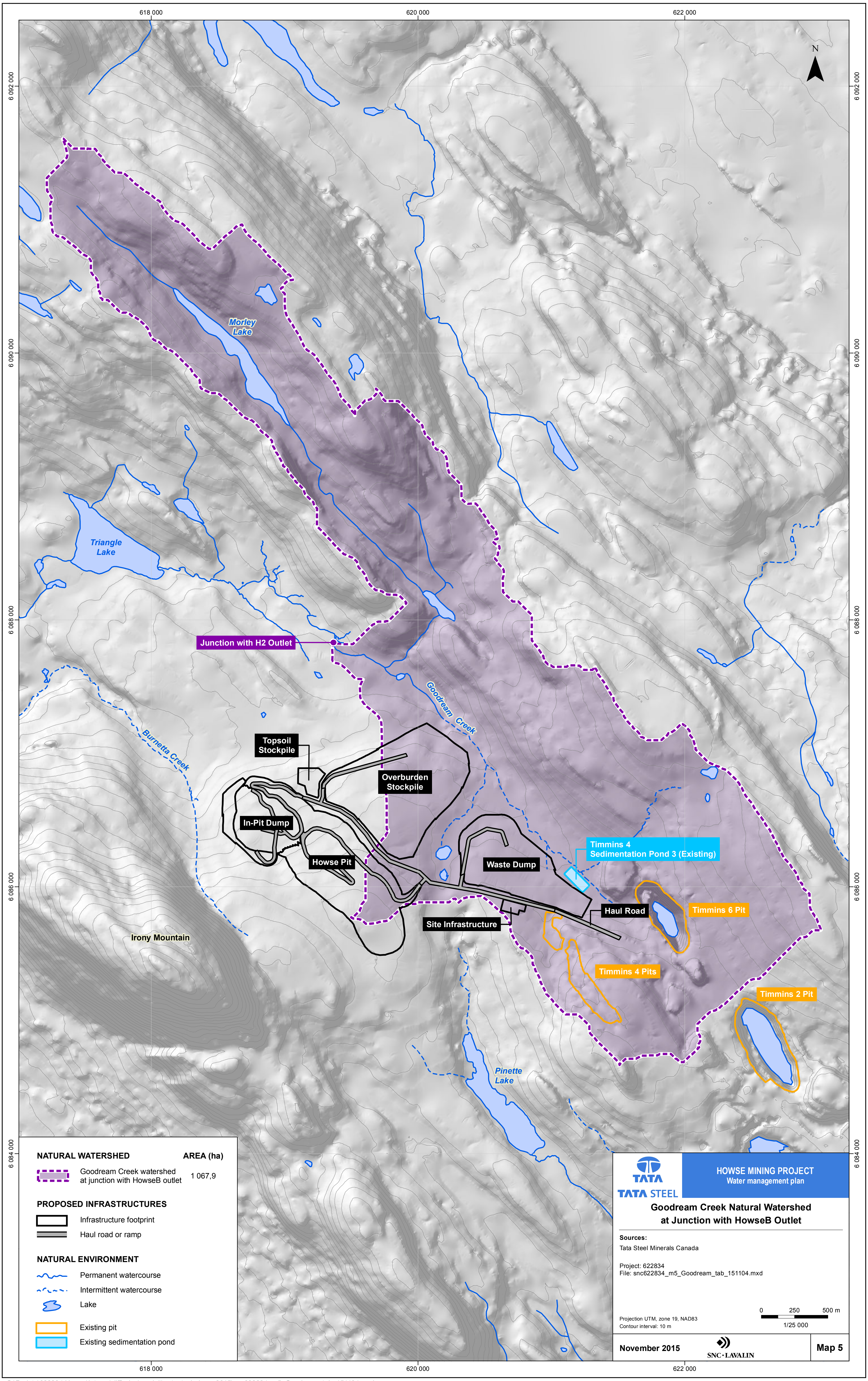
C:\Projets\622834 Howse\interne\diffusion\produit\note_technique_2015\snc622834_m2_original_tab_151104.mxd



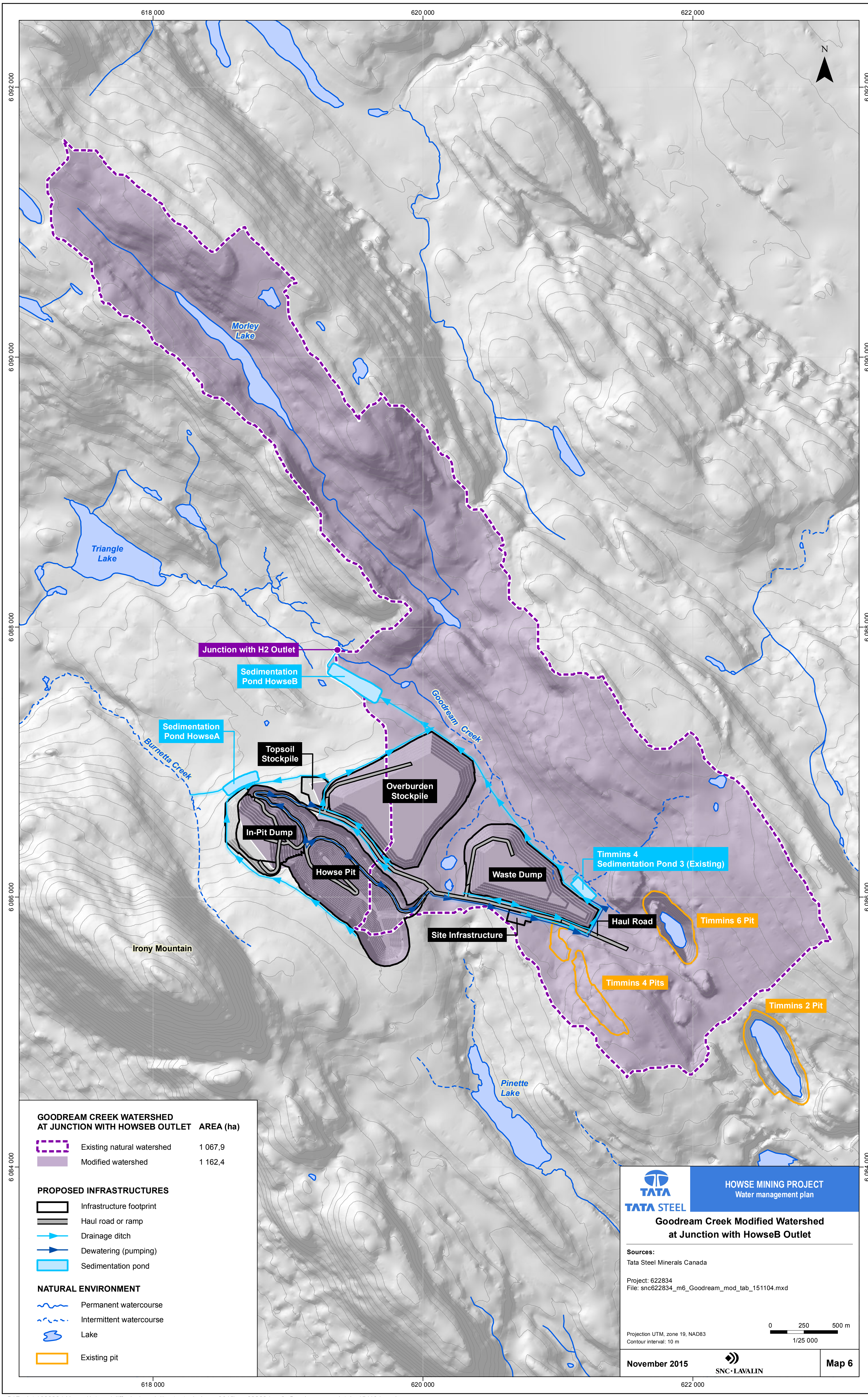
C:\Projets\622834 Howse\interne\diffusion\produit\note_technique_2015\snc622834_m3_modified_tab_151104.mxd



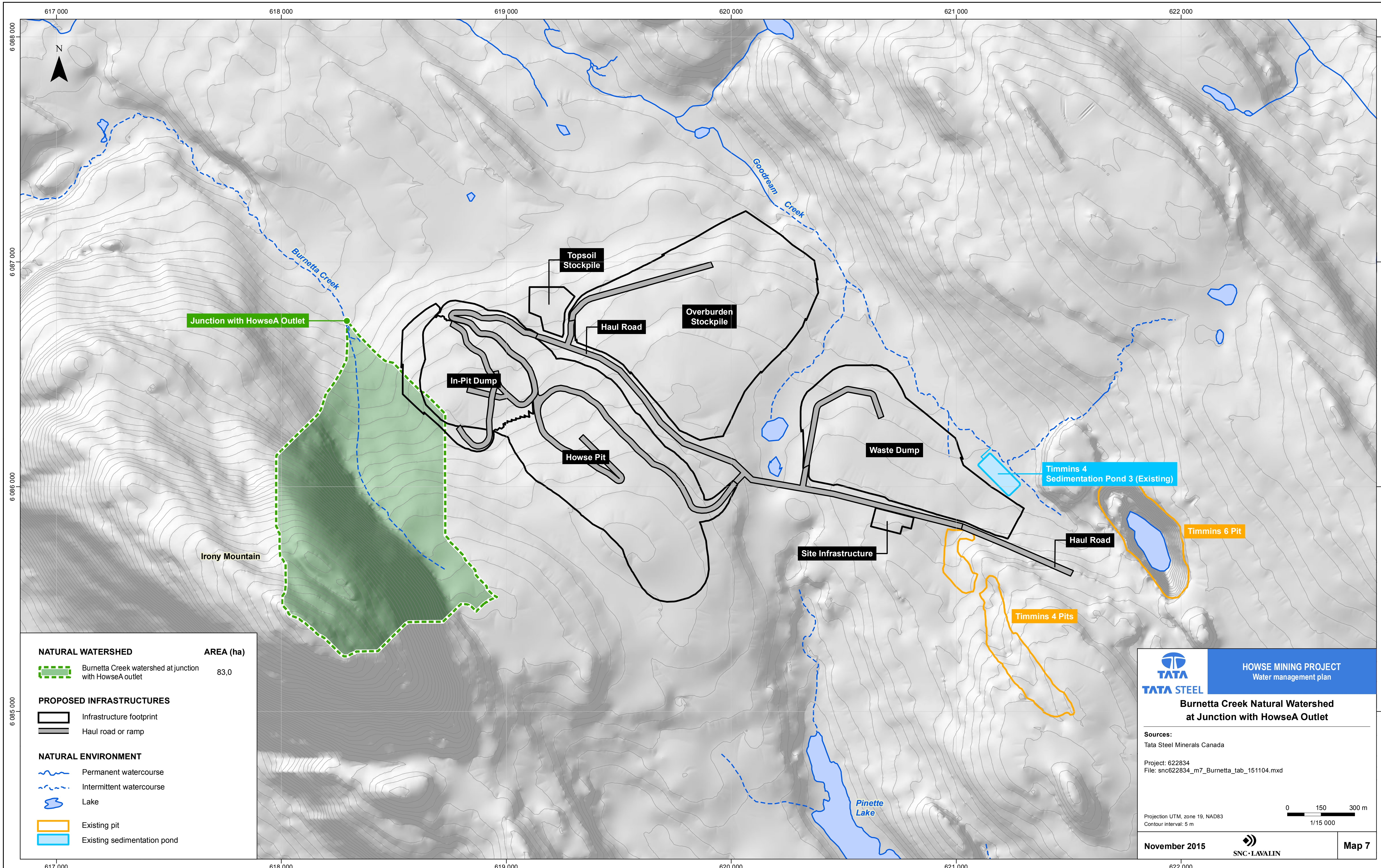
C:\Projets\622834 Howse\interne\diffusion\produit\note_technique_2015\snc622834_m4_project_tab_151104.mxd



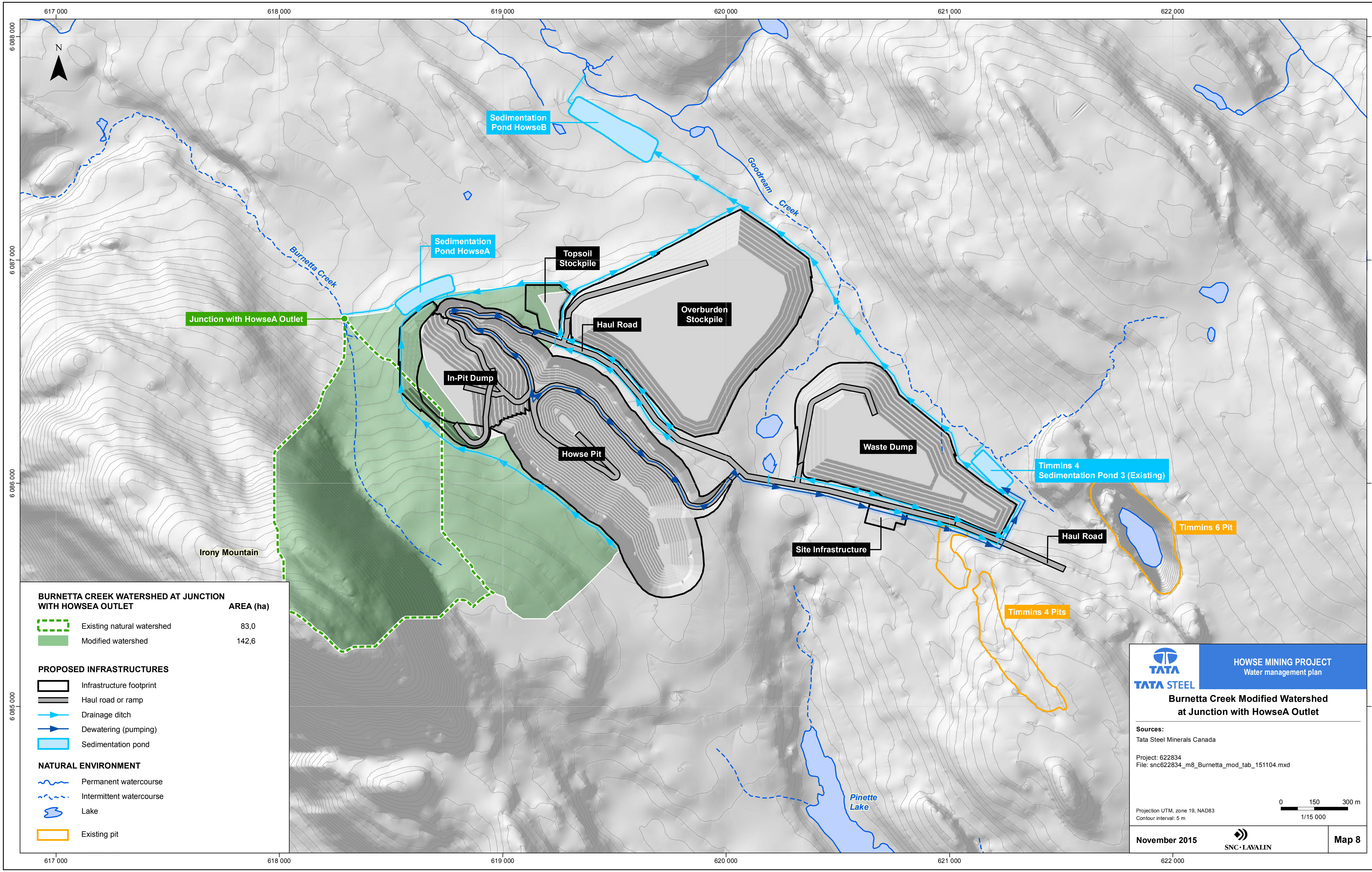
C:\Projets\622834 Howse\interne\diffusion\produit\note_technique_2015\snc622834_m5_Goodream_tab_151104.mxd

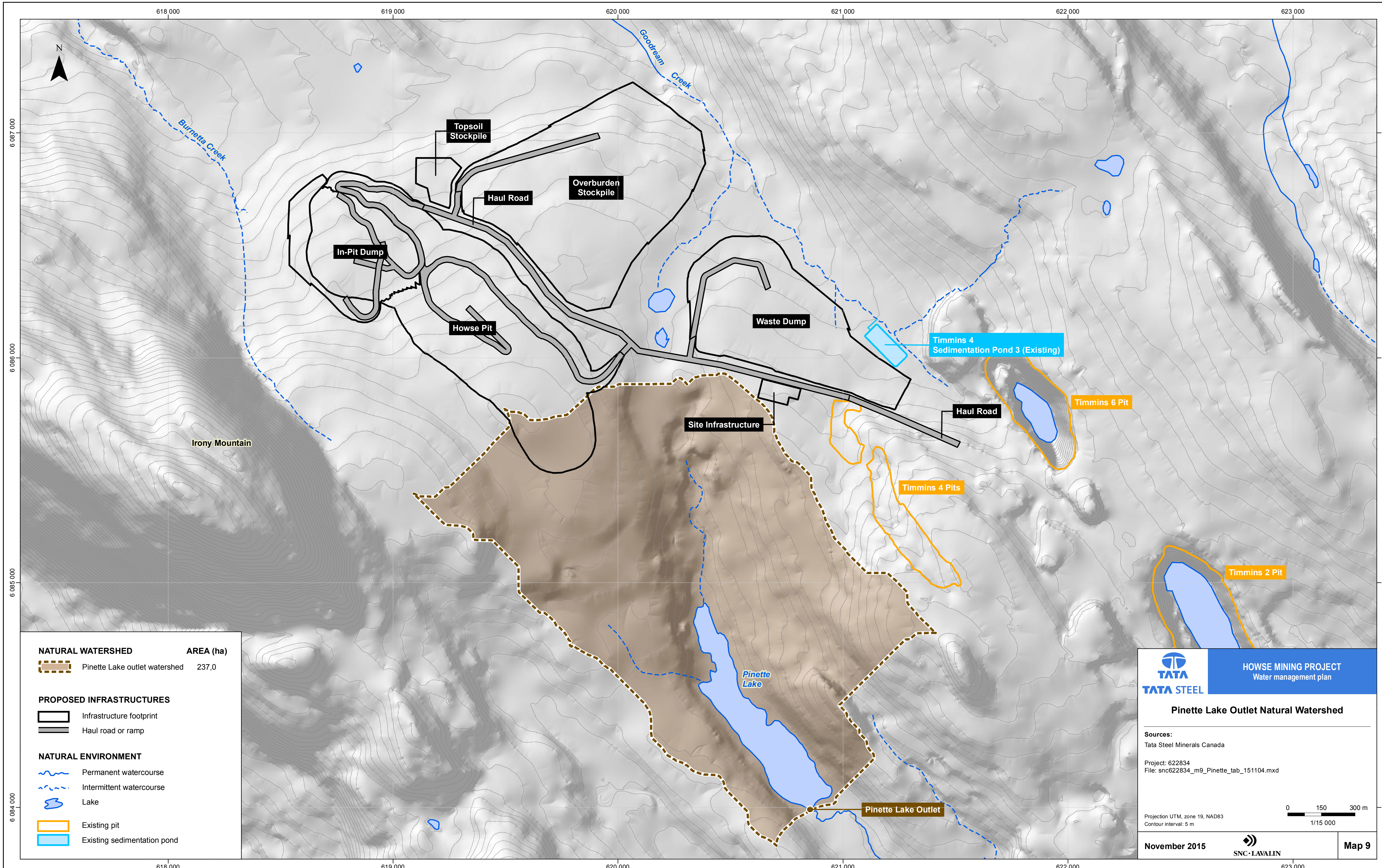


C:\Projets\622834 Howse\interne\diffusion\produit\note_technique_2015\snc622834_m6_Goodream_mod_tab_151104.mxd

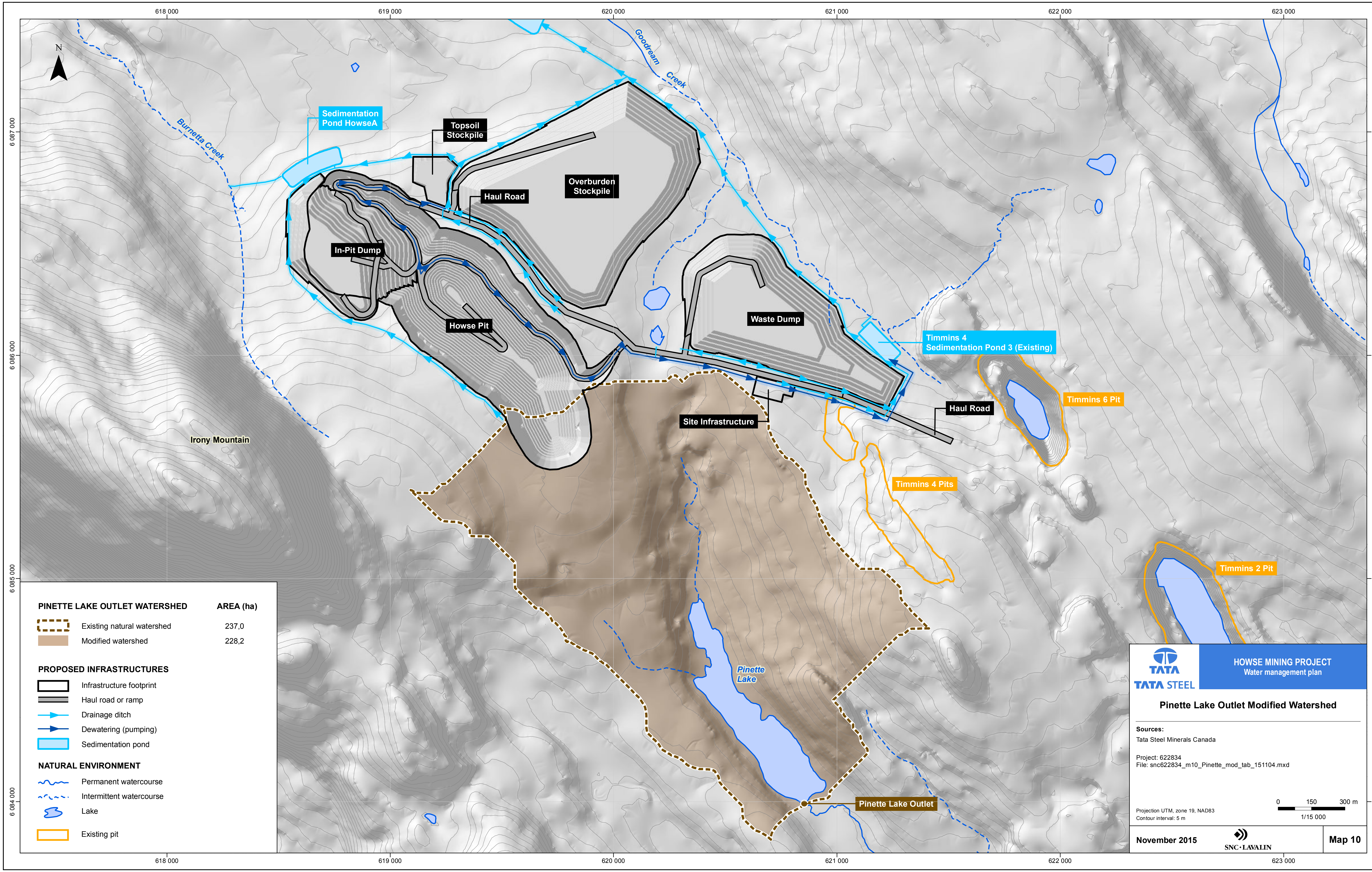


C:\Projets\622834 Howse\interne\diffusion\produit\note_technique_2015\snc622834_m7_Burnetta_tab_151104.mxd

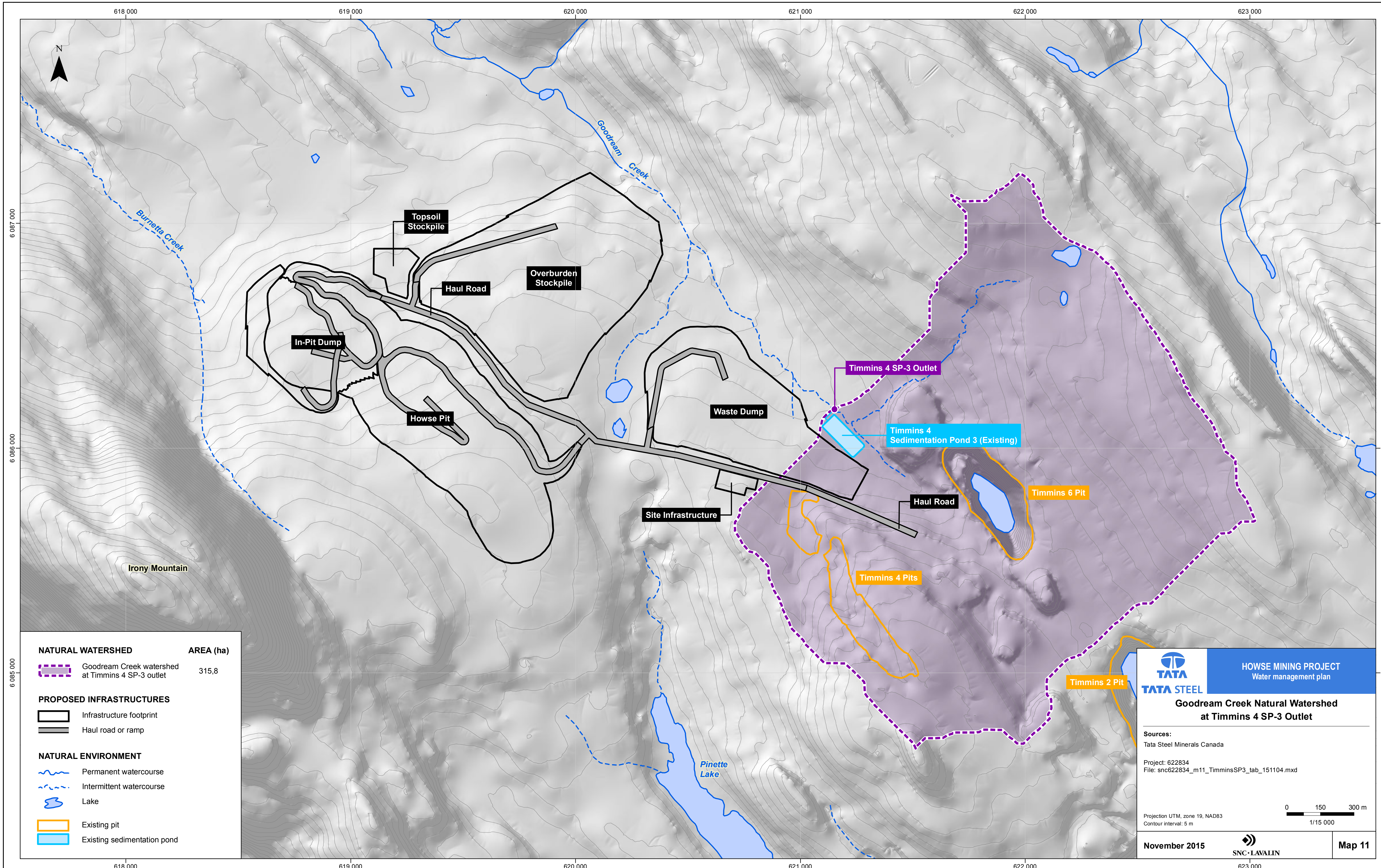

617 000
618 000
619 000
620 000
621 000
622 000
6 088 000
6 087 000
6 086 000
6 085 000
N
Sedimentation Pond HowseB
Goodream Creek
Burnetta Creek
Sedimentation Pond HowseA
Topsoil Stockpile
Overburden Stockpile
Haul Road
Junction with HowseA Outlet
In-Pit Dump
Howse Pit
Waste Dump
Timmins 4 Sedimentation Pond 3 (Existing)
Timmins 6 Pit
Haul Road
Site Infrastructure
Irony Mountain
Timmins 4 Pits
Pinette Lake
BURNETTA CREEK WATERSHED AT JUNCTION WITH HOWSEA OUTLET
AREA (ha)
Existing natural watershed 83,0
Modified watershed 142,6
PROPOSED INFRASTRUCTURES
Infrastructure footprint
Haul road or ramp
Drainage ditch
Dewatering (pumping)
Sedimentation pond
NATURAL ENVIRONMENT
Permanent watercourse
Intermittent watercourse
Lake
Existing pit
TATA
TATA STEEL
HOWSE MINING PROJECT
Water management plan
Burnetta Creek Modified Watershed at Junction with HowseA Outlet
Sources:
Tata Steel Minerals Canada
Project: 622834
File: snc622834_m8_Burnetta_mod_tab_151104.mxd
Projection UTM, zone 19, NAD83
Contour interval: 5 m
0 150 300 m
1/15 000
November 2015
SNC·LAVALIN
Map 8



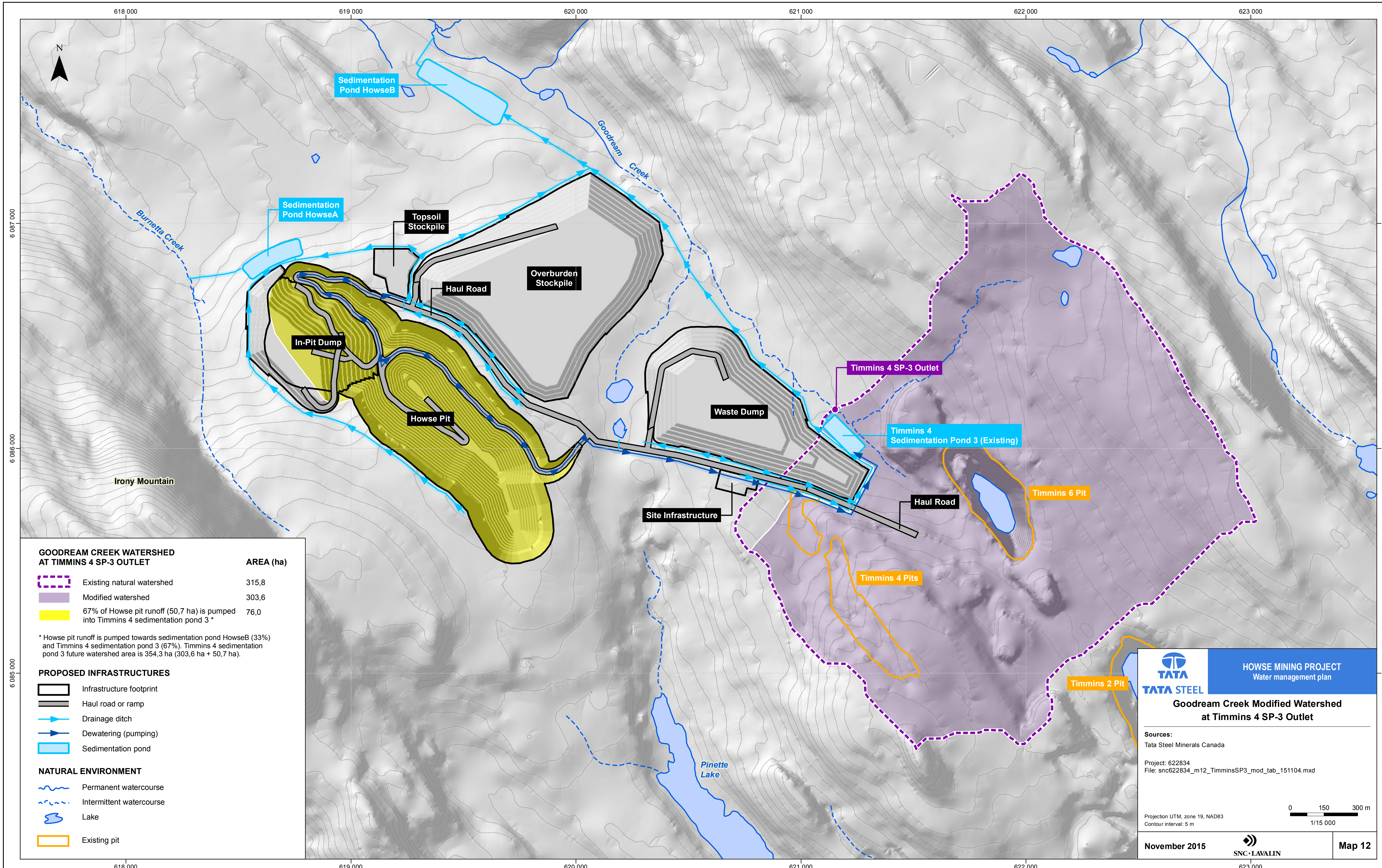
C:\Projets\622834 Howse\interne\diffusion\produit\note_technique_2015\snc622834_m9_Pinette_tab_151104.mxd



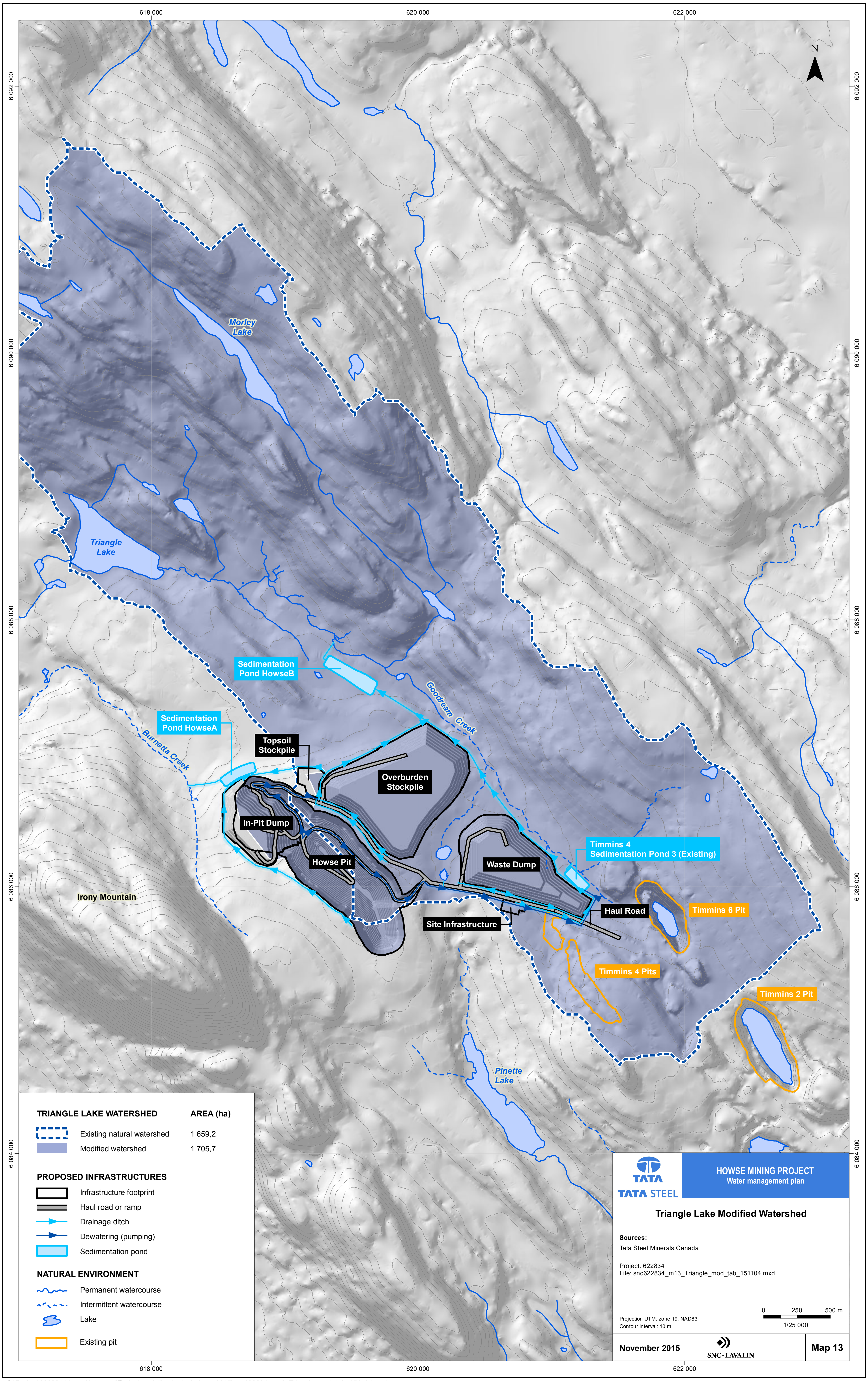
C:\Projets\622834 Howse\interne\diffusion\produit\note_technique_2015\snc622834_m10_Pinette_mod_tab_151104.mxd



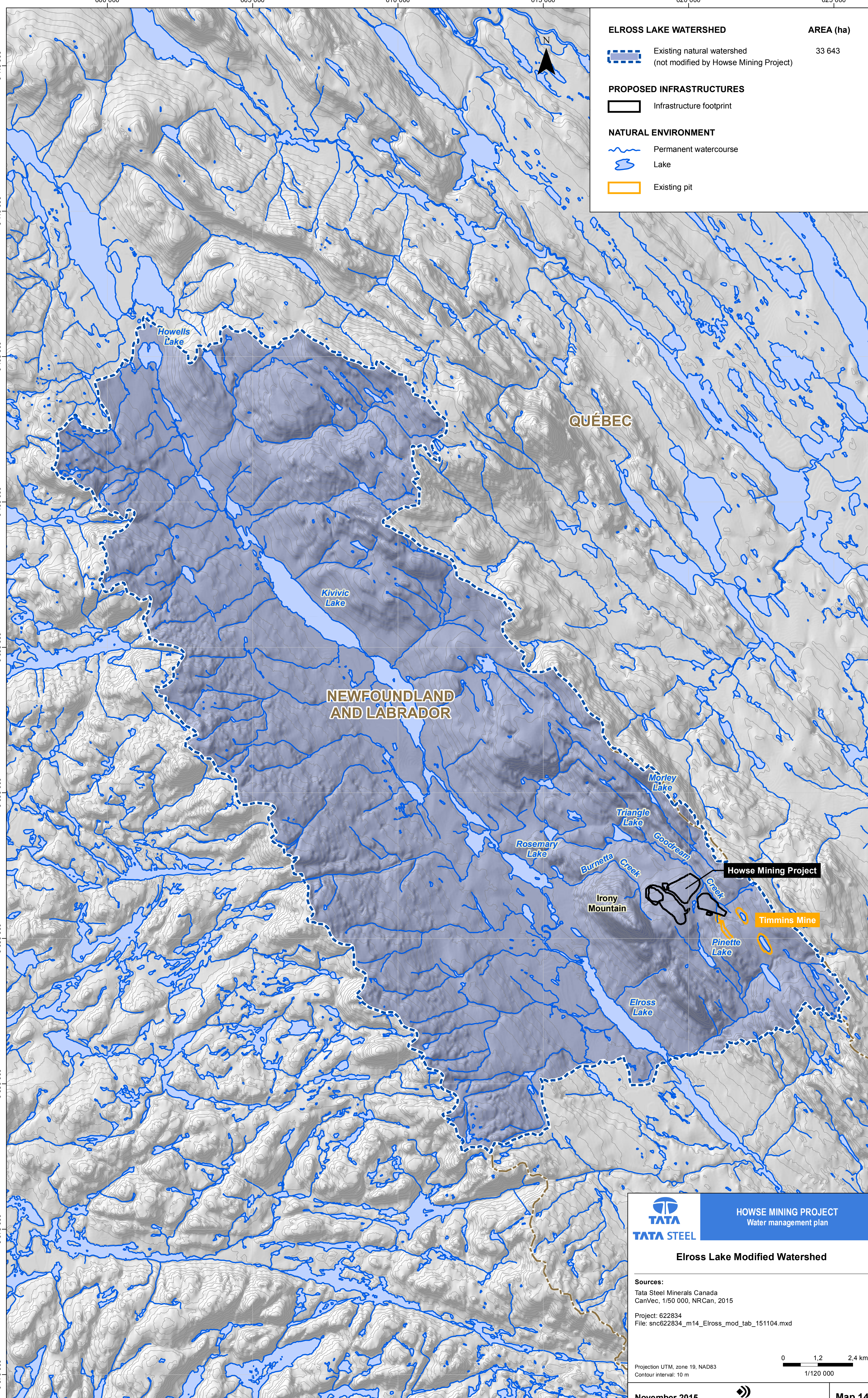
C:\Projets\622834 Howse\interne\diffusion\produit\note_technique_2015\snc622834_m11_TimminsSP3_tab_151104.mxd



C:\Projets\622834 Howse\interne\diffusion\produit\note_technique_2015\snc622834_m12_TimminsSP3_mod_tab_151104.mxd



C:\Projets\622834 Howse\interne\diffusion\produit\note_technique_2015\snc622834_m13_Triangle_mod_tab_151104.mxd



HOWSE MINING PROJECT
Water management plan

TATA STEEL

Elross Lake Modified Watershed

Sources:
Tata Steel Minerals Canada
CanVec, 1/50 000, NRCan, 2015

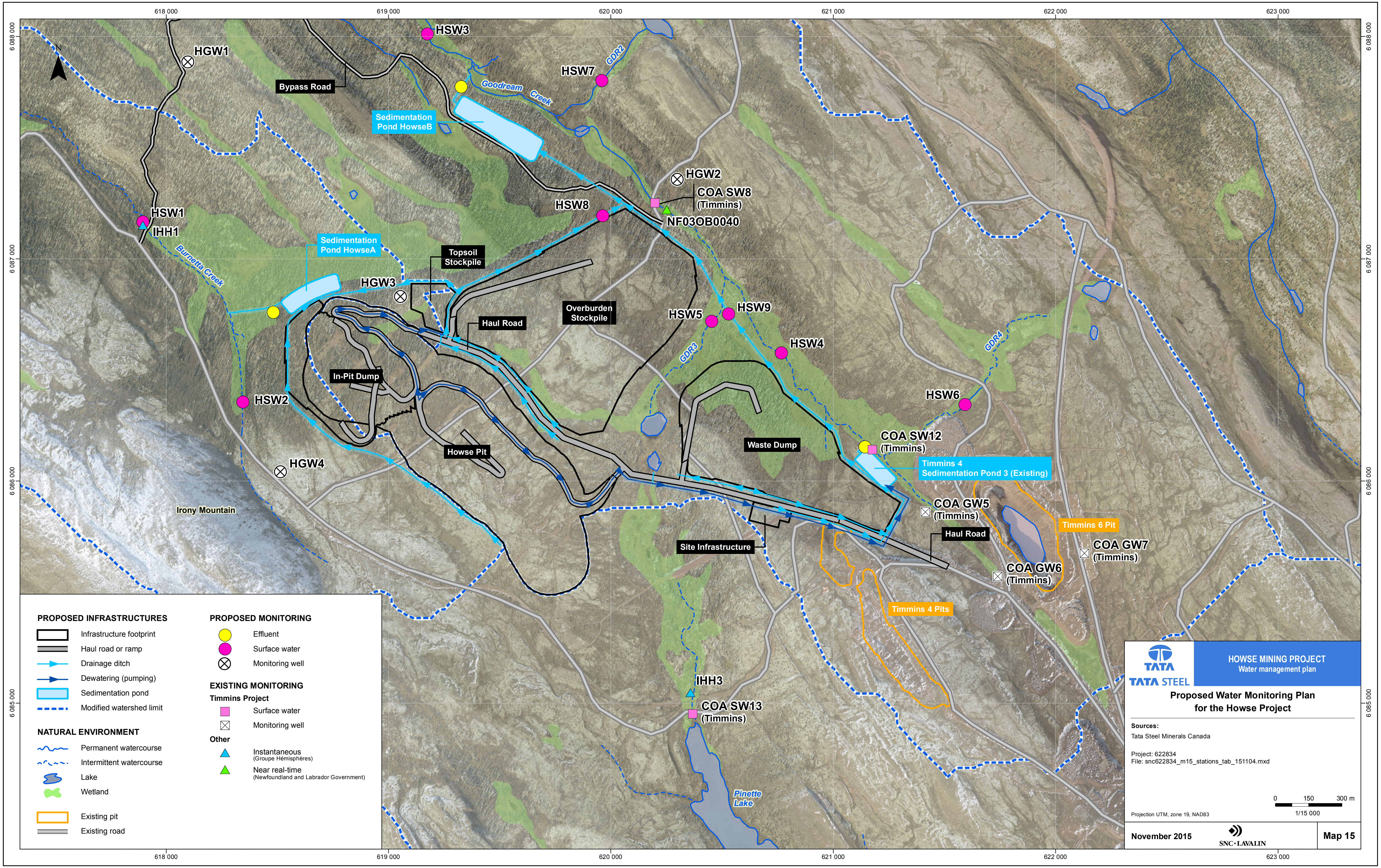
Project: 622834
File: snc622834_m14_Elross_mod_tab_151104.mxd

Projection UTM, zone 19, NAD83
Contour interval: 10 m

0 1,2 2,4 km
1/120 000

November 2015 SNC·LAVALIN **Map 14**

C:\Projets\622834 Howse\interne\diffusion\produit\note_technique_2015\snc622834_m14_Elross_mod_tab_151104.mxd



C:\Projets\622834 Howse\interne\diffusion\produit\note_technique_2015\snc622834_m15_stations_tab_151104.mxd

NOT FOR CONSTRUCTION

NOTE: LOCATION OF TIMMINS-4 SEDIMENTATION POND 3 IS APPROXIMATIVE

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No
6	03	2015/11/05	NEW SITE INFRASTRUCTURE LOCATION	
5	02	2015/09/28	ISSUED WITH REPORT V02	
4	01	2015/07/27	NEW LAYOUT	
3	00	2014/12/11	ISSUED FOR IMPACT STUDY	
2	PB	2014/11/14	ISSUED FOR CLIENT REVIEW	
1	PA	2014/11/06	ISSUED FOR INTERNAL REVIEW	

ISSUE REGISTER

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No

ISSUE REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REFERENCE DRAWINGS NUMBER
01	AU-2013-028-501-MN-REVD (OPTION 3, DEC.5, 2013)

PROFESSIONAL SEAL

SNC·LAVALIN

Sustainable Mine Development
Global Mining & Metallurgy
SNC LAVALIN INC.
455, Boul. René-Lévesque Ouest
Montreal (Quebec)
Canada H2Z 1Z3

PREPARATION	APPROVAL
DESIGNED: P. Scholz	PROJECT DISCIPLINE ENGINEER: L. Didillon
DRAWN: M. Sykes	CLIENT
CHECKED: M.H. Paquette	DATE: 2015-09-28
SCALE: 1 : 7 500	100 0 100 200 300m

CLIENT: HOWSE MINERALS CANADA LIMITED

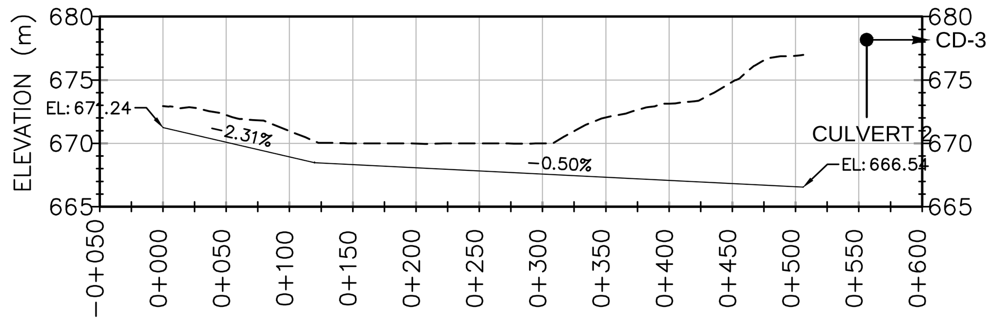
PROJECT: WATER MANAGEMENT PLAN HOWSE PROJECT

TITLE: GENERAL SITE LAYOUT

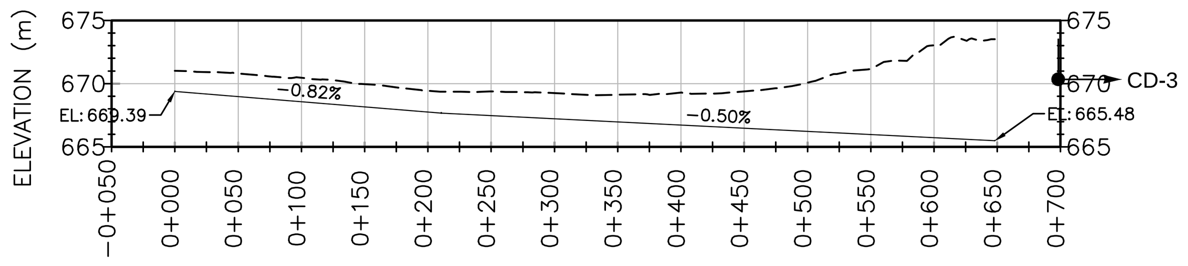
PROJECT No	SUBDIVISION	SUBJECT		SERIAL	REV.
622834	4000	40	DD	0001	03

STDSLIA1HEN – FRAME A1 HORIZONTAL ENGLISH

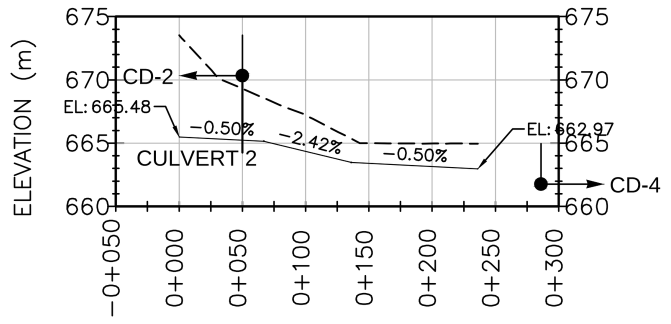
LAST SAVE: 2015/11/05 – 1:36pm
PATH: Z:\622834\40\03\622834-4000-40DD-0001 o 0003_03.dwg



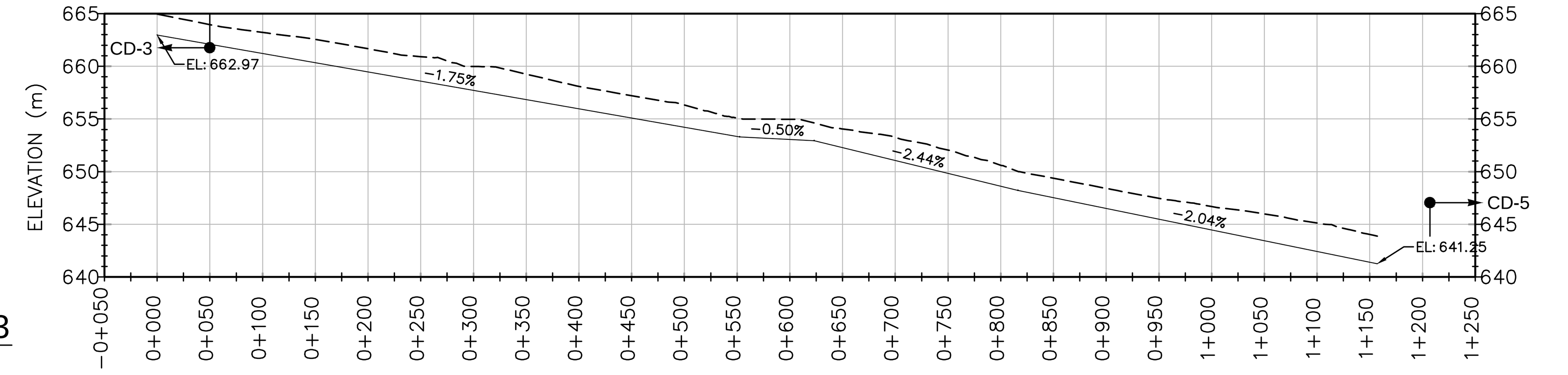
LONGITUDINAL PROFILE - DITCH CD-1
SCALE: H: 1:5000
V: 1:500



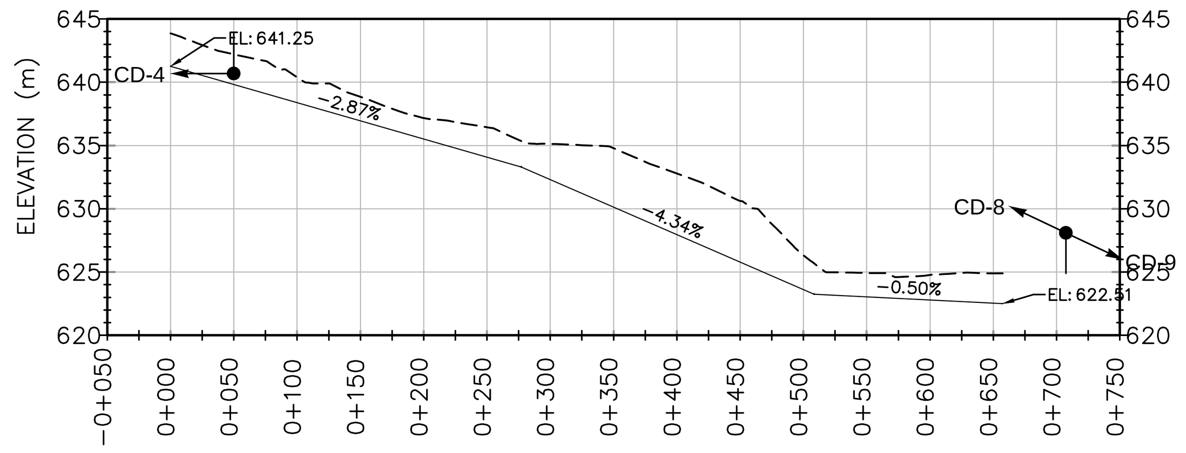
LONGITUDINAL PROFILE - DITCH CD-2
SCALE: H: 1:5000
V: 1:500



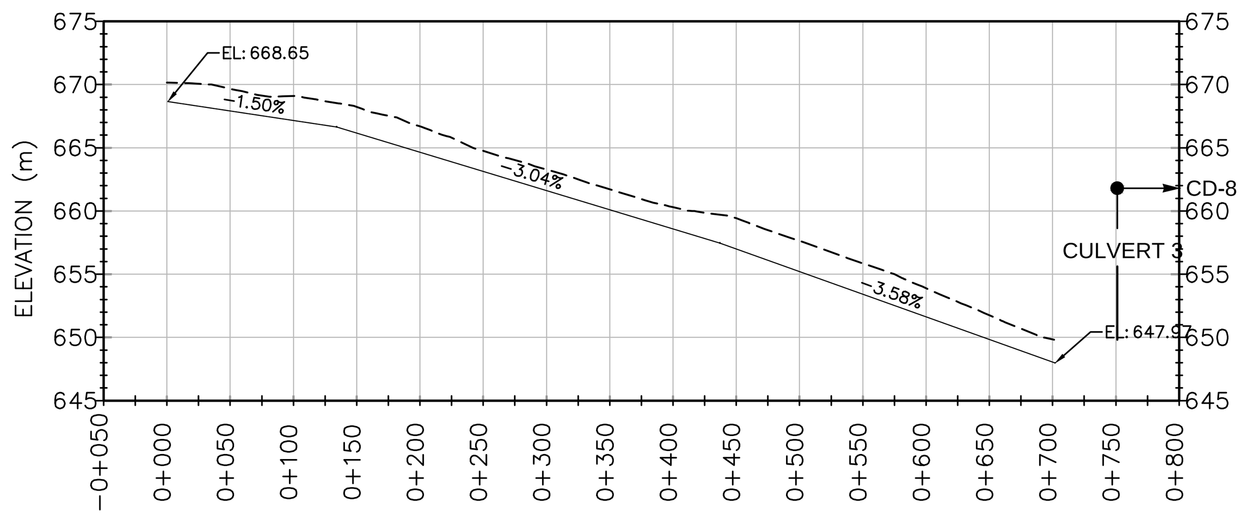
LONGITUDINAL PROFILE - DITCH CD-3
SCALE: H: 1:5000
V: 1:500



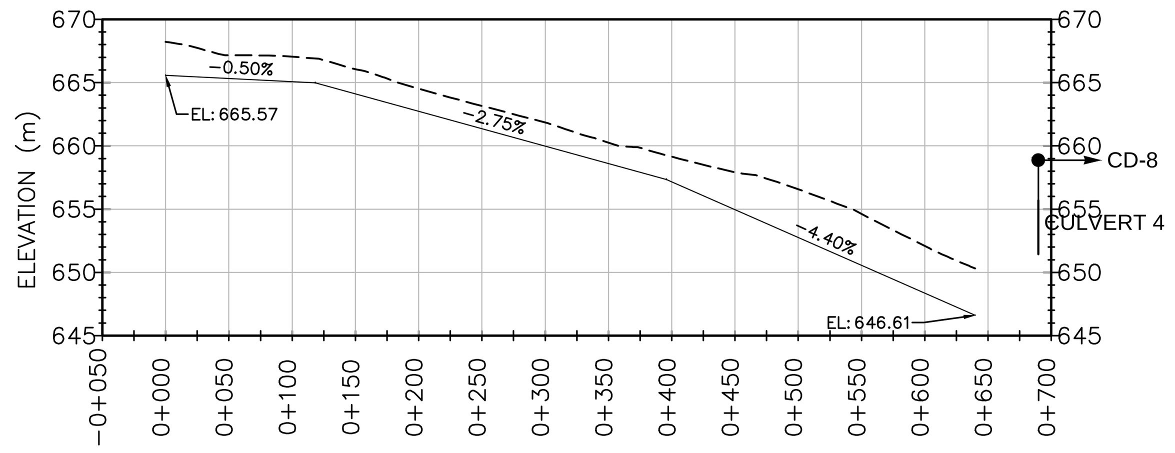
LONGITUDINAL PROFILE - DITCH CD-4
SCALE: H: 1:5000
V: 1:500



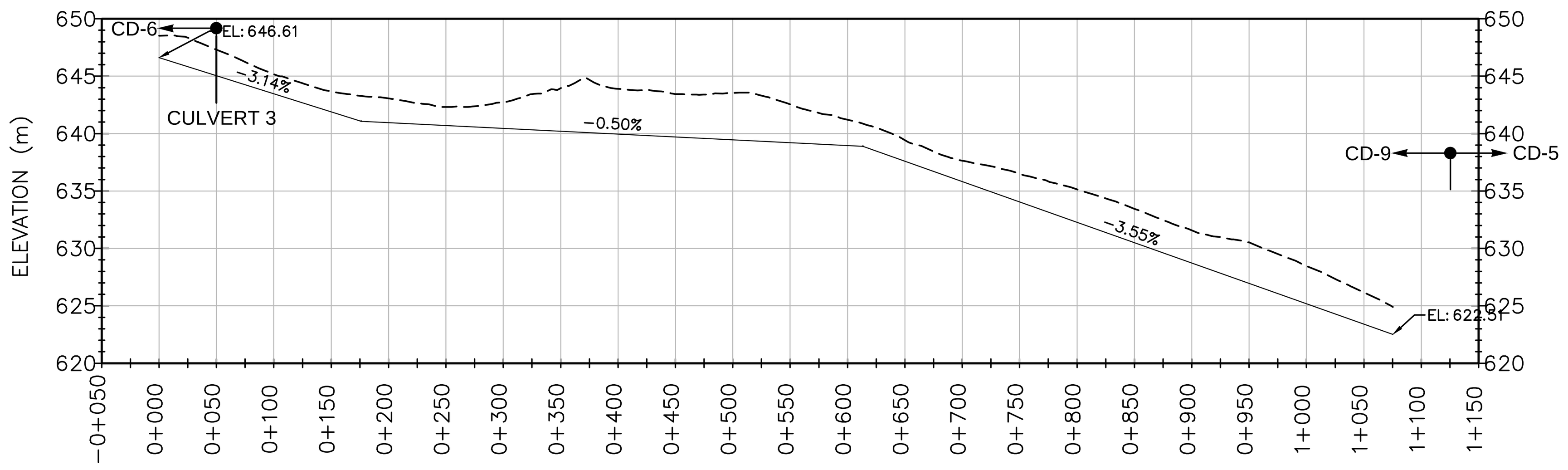
LONGITUDINAL PROFILE - DITCH CD-5
SCALE: H: 1:5000
V: 1:500



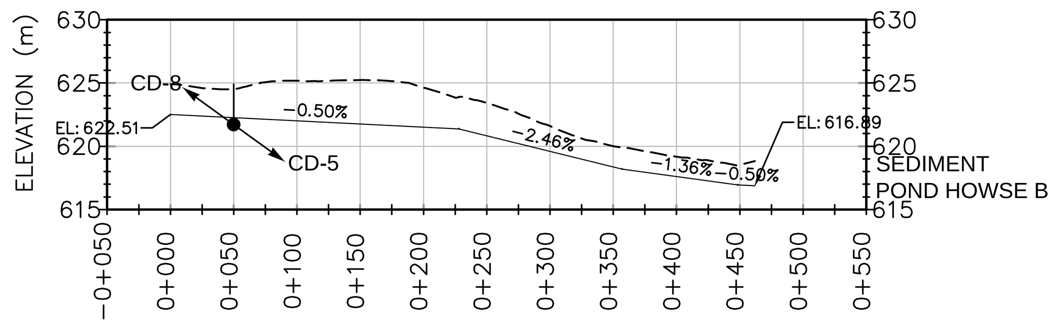
LONGITUDINAL PROFILE - DITCH CD-6
SCALE: H: 1:5000
V: 1:500



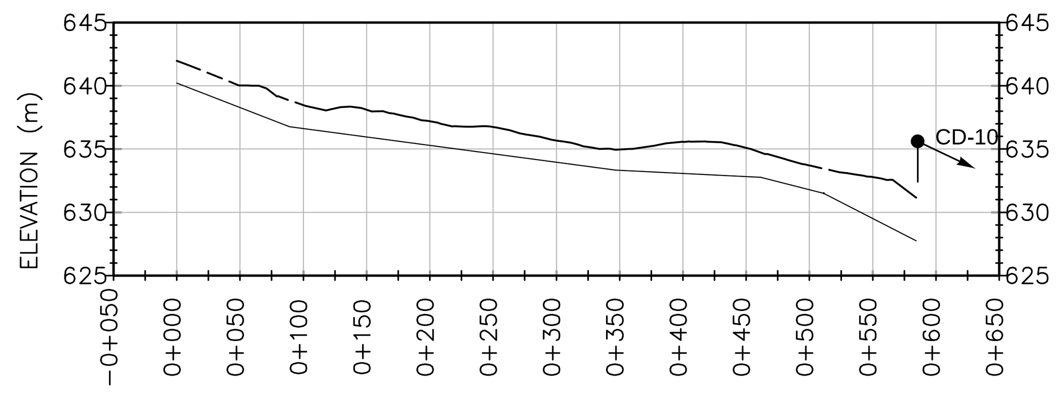
LONGITUDINAL PROFILE - DITCH CD-7
SCALE: H: 1:5000
V: 1:500



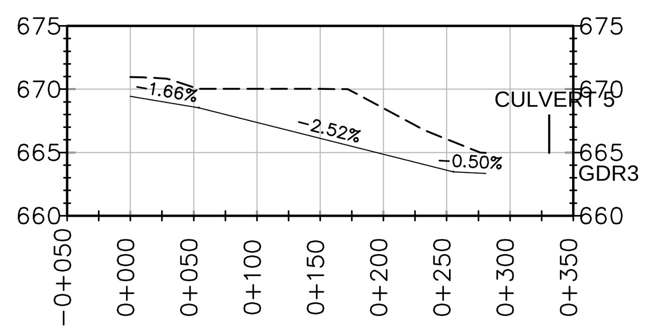
LONGITUDINAL PROFILE - DITCH CD-8
SCALE: H: 1:5000
V: 1:500



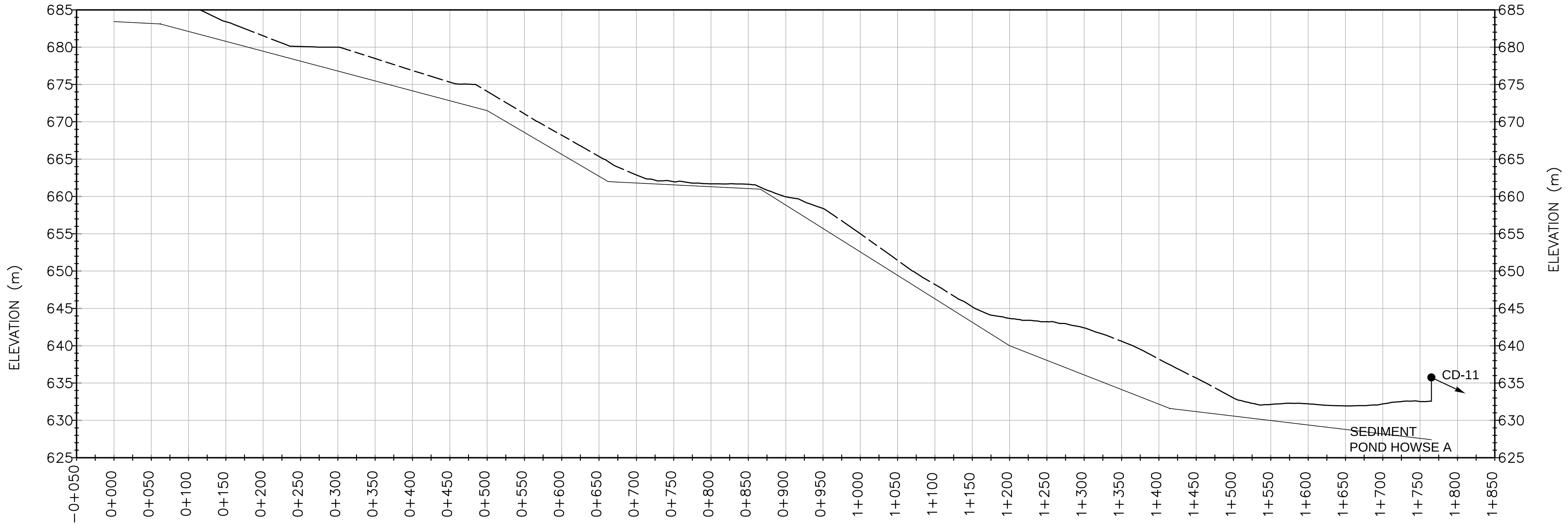
LONGITUDINAL PROFILE - DITCH CD-9
SCALE: H: 1:5000
V: 1:500



LONGITUDINAL PROFILE - DITCH CD-11
SCALE: H: 1:5000
V: 1:500



LONGITUDINAL PROFILE - DITCH CD-12
SCALE: H: 1:5000
V: 1:500



LONGITUDINAL PROFILE - DITCH CD-10
SCALE: H: 1:5000
V: 1:500

NOTE: DITCHES WILL BE PROTECTED AGAINST EROSION.

LEGEND

- - - - NATURAL GROUND
—— DITCH INVERT

NOT FOR CONSTRUCTION

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No
5	02	2015/09/28	ISSUED WITH REPORT V02	
4	01	2015/07/27	NEW LAYOUT	
3	00	2014/12/11	ISSUED FOR IMPACT STUDY	
2	PB	2014/11/14	ISSUED FOR CLIENT REVIEW	
1	PA	2014/11/06	ISSUED FOR INTERNAL REVIEW	

ISSUE REGISTER | ISSUE REGISTER | REVISION REGISTER | REVISION REGISTER | No | REFERENCE DRAWINGS NUMBER

PROFESSIONAL SEAL

SNC·LAVALIN
Sustainable Mine Development
Global Mining & Metallurgy
SNC LAVALIN INC.
455, Boul. René-Lévesque Ouest
Montreal (Quebec)
Canada H2Z 1Z3

PREPARATION	APPROVAL
DESIGNED: P. Scholz	PROJECT DISCIPLINE ENGINEER: L. Didillon
DRAWN: M. Sykes	CLIENT
CHECKED: M.H. Paquette	DATE: 2015-07-27
SCALE: 1 : 5 000	50 0 50 100 150 200m

CLIENT: HOUSE MINERALS CANADA LIMITED

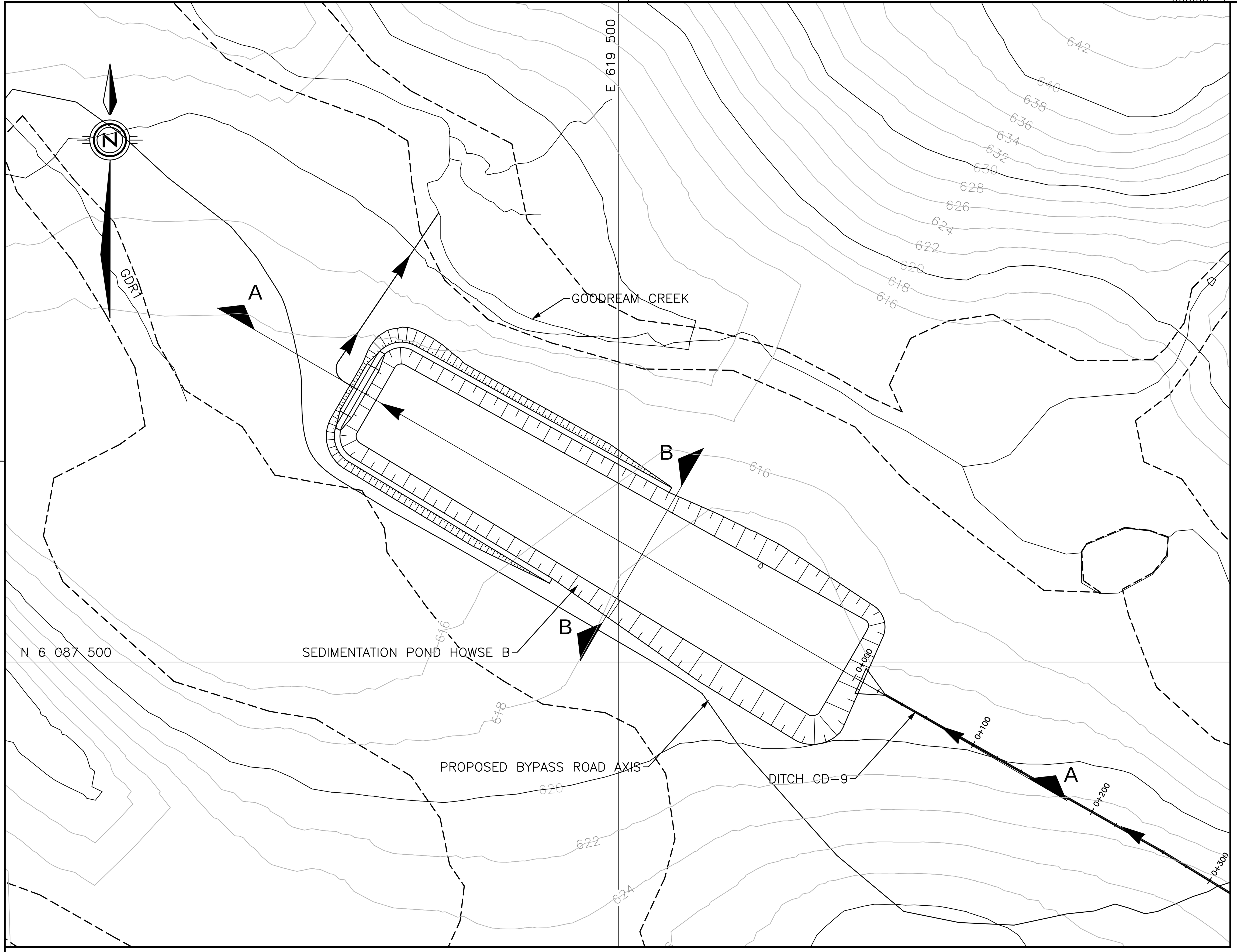
PROJECT: WATER MANAGEMENT PLAN HOWSE PROJECT

TITLE: DRAINAGE DITCHES LONGITUDINAL PROFILES (1/2)

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
622834	4000	40 DD	0002	02

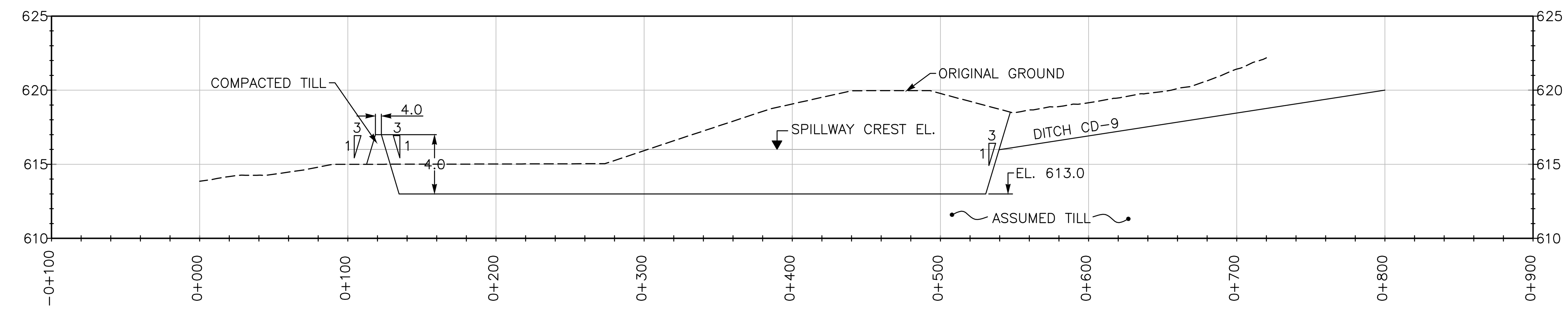
STDSLIA1HEN – FRAME A1 HORIZONTAL ENGLISH

LAST SAVE: 2015/10/16 – 3:11pm
PATH: Z:\622834\40_02\622834-4000-40DD-0001 a 0003_03.dwg



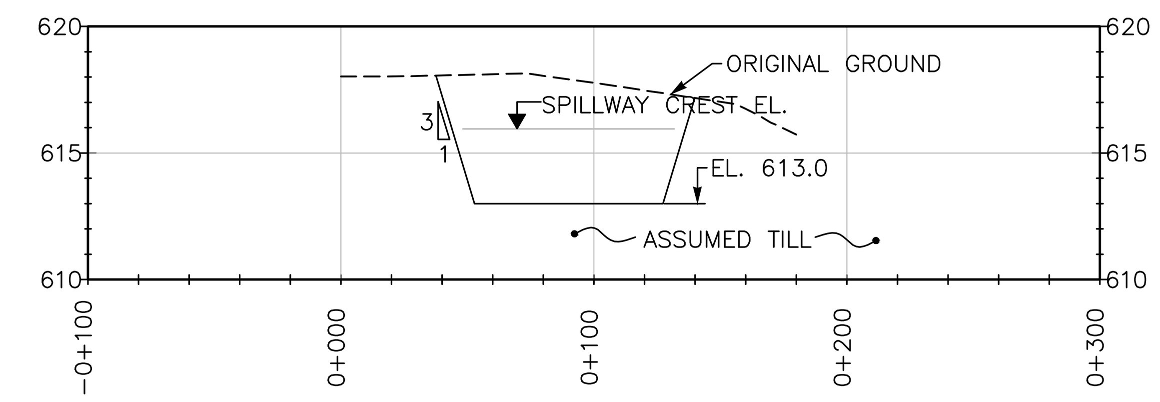
LEGEND

- PROPOSED DITCH
- WETLAND
- WATER COURSE
- CD-1 DITCH NUMBER



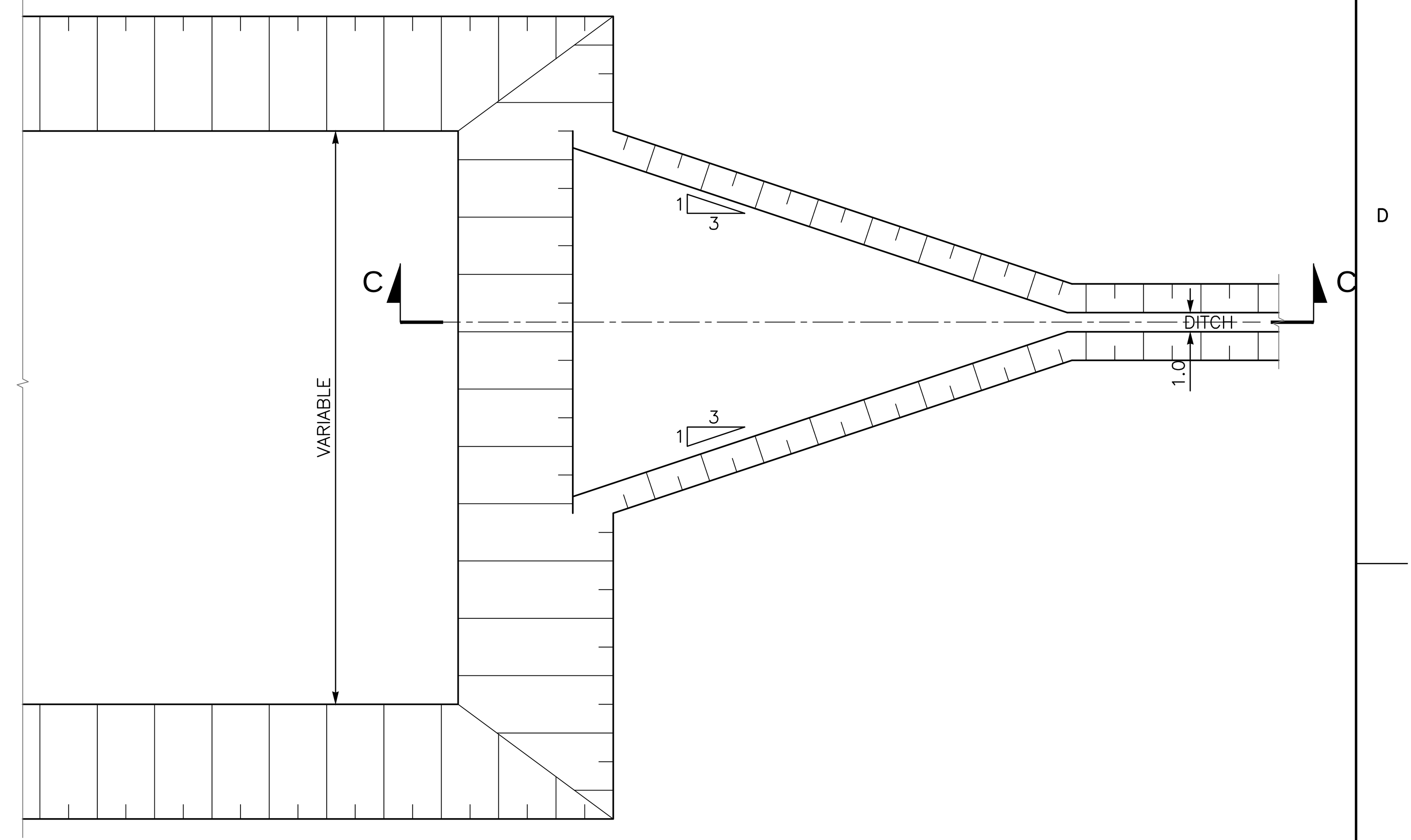
SECTION A-A - SEDIMENTATION POND HOWSE B

SCALE: H: 1:2500
V: 1:250



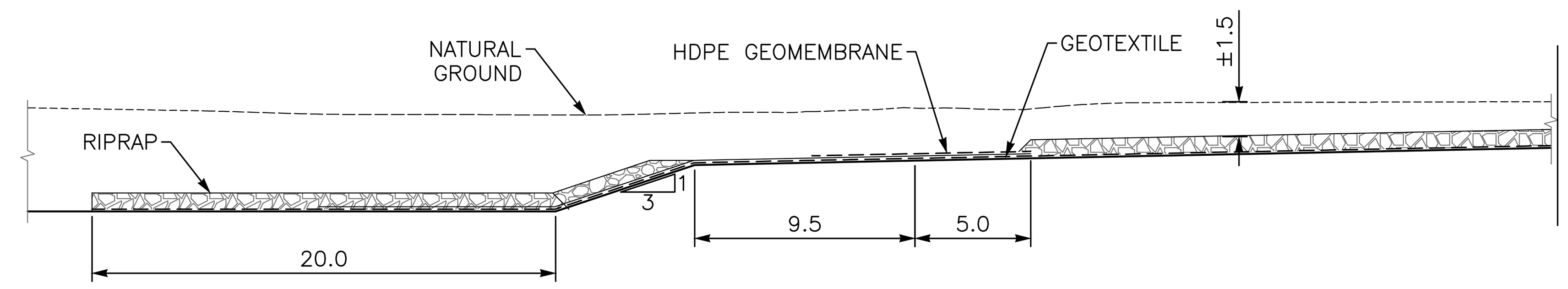
SECTION B-B - SEDIMENTATION POND HOWSE B

SCALE: H: 1:2500
V: 1:250



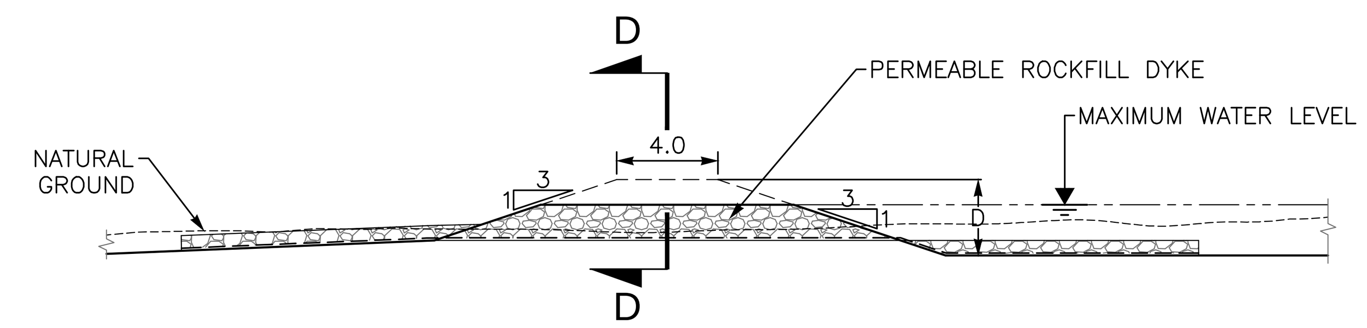
TYPICAL POND ENTRANCE DETAIL

SCALE 1:250



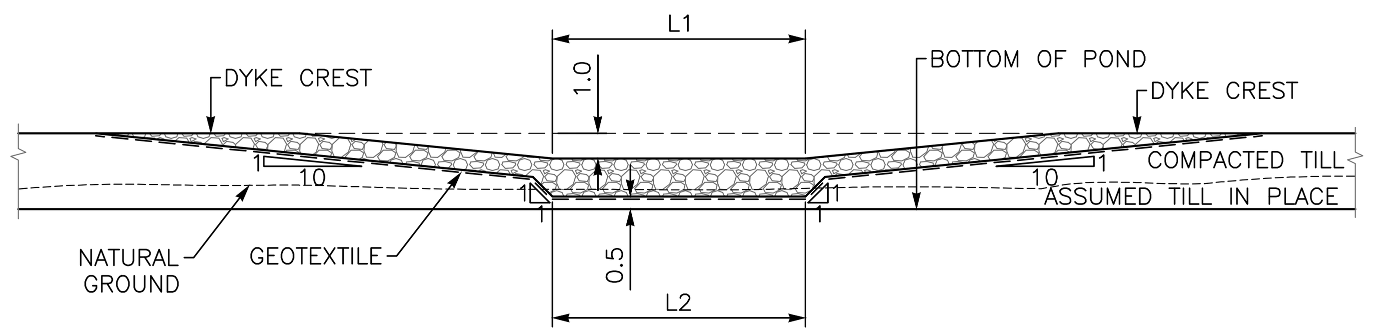
SECTION C-C

SCALE 1:250



TYPICAL SECTION PERMEABLE ROCKFILL DYKE AND EMERGENCY SPILLWAY

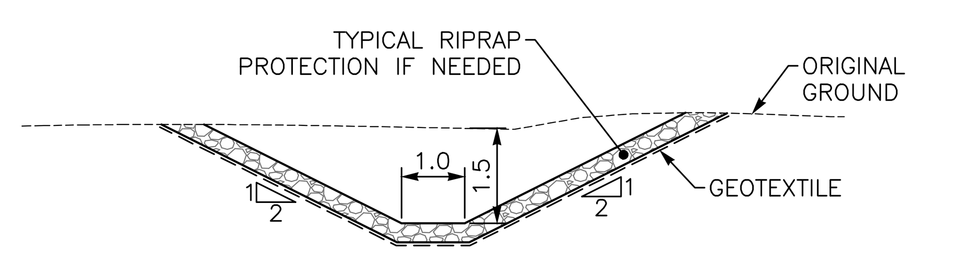
SCALE 1:250



SECTION D-D

SCALE 1:250

	L1 (m)	L2 (m)	D (m)
POND HOWSE A	20	10	3.5
POND HOWSE B	40	10	4.0
TIMMINS 4 POND 3	15	30	4.0



TYPICAL DITCH SECTION (NOTE 2)

SCALE 1:100

NOTE:

1. THE SUITABILITY OF THE EXCAVATED TILL TO BE USED FOR DYKE CONSTRUCTION WILL BE CONFIRMED IN THE NEXT PHASE OF ENGINEERING.
2. EXCEPT CD-9 (3.0m BOTTOM BASE WIDTH)

NOT FOR CONSTRUCTION

ISSUE REGISTER

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No
5	02	2015/09/28	ISSUED WITH REPORT V02	
4	01	2015/07/27	NEW LAYOUT	
3	00	2014/12/11	ISSUED FOR IMPACT STUDY	
2	PB	2014/11/14	ISSUED FOR CLIENT COMMENTS	
1	PA	2014/11/06	ISSUED FOR INTERNAL REVIEW	

REVISION REGISTER

INITIALS: * DESIGNED ** APPROVED

REFERENCE DRAWINGS NUMBER

No	REFERENCE DRAWINGS NUMBER
01	AU-2013-028-501-MN-REVD (OPTION 3, DEC.5, 2013)

PROFESSIONAL SEAL

SNC·LAVALIN

Sustainable Mine Development
Global Mining & Metallurgy
SNC LAVALIN INC.
455, Boul. René-Lévesque Ouest
Montreal (Quebec)
Canada H2Z 1Z3

PREPARATION	APPROVAL
DESIGNED: P. Scholz	PROJECT DISCIPLINE ENGINEER: L. Didillon
DRAWN: M. Sykes	CLIENT
CHECKED: M.H. Paquette	DATE: 2015-09-28
SCALE: 1 : 2 500	20 0 20 40 60 80 100m

CLIENT

HOWSE MINERALS CANADA LIMITED

PROJECT

WATER MANAGEMENT PLAN
HOWSE PROJECT

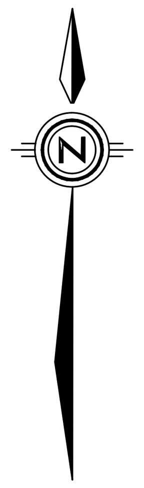
TITLE

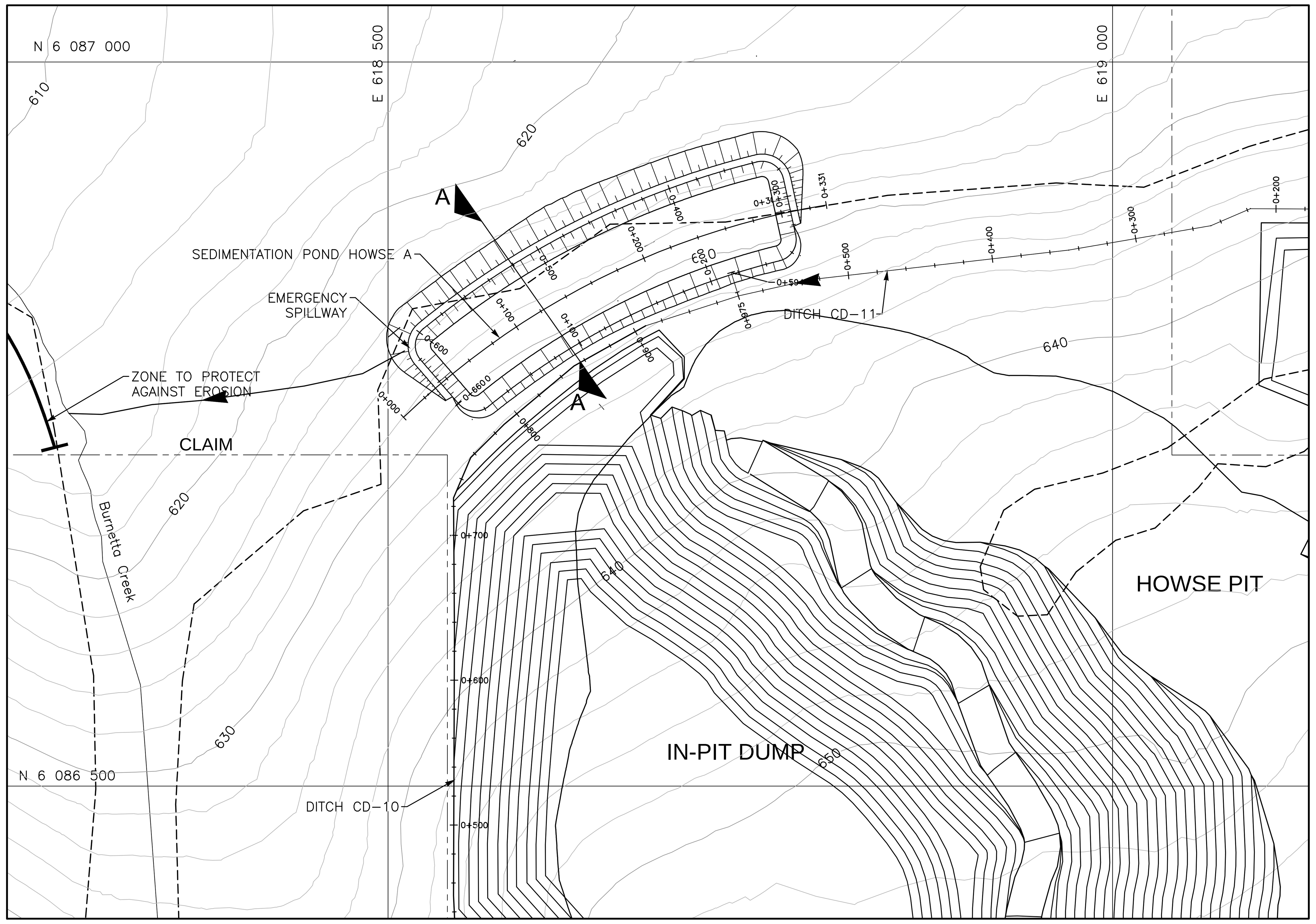
SEDIMENTATION POND HOWSE B, TYPICAL INLET AND OUTLET SECTIONS AND DETAILS

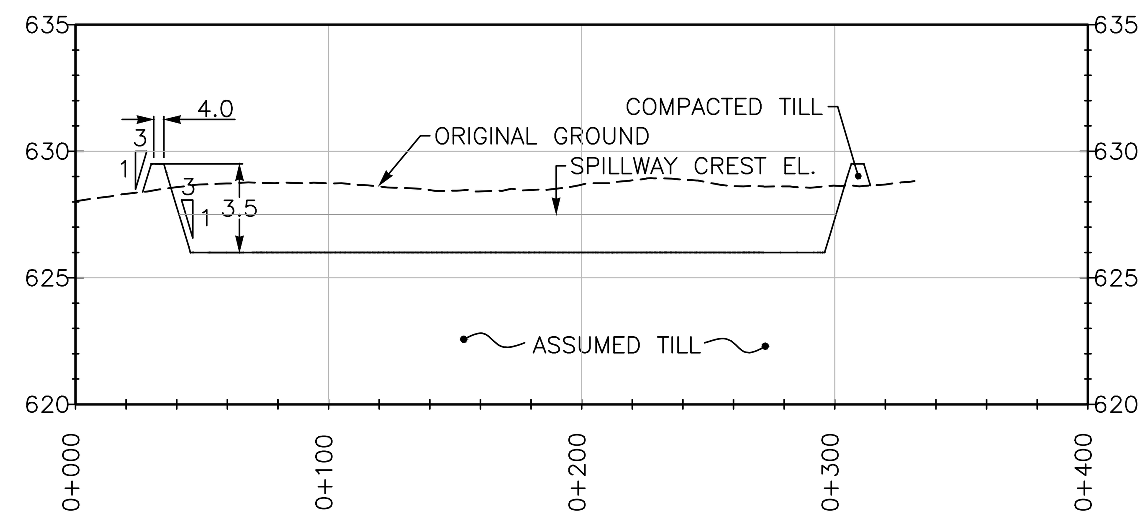
PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
622834	4000	40 DD	0005	02

STDSLIA1HEN - FRAME A1 HORIZONTAL ENGLISH

LAST SAVE: 2015/10/16 - 3:07pm
PATH: Z:\622834\40\02\622834-4000-40D0-0005-02.dwg

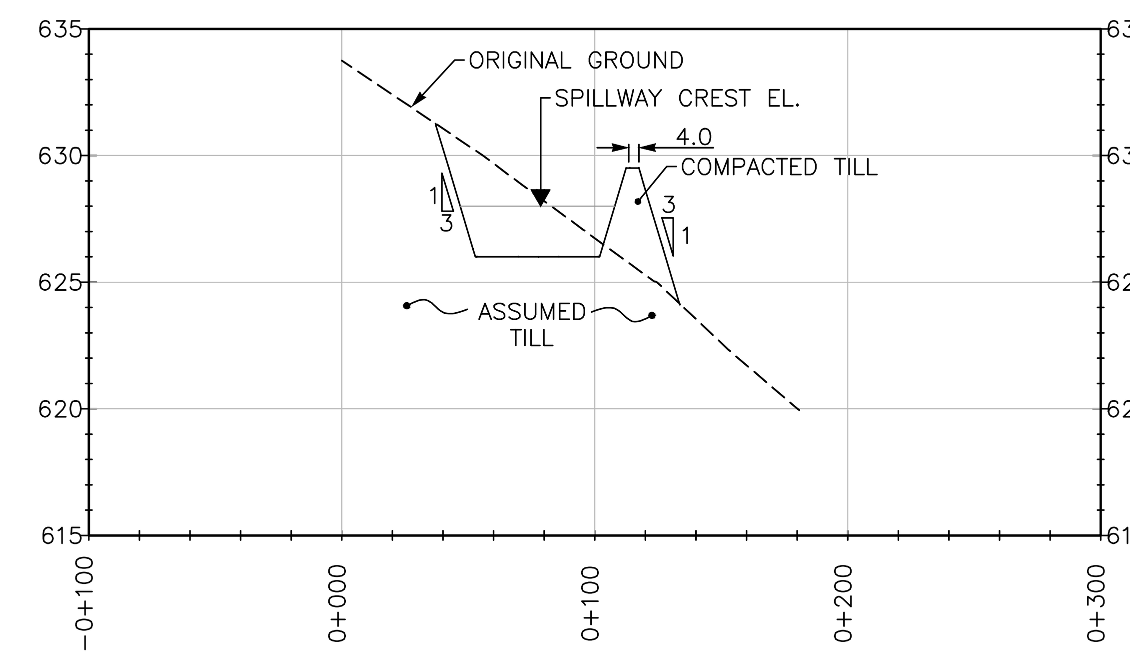






LONGITUDINAL PROFILE - SEDIMENTATION POND HOWSE A

SCALE: H: 1:2500
V: 1:250



SECTION A-A - SEDIMENTATION POND HOWSE A

SCALE: H: 1:2500
V: 1:250

LEGEND

- CLAIM
- PROPOSED DITCH
- WETLAND
- WATER COURSE
- CD-1 DITCH NUMBER

NOTE:

THE SUITABILITY OF THE EXCAVATED TILL TO BE USED FOR DYKE CONSTRUCTION WILL BE CONFIRMED IN THE NEXT PHASE OF ENGINEERING.

NOT FOR CONSTRUCTION

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No
5	02	2015/09/28	ISSUED WITH REPORT V02	
4	01	2015/07/27	NEW LAYOUT	
3	00	2014/12/11	ISSUED FOR IMPACT STUDY	
2	PB	2014/11/14	ISSUED FOR CLIENT COMMENTS	
1	PA	2014/11/06	ISSUED FOR INTERNAL REVIEW	

ISSUE REGISTER

ISSUE No	REV.	DATE (Y/M/D)	PURPOSE OF ISSUE	TRANSMISSION LETTER No

ISSUE REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REFERENCE DRAWINGS NUMBER
01	AU-2013-028-501-MN-REVD (OPTION 3, DEC.5, 2013)

PROFESSIONAL SEAL

SNC·LAVALIN

Sustainable Mine Development
Global Mining & Metallurgy
SNC LAVALIN INC.
455, Boul. René-Lévesque Ouest
Montreal (Quebec)
Canada H2Z 1Z3

PREPARATION	APPROVAL
DESIGNED: P. Scholz	PROJECT DISCIPLINE ENGINEER: L. Didillon
DRAWN: M. Sykes	CLIENT:
CHECKED: M.H. Paquette	DATE: 2015-09-28
SCALE: 1 : 2 500	20 0 20 40 60 80 100m

CLIENT: HOWSE MINERALS CANADA LIMITED

PROJECT: WATER MANAGEMENT PLAN HOWSE PROJECT

TITLE: SEDIMENTATION PONDS HOWSE A & HOWSE C SECTIONS AND DETAILS

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
622834	4000	40 DD	0006	02

STDSLIA1HEN – FRAME A1 HORIZONTAL ENGLISH

LAST SAVE: 2015/10/16 – 3:10pm
PATH: Z:\622834\40\02\622834-4000-40D0-0006-03.dwg

APPENDIX C

Design Criteria

SNC·LAVALIN	TECHNICAL NOTE Design Criteria	Prepared by: PS, ALN, AP, AB, MHP Reviewed by: MHP		
		Rev.	Date	Page
	622834-4000-40EC-0004	02	October 19th, 2015	i

Title of document: DESIGN CRITERIA

Client: HOWSE MINERALS CANADA LIMITED

Project: WATER MANAGEMENT PLAN – HOWSE PROJECT

<Original signed by>

Prepared by: Patrick Scholz, Eng., M. Eng. (Hydrology)

Anh-Long Nguyen, Eng. (Water Treatment) <Original signed by>

Reviewed by: Marie-Hélène Paquette, Eng. M. Env. <Original signed by>

Approved by: (Client) Loic Didillon

REVISION INDEX

Revision				Pages Revised	Remarks
#	Prep.	Rev.	Date		
PA	PS, ALN, AP, AB	--	October 9, 2014	--	Internal Coordination
PB	PS, ALN, AP, AB	MHP	October 10, 2014	All	Issued for Comments
00	PS, ALN, AP, AB	MHP	November 24, 2014	Tables 7-1, 7-2, 7-3	Issued for Design
01	PS	MHP	August 24th 2015	All	New Layout
02	PS	MHP	October 19th, 2015	All	New Layout

NOTICE TO READER

TABLE OF CONTENTS

LIST OF TABLES

1.0 INTRODUCTION

1.1 Context

Howse Minerals Canada Ltd (HML) plans to mine iron ore within the Howse deposit (Direct-Shipping Ore Howse Property Project) located near the border between the provinces of Quebec and Newfoundland and Labrador, approximately 25 km north of the community of Schefferville, Quebec. One open pit is planned and the anticipated mining period is from 2016 to 2024. Two waste dumps, one overburden stockpile and one topsoil stockpile are also planned for the site. No tailings will be generated in this area since the majority of the ore will only be crushed and screened on-site, with the ore then being directly shipped for secondary processing.

The Water Management Plan of the Howse property will include the design of sedimentation ponds and ditches. The location and purpose of the sedimentation ponds and ditches has already been roughly defined in the Project Registration / Project Description for the DSO-Howse Property Project. The water management plan will confirm those assumptions and the design of the water management infrastructures will be carried out to a conceptual level. Planned water management infrastructures are the following:

- Contact water will be collected by ditches leading to sedimentation ponds HOWSEA and HOWSEB.
- Water from dewatering and surface runoff into the Howse pit will be diverted, if possible, to the existing Timmins 4-sedimentation pond 3. This assumption will be confirmed in this study.

An environmental monitoring program will also be developed to assess the quality of surface water and groundwater around the Howse property.

1.2 Content

This document presents the design criteria that will be used in the design of the ditches and sedimentation ponds on the Howse property. The source of data used for this mandate will first be presented. Criteria concerning infrastructure location will then be presented, followed by criteria for the design of the ditches and sedimentation ponds for the following disciplines: geotechnical engineering, hydrogeology, hydrology and water treatment. Finally, criteria used to establish the environmental monitoring program will be presented.

The relevant regulations are also presented in each section.

2.0 SOURCE DATA

The following table summarizes the available data used to complete the water management plan.

Table 2-1 : Source Data

Document Name	Provided by	Content	Used for:
Howse DSO Deposit - Project Notice – Mine Site General Layout Howse Mine Site Layout (July 8).dxf	Tata Steel	Location of Howse pit, overburden stockpile, waste rock dump, site infrastructure, in-pit dump, topsoil stockpile	Location of infrastructures
Topographic map	Tata Steel	Topograhpic map, isocontours 5 m	Location of infrastructures
Groupe Hémisphères (March / April 2014) Project Registration / Project Description for the DSA – Howse Property Project. Submitted to Howse Minerals Limited, 223 pp and 4 appendices.	Tata Steel	Section 3.0 Description of the Physical Environment Section 7.0 Potential Environmental Effects and Their Management	Hydrological, hydrogeological, water treatment and geotechnical evaluations
Environment Canada Schefferville A Meteorological Station Data	Environment Canada	Meteorological data	Hydrological calculation
DSO-Timmins Project – Design Criteria Drainage_Design Brief Document no. DSOT-DC-4310-CI-0001 rev A	Tata Steel	Timmins 4 Sedimentation pond-3 design basis	Hydrological calculation
DSO-Timmins Project – Hydrology – Drainage – Flow Measurement – General Location Drawing no. DSOT-DW-4310-CI-0001 rev G	Tata Steel	Delineation of the watershed for the Timmins project and Timmins 4 Sedimentation pond-3	Hydrological calculation
Real Time Water Quality Monitoring Stations Web: http://www.env.gov.nl.ca/env/waterres/rti/stations.html	Newfoundland Labrador Department of Environment and Conservation	Real time water quality data for: - Goodream Creak, 2 km northwest of Timmins 6 (NF03OB0040)	Water treatment
DSO-Timmins Project – Water Monitoring Stations Drawing no. GIS-ML-19-03, 2012-12-10	Tata Steel	Actual monitoring stations for Timmins Project	Monitoring
Stratigraphic Information on Howse Property Drawing no. GIS-EXP-HOWSE-Geofor-01	Tata Steel	Bedrock groundwater level and nature of overburden	Geotechnical and Hydrogeological evaluations

Document Name	Provided by	Content	Used for:
			Water treatment
Howse Pit Hydrogeological Investigation – Summary of Factual Data in Support of Environmental Impact Assessment Process Document no. 011-13-1221-0104 MTA rev A	Geofor	Packer tests results on two boreholes and piezometric levels results in few existing boreholes	Hydrogeological evaluations
Open Pit Mine Dewatering – Knob Lake. The Canadian Institute of Mining and Metallurgy Bulletin, 58:814-822.	Public	Historical information on mine dewatering of DSO (Knob Lake)	Hydrogeological evaluations
Hydrological and hydrogeological study: survey season 2009, DSOP. Final technical report. March 2010	Groupe Hémisphères	Results of Timmins 3 pit dewatering simulations	Hydrogeological evaluations

3.0 LOCATION OF WATER MANAGEMENT INFRASTRUCTURES

3.1 Codes, Laws and Regulations

The followings laws and regulations will be used to define the location of infrastructures at the site:

- Water Resource Act, Newfoundland and Labrador, SNL2002 Chapter W-4.01
- Policy for Development in Wetland, Newfoundland and Labrador , W.R. 97-2

3.2 Design Criteria

The location of infrastructures, including water management infrastructures, mining pit, overburden stockpile and waste rock dumps, is governed by regulation, topography, nature of the land and some criteria adopted after consultation between Tata Steel and local stakeholders. The criteria used to define the location of infrastructures at the site are the following:

- A buffer zone of 500 m has to be kept between the infrastructures and Irony Mountain;
- Any alteration of Pinette Lake has to be avoided since it is considered as a sensitive area;
- A 30 m buffer strip has to be kept between infrastructures and water course and wetlands respectively ;
- When possible avoid any infrastructures in wetlands.

4.0 GEOTECHNICAL ENGINEERING

The geotechnical engineering required for the present mandate mainly consists in designing stable ponds and ditches according to latest state-of-the art practices.

4.1 Codes, Laws and Regulations

- Canadian Dam Association (2007, revised 2013), Dam Safety Guidelines.

4.2 Design Criteria

Depending on the topography at the location of the new sedimentation ponds, the ponds can be a totally excavated construction or partly excavated and partly contained with dykes.

If dykes have to be built, the design of the dykes will be determined in compliance with the design criteria presented in the Dam Safety Guidelines published by the Canadian Dam Association (2007). These guidelines present a methodology for dyke classification depending on the potential consequences of dam failure and allowances that take into account for the design for earthquake and flood conditions.

The following table presents the dam classification evaluation for the dykes that could be built as part of the sedimentation ponds.

Table 4-1 : Dam Classification Evaluation for Sedimentation Pond Dykes

Potential Consequences for :	Dam Class	Comments	Reference
Population at Risk	**Low**	There is no temporary or permanent population living downstream any pond.	Dam Safety Guidelines (2007, revised 2013, table 2-1)
Loss of Life	**Significant**	Unspecified. Loss of life can't be put to zero because employees are present on the site.	
Environmental and Cultural Values	**Low**	Only minimal short term loss could affect flora and fauna.	
Economy	**Low**	No infrastructures downstream.	
Summary of Evaluation : Significant			

Based on the evaluation presented in Table 4-2, with a **Significant** dam class, the return period for the design earthquake condition and design flood condition would be between 1:100 years and 1:1000 years.

Table 4-2 : Design Return Period According to Dam Classification

Dam Class	Return Period for Design Earthquake	Return Period for Design Flood
Low	1/100	1/100
Significant	**Between 1/100 and 1/1000**	**Between 1/100 and 1/1000**
High	1/2475	1/3 between 1/1000 and PMF
Very High	½ between 1/2475 and 1/1000	2/3 between 1/1000 and PMF
Extreme	1/10 000 or MCE	PMF

MCE = Maximum Credible Earthquake

PMF = Probable Maximum Flood

Reference : Table 6-1B, Dam Safety Guidelines (2007, revised 2013)

Design earthquake data are not presented in this study because no stability analysis will be performed at this conceptual level, as there is no information concerning ground stratigraphy at the future pond location.

According to CDA, an emergency spillway must be designed to allow passage of the design flood (see section 6).

Other design criteria concerning the building of ditches and ponds will be determined mainly from state-of-the-art practice and are presented in table 4-3.

Table 4-3 : Geotechnical Design Criteria

Item	Criteria	Note
Minimal ditch slope	0.5%	--
Ditch excavation	Minimize volume of excavation	--
Pond waterproofing	No pond waterproofing necessary	The only issue concerning water quality is total suspended solids (TSS). Refer to Section 7.0 on water treatment.
Factor of Safety for pond slope stability, static condition (downstream slope)	1.5[(*)]	No stability analysis will be carried out for this study since no information concerning ground stratigraphy at the location of the ponds is available. Therefore pond excavation slopes and dyke slopes will be set to 3H:1V for the purpose of this study.
Factor of Safety for pond slope stability, full or partial rapid drawdown (upstream slope)	1.2 – 1.3 [(*)]	
Factor of Safety for pond slope stability, pseudo-static condition	1.0[(*)]	
[(*)] According to Table 6-2 and 6-3, Dam Safety Guidelines (2007, revised 2013)		

5.0 HYDROGEOLOGY

An overview of historical mine dewatering at Knob Lake is given in Stubbins & Munro (1965). Wishart, Gagnon, French and Ruth mines were studied. It was found that dewatering was significantly correlated with pit depth. **Erreur ! Source du renvoi introuvable.** summarizes these results. The range of dewatering rates varied from approximately 16 900 to 86 500 m^3/d for those mines. This wide range of dewatering rates is due to several factors for which data is unavailable. Such factors are pit dimensions, hydraulic conductivities of geological units, fault zones, proximity to water bodies, permafrost, and mining and dewatering operations.

More recently, dewatering simulations were conducted for two mine sites projects: Timmins 3, located about 5 km northeast form Howse deposit, and LabMag, located west from Howse deposit. Obtained dewatering rates (**Erreur ! Source du renvoi introuvable.**) for these two mines are similar to the ones measured at Wishart and Gagnon mines (between 13 000 and 23 000 m^3/d).

Hydraulic conductivities for Howse iron ore units were estimated from pumping tests by Geofor in 2014. Very similar results were obtained for Howse, Timmins 3 and LabMag deposits. Therefore, Howse dewatering rate is expected to be similar to Timmins 3 and LabMag dewatering rates.

Recent groundwater flow modeling results for Howse deposit (SNC-Lavalin, January 2015) confirmed this assumption as a dewatering rate of approximately 14 000 m^3/d was estimated for a base case scenario considering a safety factor of 1.5. However, this flow rate could reach higher values, ranging from approximately 17 700 to 31 000 m^3/d, when considering slightly higher hydraulic conductivities values for the geological units surrounding the pit, and a slightly higher recharge rate. At the time of writing, field work is ongoing to obtain a more precise estimation of Howse dewatering rate.

Consequently, a dewatering rate of 22 000 m^3/d was adopted for the present study. This value is relatively conservative and corresponds to an average value between 14 000 and 31 000 m^3/d.

Howse deposit water table was found to be between 64 and 90 m deep (Geofor, 2015 and Golder, 2014). Dewatering rate is expected to be lower during the first years of mining operations than for the final pit. During the first years of mining operations, dewatering will be limited to water from direct precipitations and infiltration through the unsaturated geological units. Later, when pit depth reaches water table depth, dewatering rate will increase gradually, and reach a maximum value when the pit reaches its final depth. Therefore, there will be no dewatering until the pit reaches a certain depth. Dewatering will be ongoing all year long once the water table depth will be reached.

Table 5-1 : Summary of Hydrogeological Data

Type of Data	Mine Site	Floor Depth (m)	Dewatering (m^3/d)	Data References
Historical data of DSO mines	Wishart	69	16874	Stubbins, J. B. and P. Munro. 1965. Historical information on mine dewatering of DSO (Knob Lake). The Canadian Institute of Mining and Metallurgy Bulletin, 58:814-822.
	Gagnon	83	20412	
	French	116	84370	
	Ruth	144	86547	
Simulation Results on new mines	Timmins 3	80	12960	Groupe Hémisphères, march 2010. Hydrological and hydrogeological study: survey season 2009, DSOP. Final technical report.
	LabMag	150	22262	SNC-Lavalin, in preparation. Hydrogeology and mine pit dewatering modeling - LabMag site. New Millenium Iron – TATA Steel
Assumption	Howse	160	22 000(*)	Geofor, personnal communication, 2015
(*)Average value of the expected possible range				

6.0 HYDROLOGY

The hydrological part of the present mandate mainly consisted of designing a drainage network, made of ditches and sedimentation ponds, performing water balance computations for the Howse property, including the mine pit.

6.1 Codes, Laws and Regulations

- Canadian Dam Association (2007, revised 2013), Dam Safety Guidelines.
- Environmental code of Practice for Metal Mines (Canada)

6.2 Design Criteria

6.2.1 Ditches

The drainage network will be designed for a 100 years return period flood. The hydrograph of the 100 years flood will be derived from available intensity-duration-frequency (IDF) curves from meteorological station Schefferville A, located approximately 24 km from the Howse property.

Ditches peak discharge will be computed using the rational method:

$$Q = \frac{CIA}{360}$$

Where:

Q: Peak discharge [m^3/s].

C: Runoff coefficient [-].

I: Rainfall intensity corresponding to the watershed time of concentration [mm/h].

A: Drainage area [ha].

Ditches will have a trapezoid section and their dimensions will be determined using the manning equation:

$$Q = \frac{1}{n} A R^{2/3} S^{1/2}$$

Where:

Q: Peak discharge [m^3/s].

n: Manning's coefficient [$s/m^{1/3}$].

A: Flow area [m^2].

R: Hydraulic radius [m]. R = A/P, where P is the wetted perimeter [m].

S: Ditch slope [%].

If necessary, ditches will be protected against erosion with a layer of riprap and culverts will be used for road crossings.

6.2.2 Sedimentation ponds

Sedimentation ponds will be designed with a minimum area determined based on a design particle size (see section 7.0 Water Treatment) and a design flood with a 25 years return period.

The sedimentation ponds will have a 0.5 m dead storage at the bottom of the pond for sediment accumulation.

Sedimentation ponds are assumed empty at the end of fall, therefore no important layer of ice is expected during spring freshet. However, a 0.5 m thick layer of ice is assumed for all sedimentation ponds during the spring design flood. Sedimentation pond HOWSEB is an exception because constant pit dewatering will be treated in this pond, and for this reason a 1.0 m thick layer of ice is assumed during the spring design flood.

Part of the dyke at the downstream side of the pond will be built with coarse rock to make it permeable and allow water to flow out of the pond. This solution was selected to minimize the risks of freezing of the outlet structure.

Finally, an emergency spillway will be designed for a design flood determined accordingly to the dyke classification (Table 4-2), as a trapezoidal weir located on the dyke crest.

Average monthly water balance computations will be performed for the whole Howse property in order to evaluate the flow and residence time at each of the sedimentation ponds.

6.2.3 Summary of Hydrological Criteria

The main hydrological design criteria are the following:

- Impacts on existing creeks should be minimized as much as possible;
- The drainage network will be designed for a 100 years return period flood;
- Ditches will be designed using the rational method and Manning equation;
- Sedimentation ponds will be designed for a design particle size (section 7.0) and for a 25 years return period flood;
- Sedimentation ponds will have a 0.5 m dead storage for sediments;
- Sedimentation ponds will have a 0.5 m dead storage (1.0 m for HOWSEB) for ice cover;
- Sedimentation ponds freeboard will be determined based on CDA (2007) guidelines;
- Sedimentation ponds outlet will be located in a permeable dyke able to convey the most critical flood generated by:
  - A summer-fall 24-hours 25 years return period rainfall.
  - A combination of a 24-hours 25 years return period rainfall with the melting of a 25 years return period snowpack.
- Emergency spillways associated with the sedimentation ponds will be constructed as a trapezoidal weir designed to safely pass an inflow design flood determined according to the dam classification previously presented (see table 4.2);
- Even if water could flow out of the sedimentation ponds by infiltration through the bottom and sides of the pond, the ponds will be designed assuming no infiltration, since no data is presently available to assess infiltration rates.

7.0 WATER TREATMENT

7.1 *Codes, Laws and Regulations*

For this project, the latest revision of the following codes, laws and regulations will be used in the design of the water treatment infrastructures required for the water management:

- Water Resource Act, Newfoundland and Labrador, SNL2002 Chapter W-4.01;
- Environmental Control Water and Sewage Regulations 65/03, 2003;
- Metal Mining Effluent Regulations (Canada) SOR/2002-222, section 3 and 19.1 and 20 and Schedule 4.

7.2 *Design Criteria*

7.2.1 Sources of Effluent to be Treated

There are three effluent sources to be treated on the Howse property

- Natural site runoff;
- Runoff from the overburden stockpile and waste rock dump;
- Pit dewatering water and pit runoff.

7.2.2 Effluent Quality

7.2.2.1 Natural Site Runoff

The natural site runoff at the Howse property is expected to have an effluent quality similar to the water quality found in creeks and lakes that are within the property.

As per the data presented in the report *Project Registration / Project Description for the DSA – Howse Property Project (Groupe Hémisphères, March / April 2014*), *section 3.7,* the surface water around the site is characterized as being soft, with low conductivity and total dissolved solids as well as low concentration of metals. The pH of Goodream Creek, a stream that flows to the north of the property, range from 5.3 to 6.5, while Burnetta Creek located to the west of the property has a pH ranging from 5.0 to 6.0. Furthermore, the total suspended solids are generally low. However, the report does note that moderate turbidity events (e.g. 100 to 1000 NTU) could occur and typically coincided with rainfall activity.

Based on the data available to date, the main parameters of concern in the site runoff will be suspended solids, specifically during a rainfall event as well as possibly during a snowmelt event.

The site runoff pH is expected to be in the same range as the pH of the natural waters around the property, and thus could be lower than a pH value of 6.0. Consequently, the minimum pH discharge criterion specified in the *Environmental Control Water and Sewage Regulations* or in the *Metal Mining Effluent Regulations* should not be an issue for this project.

For the purpose of design, the following table presents the assumptions taken with regard to the quality of the suspended solids in the site runoff:

Table 7-1: Assumptions for Site Runoff Water Quality

Parameters	Units	Value
Type of suspended solid	--	Sand and grit
Minimum particle size to settle	mm (microns)	0.1 (100)
Specific Gravity	--	2.7(*)
(*) Assumption based on typical specific gravity for rock formations in Howse Area (ref. Table 3.5 Project Registration/Project Description for the DSO-Howse Property Project, March/April 2014)		

7.2.2.2 Runoff From Overburden and Waste Rock Dump

The overburden at the Howse DSO property is expected to be mainly composed of sand and gravel. The waste rock is expected to be composed of fine rock particles.

Furthermore, as per the studies presented in the report *Project Registration / Project Description for the DSA – Howse Property Project (Groupe Hémisphères, March / April 2014*), the waste rock and ore is not expected to be acid generating.

Consequently, the main parameter of issue considered for this project is related to suspended solids.

For the purpose of design, the following table presents the assumptions taken with regard to the quality of the suspended solids in the overburden and waste rock dump runoff:

Table 7-2: Assumption for Overburden and Waste Dump Runoff Water Quality

Parameters	Units	Value
Type of suspended solid	--	Sand, grit and fine rock particles
Minimum particle size to settle	mm (microns)	0.01 (10)
Specific Gravity	--	2.7(*)
(*) Assumption based on typical specific gravity for rock formations in Howse Area (ref. Table 3.5 Project Registration/Project Description for the DSO-Howse Property Project, March/April 2014)		

7.2.2.3 Pit Dewatering Water

The pit dewatering water will consist mainly of groundwater that infiltrates into the pit, as well as surface runoff. Groundwater will be intercepted by pumping wells located around the pit and transferred to the Timmins 4 sedimentation pond no. 3. Surface runoff will flow inside the pit and be collected at several sumps in the pit and transferred to the Timmins 4 sedimentation pond no. 3.

The groundwater and surface runoff around the pit are expected to be of similar quality to the natural site runoff with regard to conductivity, total dissolved solids and pH. Total suspended solids of the pit surface runoff will however be higher due to the mining activity in the pit. The pit surface runoff could also be contaminated with ammonia and nitrate coming from un-exploded explosive residues. The pit surface runoff could also be contaminated with oil and hydrocarbon from the machinery.

In order to minimize the load of ammonia and nitrate that can migrate into the pit surface runoff, proper explosive management will be implemented as described in the *Project Registration / Project Description for the DSA – Howse Property Project (Groupe Hémisphères, March / April 2014).*

To manage any oil and hydrocarbon from the machinery, an oil/water separator will be used to remove the free oil and hydrocarbon from the pit surface runoff before it is transferred to the sedimentation pond.

Consequently, the main parameter of issue considered for this project is related to suspended solids from the pit surface runoff. The groundwater pumped from the wells around the pit is expected to have very little suspended solids.

For the purpose of design, the following table presents the assumptions taken with regard to the quality of the suspended solids in the pit dewatering water:

Table 7-3: Assumptions for Pit Dewatering and Pit Runoff Water Quality

Parameters	Units	Value
Type of suspended solid	--	Grit and fine rock particles
Minimum particle size to settle	mm (microns)	.01 (10)
Specific Gravity	--	2.7(*)
(*) Assumption based on typical specific gravity for rock formations in Howse Area (ref. Table 3.5 Project Registration/Project Description for the DSO-Howse Property Project, March/April 2014)		

7.2.3 Treated Effluent Discharge Quality

The water treatment infrastructure will be designed in order to treat the effluent and produce a treated effluent that will meet the discharge quality specified in the following regulations:

- Environmental Control Water and Sewage Regulations 65/03, 2003
- Metal Mining Effluent Regulations (Canada) SOR/2002-222, section 3 and 19.1 and 20 and Schedule 4

The following table summarizes the discharge criteria specified in the above regulations:

Table 7-4: Water Quality Discharge Criteria

Parameters	Units	Environmental Control Water and Sewage Regulations, 2003	MMER (SOR/2002-222)	
		Max. Concentration	Max. Monthly Mean	Max. Concentration in Grab Sample
pH		5.5 to 9.0	6.0 to 9.5	
Arsenic	mg/L	0.5	0.5	1.00
Copper	mg/L	0.3	0.3	0.6
Cyanide	mg/L	0.025	1.0	2.0
Lead	mg/L	0.2	0.2	0.4
Nickel	mg/L	0.5	0.5	1
Zinc	mg/L	0.5	0.5	1
Total Suspended Solids	**mg/L**	**30**	**15**	**30**
Radium 226	Bq/L	0.37	0.37	1.11
Total dissolved solids	mg/L	1000	----	----
B.O.D.	mg/L	20	----	----
Barium	mg/L	5.0	----	----
Cadmium	mg/L	0.005	----	----
Chromium (VI)	mg/L	0.05	----	----
Chromium (III)	mg/L	1.0	----	----
Iron (total)	mg/L	10	----	----
Mercury	mg/L	0.005	----	----
Nitrates	mg/L	10	----	----
Nitrogen (ammoniacal)	mg/L	2.0	----	----
Phenol	mg/L	0.1	----	----
Phosphate (total as P2O5)	mg/L	1.0	----	----
Phosphorus (elementals)	mg/L	0.0005	----	----
Selenium	mg/L	0.01	----	----
Sulfides	mg/L	0.5	----	----
Silver	mg/L	0.05	----	----

As noted in the Section 7.2.2, the primary parameter of concern is expected to be limited to **total suspended solids** concentrations.

7.2.4 Design Flow Capacity

The design flow rate capacity will be determined based on the design criteria for hydrology and hydrogeology (refer to Sections 5 and 6).

7.2.5 Sedimentation Pond Design

In order to manage the total suspended solids in the three (3) effluents generated at the Howse property, these effluents will be sent to sedimentation ponds to allow for the settling of the suspended solids before they are discharged to the receiving creeks.

Each sedimentation pond will be sized based on the following design parameters:

- Pond designed based on discrete particle settling;
- Terminal settling velocity of the particle evaluated using Stokes' law based on the smallest particle size specified in Section 7.2.2;
- The sedimentation pond will have a rectangular shape, with a length to width ratio of at least 3 to 1;
- Refer to Section 6.0 for additional design criteria for the sedimentation pond.

8.0 ENVIRONMENTAL MONITORING PROGRAM

8.1 Codes, Laws and Regulations

The environmental monitoring program will be planned in accordance with the following protocols and regulations:

- Environmental Control Water and Sewage Regulations (2003);
- Protocols Manual for Real Time Water Quality Monitoring in Newfoundland and Labrador (2013);
- Metal Mining Effluent Regulations (Canada).

8.2 Design Criteria

There are several factors which need to be considered when planning and implementing real time water quality (RTWQ) stations, manual water sampling, and effluent sampling into the water monitoring program.

These factors include:

- The type of data needed to be captured: baseline data, changes in water quality, changes in water quantity;
- Reasons for monitoring water quality/quantity: regulatory management, protection of fragile ecosystems or communities, etc;
- The water bodies of interest, and their characteristics: lake, stream, tailings pond, well, and whether upstream and/or downstream data is required;
- Expected contaminants, parameters of interest, and their characteristics;
- Location of the site, including hydrogeologic/geologic characteristics and anthropologic influences;
- Groups interested in the data: government, non-government, community groups, the public, etc;
- The duration of the monitoring program: temporary or long term. Seasonally or year-round;
- Accessibility to site, and sites accessibility to resources: How will the site be accessed for station installation, maintenance, and or manual sampling (by foot, road vehicle, ATV, boat), how instrumentation will be deployed based on accessibility, and type of equipment suitable for the site chosen (power source, transmission type, monitoring instrumentation, etc.);
- Additional sources of data nearby that may be used to supplement water quality data: Nearby weather stations, and/or water quality/quantity stations.

The provincial and/or federal government will be responsible for the installation or relocation of real-time monitoring stations, as part of the Real-time water quality/quantity monitoring network. The installation of additional monitoring wells may be required if it is discovered that the current groundwater wells are not suitable for the purposes of groundwater sampling/monitoring based on hydrogeologic/geologic data.

9.0 REFERENCES

AECOM (2014), *DSO – Timmins Project – Hydrology – Drainage – Flow Measurement – General Location*, Drawing no. DSOT-DW-4310-CI-0001 revision G, September 3, 2014.

AECOM (2012), *DSO-Timmins Project – Design Criteria Drainage_Design Brief*, document no. DSOT-DC-4301-CI-0001 revision A, May 22, 2014.

Canadian Dam Association (2007, revised 2013), *Dam Safety Guidelines*, ISBN 978-0-7726-5802-9.

Environment Canada (2014), Shefferville A Meteorological Station, http://climate.weather.gc.ca/advanceSearch/searchHistoricDataStations_e.html?searchType=stnName&timeframe=1&txtStationName=schefferville+A&searchMethod=contains&optLimit=yearRange&StartYear=1840&EndYear=2014&Year=2014&Month=10&Day=8&selRowPerPage=25&cmdStnSubmit=Search, consulted on October 8, 2014.

Environment Canada (2009), Environmental Code of Practice for Metal Mines, ISBN 978-1-100-11901-4.

Golder Associés (2014), *Howse Pit Hydrogeological Investigation – Summary of Factual Data in Support of Environmental Impact Assessment Process*, Document no. 011-13-1221-0104 MTA rev A, February 28, 2014.

Government of Canada, *Metal Mining Effluent Regulation*, SOR/2002-222.

Government of Newfoundland and Labrador, *Environmental Control Water and Sewage Regulations,* Regulation 65/03.

Government of Newfoundland and Labrador, *Policy for Development in Wetland*, Newfoundland and Labrador , W.R. 97-2

Government of Newfoundland and Labrador (2013), *Protocols Manual for Real Time Water Quality Monitoring in Newfoundland and Labrador*, November 2013.

Government of Newfoundland and Labrador, *Water Ressources Act*, SNL2002 CHAPTER W-4.01.

Groupe Hémisphère (2014), *Project Registration / Project Description for the DSO Howse Property Project*. Submitted to Howse Minerals Limited, 223 pp., and 4 appendices.

Groupe Hémisphères (2010), *Hydrological and hydrogeological study: survey season 2009, DSOP*. Final technical report, march 2010.

Met-Chem (2013), *Howse DSO Deposit – Project Notice – Mine Site General Layout*, drawing no. A4-2013-028-501-MN revision C, November 27, 2013.

Newfoundland Labrador Department of Environment and Conservation (2014), *Real Time Water Quality Monitoring Stations*, http://www.env.gov.nl.ca/env/waterres/rti/stations.html, consulted on October 8, 2014.

SNC-Lavalin, in prepraration. *Hydrogeology and mine pit dewatering modeling - LabMag site*. New Millenium Iron – TATA Steel.

Stubbins, J. B. and P. Munro. 1965. *Historical information on mine dewatering of DSO (Knob Lake),* The Canadian Institute of Mining and Metallurgy Bulletin, 58:814-822.

- Tata Steel Minerals Canada (2012), *DSO-Timmins Project – Water Monitoring Stations*, Drawing no. GIS-ML-19-03, December 10, 2012.

APPENDIX D

Water Quality from Timmins 4 Project

SAMPLE: COA-SW11

SOURCE: SURFACE WATER FROM FLEMMING 7N AND TIMMINS 7N PIT AREAS, AFTER PASSING THROUGH SEDIMENTATION POND A AND B

Parameters	Units	CofA	MMER (review 10 years)	COA-SW11-10 May 27 2014	COA-SW11-9 May 19 2014	COA-SW11-8 May 14 2014	COA-SW11-7 May 6 2014	COA-SW11-6 Oct 21 2013	COA-SW11 Oct 2 2013	COA-SW11-5 Sep 25 2013	COA-SW11-4 Sep 18 2013	COA-SW11-4 Sep 16 2013	COA-SW11-3 Sep 11 2013	COA-SW11 Aug 27 2013	COA-SW11 Aug 19 2013	COA-SW11 Aug 15 2013	COA-SW11 Jun 9 2013	COA-SW11 May 5 2013
Arsenic (As)	ug/L	1.0 mg/L	0.2 mg/L	0.5	0.5	1.6	8.1	8.4	1.1	2.4	2.3	2.0	1.8	0.5	0.5	3.3	<1.0	0.5
Copper (Cu)	ug/L	0.6 mg/L	0.1 mg/L	2.5	2.2	2.2	40	21	4.6	3.8	3.5	2.3	3.0	2.4	1.6	4.7	0.55	0.85
Nickel (Ni)	ug/L	1.0 mg/L	0.5 mg/L	1	1	1	28	14	2.1	2.9	2.4	3.0	2.7	1.4	1.1	3.8	n/a	0.5
Lead (Pb)	ug/L	0.4 mg/L	0.1 mg/L	0.64	0.68	0.65	13	5.2	0.58	0.97		0.80	0.79	1.1	0.82	1.5	0.14	0.38
Zinc (Zn)	ug/L	1.0 mg/L	1.0 mg/L	110	36	52	120	140	1300	180	190	160	140	45	44	43	n/a	29
pH	pH	5.5 - 9.0		6.33	6.45	7.84	5.77	6.77	7.09	7.12	7.27	7.08	6.75	6.89	6.85	6.83	6.89	6.61
Total suspended solids (TSS)	mg/L	30 mg/L	30 mg/L	9	24	25	510	120	4	1	13	3	1	6	22	30	18	53
Radium 226	Bq/L	1.11 mg/L	1.11 Bq/L	0.001	0.001	0.002	0.044	0.02	0.003	0.01	0.005	0.002	0.006	0.01	0.01			
Iron	ug/L															11000	<100	
Turbidity	NTU															510	n/a	

SAMPLE: COA-SW12

SOURCE: SURFACE WATER FROM TIMMINS 4, AFTER PASSING THROUGH SEDIMENTATION POND C

Parameters	Units	CofA	MMER (review 10 years)	COA-SW12-1 May 19 2014	COA-SW12 May 5 2013
Arsenic (As)	ug/L	1.0 mg/L	0.2 mg/L	2.8	<1.0
Copper (Cu)	ug/L	0.6 mg/L	0.1 mg/L	5.8	1.5
Nickel (Ni)	ug/L	1.0 mg/L	0.5 mg/L	4.0	<1.0
Lead (Pb)	ug/L	0.4 mg/L	0.1 mg/L	1.4	0.50
Zinc (Zn)	ug/L	1.0 mg/L	1.0 mg/L	22	7.1
pH	pH	5.5 - 9.0		6.45	6.06
Total suspended solids (TSS)	mg/L	30 mg/L	30 mg/L	24	84
Radium 226	Bq/L	1.11 mg/L	1.11 Bq/L	<0.002	<0.002
Iron	ug/L				
Turbidity	NTU				

Legend		
	XXX	Above the Certificate of Approval regulation
	XXX	Unusually high

SNC·LAVALIN

360 St Jacques West, 16th Floor
Montreal, QC, H2Y 1P5
514-393-1000 - 514-390-2765