Appendix 66

Whale Tail Blasting Activities - Mammoth Dike Construction Version 2

AGNICO EAGLE

Memo

To: Department of Fisheries and Ocean (DFO)

From: Patrice Gagnon, Pier-Eric McDonald

CC: Meadowbank Environment

Date: February 5th, 2019

Subject: Blasting Activities – Mammoth Dike construction

1. Introduction

Agnico Eagle plans to build the Mammoth Dike that will allow for the mining of the Whale Tail Pit. One of the construction activities consists of drill & blasting (D&B) the foundation of the dike. That area is located on a very shallow shoreline of Mammoth Lake and this activity is critical for assuring the performance of the dike. Since this activity is close to a water body, Agnico aims to comply with the DFO's Guidelines for Use of Explosives in or Near Canadian Fisheries Waters. In addition to the federal guidelines, Condition 2.3.3 of the Fisheries Authorization 16-HCAA-00370 states: '*The Proponent shall develop a blasting mitigation plan in consultation with DFO to ensure effects on fish and fish habitat are minimized, as per Nunavut Impact Review Board Project Certificate No. 008 Condition 22. The blasting mitigation plan shall be submitted to DFO prior to construction for approval, and shall adhere to the guidance provided in the Monitoring Explosive-Based Winter Seismic Exploration in Waterbodies, NWT 2000-2002 (Cott and Hanna, 2005)'*. The recommendations outlined in this document are objects of DFO's most recent recommendations on blast practices close to waterbodies.

This memo presents the proposed monitoring and mitigation measures required for Dike construction works that Agnico has developed to respect the above mentioned guidelines. Those requirements and their underlying mitigations proposed by Agnico are being referred to as a "Blasting Mitigation Plan" which consist of both Section 4 and 5 of this present document. This memo will be communicated to all personal involved with drill and blast activities.

2. Description of Blasting Activities & Current Site Conditions

2.1 Description of Blasting Activities and Associated Computations

Drill and Blast of the Mammoth Dike foundation is required as per the Design Report, approved on December 5, 2018 as part of NWB Water License 2AM-WTP1826, in order to get to the proper foundation elevation and frozen conditions to install the liner in the key trench (impervious part of the dike). This will ensure the dike performs as per design's intent by ensuring that its foundation is on frozen material not prone to thaw settlement and of low hydraulic conductivity. Drill and blast activities are planned to be undertaken close to the center line of the dike while respecting the requirements mentioned in Section 3. The blasting activities are planned to occur in the months of February/March 2019 so the construction is completed before the thawing season for construction effectiveness and for being as far away from free water (fish bearing habitat). The extent of the blasting area is presented in Appendix A.

The drilling and loading design specific for this blast was performed by Agnico's drill and blast engineers, it is shown in Appendix E and F. This design was used to compute the setback distance. The instantaneous pressure change (IPC) threshold is maximum 50 kPa, as recommended by DFO in "Monitoring Explosive-Based Winter Seismic Exploration in Waterbodies". Those detailed computations are shown in Appendix D and are taken from Appendix II & III of DFO's document 'The Use of Explosives in or Near Canadian Fisheries Waters'. It should be noted that Guideline 9 from 'The Use of Explosives in or Near Canadian Fisheries Waters' that states that the setback requirement to respect the 13 mm*s-1 from spawning beds is found to be the most stringent guideline regarding setback distances to respect. Also, Appendix B below presents the fish habitats type and it can be seen that the Mammoth Dike's alignment and proposed blasting area is in a low risk zone and more than 115m away from any critical areas and that is greater than any of the setback distances computed.

2.2 Current Site conditions

Mammoth Lake bathymetry and fish habitat survey indicate a shallow depth (<2m) that is continuous up to the closest fish habitat shown in Appendix B. Past years ice survey profile at the end of January indicate that there is at least 1.1m thickness of ice and recent ice cutting with the auger indicate at least 1.2m as per blade length reference. Hence, it is Agnico's interpretation

that the lake is likely frozen from top to bottom for at least 116m from the blasting area to both the deeper portion and fish bearing habitat. This interpretation is consistent with the recommendation detailed in the 'Monitoring Explosive-Based Winter Seismic Exploration in Waterbodies" (Cott and Hanna, 2005) stating that no seismic exploration should be conducted in waterbodies not frozen to the bottom.

Furthermore, Appendix C shows the data of thermistor MD-2015-02 located in the deeper portion of the water channel linking Whale Tail Lake to Mammoth Lake and also located in the key trench of the dike. It was installed as part of SNC Lavalin field investigation for dike design and reveals that after December 10th, all the thermistor beads exhibit frozen conditions meaning no blasting under water will be undertaken for this specific activity on which most recommendations of Cott and Hanna (2005) are based. Nevertheless, Agnico is committed to follow the recommendations where they are summarized in Section 3 and how it intends to address them which is shown in Sections 4 & 5.

3. Review of Existing Guidelines and Recommendations

3.1 DFO's Guidelines for Use of Explosives in or Near Canadian Fisheries Waters

Agnico intends to comply with the nine (9) *guidelines of the document "Guidelines for Use of Explosives in or Near Canadian Fisheries Waters" summarize* below. For Guideline no 8, Agnico will use a more stringent ICP of 50 kPa as recommended by DFO in the Monitoring Explosive-Based Winter Seismic Exploration in Waterbodies (Cott and Hanna, 2005):

1. *Proponents considering the use of explosives are encouraged to consult the appropriate DFO Regional/Area authorities as early as possible in their planning process to identify possible alternatives to the use of explosives, the biological resources and their habitats at risk, and/or effective mitigation measures.*

2. *Where provincial or territorial resource management agencies, or aboriginal resource management boards undertake the administration of fisheries, the proponent is encouraged to consult with the relevant authorities.*

3. *The use of confined or, in particular, unconfined explosives in or near Canadian fisheries waters is discouraged, and proponents are encouraged to utilize other potentially less destructive methods wherever possible.*

4. *No use of ammonium nitrate-fuel oil mixtures occurs in or near water due to the production of toxic by-products (ammonia).*

5. *After loading a charge in a hole, the hole is to be back-filled (stemmed) with angular gravel to the level of the substrate/water interface or the hole collapsed to confine the force of the explosion to the formation being fractured. The angular gravel is to have a particle size of approximately 1/12th the diameter of the borehole.*

6. *All "shock-tubes" and detonation wires are to be recovered and removed after each blast.*

7. *No explosive is to be knowingly detonated within 500 m of any marine mammal (or no visual contact from an observer using 7x35-power binocular).*

8. *No explosive is to be detonated in or near fish habitat that produces, or is likely to produce, an instantaneous pressure change (i.e., overpressure) greater than 100 kPa (14.5 psi) in the swimbladder of a fish.*

9. *No explosive is to be detonated that produces, or is likely to produce, a peak particle velocity greater than 13 mm•s-1 in a spawning bed during the period of egg incubation.*

3.2 Monitoring Explosive-Based Winter Seismic Exploration in Waterbodies" (Cott and Hanna, 2005)

Below are recommendations from "Monitoring Explosive-Based Winter Seismic Exploration in Waterbodies", NWT 2000-2002 (Cott and Hanna, 2005) that Agnico intends to follow:

1. *Seismic exploration should not be conducted under water-bodies not frozen to the bottom in the NWT due to the unpredictability of IPC (Instantaneous Pressure Change) and absence of proven mitigation to suppress the negative effects of a detonated charge.*

2. *Guidelines should be used as intended, as "guidelines", and be adjusted to site-specific conditions accordingly, not applied as a mitigation.*

3. *Ice profiling on waterbodies should be used as a tool to determine the extent of bottom-fast ice.*

4. *Proven mitigation to minimize the impact on fish from the effects of high IPC should be available on site in the event that an unforeseen event occurs, such as a shallow buried charge.*

5. *For any explosive-based seismic program, a protocol must be developed that clearly indicates what is expected, how monitoring is to be conducted, what and how information is to be recorded, and when the results are to be submitted. The protocol should be designed well in advance of the proposed seismic exploration program, and be a joint effort between industry and regulators.*

6. *Initial testing should be conducted to determine site-specific charge size/burial depth combinations.*

7. *Charge burial depth must be accurately measured and confirmed.*

8. *A maximum threshold of <50kpa should be set for testing and production seismic operations.*

9. *Monitoring equipment should be capable of monitoring at the highest frequency available, currently 65,000s-1 is standard.*

10. *A pre-determined number of production holes should be monitored to confirm the adequacy of the site-specific charge size/burial depth combinations for the entire project area.*

11. *When designing a program to monitor activities of industry, it is important that the requirements be practical and considers the technical and environmental conditions in which the industry is bound to operate.*

4. Proposed Monitoring Plan

The Blast Mitigation Plan is outlined in this present section for the monitoring and Section 5 for the mitigations. Both section are meant to address the guidelines and recommendations described in the previous section of this memo.

Agnico will monitor blast vibrations with Instantel Minimate™ seismograph monitoring devices to be installed as indicated by the manufacturer at the same location every blast. Note that one station is suggested on each side of the dike. Those locations are to be in a representative area on the shoreline and outside the footprint of dike construction. Refer to Appendix A for proposed locations of the existing and new proposed station. Such practices are consistent with the current practices at Meadowbank and Whale Tail, plus it ensures redundancy of recording units and respects the recommendation regarding the type of equipment to be used that is consistent with industry standards.

The whole blast footprint shall be shot in at least 3 sequences of equivalent holes quantity in such a way that after each blast, the recorded values and post-blast visual assessment shall be analyzed and documented by competent personal so adjustments on the next blasting sequences could be brought forward if the guidelines are not respected or exceeded. Lastly, in case of a “no data” event, Agnico will investigate the cause to assess whether the error is human or material related and bring corrective measures where applicable.

5. Potential Mitigation Measures

Agnico already has practices that are aligned with some requirements of Section 3 regardless if a blast is in proximity to a waterbody or not, for example: holes are backfilled with angular ¾” net gravel, emulsion is used which is not soluble in water, blasters inspect the blast area after each blast and design parameters are optimized.

Although Agnico is confident that actual practices and design will comply with the requirements of Section 3, a handful of potential mitigation measures were identified that could be applied should the first sequence exceeds the requirements. Those are developed from a combination of literature and past experiences at Meadowbank that have proven to be successful, namely:

- Drill on small diameters hole as low as 3” to limit vibrations;

- The explosive charge in each hole (powder factor) shall be reduced to the minimum judged practical in the design phase of the blast and re-adjusted if required after the first sequence;

- Number of holes blasting per delay and blast geometry shall be reduced to a minimum as much as practical in the tying plan produced by the D&B engineer to limit vibrations to respect the computations shown in Appendix D;

- The blasting area might be broken down to smaller blast patterns and more sequences, to be blasted in a chronological manner.

- Agnico will perform a 2nd visual inspection of the area around the blast after each blast and remove any shock tubes or detonators that might have been projected outside the perimeter. If visual inspection reveals blasting accessories on the iced surface of the Mammoth Lake, the blaster will advise the Engineering Department so that the material is removed via appropriate procedures;

- Quality control by competent personal could be performed after the first blast sequence to ensure that no overloading occurs in such a way that the maximum charge per hole respects the design that was used as in input for the Instantaneous Pressure Change and Vibrations computations for calculating the setback distances;

- In the event where projections are judged problematic, blasting mats or geotextile could be applied over the whole blasting sequence with an appropriate amount of aggregates over it in such a way that the energy is kept in the rock mass as opposed to sending projections and deleterious blasting material in the air.

6. Closure

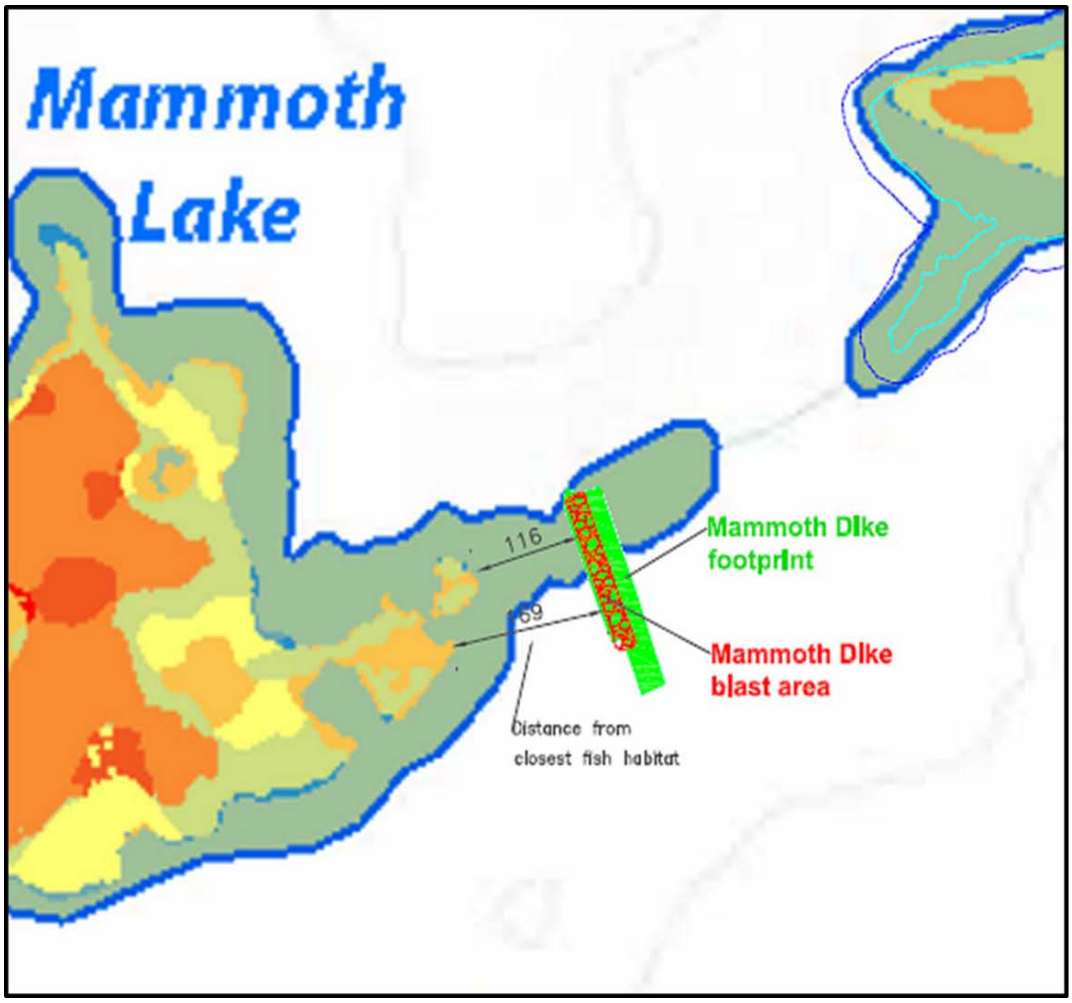
This memo communicates Agnico intent's on Drill and Blast activities and the rationale behind it on a construction and design standpoint. Site specific conditions also show that free water is expected to be further than the maximal setback distance to respect, so is the closest spawning bed. Also, it is clear that site specific designs are meeting the computational requirements of the guidelines and recommendations that DFO proposes to comply.

Agnico took into consideration guidelines and recommendations to comply and then built a monitoring program accordingly. Lastly, Agnico listed realistic and practical mitigations that could be implemented should the first blast sequence show unfavourable results which is also consistent with DFO’s guidelines and Cott & Hanna’s set of recommendations.

APPENDIX A – Proposed Blast Monitoring Stations


Existing blast
monitoring station
116
MAMMOTH DIKE
Proposed blast
monitoring station
169

Appendix B: Fish Habitat Types



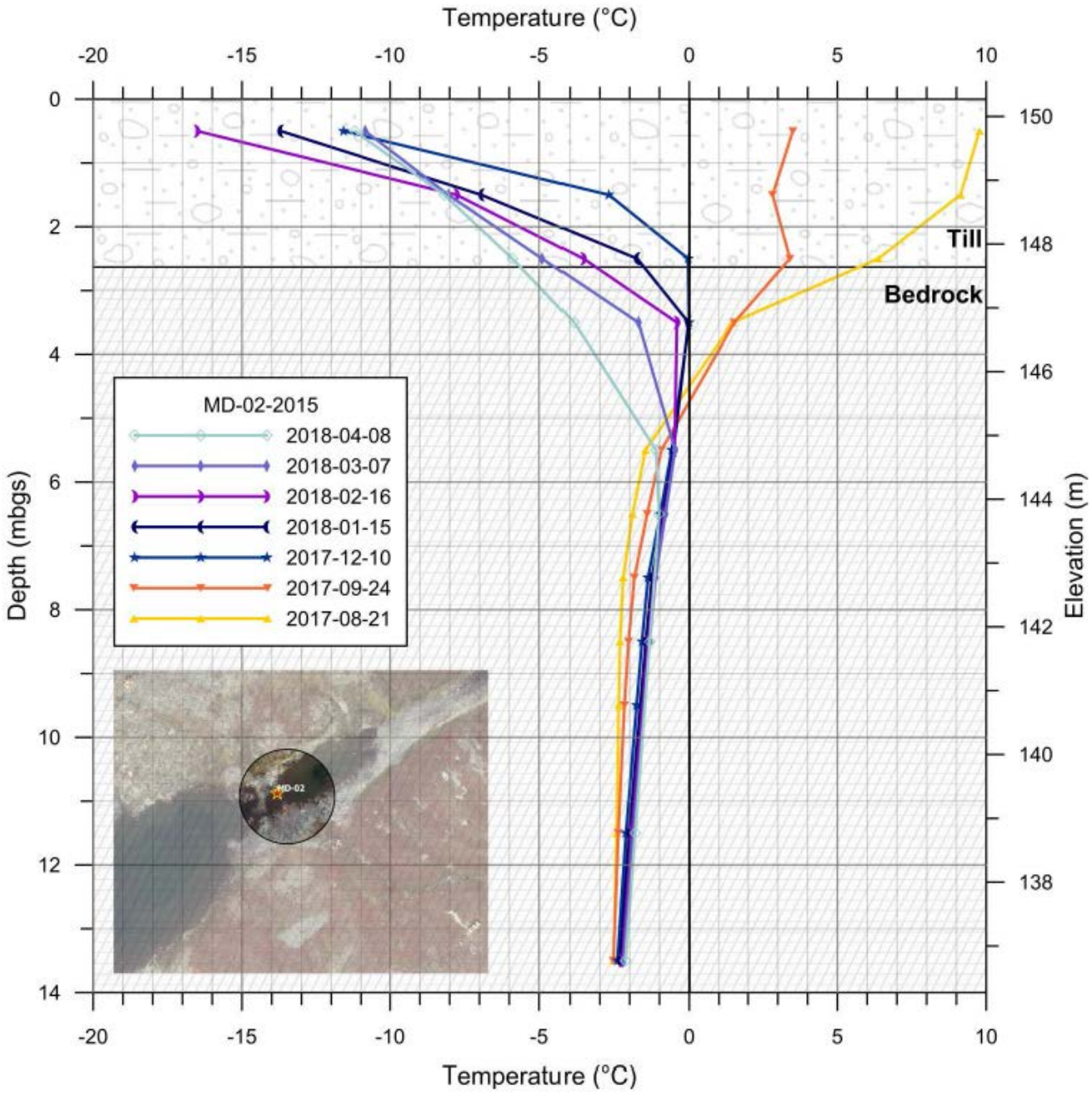
Habitat Type

1
2
3
4
5
6
7
8
9

Habitat Type	Criteria	
	Depth Zone	Substrate
1	<2 m	Fines
2	<2 m	Mixed
3	<2 m	Coarse
4	2-4 m	Fines
5	2-4 m	Mixed
6	2-4 m	Coarse
7	> 4 m	Fines
8	> 4 m	Mixed
9	> 4 m	Coarse

Whale Tail Habitat Types
Pre-Construction

Appendix C: Thermistor MD-2015-02 data


Temperature (°C)
-20
-15
-10
-5
0
5
10
Depth (mbgs)
0
2
4
6
8
10
12
14
Elevation (m)
150
148
146
144
142
140
138
Till
Bedrock
MD-02-2015
2018-04-08
2018-03-07
2018-02-16
2018-01-15
2017-12-10
2017-09-24
2017-08-21
MD-02
Temperature (°C)

Appendix D: Blasting setback distance calculations on 4.5” hole diameter – 50 kPa requirement

			Guideline 8	Guideline 9
Hole diameter (in)	4.5	**Description**	Instantaneous pressure change over 50 Kpa in the swimbladder of a fish	Peak particule velocity greater than 13mm/s in a spawning bedduring the period of egg incubation
Charge Length (m)	3.2			
Explosives Qty (Kg)	37			
		Radius to respect (m)	43.7	100.4

Set back distance required to meet 50Kpa Guideline

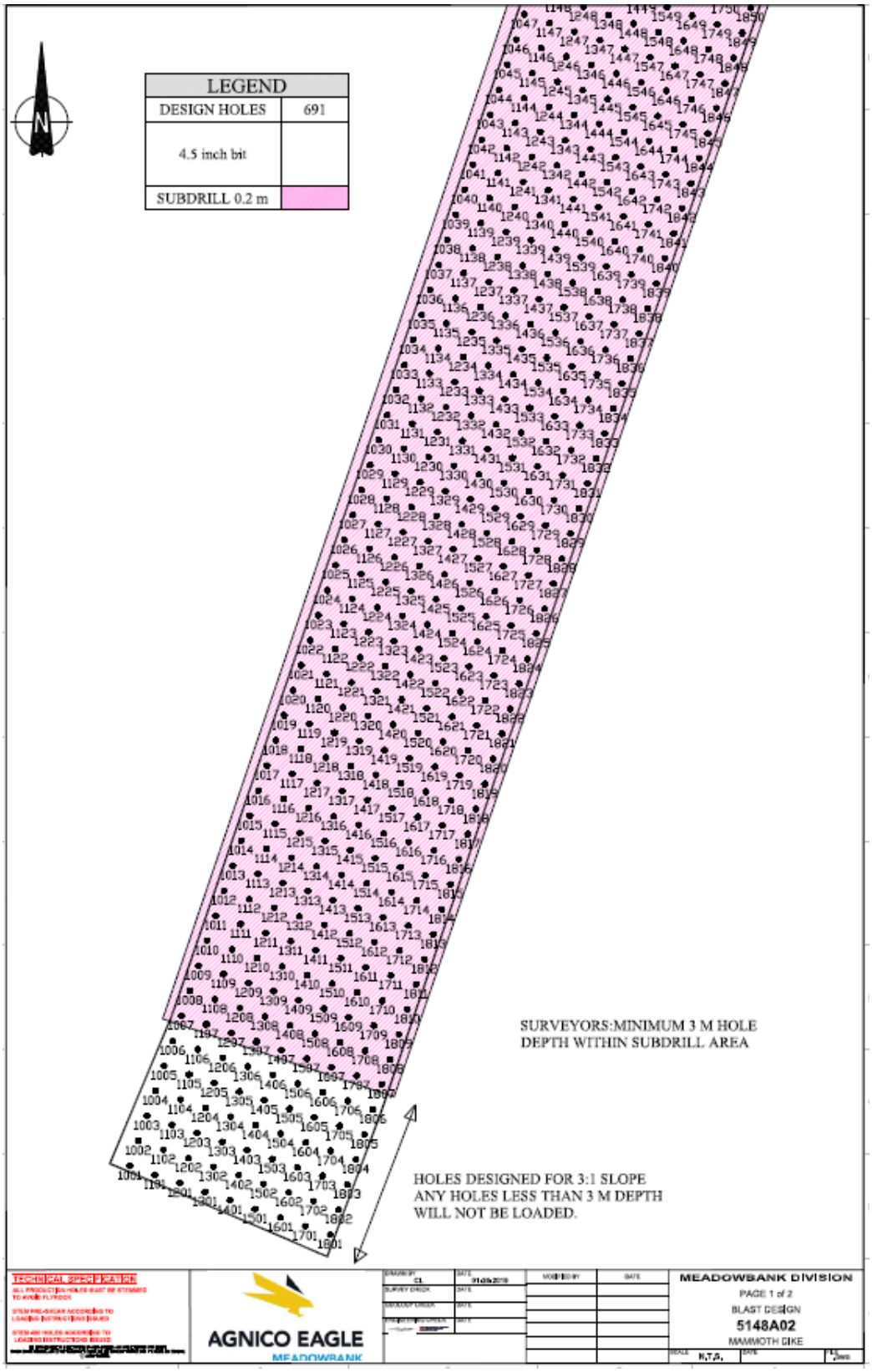
Dw	1	g/cm3	Zw/Zr=	0.249993	
Cw	146300	cm/s			
Dr	1.92	g/cm3			
Cr	304800	cm/s			
Pw	50	KPa			
			Pw=	0.399991	*Pr
Hole diameter	4.5	in			
	11.43	cm	Pr=	125.0027	KPa
Emuls. Density	0.00113	Kg/cm3	Pr=	1250027	dynes (g*cm/s2)
Charge per meter	11.59473	Kg/m			
Charge length	3.2	m*	Vr=	4.27202	cm/s
Explosive Qty	37.10315	Kg			
			R=	43.70786	m

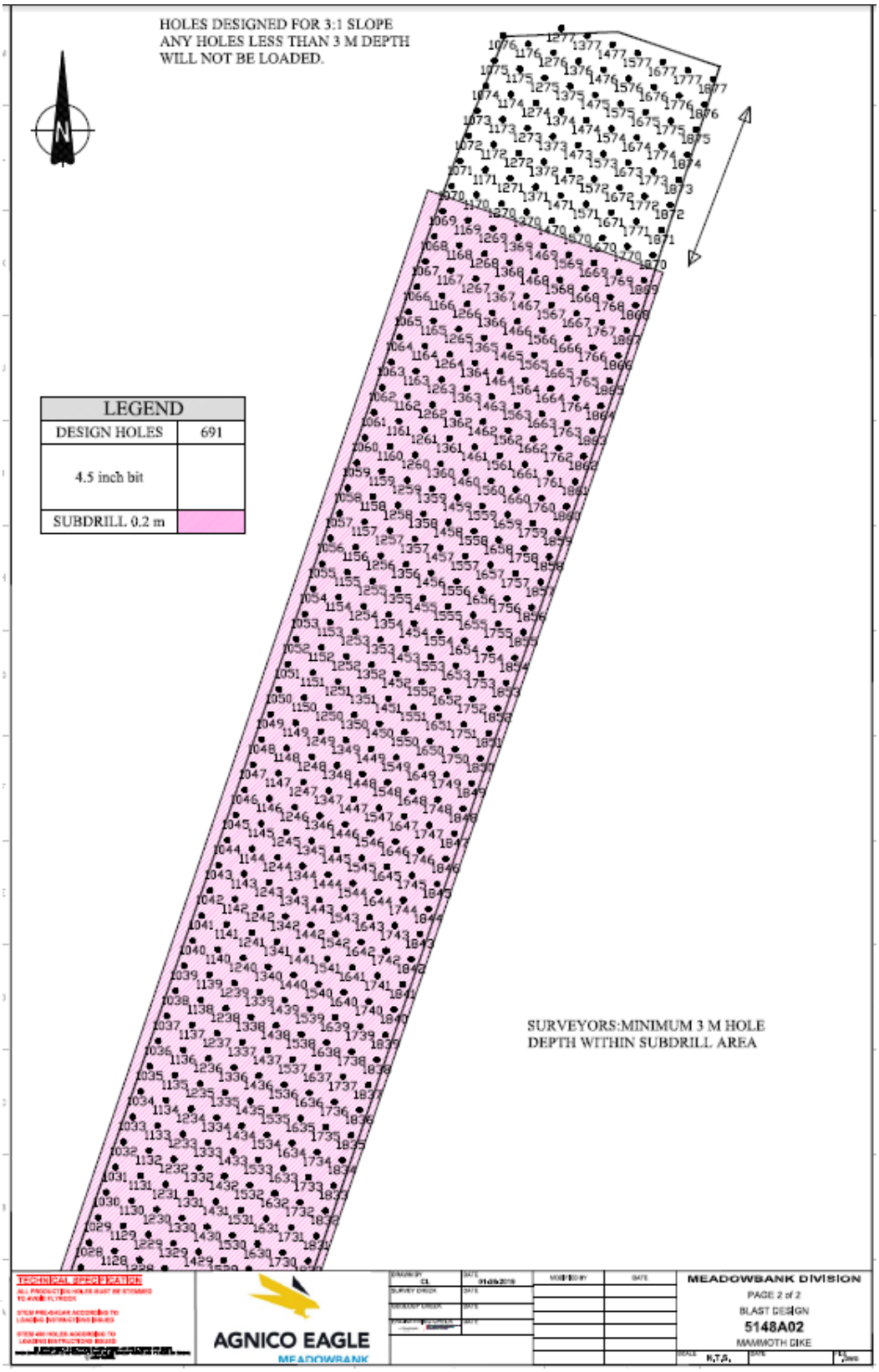
** Using target floor elevation 148.8 with SNC's design highest Natural ground between cut B-B & C-C of 153masl and also considering Loading instructions plans collar Length specified by D&B engineers (1*

Set back distance required to meet 13mm/s Guideline

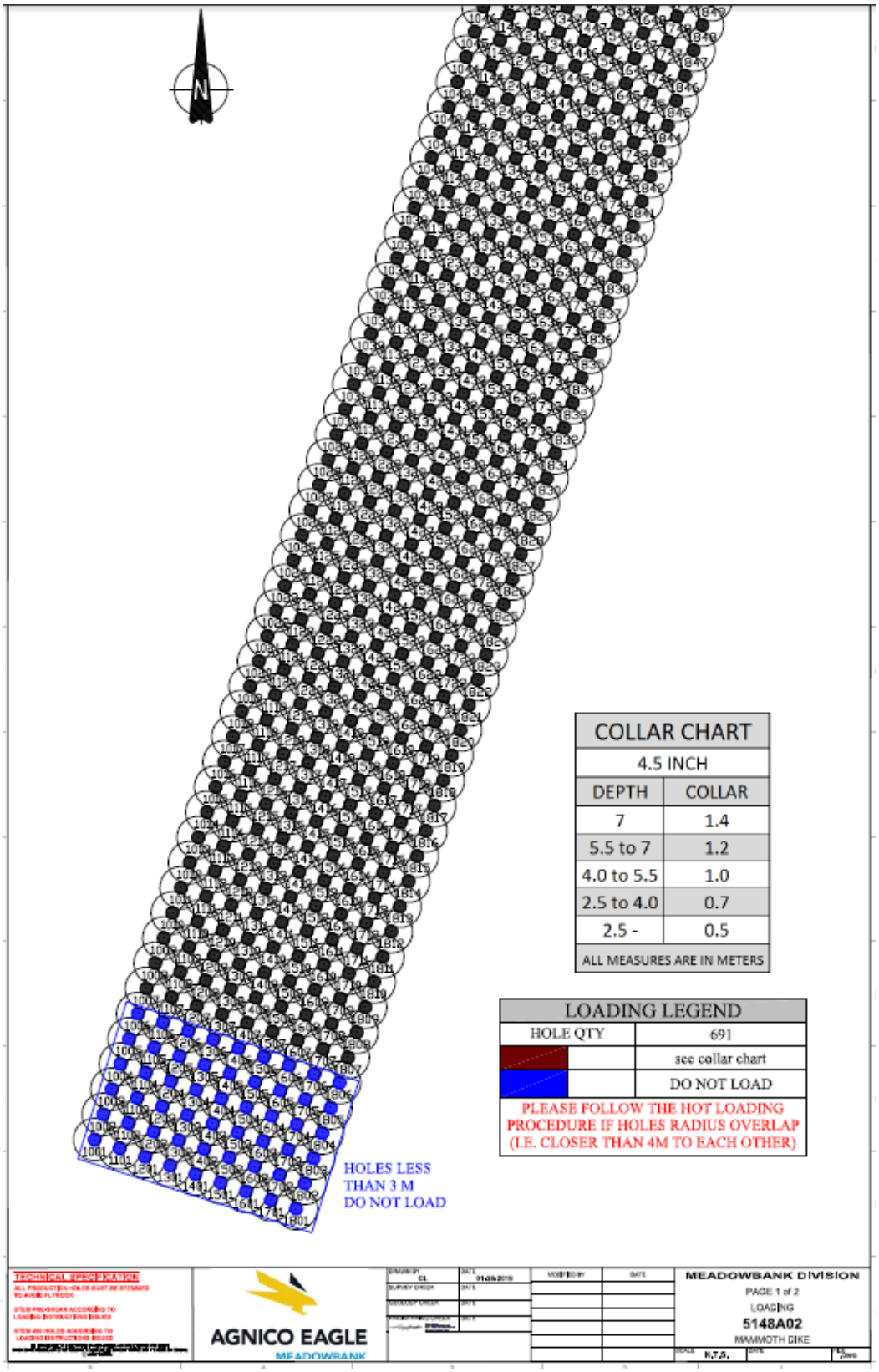
Vr	1.13	cm/s	R=	100.3532	m

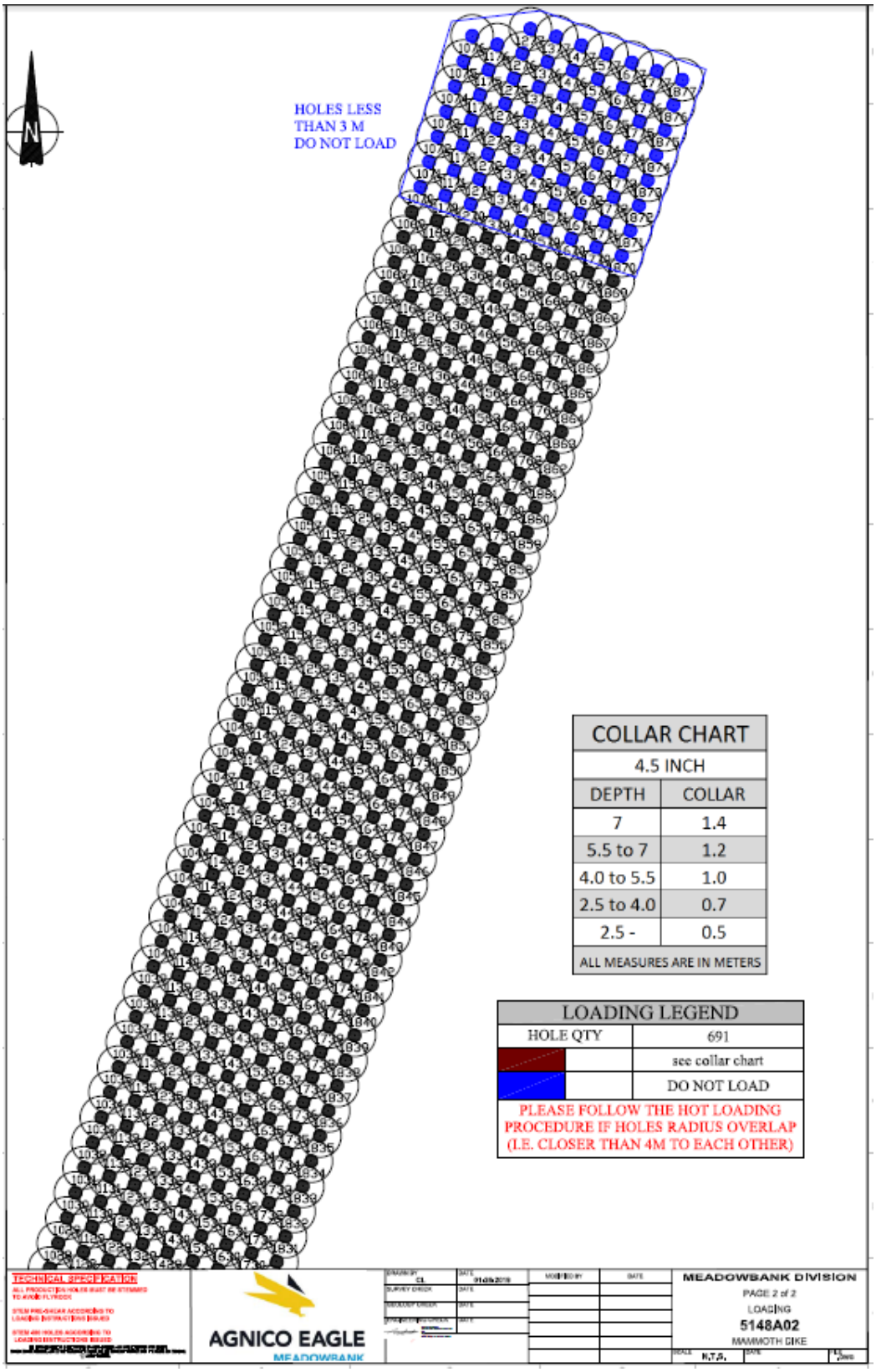
Appendix E: Drilling Design


LEGEND
DESIGN HOLES 691
4.5 inch bit
SUBDRILL 0.2 m
N
SURVEYORS:MINIMUM 3 M HOLE DEPTH WITHIN SUBDRILL AREA
HOLES DESIGNED FOR 3:1 SLOPE
ANY HOLES LESS THAN 3 M DEPTH
WILL NOT BE LOADED.
AGNICO EAGLE
MEADOWBANK
MEADOWBANK DIVISION
PAGE 1 of 2
BLAST DESIGN
5148A02
MAMMOTH DIKE


HOLES DESIGNED FOR 3:1 SLOPE
ANY HOLES LESS THAN 3 M DEPTH
WILL NOT BE LOADED.
N
LEGEND
DESIGN HOLES 691
4.5 inch bit
SUBDRILL 0.2 m
SURVEYORS:MINIMUM 3 M HOLE
DEPTH WITHIN SUBDRILL AREA
AGNICO EAGLE
MEADOWBANK
MEADOWBANK DIVISION
PAGE 2 of 2
BLAST DESIGN
5148A02
MAMMOTH DIKE

Appendix F: Loading Design


N
HOLES LESS
THAN 3 M
DO NOT LOAD
COLLAR CHART
4.5 INCH
DEPTH | COLLAR
7 | 1.4
5.5 to 7 | 1.2
4.0 to 5.5 | 1.0
2.5 to 4.0 | 0.7
2.5 - | 0.5
ALL MEASURES ARE IN METERS
LOADING LEGEND
HOLE QTY | 691
see collar chart
DO NOT LOAD
PLEASE FOLLOW THE HOT LOADING PROCEDURE IF HOLES RADIUS OVERLAP (I.E. CLOSER THAN 4M TO EACH OTHER)
AGNICO EAGLE
MEADOWBANK
MEADOWBANK DIVISION
PAGE 1 of 2
LOADING
5148A02
MAMMOTH DIKE


HOLES LESS
THAN 3 M
DO NOT LOAD
N
COLLAR CHART
4.5 INCH
DEPTH
COLLAR
7
1.4
5.5 to 7
1.2
4.0 to 5.5
1.0
2.5 to 4.0
0.7
2.5 -
0.5
ALL MEASURES ARE IN METERS
LOADING LEGEND
HOLE QTY
691
see collar chart
DO NOT LOAD
PLEASE FOLLOW THE HOT LOADING
PROCEDURE IF HOLES RADIUS OVERLAP
(I.E. CLOSER THAN 4M TO EACH OTHER)
AGNICO EAGLE
MEADOWBANK
MEADOWBANK DIVISION
PAGE 2 of 2
LOADING
5148A02
MAMMOTH BIKE