Volume 1 Annex V1-7 Type A Water Licence Applications

Package P5-29

Hope Bay Project: Boston Airstrip Preliminary Design

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Memo

To:	John Roberts, PEng, Vice President Environment	**Client:**	TMAC Resources Inc.
From:	Kaitlyn Kooy, EIT Megan Miller, PEng	**Project No:**	1CT022.013
Reviewed By:	Maritz Rykaart, PhD, PEng	**Date:**	November 30, 2017
Subject:	Hope Bay Project: Boston Airstrip Preliminary Design		

Change Log

The following table provides an overview of material changes to this report from the previous version issued as Appendix V3-3K as part of the DEIS for Phase 2 of the Hope Bay Project dated December 2016.

Changes by Section

Information Request, Technical Comment, or Other Change	Section	Comments
INAC-IR35	4.1.2	Clarified material type specifications, water management strategies, and embankment thickness design
Other	4.1.2	Inclusion of de-icing facility

1 Introduction

1.1 General

The Hope Bay Project (the Project) is a gold mining and milling undertaking of TMAC Resources Inc. The Project is located 705 km northeast of Yellowknife and 153 km southwest of Cambridge Bay in Nunavut Territory, and is situated east of Bathurst Inlet. The Project comprises of three distinct areas of known mineralization plus extensive exploration potential and targets. The three areas that host mineral resources are Doris, Madrid, and Boston.

The Project consists of two phases; Phase 1 (Doris project), which is currently being carried out under an existing Water Licence, and Phase 2 (Madrid-Boston project) which is in the environmental assessment and regulatory stage. Phase 1 includes mining and infrastructure at Doris, while Phase 2 includes mining and infrastructure at Madrid and Boston located approximately 10 and 60 km due south from Doris, respectively

Madrid is sufficiently close to Doris that the existing 1,524 m (5,000 ft) long gravel all-weather airstrip at Doris will suffice. The greater distance to Boston however necessitates a dedicated airstrip of the same design at Doris. There is an existing 500 m long gravel all-weather airstrip at Boston; however, this airstrip cannot support the proposed design aircraft, and based on its location cannot be expanded.

1.2 Objectives

This memo provides preliminary engineering design details of the Boston airstrip.

2 Design Concept

2.1 Approach

The all-weather gravel airstrip is intended for private use to support year-round operations at Boston. Normal use would include regular scheduled crew changes, equipment and materials resupply, and emergency medical evacuation. The airstrip will also function as an emergency lifeline for special cargo delivery as required. The airstrip will be a non-precision approach runway in general accordance with the Aerodrome Standards and Recommended Practices (Transport Canada 2015).

The airstrip will be 1,524 m (5,000 ft) in length, and designed for the Bombardier Dash 8 and the gravel equipped Boeing 737-200, or equivalent aircraft. To retain flexibility and allow for larger aircraft to land, a 450 m extension (total airstrip length of 1,974 m) will also be considered.

2.2 Airstrip Components

The components associated with the Boston airstrip are:

- Airstrip;
- Apron;
- Access road; and
- Visual aids for navigation.

2.3 Topographic Data

Design of the Boston airstrip and associated access road are based on topographic contour maps with 1.0 m vertical resolution produced from 2012 satellite imagery supplied by TMAC. Detailed ground surveys have not been completed.

2.4 Foundation Conditions

A surficial geology and permafrost investigation was carried out at Boston in 1996 (EBA 1996). The investigation included air photo interpretation followed by ground truthing and completion of six onshore drill holes, followed up by laboratory testing of select geotechnical samples.
The investigation found the proposed Boston area is characterized mostly by marine deposits of silty-clay with trace sand. With small pockets of glaciofluvial deposits of coarse sand and some gravel (EBA 1996). Only one of the drill holes (BH7/12259-07) is located near the alignment of the airstrip, and this drill hole suggests that sand and silty sand deposits with ice lenses should be expected in the airstrip alignment (EBA 1996). Rock outcrop mapping by Sherlock (2002) supports this characterization, as few rock outcrops were identified in the proposed Boston airstrip area. The overburden soils in the area have very high water and ice content resulting in low strength when thawed.

Permafrost at the Project area extends to depths of about 565 m, with an average geothermal gradient of 0.021°C/m. Active layer depths in overburden soil averages 1.0 m, with a range from 0.5 to 1.7 m. General foundation conditions, and material properties for geotechnical analysis are described in more detail in the Geotechnical Design Parameters and Overburden Summary Report (SRK 2017a).

2.5 Environmental Setbacks

The following environmental setbacks have been applied when selecting the location of the infrastructure:

- Minimum 31 m setback from waterbodies, 51 m setback where ever possible;
- Minimum 30 m buffer zone from known rare plants; and
- Minimum 30 m buffer zone from known archeological sites.

While priority was given to avoid these areas, in some cases the minimum buffer around archeological sites and rare plants could not be maintained. In these instances, the archeological site will be mitigated in accordance with the Heritage Resources Protection Plan (TMAC 2016).

2.6 Airstrip Orientation

Airstrip orientation is largely determined by the wind characteristics of the area, with the preferred orientation being parallel to the prevailing wind direction. Site specific wind speed and direction data was collected from August 1998 to September 1999 and again from June to September of 2000 (SRK 2008). Analysis of the available wind data suggests bearings between 280° and 350°, or between 100° and 170° are optimal at the Boston airstrip.

3 Alternatives

3.1 Airstrip Locations

Several studies have previously been carried out identifying potential airstrip location at Boston (EBA 1993, 2011). A total of seven airstrip locations were previously identified as illustrated in Figure 1. The airstrip alternatives were reassessed for the current project description and design aircraft; no new airstrip locations were considered for this assessment. Table 3.1 describes the airstrip alternatives considered.

Table 3.1: Airstrip location Alternatives

Alternative	Details
1	Located on a relatively flat spit of land that projects into Aimaokatalok Lake, approximately 1 km from the Boston portal. This location is preferred as it is favorably orientated with respect to wind direction, it is located close to camp and there are no stream crossings in the alignment. The disadvantages of this location are that the airstrip lighting will likely have to extend into Aimaokatalok Lake, and the obstacle limitation surface will limit the ultimate height of the dry stack tailings.
2	Airstrip alternative 2 is located directly north of Stickleback Lake, over the area of the Boston portal. This location is not preferred as it overlies the mine workings where the crown pillar is less than 50 m, and blocks the portal. Expansion of this alternative would not be possible as it is confined by Aimaokatalok Lake to the north and Stickleback Lake to the south. The close proximity of this alternative to the Boston mining area is advantageous.
3	Airstrip alternative 3 is located east of Stickleback Lake approximately 4 km from the Boston portal. The disadvantage of this alternative is it is located in a wet area with many small streams, and drainage is expected to be an issue. The advantages of this location are that the airstrip can be expanded as needed, as this alignment has previously been assessed for a 3,000 m (9,843 ft) long airstrip (EBA 2011), and the airstrip is favorably orientated with respect to wind direction.
4	Airstrip alternative 4 is located east of Stickleback Lake, approximately 1.5 km from the Boston portal. The airstrip is not favorably oriented with respect to wind direction and the footprint lies within 31 m of Stickleback Lake. Expansion of this alternative would be difficult due to the close proximity of several lakes and streams. The advantage of this alternative is that it is very close to the Boston portal.
5	Airstrip alternative 5 is located southwest of Stickleback lake, approximately 3.5 km from the Boston portal. The airstrip alignment is favorably orientated with respect to wind direction This alignment crosses a stream. Additionally, due to the sloping topography, significant fill may be required.
6	Airstrip alternative 6 is located southwest of Stickleback Lake, approximately 3.5 km from the Boston portal. The airstrip alignment is favorably orientated with respect to wind direction This alignment crosses a stream and would require infilling of a small lake. Additionally, due to the sloping topography, significant fill may be required.
7	This airstrip is located on sloping terrain approximately 5.5 km south east of the Boston portal. This location would require the longest access road, and the access road would require several stream crossings. The airstrip alignment also crosses one stream. Additionally, due to the sloping terrain this airstrip would require large amounts of fill. The airstrip is favorably orientated with respect to wind direction.

Airstrip Alternative 1 is the preferred airstrip alternative because of its location near the camp, it oriented favorably with respect to the wind, and it does not cross streams.

4 System Design

4.1 Runway and Airspace

4.1.1 Design Criteria

The primary design aircraft is the Bombardier Dash 8 and the gravel equipped Boeing 737-200, or equivalents. The Dash 8 has a length of 22.3 m, a wing span of 25.9 m, and a maximum take-off weight of 16,465 kg. The Boeing 737-200 has a length of 30.5 m, a wing span of 28.4 m, and a maximum take-off weight of 45,722 kg. The Dash 8 requires a category IIIA airstrip, and the Boeing 737-200 requires a category IIIB airstrip (Transport Canada 2015).

The recommended airstrip length of a Dash 8 varies, but is less than 1,524 m (5,000 ft) for expected conditions in the Project area (Bombardier 1993). The Boeing 737-200 (Boeing 2013) has a recommended airstrip length of 1,829 m (6,000 ft); however; with a reduction in payload, the Boeing 737-200 can land on airstrips 1,524 m (5,000 ft) long (Boeing 2013). Therefore, the airstrip design length is 1,524 m (5,000 ft).

To retain the flexibility of allowing larger aircraft to land at the Boson airstrip, a potential future extension of 450 m (1476 ft) has been considered. The design aircraft for the extended airstrip is the Hercules C130 with a length of 29.3 m, a wing span of 39.7 m, and a maximum take-off weight of 69,750 kg. The Hercules C130 requires a category IV airstrip (Transport Canada 2015).

Since the Hercules C130 has more stringent design requirements than the Dash 8 and Boeing 737-200, the Hercules C130 will be adopted as the design aircraft for the initial 1,524 m (5,000 ft) airstrip for all criteria, excluding runway width and length. This will allow the airstrip to be upgraded by extending the airstrip length without having to redesign and reconstruct the existing airstrip. A summary of the design criteria of the Boston airstrip is provided in Table 4.1.

The design geometry and clearance requirements summarized in Table 4.1 will allow for the landing and takeoff of larger aircraft such as the Hercules C130. However, due to the shorter than recommended length of the proposed airstrip, these aircraft likely cannot be operated at their maximum payload. The judgement of the aircraft operator will ultimately determine the suitability of the airstrip to accept aircraft other than the Dash 8 and Boeing 737-200 design aircraft.

Table 4.1: Design Criteria of Boston Airstrip

Design Component	Design Criteria
Design Aircraft	Airstrip: Dash 8 and Boeing 737-200 Airstrip Extension: Hercules C130
Category	Dash 8: Category IIIA Boeing 737-200: Category IIIB Hercules C130: Category IV Design Adopted: Length and width – Category IIIB; All other components – Category IV
Runway Orientation	Between bearings 280° and 350°, or between 100° and 170° in the other direction (SRK 2008)
Runway Length	1,524 m (5,000 ft)
Runway Width	40 m (98 ft)
Approach Type	Non-Precision Approach
Taxiway	Not required
Ramp/Apron	Apron located at the south end of the airstrip with dimensions of 60 m x 100 m
Runway Slope	Maximum longitudinal slope of the runway of 1.25% up or down. Maximum longitudinal slope change of 1.25%. Vertical slope changes are joined with a curved surface with a maximum rate of change per 30 m of 0.1%. Symmetrical 1.0% crown for drainage. 3H:1V (18.4°) side slopes.
Runway Safety Area	Minimum distance of 75 m each side of the runway centreline and extended centreline with a maximum transverse slope of 2.5% down from the runway edge. Minimum length of runway end safety area is 150 m with a maximum slope of 1.5% up or down.
Waviness	The runway is designed so that no undulations occur, if undulations occur over time they should be filled in during regular maintenance.
Obstacle Clearance Requirements	No buildings, cargo or other obstructions shall be within 61 m of the runway centerline. Beyond that, any object must be below the obstacle limitation surface which arises with a slope of 25% to 23 m above the runway reference point and continues to rise with a slope of 14.3% to an outer surface 45 m above the runway reference point. The outer surface of the obstacle limitation surface extends in a circle with a radius of 4,000 m from the centerline of the runway.
End Clearance Requirements	At the end of each runway there is 61 m of level surface beyond which the end clearance surface of the runway rises with a slope 2.5% to a distance of 720 m, then for another 4,280 m with a slope of 2.9%. The end clearance surface extends for 5,000 m either end of the runway. The end clearance surface diverges from the 150 m clearance area centered on the runway centerline by 15% on either side.

Note(s):

1. *Runway* refers to the actual surface available for landing aircraft while the *Airstrip* includes the runway and runway safety areas. In this case, the runway includes the 150 m runway end safety area on either end.

4.1.2 Design

The airstrip is oriented at a bearing of 150° if approaching from the north and 230° if approaching from the south. This orientation puts it within the recommended airstrip orientation based on the prevailing wind direction in the area.

The longitudinal profile of the runway can be seen in Drawing BAS-02 (Attachment 1). From station 0+000 to 0+180, the runway slopes upward to the south by 0.4%. From stations 0+180 to 0+300, there is a transition curve with a radius of 30,142 m. From station 0+300 to station 0+760, the runway has no slope. There is another transitional curve with a radius of curvature of 28,273 m from stations 0+760 to 0+940. From stations 0+940 to 0+960, the runway has a slope of 0.6% downward to the south. There is a transitional curve with a radius of curvature of 83,812 from stations 0+960 to 1+500. Finally, the runway slopes downward at 1.2% from station 1+500 to its south end.

Thermal modelling was completed to determine how much fill would be required over the tundra to ensure the permafrost would be preserved for infrastructure construction (e.g. the airstrip and access road) (SRK 2017b). Based on this assessment, and air photo interpretation of the area, the minimum fill thickness should be 1.0 m. However, since it is critical that the airstrip surface remain free of irregularities and undulations, a minimum fill thickness of 2.0 m was selected as it is the thickness specified for the least favourable ground conditions. The minimum fill thickness of the runway safety area will be 1.0 m. The airstrip will be constructed from run-of-quarry (ROQ) material obtained from geochemically suitable rock quarries. This material will be placed in lift thicknesses that do not exceed 1.0 m and compacted to a density equivalent to a California Bearing Ratio (CBR) value of at least 30 using a site-specific compaction specification. The runway surface includes a 150 mm thick surfacing layer of 32 mm minus crushed rock and a 150 mm thick bedding layer of 19 mm minus crushed rock. The runway safety area is composed entirely of ROQ and does not have a surfacing or bedding layer.

The 40 m wide gravel runway will be crowned at 1% and have a minimum fill thickness of 2.0 m. The runway safety areas extend 55 m from the edge of the runway on both sides with a slope of 2.5%. The runway safety areas have a minimum fill thickness of 1.0 m and side slopes of 3H:1V. Drawing BAS-03 (Attachment 1) provides airstrip sections and details.

A 60 by 100 m apron will be at the south end of the airstrip to allow for turning and parking of the aircraft. The apron should have a minimum fill thickness of 1.0 m, comprised of a 150 mm thick surfacing layer and 150 mm thick bedding layer overlying ROQ fill (Drawing BAS-03, Attachment 1).

An approximately 60 by 60 m de-icing facility will be constructed in the south end of the airstrip opposite the apron. The de-icing facility is lined and has a containment berm around the perimeter. The facility will have a minimum of 0.9 m of fill above the liner system and a minimum 1% slope towards a sump. Details of the de-icing facility are presented in Drawings BAS-04 (Attachment 1).

The sump details are provided on Drawing BAS-04 (Attachment 1) will be a HDPE 900 mm diameter pipe with a plate welded to the bottom set 900 mm below grade. The containment area will have a minimum slope of 1% towards the sump. This is a typical sump design that has been constructed at existing fuel storage facilities at the site and has been proven to function effectively. Any excess water in the containment area will be tested and compared to the Water License water quality criteria. If the water meets discharge criteria it will be used as dust suppressant, alternately if it does not meet discharge criteria it will be transported to the Surge pond for treatment in the water treatment plant and ultimate discharge. If the water contains hydrocarbons it will first be pumped through a mobile oil-water separator.

Should an increase in runway length be deemed necessary, the airstrip can be extended as shown in Drawings BAS-01 and BAS-02 (Attachment 1). The airstrip extension will follow the same design criteria as the original airstrip and will extend 221 m to the north and 229 m to the south.

The obstacle limitation surface is described in Table 4.1 and illustrated in Drawing BAS-05 (Attachment 1). The aerodrome reference point from which the location of the outer surface is based was taken as 82.3 m, the centerline elevation of the runway at the midpoint of the runway length. The height of the objects on the south apron of the airstrip will be restricted by the obstacle limitation surface. Ground elevation in several areas surrounding the airstrip have been determined to be above the obstacle limitation surface (Drawing BAS-05, Attachment 1). It is understood that provided the aircraft operators are aware of these restrictions, it should be acceptable.

The airstrip is located on topographically high ground making any surface water runoff management measures unnecessary. Surface runoff will naturally flow away from the airstrip and apron. Should any ponded water accumulate against the airstrip and/or apron, it will be removed by mobile pumping.

4.2 Access Road

4.2.1 Design Criteria

The Boston airstrip will be accessible by an all-weather access road connecting the south apron and the Madrid-Boston all-weather road. The design criteria for the access roads is similar to that used on other roads on-site, specific criteria are listed below.

- The design vehicle will be crew cab trucks, personnel transfer busses, Super B fuel trucks and lowbed trucks;
- The access road shall have a maximum grade of 10%;
- The roadway will be crowned at 0.5% to promote drainage;
- Side slopes shall be 2H:1V (26.5°) when fill thickness is greater than 2 m, and 1.5H:1V (34°) when fill thicknesses are less than 2 m;
- The road shall be single lane with a minimum width of 8 m and turnouts to allow for passing;
- Where road thickness is greater than or equal to 3 m, safety berms or barriers will be placed along the road edge, and the road crest will be widened to accommodate the berms; and
- No cut is allowed into overburden.

4.2.2 Design

The proposed road alignment is included in Drawing BAS-06 (Attachment 1). The southern portion of the access road will double as a contact water pond berm for the Boston tailings management area (TMA), this is described in SRK (2017c).

The road thickness varies depending on fill zone. Fill zones are assigned based on site specific ground conditions identified through air photo interpretation as follows:

- Bedrock Zone is exposed bedrock outcrop that may be blasted if necessary and has a minimum fill thickness of 0.3 m;
- Zone 1 is even, un-patterned ground and has a minimum fill thickness of 1 m;
- Zone 2 is transitional, un-patterned ground with indications of drainage areas, but no frost polygons. This zone has a minimum fill thickness of 1.5 m; and
- Zone 3 is patterned ground with observable frost polygons or wet areas and has a minimum fill thickness of 2 m.

The road will consist of 0.15 m of surfacing material overlying a layer of ROQ material. A turnout will be located where the access road intersects the Madrid-Boston all-weather road. The access road plan and typical cross sections can be seen in Drawing BAS-06 (Attachment 1).

A preferential drainage path has been identified through air photo interpretation at station 0+125 of the access road. To avoid ponding water along the edges of the road, a corrugated steel culvert or a rock drain will be installed in the road.

4.3 Visual Aids for Navigation

In accordance with the Aerodrome Standards and Recommended Practices (Transport Canada 2015), a wind direction indicator will be positioned near each end of the runway a minimum of 60 m from the runway edge. The wind direction indicator will have a maximum height of 7.5 m above grade and must be clear of the obstacle limitation surface. It must be visible from aircraft in flight and should be positioned in such a way as to be unaffected by air disturbances caused by nearby objects.

The following lighting elements will be required for the Boston airstrip:

- Two sets of omnidirectional approach lighting systems extending 450 m beyond the ends of the runway;
- Two wind direction indicator lighting systems;
- Runway edge lights;
- Runway end and threshold lights;
- One aerodrome beacon; and
- Two apron floodlights.

The omnidirectional approach lighting systems extending to the north of the airstrip will extend into Aimaokatalok Lake and will require the use of a floating anchored lighting system.

5 Construction Methodology

All construction fill materials will be obtained from geochemically suitable permitted quarries, or geochemically suitable waste rock. Management and monitoring of these quarries will be according to the quarry monitoring plan (TMAC 2017). Surfacing (32 mm minus) and bedding (19 mm minus) materials will be produced at an on-site crusher located within one of the permitted quarries. The estimated construction quantities are provided in Drawing BAS-07 (Attachment 1).

Based on previous surface infrastructure construction on the Project it is assumed that the construction fleet will consist of CAT 730 haul trucks, CAT 773 haul trucks, CAT D8 dozers, CAT C330 excavator(s), CAT CS563 compactor and a crusher.

Prior to construction, the airstrip and access road alignments should be cleared of snow and ice. At no time will disturbance of the tundra vegetation or soils be allowed outside of the airstrip and access road footprint, and no permafrost disturbance will be allowed. Construction fill will be placed by end-dumping on the existing road or airstrip surface and pushing the dumped material with a bulldozer. Surfacing and bedding materials will not be placed until the underlying layer is compacted, at design grade and level and a topographical survey has been performed. All construction should be performed in accordance with the technical specifications (SRK 2011). Where necessary, rock drains will be installed at topographic lows to ensure no standing water is created along the edges of the airstrip or access road.

Wherever possible, the airstrip and access road will be constructed in the winter to ensure the foundation materials remain frozen. Summer construction may be required to meet development schedules. Winter and summer construction techniques will be identical; however, summer construction will result in the use of more construction material as greater imbedding of material into the active layer will occur. Summer construction will also require careful screening of the site for nesting birds, and modifications to the construction schedule may be required to avoid disturbing nesting populations.

6 References

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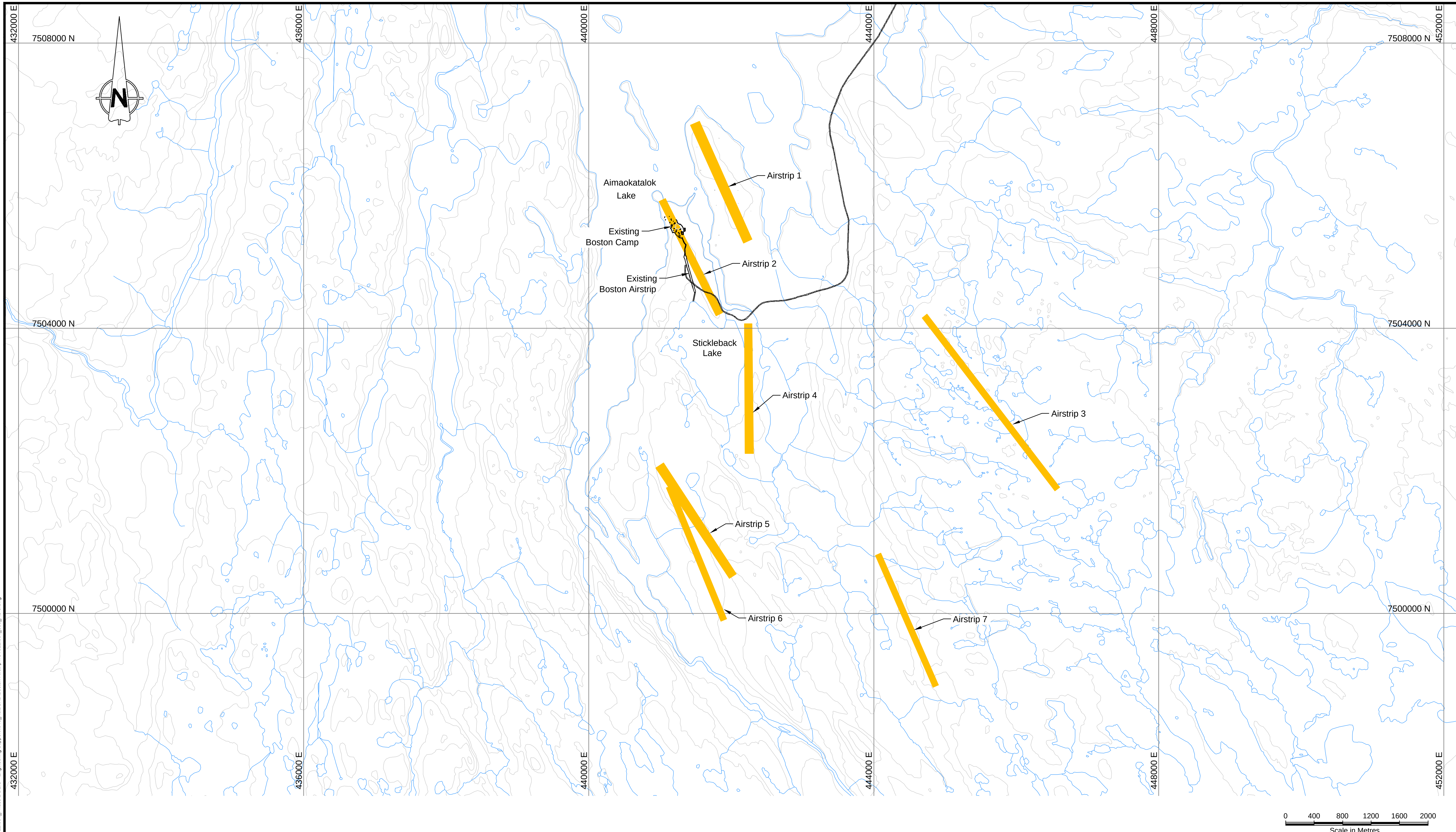
Figures



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SRK JOB NO.: 1CT022.004

FILE NAME: 1CT022.004_630_Boston_AS-3.dwg

TMAC RESOURCES

Hope Bay Project

Boston Airstrip Design

Boston Airstrip Alternatives

DATE:	APPROVED:	FIGURE:
May 2016	EMR	1

Attachment 1: Drawings

Engineering Drawings for the Boston Airstrip Hope Bay Project, Nunavut, Canada

ACTIVE DRAWING STATUS

DWG NUMBER	DRAWING TITLE	REVISION	DATE	STATUS
BAS-00	Engineering Drawings for the Boston Airstrip Hope Bay Project, Nunavut, Canada	C	Dec. 8, 2017	Issued for Discussion
BAS-01	General Arrangement	C	Dec. 8, 2017	Issued for Discussion
BAS-02	Runway Plan and Profile	B	Dec. 8, 2017	Issued for Discussion
BAS-03	South Apron Plan and Sections	B	Dec. 8, 2017	Issued for Discussion
BAS-04	De-icing Apron Typical Section and Details	B	Dec. 8, 2017	Issued for Discussion
BAS-05	Obstacle Limitation Surface and Obstruction Areas	C	Dec. 8, 2017	Issued for Discussion
BAS-06	Obstacle Limitation Surface Details	B	Dec. 8, 2017	Issued for Discussion
BAS-07	Access Road Plan and Sections	C	Dec. 8, 2017	Issued for Discussion
BAS-08	Material List and Quantity Estimates	B	Dec. 8, 2017	Issued for Discussion

TMAC RESOURCES

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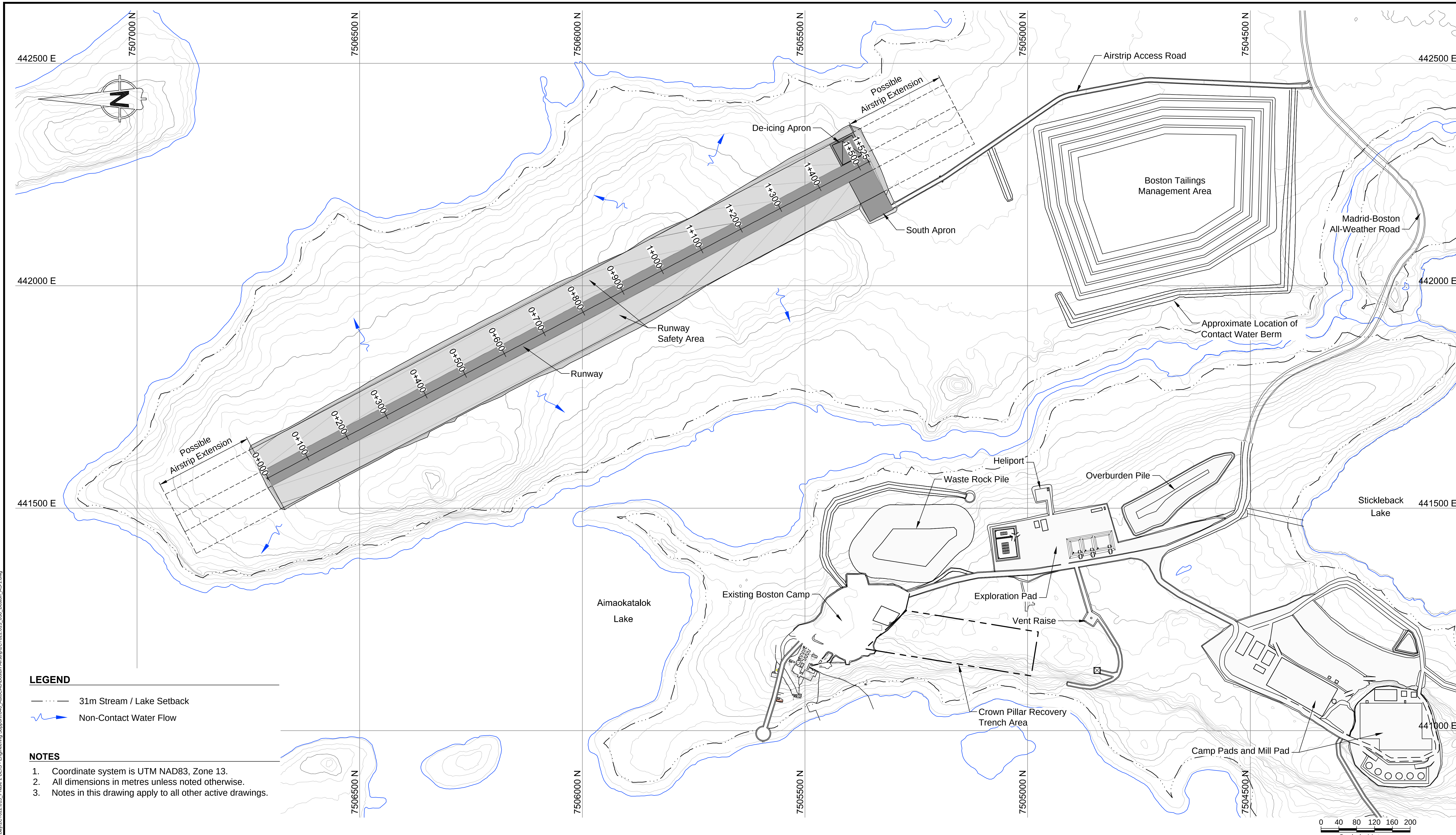
PROJECT NO: 1CT022.013
Revision C
December 8, 2017
Drawing BAS-00



LEGEND

- 31m Stream / Lake Setback
- Non-Contact Water Flow

NOTES

1. Coordinate system is UTM NAD83, Zone 13.
2. All dimensions in metres unless noted otherwise.
3. Notes in this drawing apply to all other active drawings.

NO.	DESCRIPTION	CHK'D	APP'D	DATE
C	Issued for Discussion	CH	EMR	8Dec17
B	Issued for Discussion	CH	EMR	22Nov16
A	Issued for Discussion	MMM	EMR	8Jul16

REVISIONS

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE

REFERENCE DRAWINGS

PROFESSIONAL ENGINEERS STAMP

srk consulting

DESIGN: KK | DRAWN: NV | REVIEWED: CH
CHECKED: CH | APPROVED: EMR | DATE: Dec. 2017

FILE NAME: 1CT022.013_Boston_AS-1.dwg

TMAC RESOURCES

HOPE BAY PROJECT

SRK JOB NO.: 1CT022.013

Boston Airstrip Design

DRAWING TITLE:

General Arrangement

DRAWING NO.: BAS-01 | SHEET: 2 OF 9 | REVISION NO.: C

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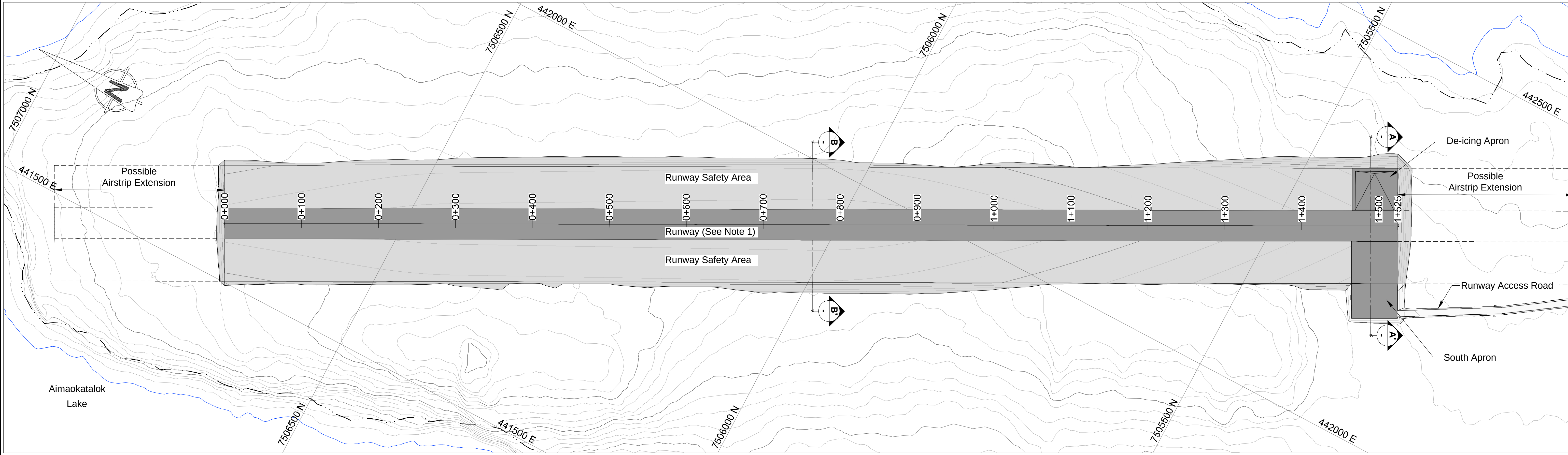


BOSTON RUNWAY PLAN VIEW

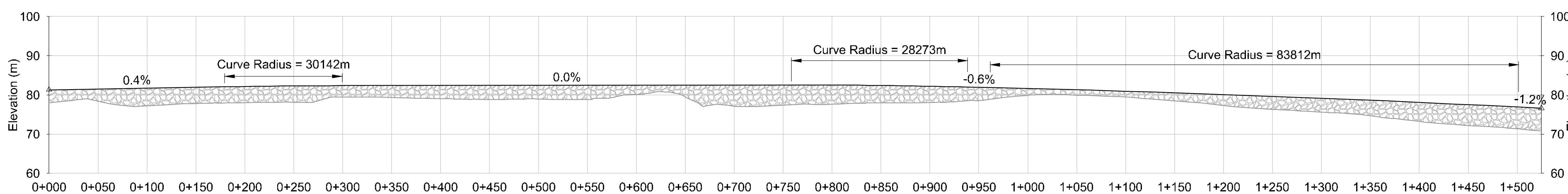
0 20 40 60 80 100
Scale in Metres

LEGEND

- Finishing Material
- Surfacing Material
- Run of Quarry Material
- 31m Stream / Lake Setback

NOTE

1. Runway shown includes end safety area.



BOSTON AIRSTRIP PROFILE

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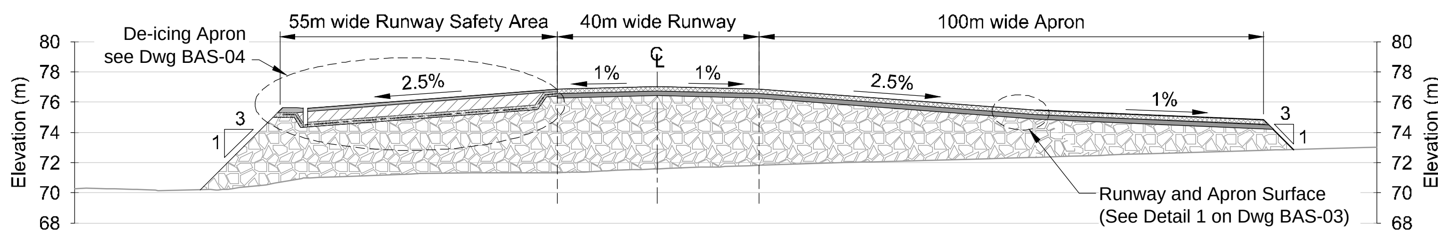
Horizontal Scale in Metres
Vertical Exaggeration 4X



A - SECTION A - A'

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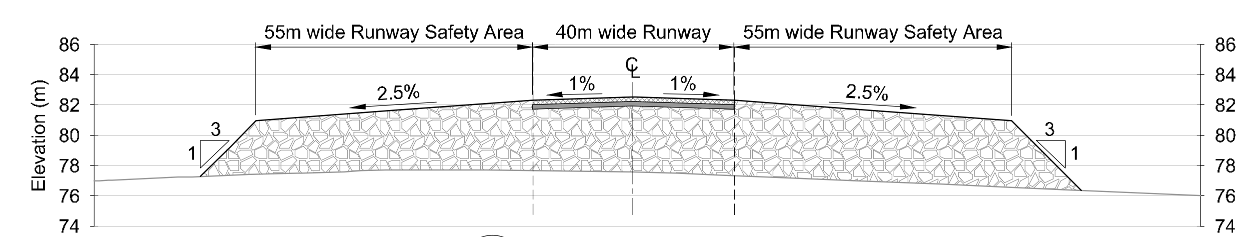
Vertical Exaggeration 3X



B - SECTION B - B'

0 5 10 15 20 25
Horizontal Scale in Metres
Vertical Exaggeration 3X

NO.	DESCRIPTION	CHK'D	APP'D	DATE
B	Issued for Discussion	CH	EMR	8Dec17
A	Issued for Discussion	MMM	EMR	8Jul16

REVISIONS

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE

REFERENCE DRAWINGS

PROFESSIONAL ENGINEERS STAMP

srk consulting

DESIGN: KK | DRAWN: NV | REVIEWED: KK
CHECKED: CH | APPROVED: EMR | DATE: Dec. 2017

FILE NAME: 1CT022.013_Boston_AS-1.dwg

TMAC RESOURCES

HOPE BAY PROJECT

SRK JOB NO.: 1CT022.013

Boston Airstrip Design

DRAWING TITLE: Runway Plan and Profile

DRAWING NO. BAS-02 | SHEET 3 OF 9 | REVISION NO. B

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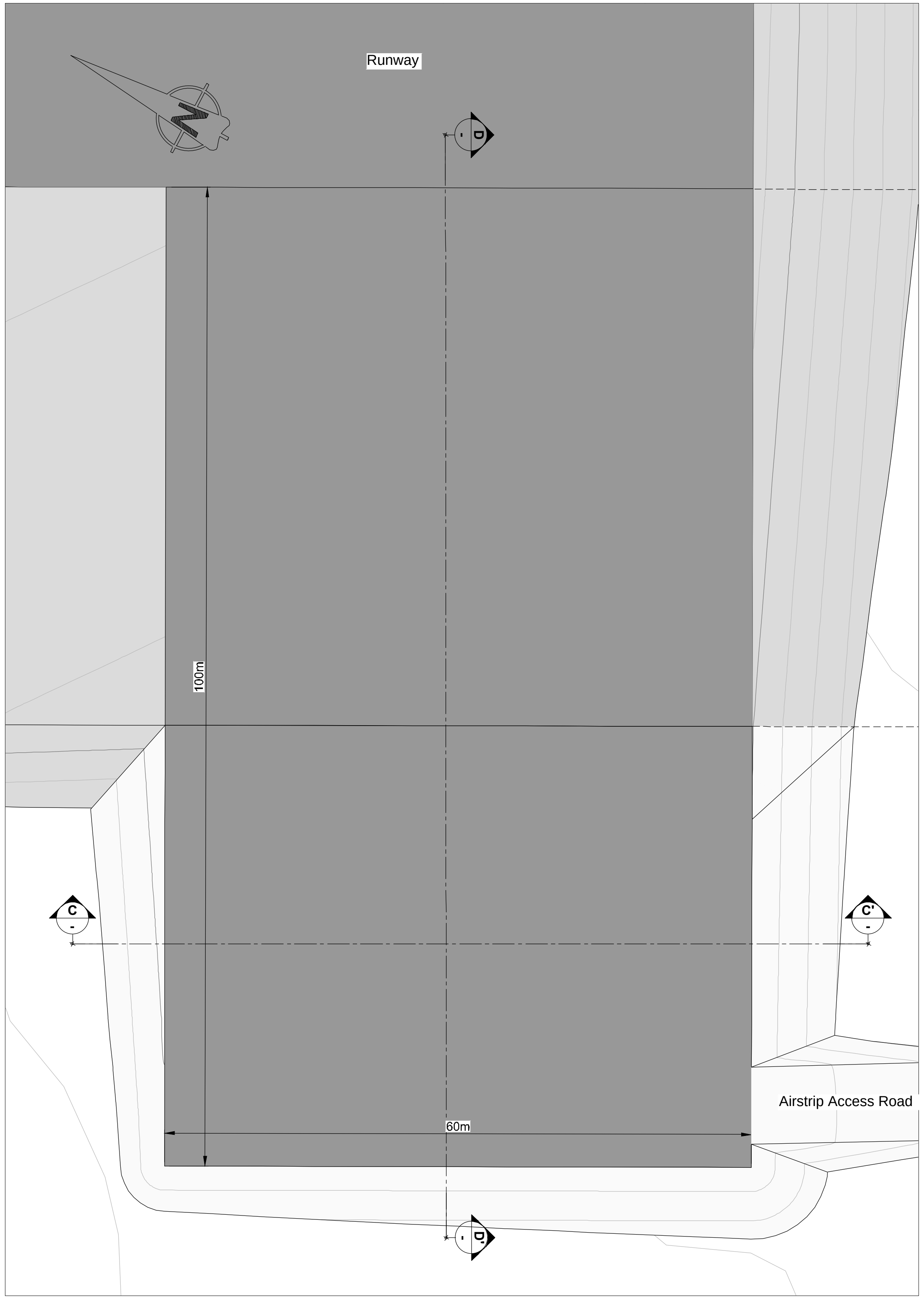
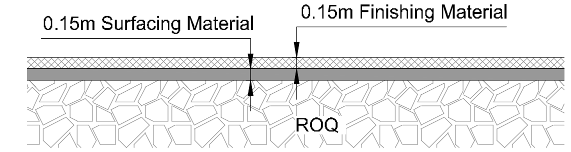


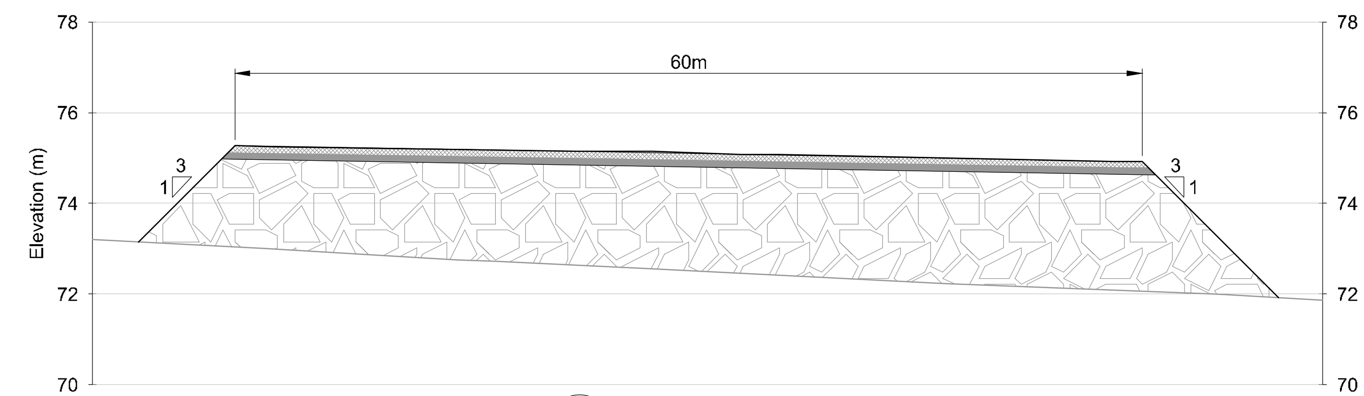
SOUTH APRON PLAN VIEW

0 2 4 6 8 10
Scale in Metres



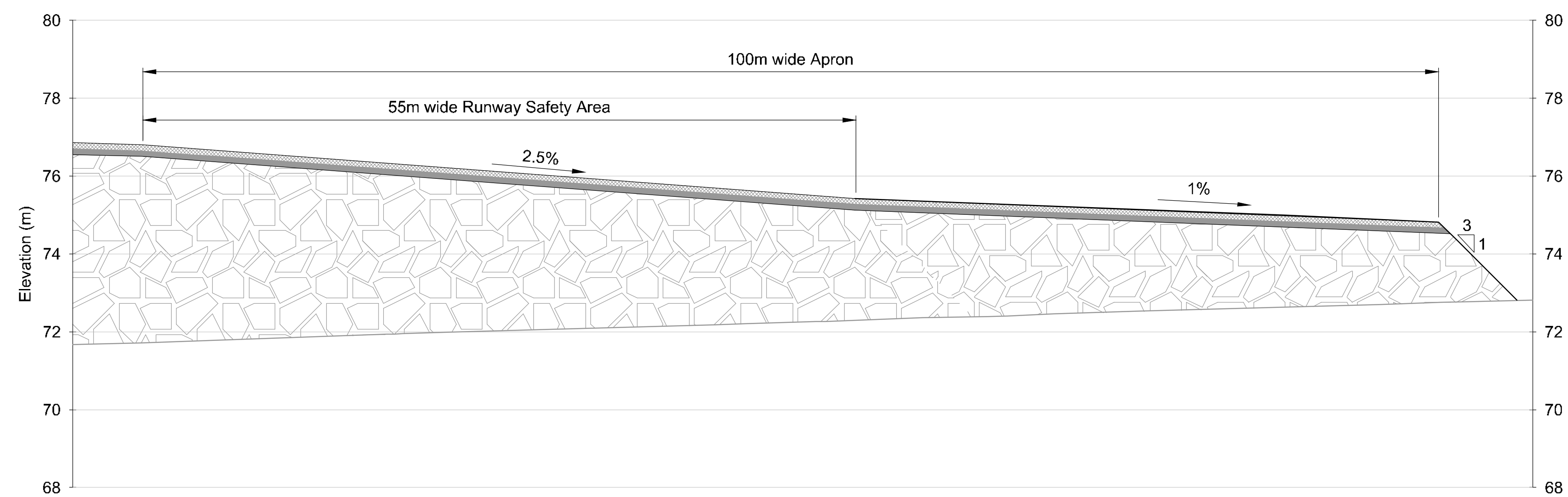
DETAIL 1 (1 / BAS-02)

0 0.5 1 1.5 2 2.5
Scale in Metres



SECTION C - C' (C / -)

0 2 4 6 8 10
Horizontal Scale in Metres
Vertical Exaggeration 3X



SECTION D - D' (D / -)

0 2 4 6 8 10
Horizontal Scale in Metres
Vertical Exaggeration 3X

LEGEND

- Finishing Material
- Surfacing Material
- Run of Quarry Material

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NO.	DESCRIPTION	CHK'D	APP'D	DATE
B	Issued for Discussion	CH	EMR	8Dec17
A	Issued for Discussion	MMM	EMR	8Jul16

REVISIONS

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE

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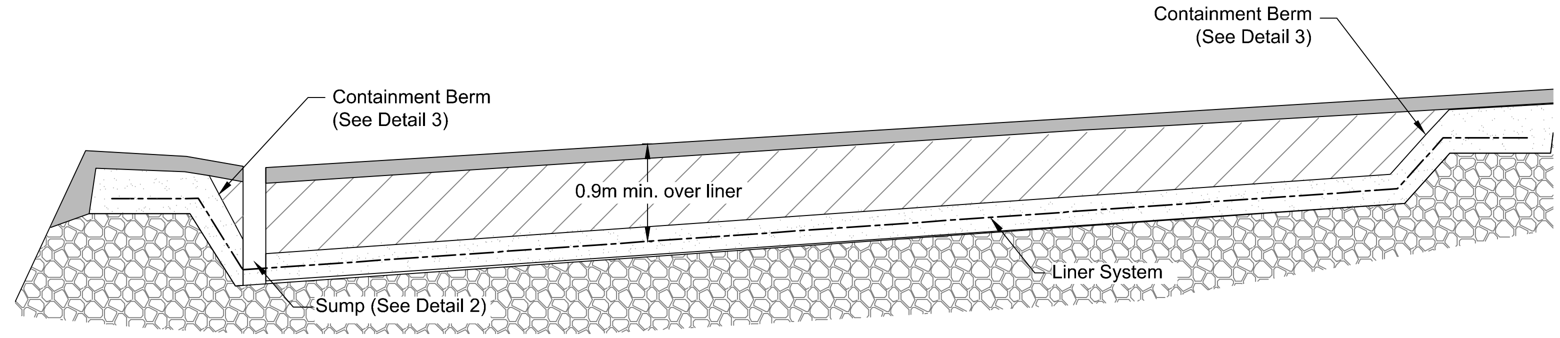
HOPE BAY PROJECT

SRK JOB NO.: 1CT022.013

Boston Airstrip Design

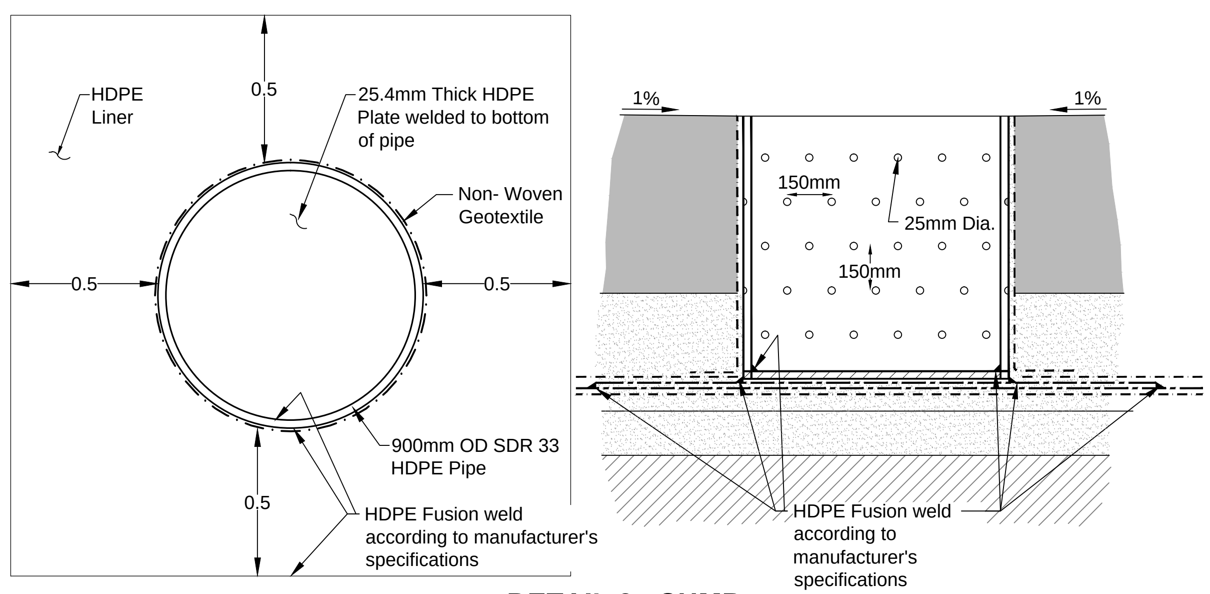
DRAWING TITLE:
South Apron
Plan and Sections

DRAWING NO.: BAS-03
SHEET 4 OF 9
REVISION NO.: B



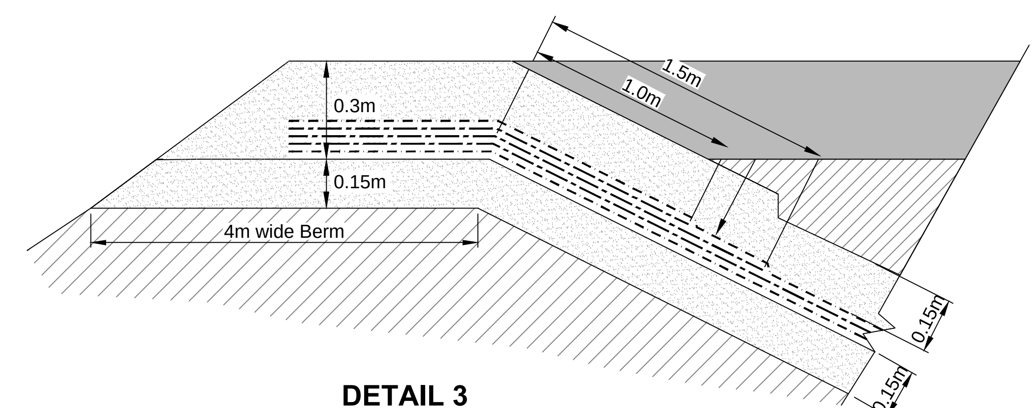
TYPICAL DE-ICING APRON SECTION

NTS



DETAIL 2 - SUMP

NTS



DETAIL 3
TYPICAL LINER SYSTEM AT CONTAINMENT BERM

NTS

LEGEND

- Surfacing Material
- Bedding Material
- Transition Material
- Run of Quarry Material
- Rip Rap
- Non-woven Geotextile
- HDPE Liner
- Airstrip / Apron Design
- Existing Ground
- Original Ground

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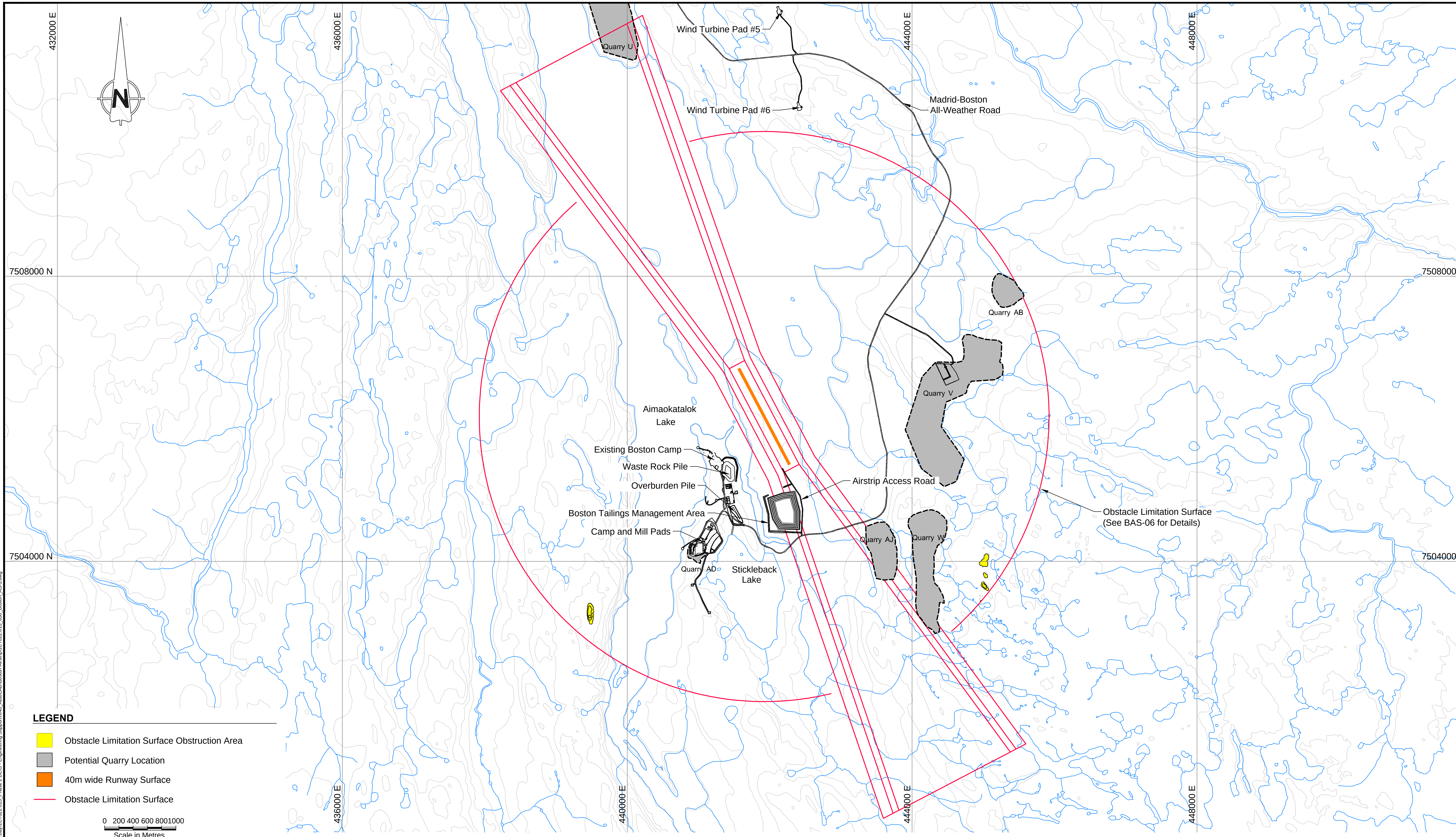
Boston Airstrip Design

DRAWING TITLE:
De-icing Apron
Typical Section and Details

DRAWING NO. BAS-04 | SHEET 4 OF 9 | REVISION NO. B



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NO.	DESCRIPTION	CHK'D	APP'D	DATE
C	Issued for Discussion	CH	EMR	8Dec17
B	Issued for Discussion	CH	EMR	22Nov16
A	Issued for Discussion	MMM	EMR	8Jul16

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HOPE BAY PROJECT

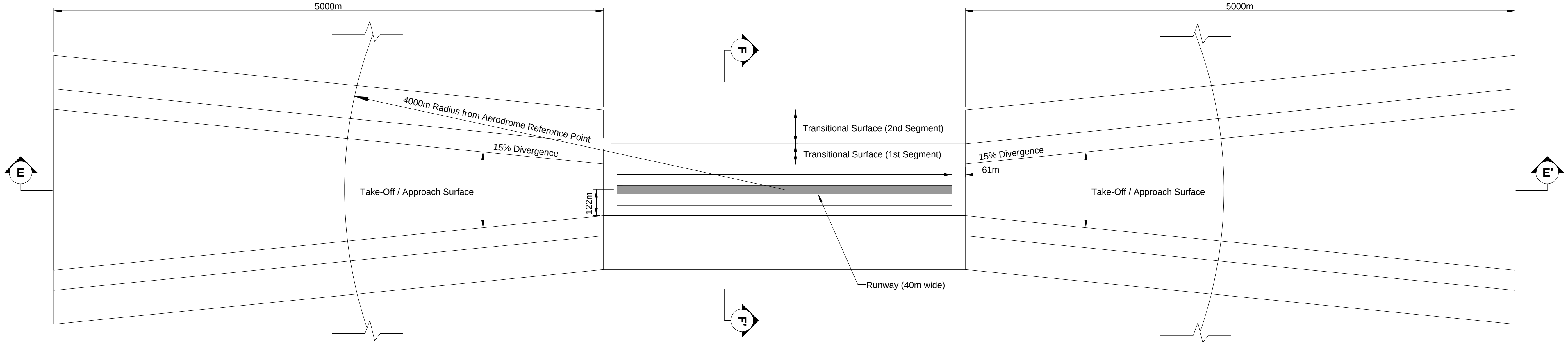
SRK JOB NO.: 1CT022.013

Boston Airstrip Design

DRAWING TITLE:

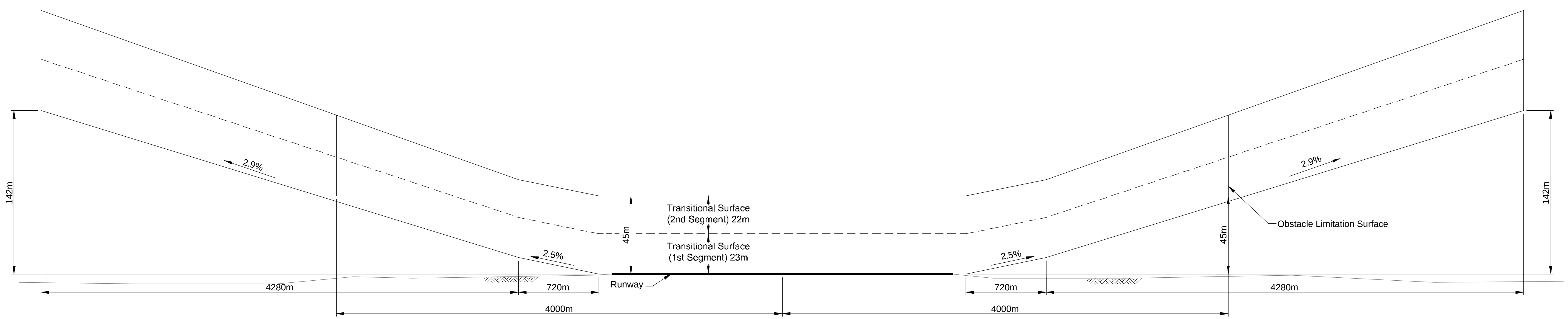
Obstacle Limitation Surface and Obstruction Areas

DRAWING NO.: BAS-05 | SHEET 6 OF 9 | REVISION NO. C



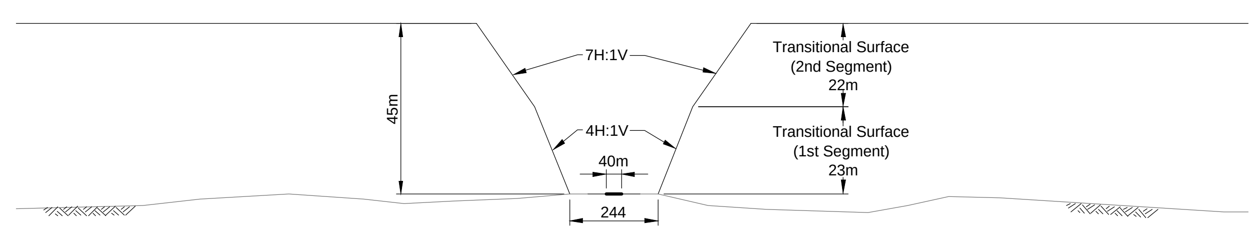
TYPICAL OBSTACLE LIMITATION SURFACE PLAN VIEW

not to scale



SECTION E - E'

not to scale



SECTION F - F'

not to scale

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A	Issued for Discussion	MMM	EMR	8Jul16

REVISIONS

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Boston Airstrip Design

DRAWING TITLE:

Obstacle Limitation Surface Details

DRAWING NO.: BAS-06 | SHEET: 7 OF 9 | REVISION NO.: B

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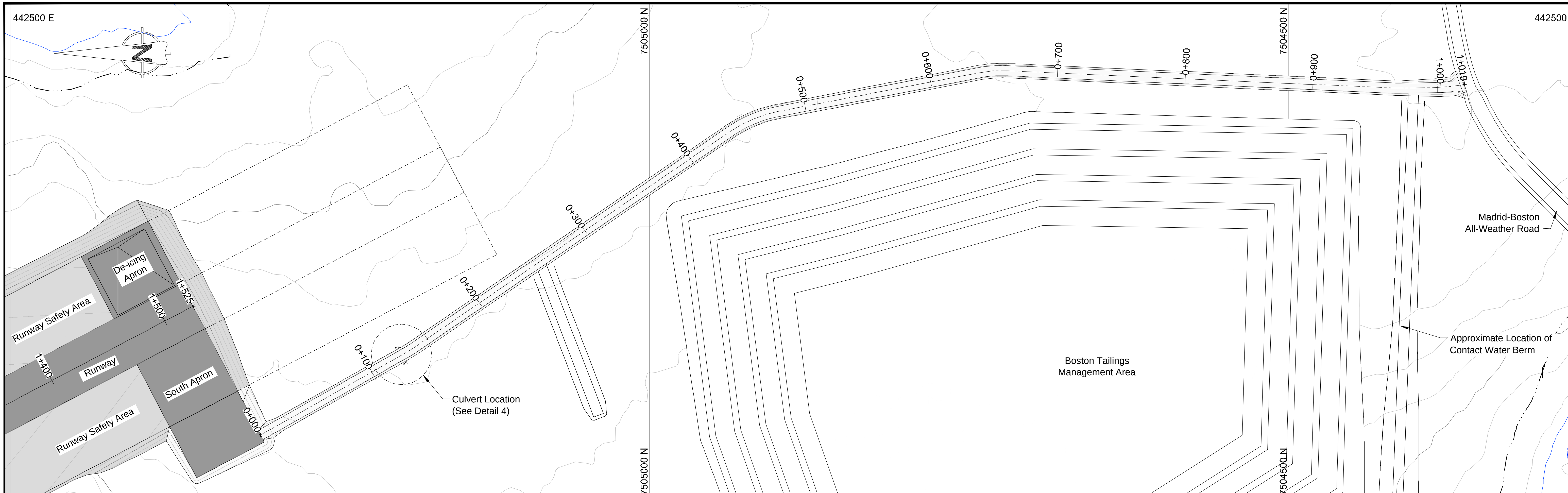
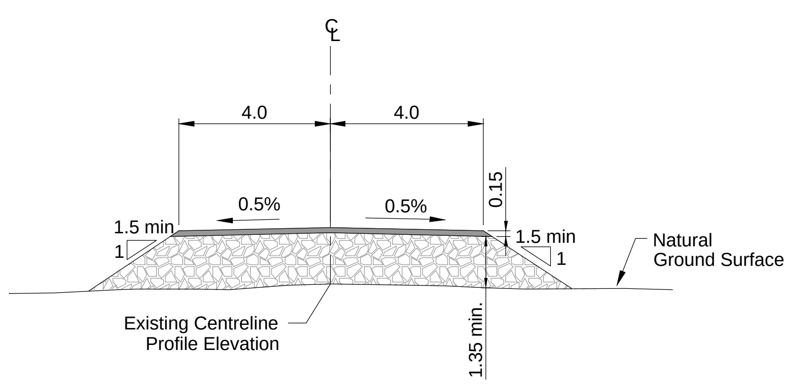


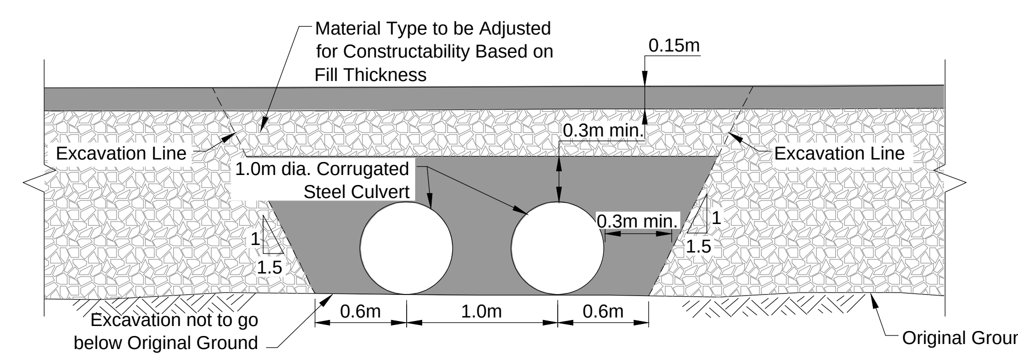
ACCESS ROAD PLAN VIEW

0 10 20 30 40 50
Scale in Metres



TYPICAL ACCESS ROAD SECTION

NOT TO SCALE



DETAIL 2
TYPICAL CROSS SECTION OF
4 NON-FISH-BEARING STREAM CULVERT CROSSING

NOT TO SCALE

LEGEND

- Finishing Material
- Surfacing Material
- Run of Quarry Fill

NOTES

1. All dimensions in metres unless noted otherwise.
2. Minimum design thickness must be maintained for all sections of the access road.

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REFERENCE DRAWINGS

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DESIGN: KK | DRAWN: NV | REVIEWED: CH
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FILE NAME: 1CT022.013_Boston_AS-1.dwg

HOPE BAY PROJECT

SRK JOB NO.: 1CT022.013

Boston Airstrip Design

DRAWING TITLE: Access Road Plan and Sections

DRAWING NO. BAS-07 | SHEET 8 OF 9 | REVISION NO. C

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Materials List and Quantity Estimates

Item	Quantity / Area / Volume			Description
		ROQ (cu.m.)	Cut (cu.m.)	
1. Run of Quarry Material	Runway and South Apron	757,300	6,700	Approximate In-Place Neat-line Volume (3D volume based on Civil 3D surfaces - no allowance has been made for losses and/or tundra embedment)
	Runway Access Road	12,500		
	Totals	769,800	6,700	
2. Surfacing Material	Runway and South Apron	10,050		Based on Runway/Road Surface Areas
	Runway Access Road	1,200		
	Totals	11,250		
2. Finishing Material	Runway and South Apron	10,050		Based on Runway/Apron Surface Areas

Tolerances Road Material Placement:

Location	Fill (mm)	Excavation (mm)
Vertical Tolerance on Roads	0 to +75	n/a
Horizontal Tolerance on Roads	-150 to +150	

Note: Grade shall not be uniformly high or low.

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TMAC RESOURCES

HOPE BAY PROJECT

SRK JOB NO.: 1CT022.013

Boston Airstrip Design

DRAWING TITLE: Material List and Quantity Estimates

DRAWING NO.: BAS-08
SHEET 9 OF 9
REVISION NO.: B

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