

Volume 1 Annex V1-7 Type A Water Licence Applications

Package P5-8

Hope Bay Project: Wind Energy Project
Preliminary Design



Memo

To:	John Roberts, PEng, Vice President Environment	Client:	TMAC Resources Inc.
From:	Cameron Hore, CPEng	Project No:	1CT022.013
Reviewed By:	Maritz Rykaart, PhD, PEng	Date:	November 30, 2017
Subject:	Hope Bay Project: Wind Energy Project Preliminary Design		

1 Introduction

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.

The Hope Bay Wind Energy Project (HBWEP) consists of six (6) wind turbines and associated access roads, crane pads and electrical cabling, with two (2) turbines located at each site: Doris, Madrid, and Boston. This memo provides complete details of the HBWEP infrastructure. This should be read in conjunction with the attached set of engineering drawings (Attachment 1).

2 Design Concept

2.1 Approach

The overall design concepts for the HBWEP infrastructure (i.e., pads and roads) are based on the same principles as used for the existing approved Doris infrastructure. All pads and roads will be constructed either on bedrock, or geochemically suitable rockfill pads designed to protect the permafrost. Site layouts are designed to minimize the overall footprint and avoid disturbance of waterways.

Access roads are considered private roads, administered and controlled entirely by TMAC. TMAC has opted to design all site roads to mine haul road standards as set out in the Nunavut Mine Health and Safety Regulation (WSCC 2015).

2.2 Infrastructure Components

The surface infrastructure associated with the HBWEP include the electrical collector system, access roads, and pads to support construction and operation of the wind turbines. These components, for all six (6) turbines, are summarized in Table 2.1.

Table 2.1: Summary of Infrastructure Associated with HBWEP (6 Turbines)

Infrastructure Component	Surface Area / Length	Limitations and Comments
Wind Turbines	2,700 m ² (foundation area)	6 x 4.2 MW E-126 EP4 turbines from Enercon (99 m high hub height, 127 m rotor diameter). See Attachment 1 and Attachment 2 for Turbine Details, and Drawing TB-24 for Foundation Details.
Electrical Collector System	33,700 m	Medium voltage (25 to 35 kV) surface-run 4/0 AWG TECK interlocked armoured cable (50 mm diameter). Placed on tundra along road alignments.
Access Roads	33,260 m ² 3,134 m length	As per existing site access roads.
Crane Pads	33,750 m ²	Construction pads for assembly and construction of turbines immediately adjacent to turbine foundations.

2.3 Location Criteria

The key criteria in siting of the wind turbines is summarised in Table 2.2.

Table 2.2: Summary of Key Siting Criteria

Criteria	Description
Flight path	The wind turbines cannot be located within the Doris or Boston Airstrip flight path exclusion zones (Drawing TB-02 and TB-16, Attachment 1).
Ice throw exclusion zone	The wind turbines have a 200 m exclusion zone due to the potential for ice throw from the turbine blades. This applies to regularly occupied or travelled areas including camp pads and haul roads (including the All-Weather Roads (AWRs)).
Elevation	Areas of higher elevation are preferred, due to the likelihood of higher wind speeds on hilltops.
Wind potential	A wind resource assessment has been undertaken based on available wind data to determine optimal turbine locations within the project area.
Wake losses	The turbines must be spaced at least 500 m apart to negate wake losses from one turbine to another.
Foundation	The turbines should be founded on competent bedrock where possible.
Constructability	The turbines should be located such that the access roads and crane pads can be constructed with minimal earthworks. This requires large relatively flat areas on or adjacent to bedrock outcrops for the crane pads.
New infrastructure	The turbines should be located to make use of existing infrastructure for access roads and electrical collector cable routes where possible.

2.4 Foundation Conditions

2.4.1 Bedrock

The crane pads and turbines will be constructed with bedrock foundations. Competent bedrock foundations will be obtained by drilling and blasting exposed bedrock ridges. The most prevalent rock types on site with surface exposure are mafic volcanics, predominantly basalt. The bedrock ridges in the turbine locations are characterised as Ultramafic to Mafic Metavolcanic Rock (Drawing TB-08, TB-15 and TB-22, Attachment 1). This is the same rock type as the existing permitted construction material quarries. As described in SRK (2017a), this blasted material is therefore suitable for use in construction of the crane pads.

Complete details regarding geochemical and geotechnical characteristics of the bedrock foundation conditions, including design parameters, are found in SRK (2017a) and SRK (2017b).

2.4.2 Overburden

The access roads will be primarily constructed on overburden foundation areas.

Detailed geotechnical site characterisation studies have not been performed along the entire length of the proposed access roads. The Project area has however been well studied, and foundation conditions and geology along the road lengths are similar. For details on these conditions refer to SRK (2017b).

Permafrost at the Project area extends to depths of about 570 m and is absent beneath some large lakes. The ground temperature near the depth of zero annual amplitude ranges from -9.8 to -5.6°C , with an average of -7.6°C . Active layer depth based on ground temperatures measured in overburden soil averages 0.9 m with a range from 0.5 to 1.4 m. The average geothermal gradient is 0.021°C/m .

Permafrost soils are comprised mainly of marine clays, silty clay and clayey silt, with pockets of moraine till underlying these deposits. The marine silts and clays contain ground ice on average ranging from 10 to 30% by volume, but occasionally as high as 50%. The till typically contains low to moderate ice contents ranging from 5 to 25%.

Overburden soil pore water is typically saline due to past inundation of the land by seawater following deglaciation of the Project area. The salinity typically ranges from 37 to 47 parts per thousand which depresses the freezing point and contributes to higher unfrozen water content at below freezing temperatures.

General foundation conditions, material properties for geotechnical analysis, and development of the overburden isopach surface are described in more detail in SRK (2017b).

2.5 Environmental Setbacks

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

- Minimum 31 m setback from waterbodies, 50 m setback where possible;
- Minimum 30 m buffer zone from known rare plants; and
- Minimum 30 m buffer zone from known archeological sites.

There are no known instances where these setbacks have not been upheld for the HBWEP.

3 Alternatives

3.1 Turbine Locations

Alternative locations were sited and assessed based primarily on the flight path and ice throw exclusion zones, wind potential, foundation conditions and constructability. Table 3.1 to Table 3.3 list the general site layouts that were considered for Doris (Figures 1 to 3), Madrid (Figure 4 to 5) and Boston (Figures 6 to 7), respectively.

Alternative D2 locations are preferred for the two Doris turbines. All locations meet the exclusion zone, turbine separation, wind potential and foundation criteria; however, the Alternative D2 Turbine #1 site has more favourable foundation and constructability conditions, compared to the Turbine #1 location in Alternative D1. Alternative D3 was not further assessed due to the greater length of access roads required, and the turbine locations are outside the project boundaries previously included in the environmental assessment covered by TMAC's current Project Certificate (No. 003).

Alternatives M3 and M4 are preferred locations for the two Madrid turbines. All locations meet the exclusion zone, turbine separation and foundation criteria; however, Alternative M3 and M4 require the least amount of access road construction. Alternatives M1 and M2 were not further pursued to avoid sterilisation of these areas from potential future expansion. The substation for the Madrid turbines will be located at the Madrid North site.

Alternatives B5 and B6 are preferred locations for the two Boston turbines. All locations meet the exclusion zone, turbine separation and foundation criteria; however, Alternative B5 and B6 are the closest locations to Boston with reasonable access road requirements. Alternative B8 and B9 was not pursued based on the difficulty accessing the location as long access roads or aquatic vehicles would be needed.

Table 3.1: Doris Alternative Infrastructure Locations

Alternative	Distance to Doris	Pad Elevation (masl)	Access Road Length (m)	Details
D1	1.9 km 3.0 km	85 85	540 600	Turbine #1 would be located near the Doris Central vent raise. This layout meets all flight path and ice throw exclusions zones, wind potential, turbine separation and foundation conditions criteria. However, the rock outcrop for Turbine #1 is not suitable for the crane pad construction. To achieve the required level crane pad area, extensive drilling and blasting of the outcrop and large construction fills would be required.
D2	2.5 km 3.0 km	93 85	560 600	Turbines are located near the Doris-Windy AWR, south of Doris.
D3	9.8 km 9.3 km	125 110	4800	Turbines would be located west of Roberts Bay. These locations have a greater wind potential. However, it is located outside the area defined by the current Project Certificate, is outside of the current TMAC mining lease, and would require significant new infrastructure to develop.

Note: masl = metres above sea level

Table 3.2 Madrid North Alternative Infrastructure Locations

Alternative	Distance to Madrid North	Pad Elevation (masl)	Access Road Length (m)	Details
M1	2.0 km	70	380	This location has been ruled out to avoid sterilisation of this area from potential future expansion.
M2	0.7 km	75	360	This option has the highest elevation with flat ground, however the topography is sloped and will require a steep road. This location has been ruled out to avoid sterilisation of this area from potential future expansion.
M3	1.6 km	65	230	A short access road is required to reach the Madrid-South AWR. The surrounding ground is gradually sloped. This alternative has the least amount of road construction and is the closest viable alternative to Madrid North.
M4	3.1 km	71	400	Location M4 is at a relatively high elevation and the access road route allows relatively simple construction.
M5	4.0 km	75	500	A relatively long access road is required to reach the Madrid-Boston AWR with some construction complexity. This location has irregular topography and is the furthest away from Madrid North.
M6	2.6 km	75	360	The rock outcrop for Location M6 is not suitable for the crane pad construction. To achieve the required level of the crane pad, extensive drilling and blasting of the outcrop and large construction fills would be required.

Table 3.3 Boston Alternative Infrastructure Locations

Alternative	Distance to Boston	Pad Elevation (masl)	Access Road Length (m)	Details
B1	14.0 km	102	260	This location is the North-most, furthest alternate location from the Boston site and has a relatively low elevation.
B2	13.0 km	101	220	This location will have the shortest access road; however, this location is far from the Boston site and has a relatively low elevation.
B3	10.0 km	101	550	This location is the closest in proximity to the Boston site from the Northeast region, however it requires a long access road that also requires a stream crossing.
B4	12.5 km	107.5	725	This location can not be used in conjunction with Location B6 which is the preferred alternative as it does not meet the 500 m separation to minimise wake losses.
B5	11.5 km	107	640	This location has a relatively high elevation, is relatively close to the Boston site and the access road does not require any complex construction.
B6	12.0 km	115	705	This location has the highest elevation of the feasible locations and is the preferred alternative for this reason.
B7	8.8 km	101.5	920	This location has a relatively low elevation and requires a long access road.
B8	6.0 km	118.5	4000	This option has a high elevation but requires the longest access road to reach the Madrid-Boston AWR.
B9	2.2 km	122	2 x 200	This option is the closest, however, this location would require seasonal access by boat, and access roads on either side of the lake. The collector system would consist of a submerged cable.

4 System Design

4.1 Turbine Foundations

4.1.1 Design Criteria

The design criteria for the turbine foundations are as follows:

- To be primarily founded on bedrock;
- Provide sufficient bearing capacity, structural strength and vibration resistance for turbine loadings; and
- Provide a 15 m diameter flat area for construction of the foundation structure.

4.1.2 Design

The turbine foundation is to be excavated to bedrock, with the blasted material used for construction of the crane pads. Detailed design will minimize cut within this area as far as practical.

The turbine foundation will be a “spider-type” foundation constructed on piles bored into bedrock (Drawing TB-24, Attachment 1). The foundation is anchored to the bedrock through the piles. It is then assembled on site, in a kit fashion, and the resulting “spider legs” are bolted directly onto the piles. The foundation is then enclosed by pre-cast concrete members and the voids are filled with rockfill or concrete.

4.2 Crane Pads

4.2.1 Design Criteria

The design criteria for the pads are as follows:

- Minimum top surface dimensions as shown in Drawing TB-05, TB-12 and TB-19, Attachment 1;
- Constructed of geochemically suitable Run of Quarry (ROQ) or Run of Mine (ROM) material, with a 0.15 m thick surfacing layer;
- Surface leveled to about 0.25% for construction;
- Side slopes will be 1.5H:1V (34°) when fill thickness are less than 2 m;
- Side slopes will be 2H:1V (26.5°) when fill thicknesses are greater than 2 m;
- No cut is allowed in overburden; and
- The floor of bedrock will be cut to a slope of 1% to shed water.

4.2.2 Design

The pads are temporary use construction pads only and therefore do not require long term structural performance criteria. The pads are primarily founded on bedrock. Where small areas of overburden exist beneath the pad, these are shallow deposits within the larger bedrock outcrop. Minor settlement may occur in the longer term in the small pockets and can be visually monitored and repaired as required. All fill will consist of geochemically suitable ROQ or ROM material overlain by 0.15 m of surfacing material consisting of crushed rock.

There is no sediment or contact water pond associated with the crane pads; therefore, best management practices including silt fences will be required during the first spring after construction.

4.3 Access and Haul Roads

4.3.1 Design Criteria

An access road is needed to access each of the six (6) wind turbines. The design criteria for the access and haul roads are like that used for other roads on site, with the addition of more stringent road profile criteria to accommodate the turbine blade transport.

- Road profile criteria as per Table 4.1;
- The roadway will be crowned at 0.5% to promote drainage;
- Minimum fill thickness of 1 m over permafrost soils and 0.3 m over bedrock;
- 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;
- Unless otherwise noted, roads shall be a minimum of 6 m wide. All roads are single lane with turnouts to allow for passing at a minimum of every 1 km;
- 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.

Table 4.1: Access Road Profile Criteria

Description	Criteria
Clearance width	6.8 m
Clearance height	4.6 m
Inner curve radius	28 m
Outer curve radius	35 m
Elevation gradient with loose surface course	≤ 7%
Elevation gradient with bonded surface course	≤ 12%
Elevation Gradient in curves with lateral gradient	≤ 4%
Lateral gradient of access roads	≤ 5%
Lateral gradient of access roads, particularly in curves and at gradients	≤ 1.5%
Ground clearance of transport vehicles	0.10 m
Radius of hilltop/bottom of valley	700 m

4.3.2 Design

The access roads have been optimised to minimize length and are all 6 m wide with a minimum fill thickness of 1 m over permafrost soils and 0.3 m over bedrock. No turnouts are required as the crane pad provides sufficient space for passing and turn-around and all access roads are less than 1 km long. All roads will be constructed of geochemically suitable ROQ or ROM material, with a 0.15 m thick surfacing layer

For Doris, the Turbine #2 access road branches off the existing Doris-Windy AWR. The Turbine #1 access road branches off the Turbine #2 access road. Therefore, only a single intersection with the Doris-Windy AWR is required.

The Turbine #2 access road is a 600 m long road that starts from Doris-Windy AWR and ends in a turn out on the south side of the Turbine #2 crane pad. The Turbine #1 access road is a 560 m long road that starts from Turbine #2 access road and ends in a turn out on the south side of the Turbine #1 crane pad (Drawings TB-03 and TB-04, Attachment 1).

For Madrid, the Turbine #3 access road branches off the existing Madrid-South AWR and the Turbine #4 access road branches off the existing Madrid-Boston AWR. An intersection for each road is required.

The Turbine #3 access road is a 230 m long road that starts from Madrid-South AWR and ends in a turn out on the east side of the Turbine #3 crane pad. Turbine #4 is a 400 m long road that starts from the Madrid-Boston AWR and ends in a turn out on the north side of the Turbine #4 pad. (Drawings TB-10 and TB-11, Attachment 1).

Both Boston Turbine #5 and Boston Turbine #6 access roads branch off the Madrid-Boston AWR. Two intersections are required with the Madrid-Boston AWR for the Boston turbines.

The Turbine #5 is a 640 m long road that starts from the Madrid-Boston AWR and ends in a turn out on the east side of the Turbine #5 crane pad. Turbine #6 is a 705 m long road that starts at the Madrid-Boston AWR and ends in the west side of the Turbine #6 crane pad. (Drawings TB-17 and TB-18, Attachment 1).

5 Construction Methodology

The access roads and crane pads will be constructed prior to any turbine foundation construction works. All construction fill materials will be obtained from geochemically suitable permitted quarries, or locally cut geochemically suitable rock within the turbine foundation or crane pad footprint. Management and monitoring of quarries will be according to the existing quarry management and monitoring plan (TMAC 2017). Surfacing (32 mm minus), bedding (19 mm minus), and transition (150 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 TB-26, Attachment 1.

Prior to construction, the road alignments and pad areas should be cleared of snow and ice. At no time will disturbance of the tundra vegetation or soils be allowed outside of the road footprint, and no permafrost disturbance will be allowed. Construction fill will be placed by end-dumping on the existing road or pad surface and pushing the dumped material with a bulldozer. Surfacing material will not be placed until the ROQ material layer is at design grade and level. All construction should be performed in accordance with the Technical Specifications (SRK 2011).

Wherever possible, pads and roads 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.

Following construction of the access roads and crane pads, drilling into the bedrock will be undertaken for installation of the turbine foundation piles. The pre-assembled reinforcement mesh will be placed in the drilled holes and cast with concrete mixed in the existing concrete batch plant. The foundation structure is assembled on site, in a kit fashion, and the resulting “spider legs” are bolted directly onto the piles. The foundation structure is then enclosed by pre-cast concrete members. The tower segments are delivered to the crane pad. The tower is progressively installed as the individual steel sections are lifted into position by means of a large crane and then bolted together. The nacelle is pre-assembled on the pre-assembly area. After installing the nacelle and the generator on the tower, the hub is pre-assembled on the ground. Generally, the rotor blades are bolted to the hub on the ground and the entire assembly is hoisted. No storage or placement of structures is required outside of the crane pad extents for installation of the turbines.

It is assumed that the ground transport fleet will consist of prime movers with lowboy and drop-deck trailer combinations. It is assumed the construction fleet will consist of a diamond drill for blasting, large diameter drill for pile installation, 1,000 T crawler crane for turbine installation, 30 or 40 T haul trucks, dozers, excavator(s), and a vibrating smooth drum compactor.

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The opinions expressed in this report have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information, except to the extent that SRK was hired to verify the data.

6 References

SRK Consulting (Canada) Inc. 2011. Technical Specifications Earthworks and Geotechnical Engineering, Hope Bay Project Nunavut, Canada, Revision G – Issued for Construction. Report Prepared for Hope Bay Mining Limited. Project No.: 1CH008.033. March.

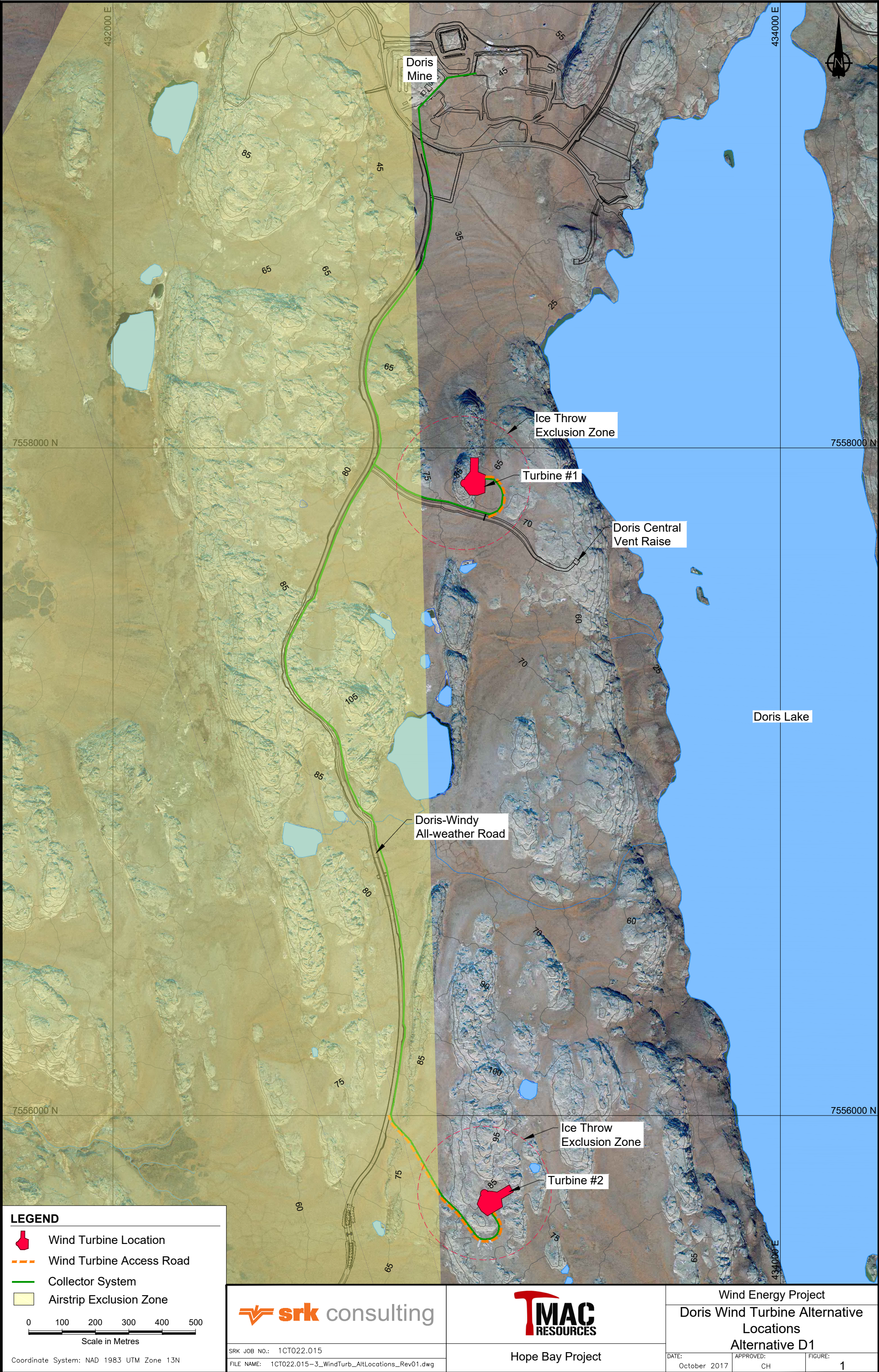
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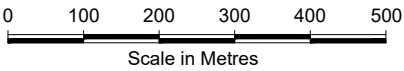
Figures





LEGEND

-  Wind Turbine Location
-  Wind Turbine Access Road
-  Collector System
-  Airstrip Exclusion Zone



Coordinate System: NAD 1983 UTM Zone 13N

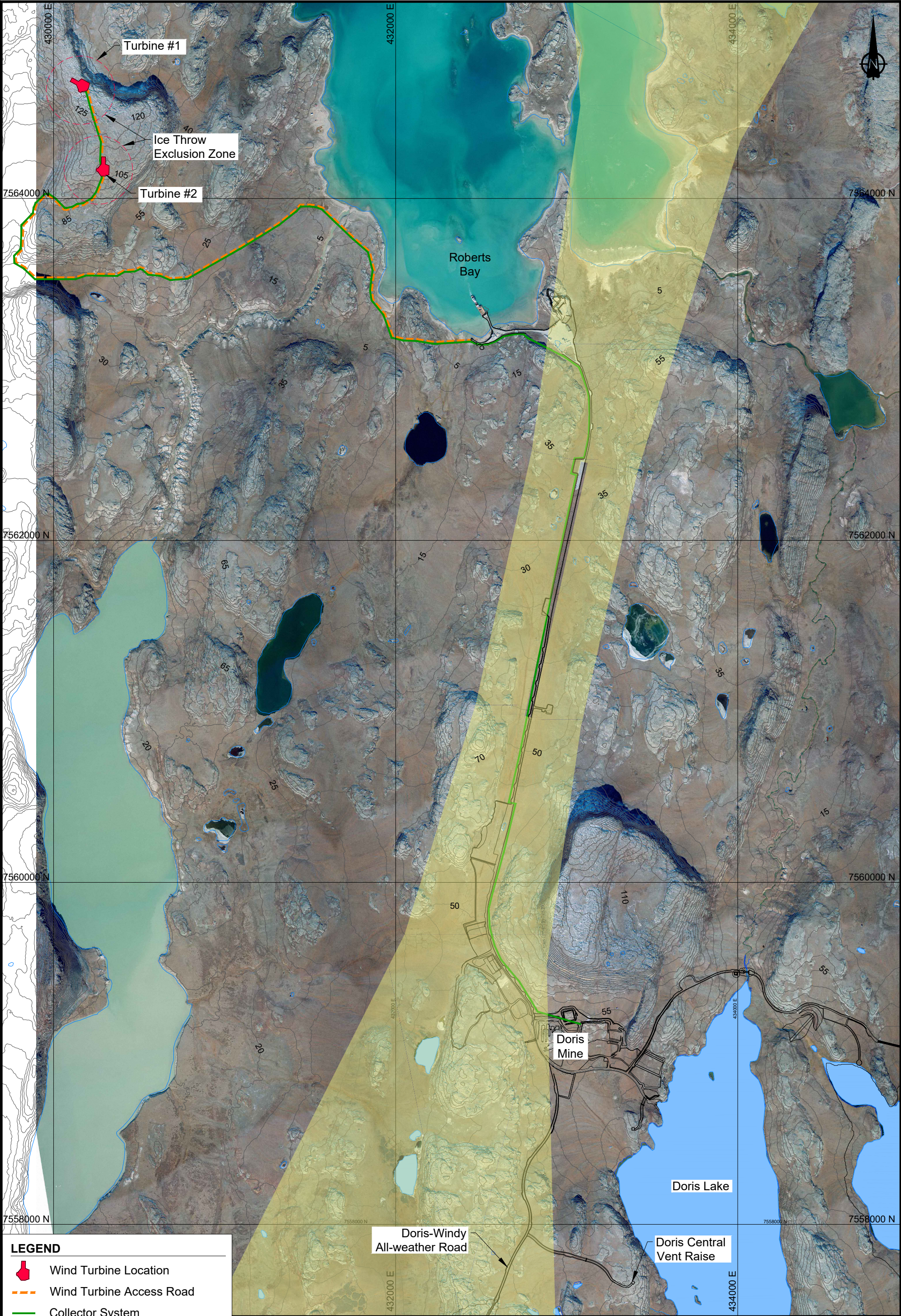


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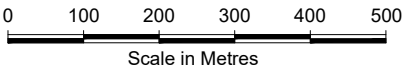
Hope Bay Project

Wind Energy Project		
Doris Wind Turbine Alternative Locations		
Alternative D2		
DATE: October 2017	APPROVED: CH	FIGURE: 2



LEGEND

-  Wind Turbine Location
-  Wind Turbine Access Road
-  Collector System
-  Airstrip Exclusion Zone



Coordinate System: NAD 1983 UTM Zone 13N



SRK JOB NO.: 1CT022.015

FILE NAME: 1CT022.015-3_WindTurb_AltLocations_Rev01.dwg



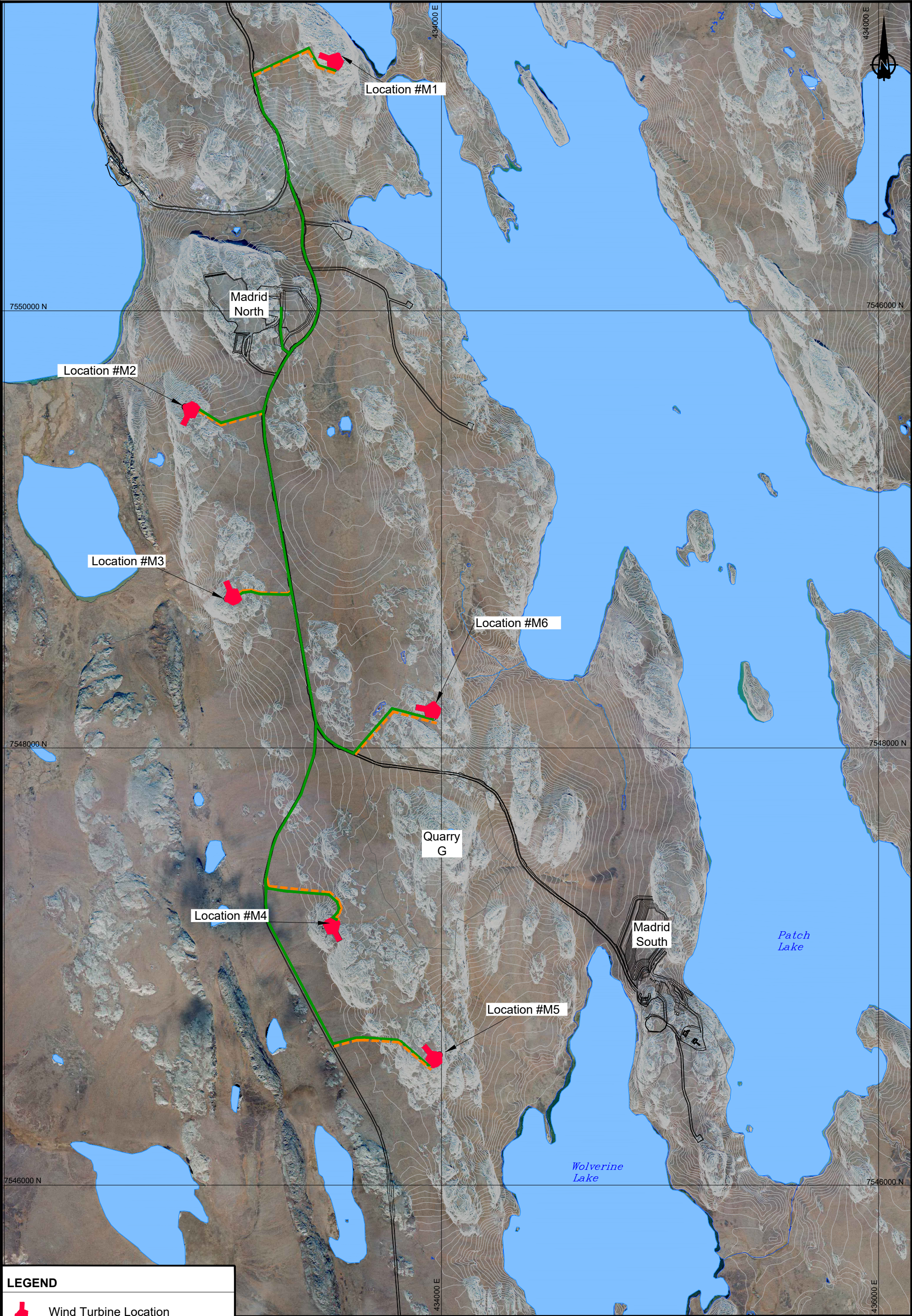
Hope Bay Project

Wind Energy Project
Doris Wind Turbine Alternative
Locations
Alternative D3

DATE: October 2017

APPROVED: CH

FIGURE: 3



LEGEND

-  Wind Turbine Location
-  Wind Turbine Access Road
-  Collector System
- 0

200

400

600

800

1000

Scale in Metres
- Coordinate System: NAD 1983 UTM Zone 13N



SRK JOB NO.: 1CT022.013
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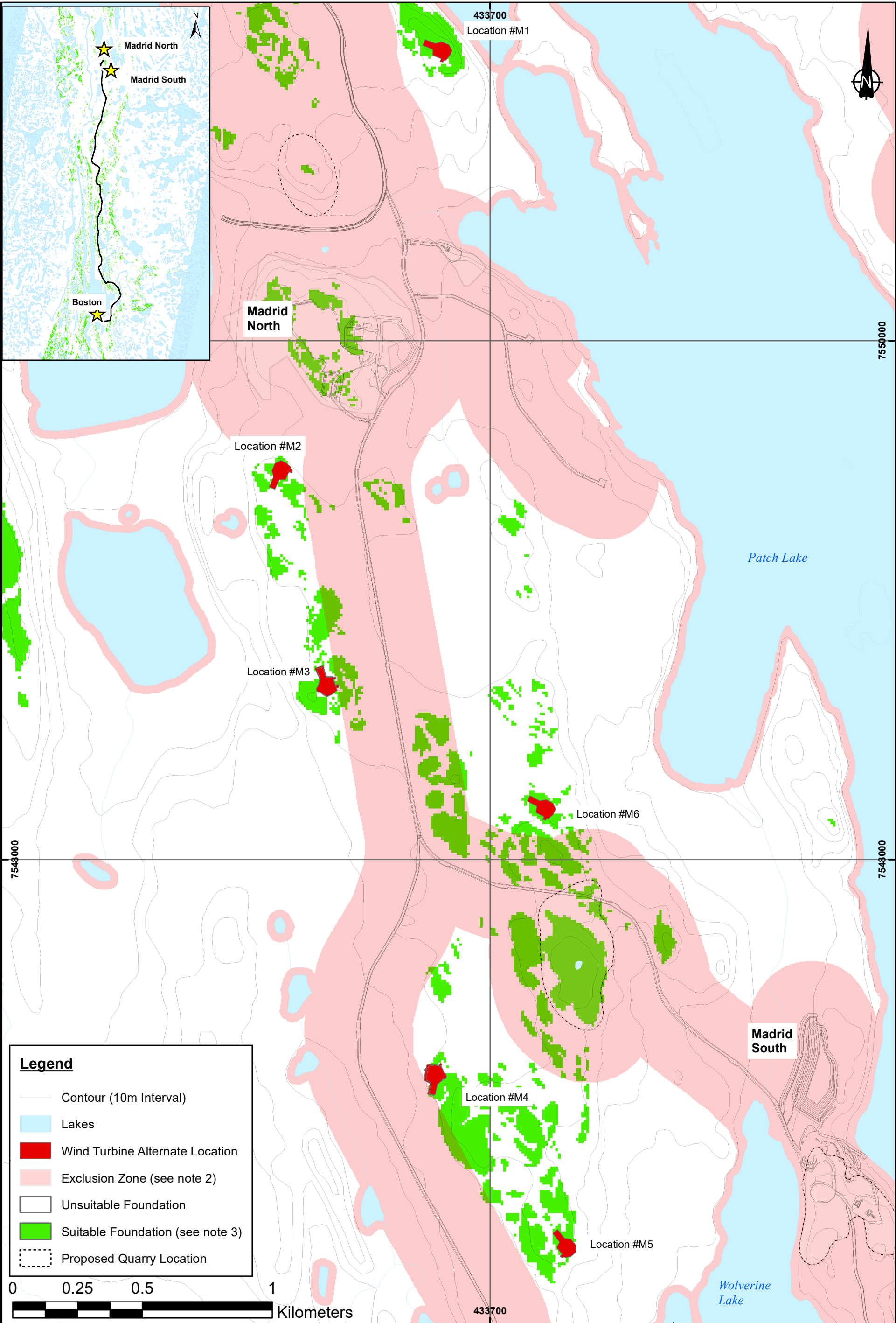


Hope Bay Project

Wind Energy Project

Madrid North
Alternate Wind Turbine Locations

DATE:	APPROVED:	FIGURE:
Oct 2017	CH	4



Legend

- Contour (10m Interval)
- Lakes
- Wind Turbine Alternate Location
- Exclusion Zone (see note 2)
- Unsuitable Foundation
- Suitable Foundation (see note 3)
- Proposed Quarry Location

Notes:
1. Coordinate System: NAD 1983 UTM Zone 13N.
2. Exclusion zones: Ice Throw - 200 m, Water Offset - 31 m
31 m water offset.
3. Suitable foundation: Bedrock outcrop and >70 m elevation.



Project No: 1CT022.13
Filename: Madrid Wind Turbine Alternative Locations



HOPE BAY PROJECT

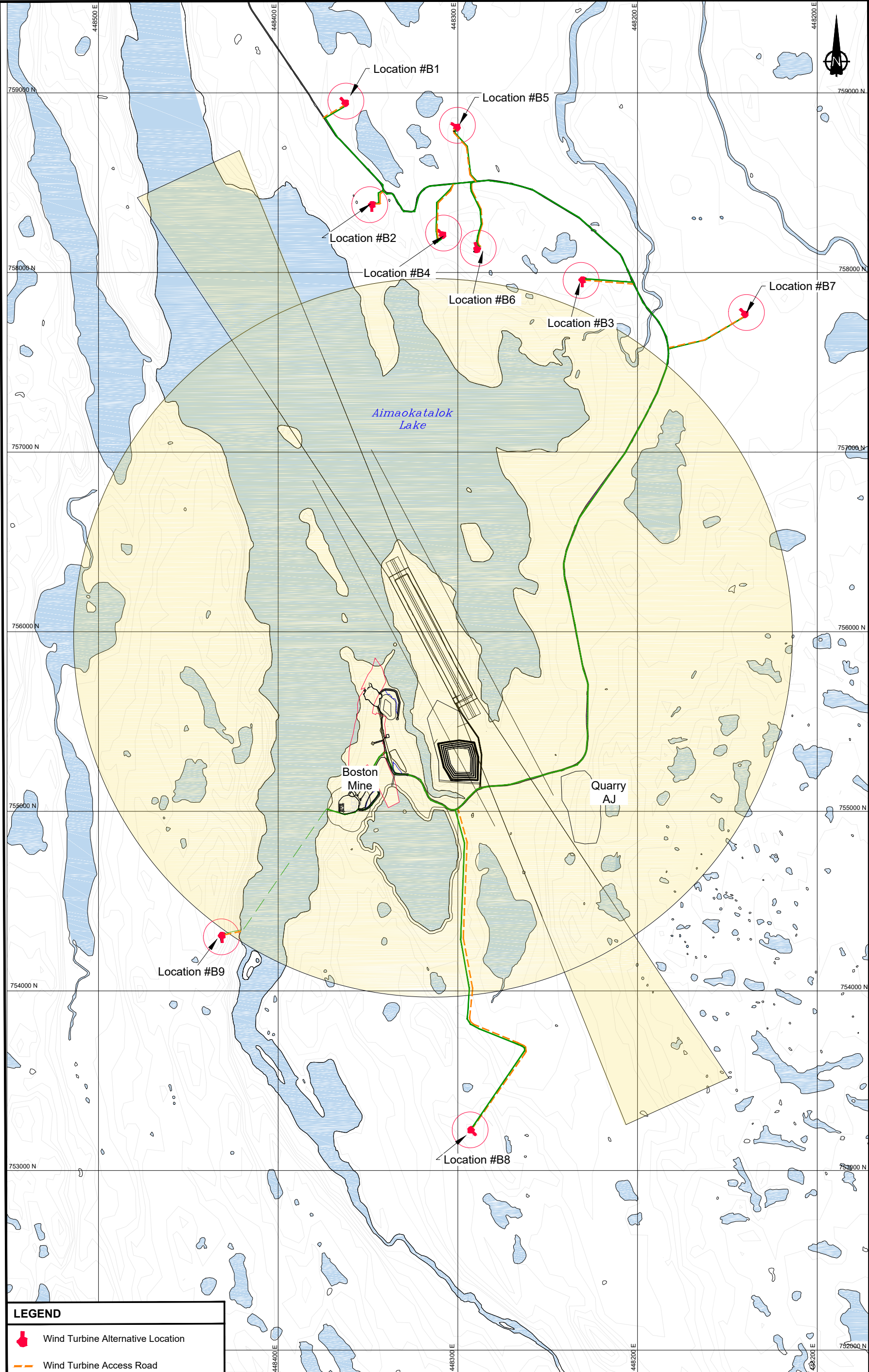
Wind Energy Project

Madrid Alternative
Wind Turbine Locations

Date:
Oct 2017

Approved:
CH

Figure:
5



LEGEND

-  Wind Turbine Alternative Location
 -  Wind Turbine Access Road
 -  Collector System
 -  Airstrip Exclusion Zone
- 0 200 400 600 800 1000
- Scale in Metres
- Coordinate System: NAD 1983 UTM Zone 13N



SRK JOB NO.: 1CT022.013

FILE NAME: 1CT022.0113-1_Boston_Wind Turb.dwg



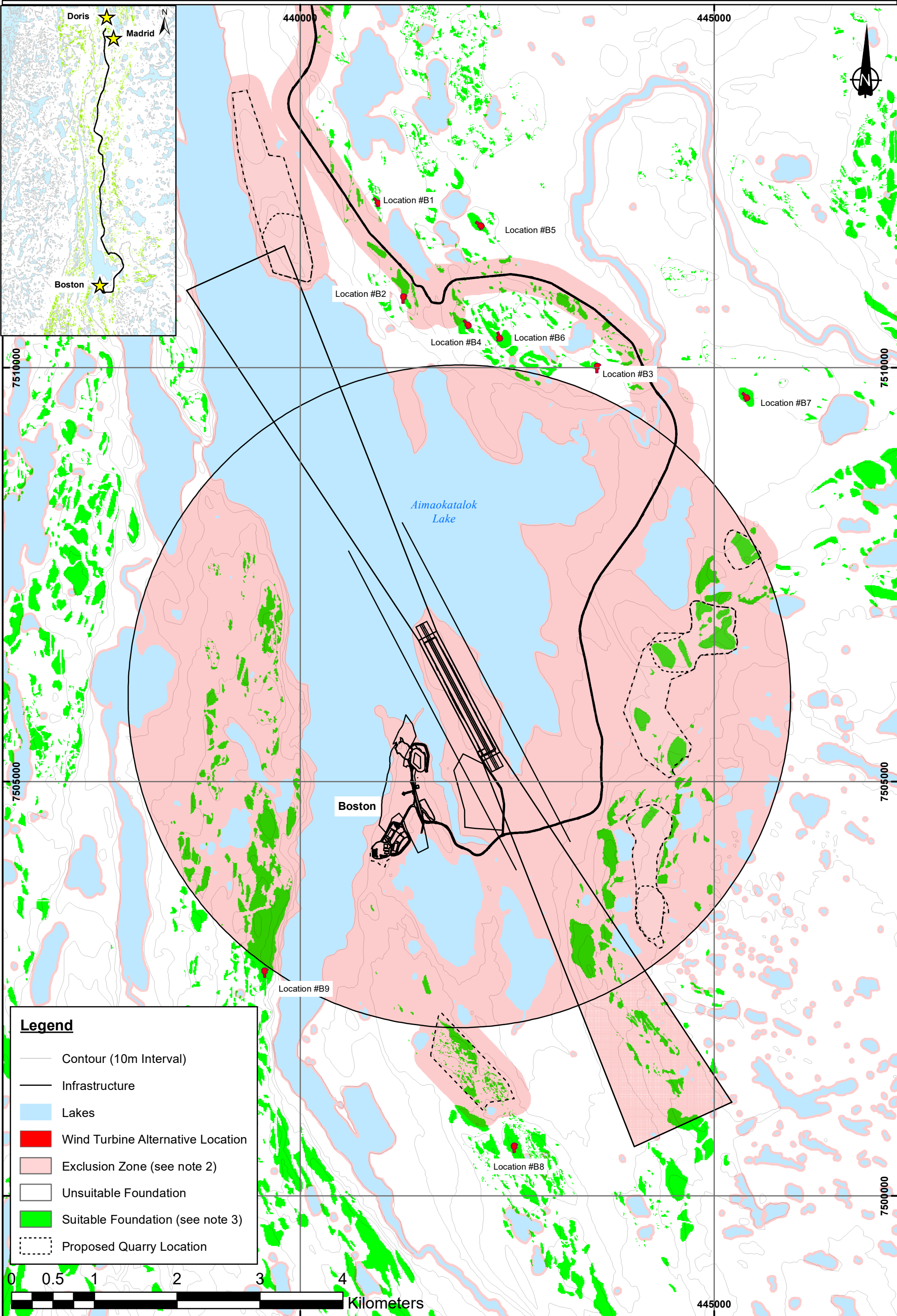
Hope Bay Project

Wind Energy Project

Boston Alternative
Wind Turbine Locations

DATE:	APPROVED:	FIGURE:
Oct 2017	CH	6

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Legend

- Contour (10m Interval)
- Infrastructure
- Lakes
- Wind Turbine Alternative Location
- Exclusion Zone (see note 2)
- Unsuitable Foundation
- Suitable Foundation (see note 3)
- Proposed Quarry Location

Notes:
1. Coordinate System: NAD 1983 UTM Zone 13N.
2. Exclusion zones: Ice Throw - 200 m, Water Offset - 31 m
3. Suitable foundation: Bedrock outcrop and >95 m elevation.



Project No: 1CT022.13
Filename: Boston Wind Turbine Alternative Locations



HOPE BAY PROJECT

Wind Energy Project

Boston Alternative
Wind Turbine Locations

Date:
Oct 2017

Approved:
CH

Figure:
7

Attachment 1: Engineering Drawings for the Hope Bay Wind Energy
Project

Engineering Drawings for the Wind Energy Project, Hope Bay Project, Nunavut, Canada

ACTIVE DRAWING STATUS

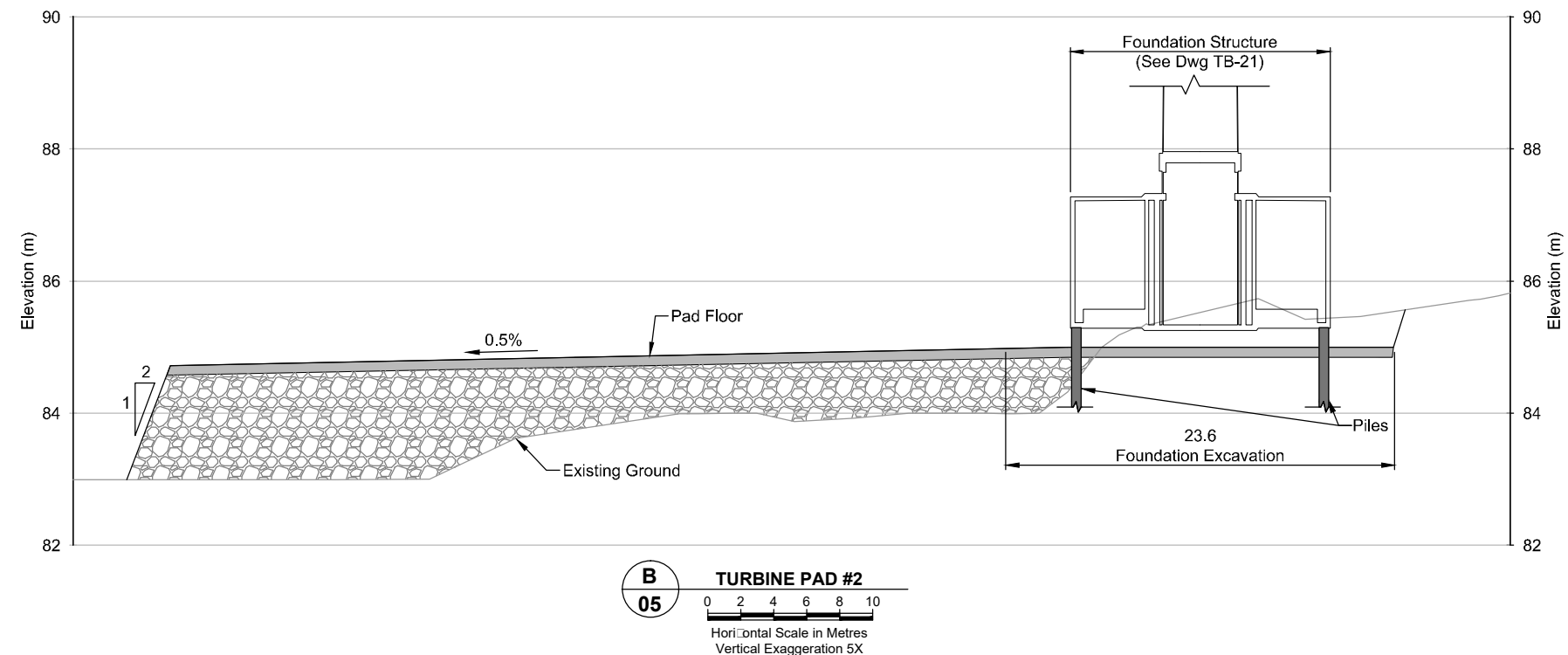
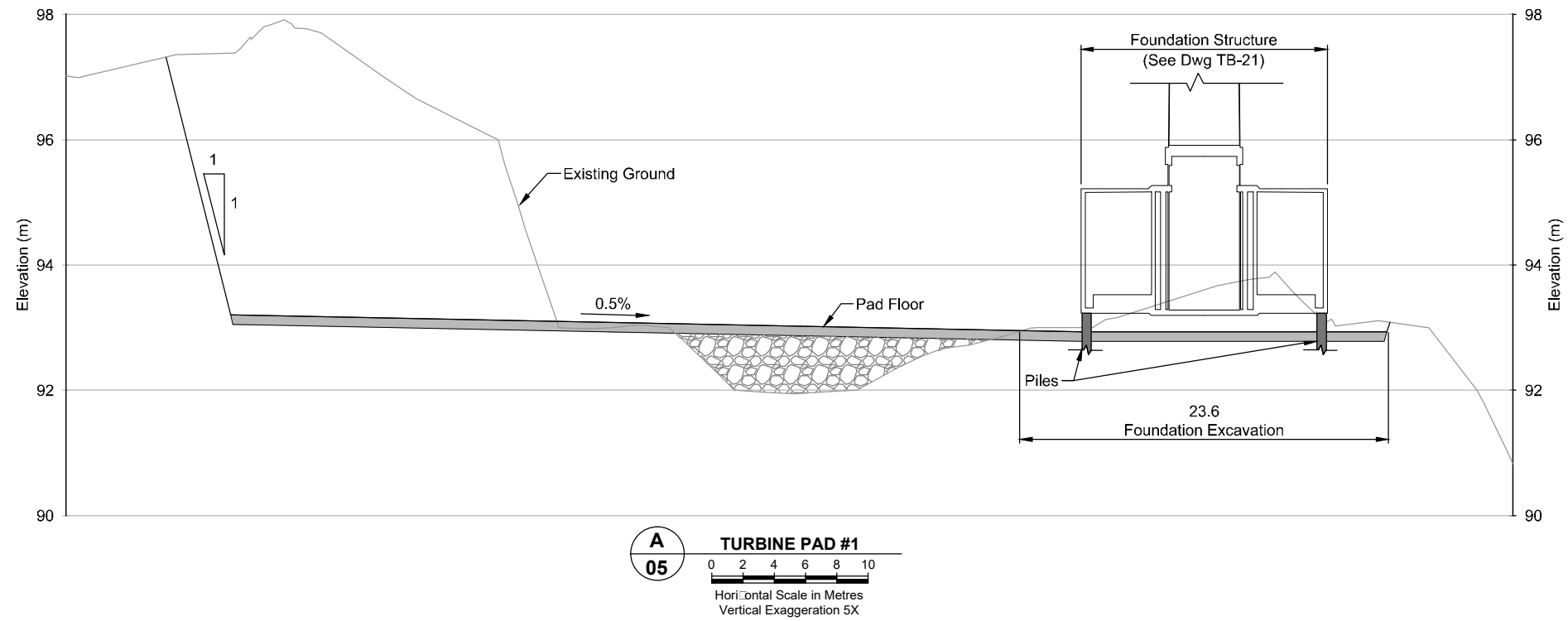
DWG NUMBER	DRAWING TITLE	REVISION	DATE	STATUS
TB-01	Engineering Drawings for the Wind Energy Project, Hope Bay Project, Nunavut, Canada	A	Sept. 22, 2017	Issued for Discussion
TB-02	Doris Area General Arrangement	A	Sept. 22, 2017	Issued for Discussion
TB-03	Doris Turbine #1 Access Road Plan & Profile	A	Sept. 22, 2017	Issued for Discussion
TB-04	Doris Turbine #2 Access Road Plan & Profile	A	Sept. 22, 2017	Issued for Discussion
TB-05	Doris Turbine Pad Layouts	A	Sept. 22, 2017	Issued for Discussion
TB-06	Doris Turbine Pad Sections	A	Sept. 22, 2017	Issued for Discussion
TB-07	Doris Turbine Pad Thicknesses	A	Sept. 22, 2017	Issued for Discussion
TB-08	Geology in the Doris Turbine Pads Vicinity	A	Sept. 22, 2017	Issued for Discussion
TB-09	Madrid Area General Arrangement	A	Sept. 22, 2017	Issued for Discussion
TB-10	Madrid Turbine #3 Access Road Plan & Profile	A	Sept. 22, 2017	Issued for Discussion
TB-11	Madrid Turbine #4 Access Road Plan & Profile	A	Sept. 22, 2017	Issued for Discussion
TB-12	Madrid Turbine Pad Layouts	A	Sept. 22, 2017	Issued for Discussion
TB-13	Madrid Turbine Pad Sections	A	Sept. 22, 2017	Issued for Discussion
TB-14	Madrid Turbine Pad Thicknesses	A	Sept. 22, 2017	Issued for Discussion
TB-15	Geology in the Madrid Turbine Pads Vicinity	A	Sept. 22, 2017	Issued for Discussion
TB-16	Boston Area General Arrangement	A	Sept. 22, 2017	Issued for Discussion
TB-17	Boston Turbine #5 Access Road Plan & Profile	A	Sept. 22, 2017	Issued for Discussion
TB-18	Boston Turbine #6 Access Road Plan & Profile	A	Sept. 22, 2017	Issued for Discussion
TB-19	Boston Turbine Pad Layouts	A	Sept. 22, 2017	Issued for Discussion
TB-20	Boston Turbine Pad Sections	A	Sept. 22, 2017	Issued for Discussion
TB-21	Boston Turbine Pad Thicknesses	A	Sept. 22, 2017	Issued for Discussion
TB-22	Geology in the Boston Turbine Pads Vicinity	A	Sept. 22, 2017	Issued for Discussion
TB-23	Typical Road Plan and Sections	A	Sept. 22, 2017	Issued for Discussion
TB-24	Foundation Details	A	Sept. 22, 2017	Issued for Discussion
TB-25	Wind Turbine Schematic	A	Sept. 22, 2017	Issued for Discussion
TB-26	Material List and Quantity Estimates	A	Sept. 22, 2017	Issued for Discussion



PROJECT NO 1CT022.013
Revision A
September 22 2017
Drawing TB-01

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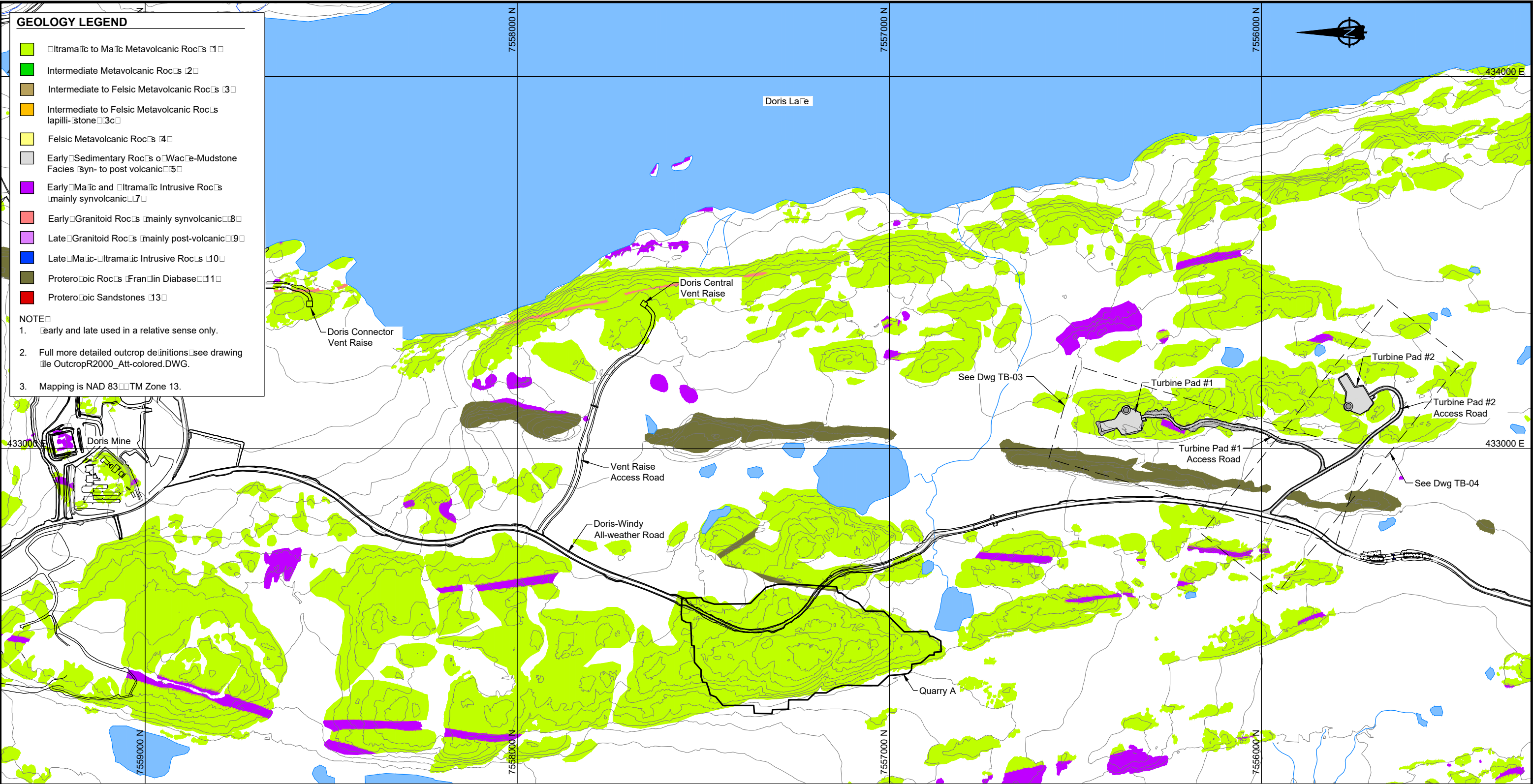


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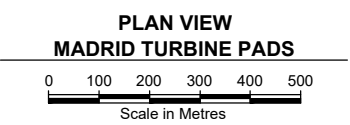
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								DATE: Sept. 22, 2017			DATE:			Doris Turbine Pads Vicinity		
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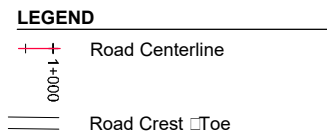
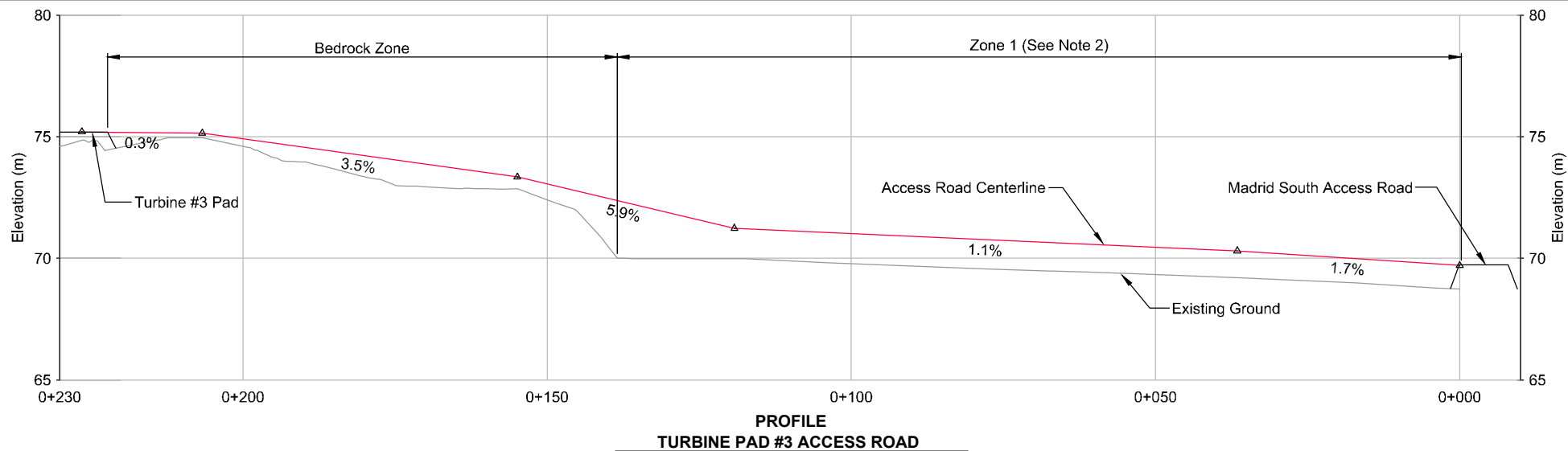
- NOTES**
- 1. The co-ordinate system is NAD 83 Zone 13.
 - 2. All dimensions are in metric units unless otherwise specified.
 - 3. All drawings are scaled appropriately for D-Site construction drawings. Scales may not be correct if these drawings are reproduced and presented in any other site format.
 - 4. Notes in this drawing apply to all other active drawings.

LEGEND

— Collector System



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PLAN VIEW
TURBINE PAD #3 ACCESS ROAD

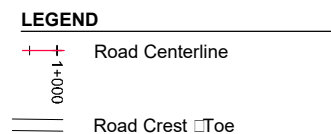
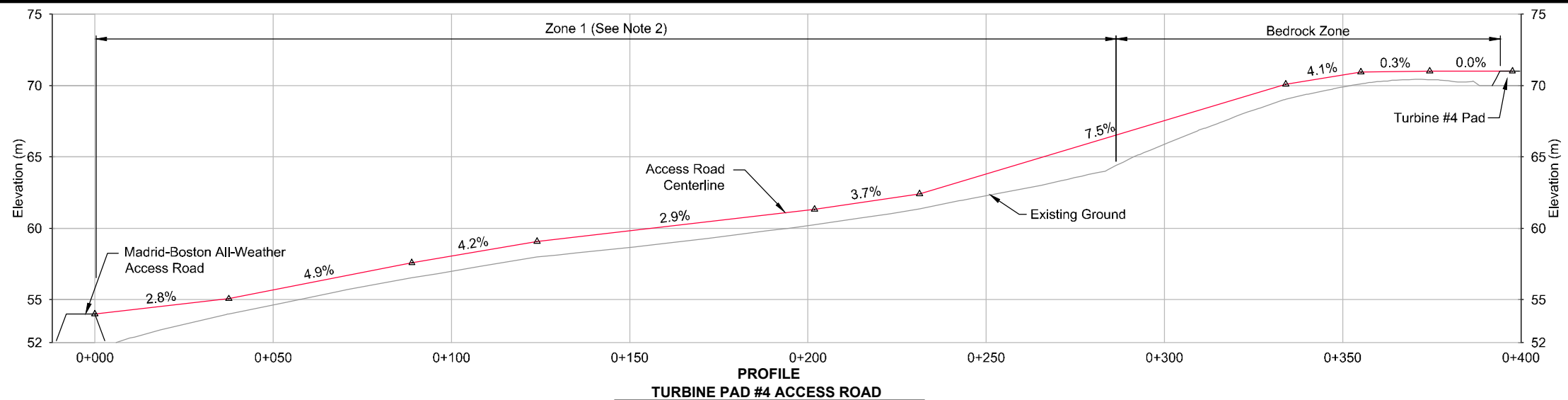


0 5 10 15 20 25
Scale in Metres

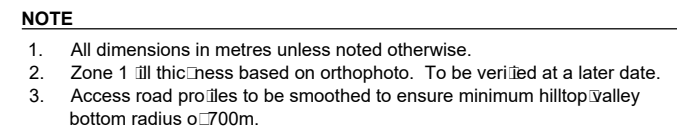
NOTE

1. All dimensions in metres unless noted otherwise.
2. Zone 1 fill thickness based on orthophoto. To be verified at a later date.
3. Access road profiles to be smoothed to ensure minimum hilltop/valley bottom radius of 700m.

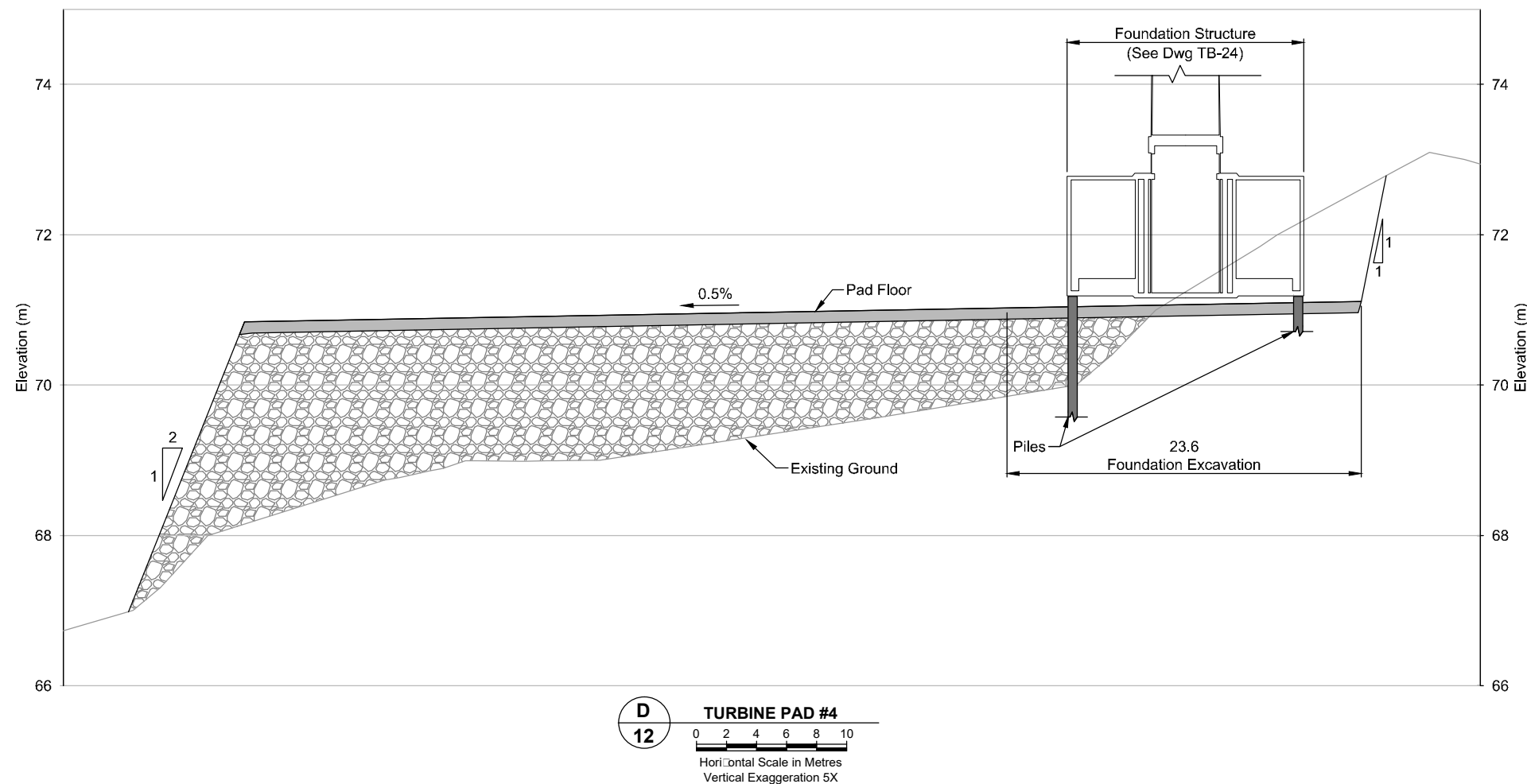
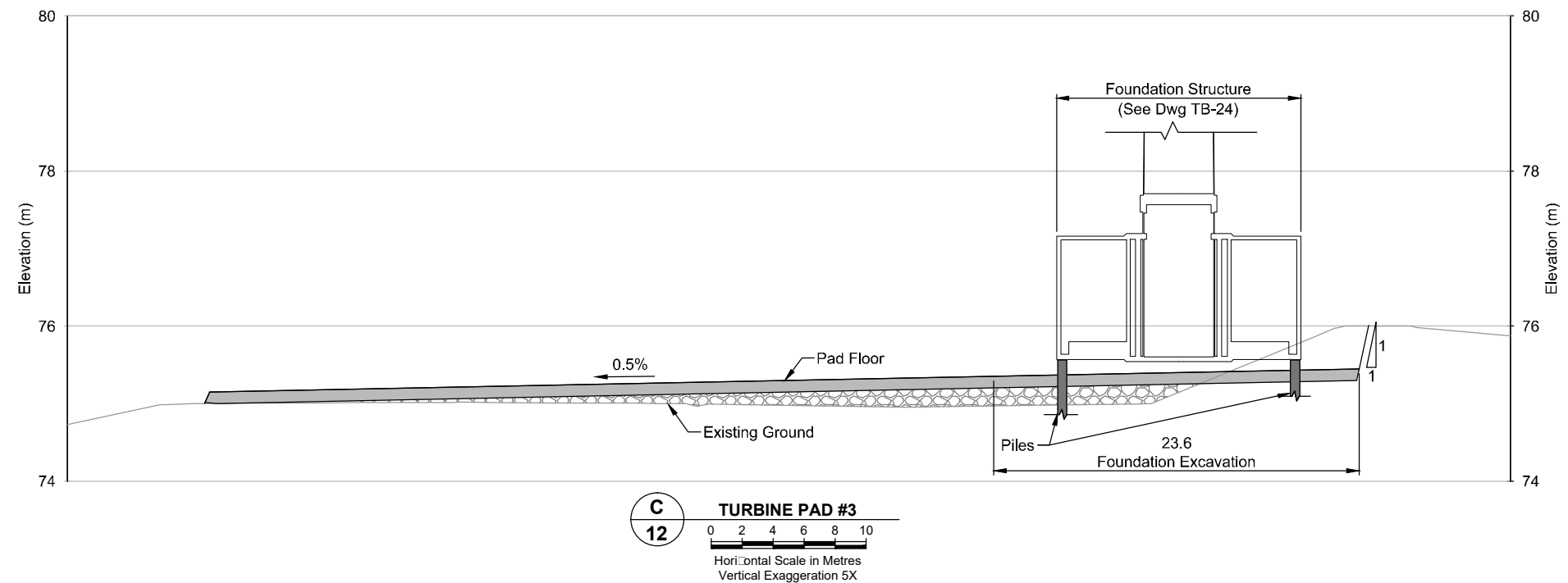
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Fill Zone 1	1.0m min. Overall Road Thickness with 1.5H:1V Side Slopes
Fill Zone 2	1.5m min. Overall Road Thickness with 1.5H:1V Side Slopes
Fill Zone 3	2.0m min. Overall Road Thickness with 2.0H:1V Side Slopes
Bedrock Zone	0.3m min Road Thickness (ROQ not required) with Side Slopes to be determined in the field



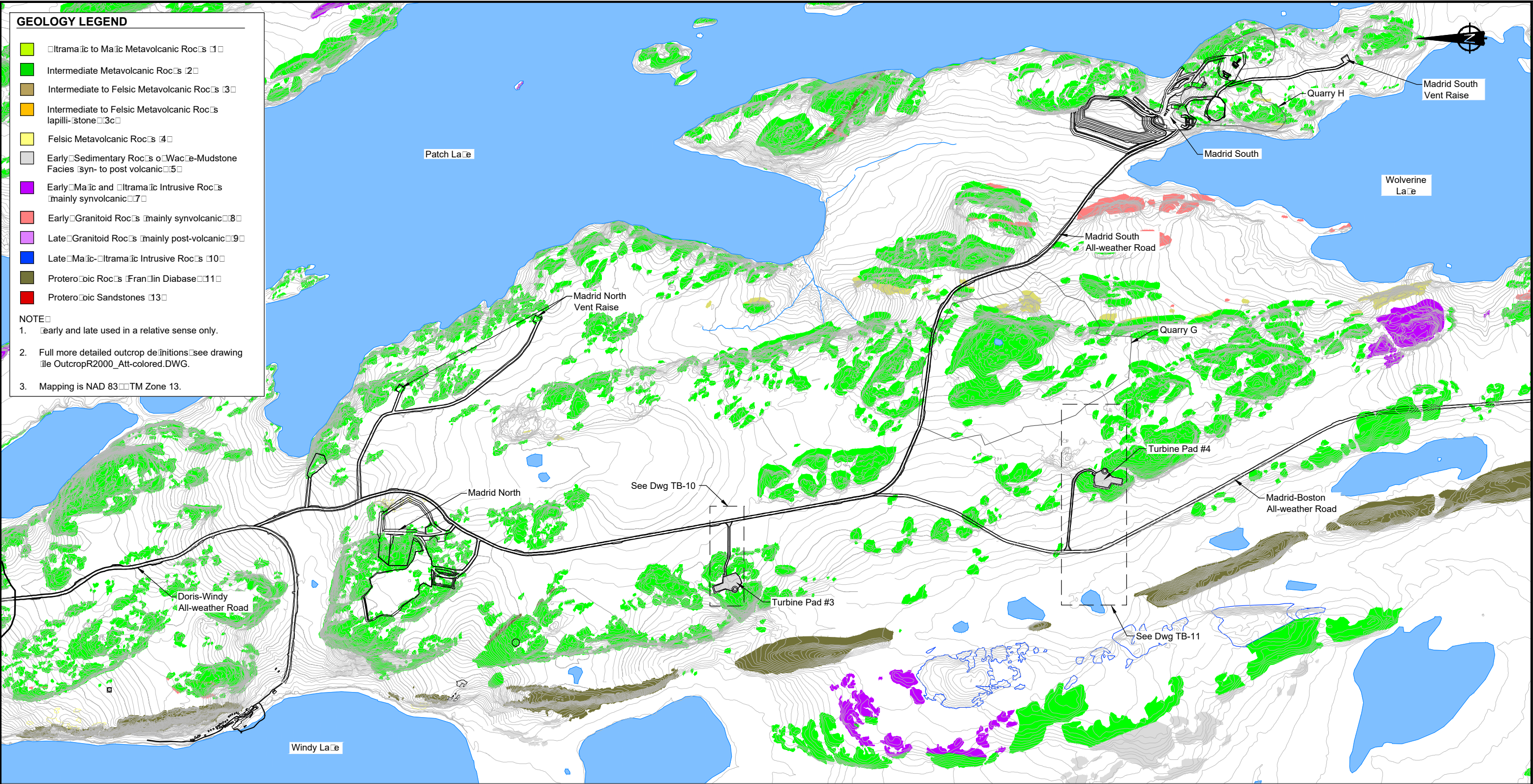
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										CHECKED: CH APPROVED: DATE: Sept. 22, 2017						Madrid Turbine #4 Access Road Plan ☐ Profile		
DRAWING NO. DRAWING TITLE DRAWING NO. DRAWING TITLE										A Issued for Discussion CH 22Sept17			PROFESSIONAL ENGINEER'S STAMP			SRK JOB NO.: 1CT022.013		
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REFERENCE DRAWINGS										REVISIONS						SHEET 11 of 26		
																REVISION NO. A		



LEGEND

-  Surfacing Material
-  Run of Quarry Material

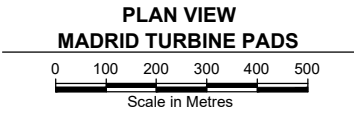
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GEOLOGY LEGEND

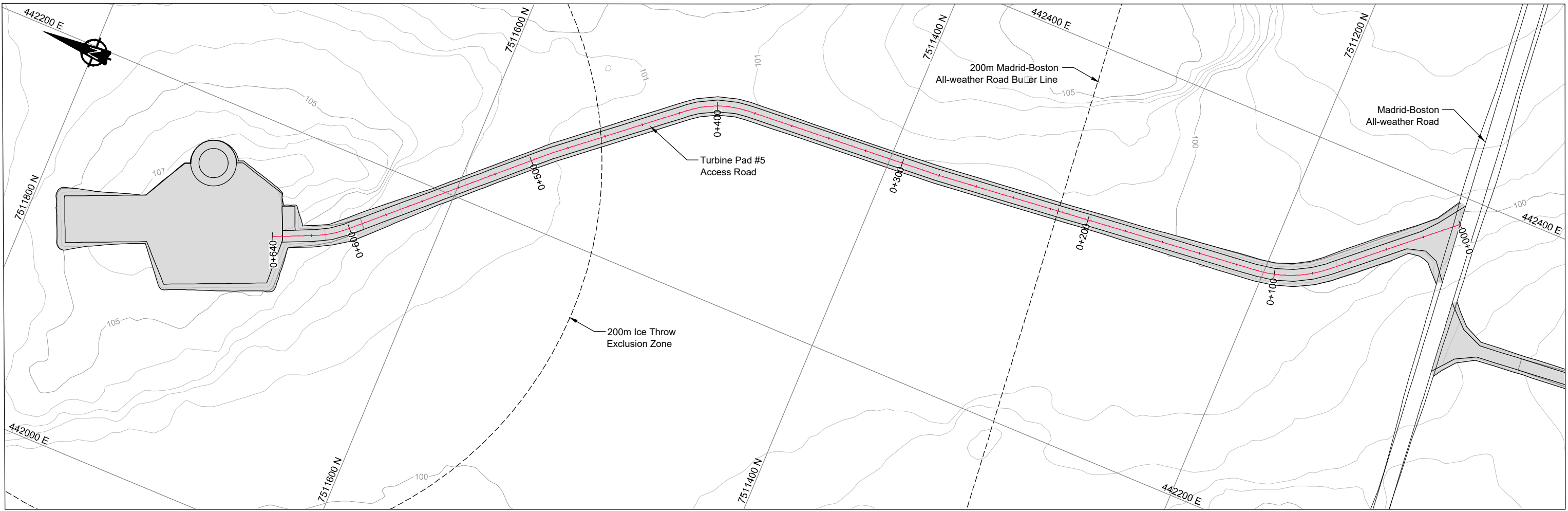
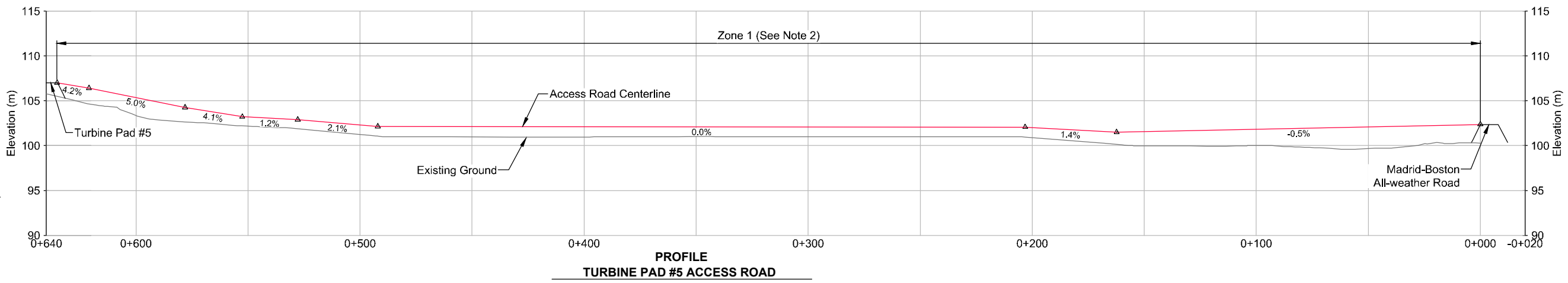
- 1 Ultramafic to Mafic Metavolcanic Rocks
- 2 Intermediate Metavolcanic Rocks
- 3 Intermediate to Felsic Metavolcanic Rocks
- 3c Intermediate to Felsic Metavolcanic Rocks lapilli-stone
- 4 Felsic Metavolcanic Rocks
- 5 Early Sedimentary Rocks of Wacke-Mudstone Facies syn- to post volcanic
- 7 Early Mafic and Ultramafic Intrusive Rocks mainly synvolcanic
- 8 Early Granitoid Rocks mainly synvolcanic
- 9 Late Granitoid Rocks mainly post-volcanic
- 10 Late Mafic-Ultramafic Intrusive Rocks
- 11 Proterozoic Rocks (Felsic) in Diabase
- 13 Proterozoic Sandstones

- NOTE
- 1. Early and late used in a relative sense only.
 - 2. Full more detailed outcrop definitions see drawing file OutcropR2000_Att-colored.DWG.
 - 3. Mapping is NAD 83 UTM Zone 13.



																		Wind Energy Project																																				
										DESIGN: CH				DRAWN: NV				REVIEWED: CH				Geology in the Madrid Turbine Pads Vicinity																																
										CHECKED: CH				APPROVED:				DATE: Sept. 22, 2017																																				
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LEGEND

—+— Road Centerline

— Road Crest / Toe

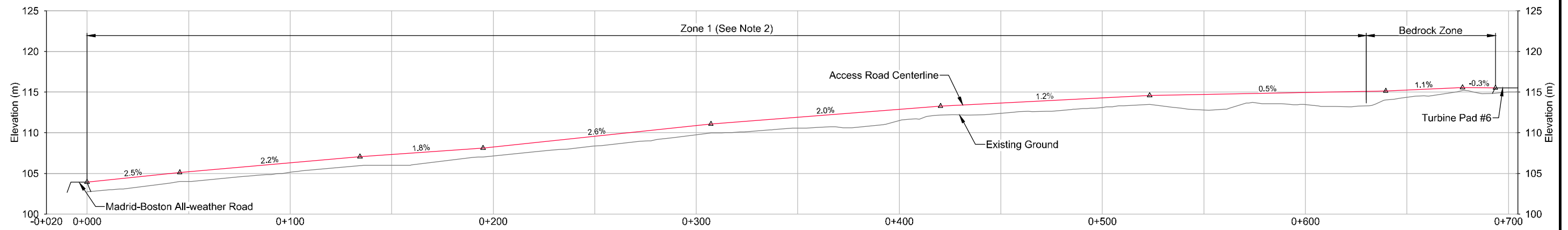
ROAD CONSTRUCTION ZONES TABLE:	
Fill Zone 1	1.0m min. Overall Road Thickness with 1.5H:1V Side Slopes
Fill Zone 2	1.5m min. Overall Road Thickness with 1.5H:1V Side Slopes
Fill Zone 3	2.0m min. Overall Road Thickness with 2.0H:1V Side Slopes
Bedrock Zone	0.3m min Road Thickness (ROQ not required) with Side Slopes to be determined in the field

PLAN VIEW
TURBINE PAD #5 ACCESS ROAD

0 10 20 30 40 50
Scale in Metres

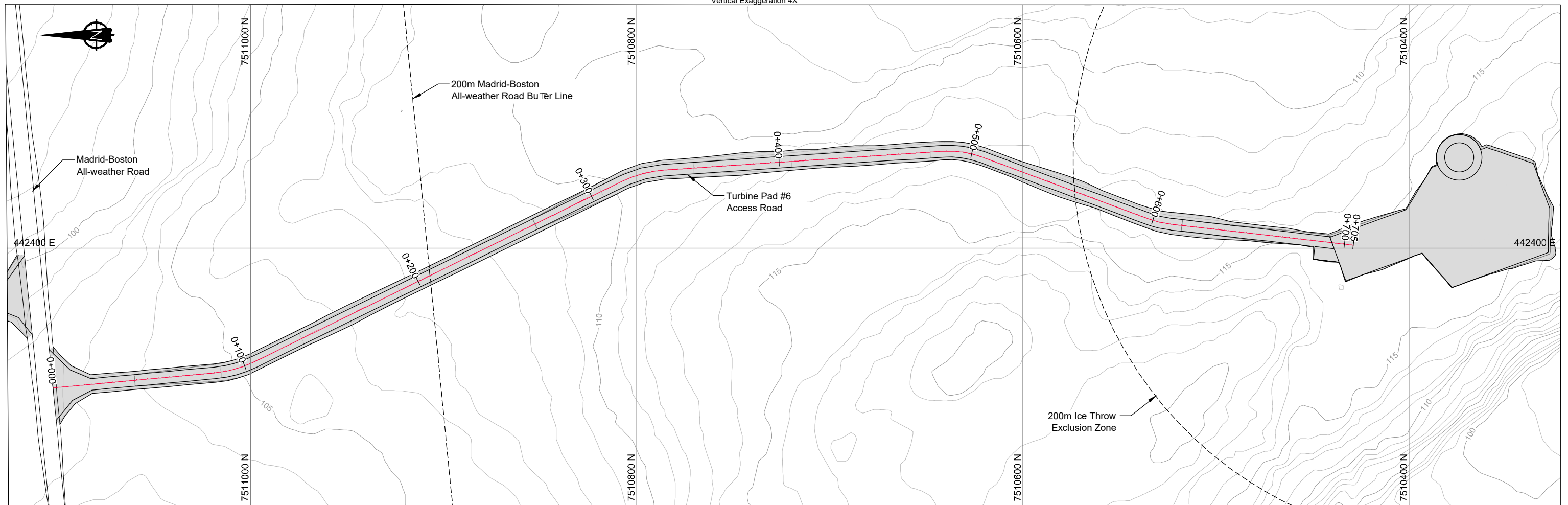
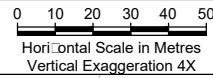
- NOTE**
1. All dimensions in metres unless noted otherwise.
 2. Zone 1 fill thickness based on orthophoto. To be verified at a later date.
 3. Access road profiles to be smoothed to ensure minimum hilltop/valley bottom radius of 700m.

																Wind Energy Project					
																DRAWING TITLE:					
																Boston Turbine #5 Access Road Plan & Profile					
																DRAWING NO.		SHEET			
																TB-17		17 of 26			
																		REVISION NO.			
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PROFILE LEGEND

- ▲ Point of Intersection
 6.1 Grade



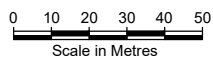
LEGEND

-  Road Centerline
 Road Crest ☐ Toe

ROAD CONSTRUCTION ZONES TABLE:

Fill Zone 1	1.0m min. Overall Road Thickness with 1.5H:1V Side Slopes
Fill Zone 2	1.5m min. Overall Road Thickness with 1.5H:1V Side Slopes
Fill Zone 3	2.0m min. Overall Road Thickness with 2.0H:1V Side Slopes
Bedrock Zone	0.3m min Road Thickness. ROQ not required with Side Slopes to be determined in the field

PLAN VIEW
TURBINE PAD #6 ACCESS ROAD



NOTE

1. All dimensions in metres unless noted otherwise.
2. Zone 1 fill thickness based on orthophoto. To be verified at a later date.
3. Access road profiles to be smoothed to ensure minimum hilltop to valley bottom radius of 700m.

[illegible]

PROFESSIONAL ENGINEER'S STAMP



DESIGN: CH	DRAWN: NV	REVIEWED: CH
CHECKED: CH	APPROVED:	DATE: Sept. 22, 2017

FILE NAME: 1CT022_013-1_Boston Wind Turb.dwg



HOPE BAY PROJECT

SRK JOB NO.:	1CT022.013
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Wind Energy Project

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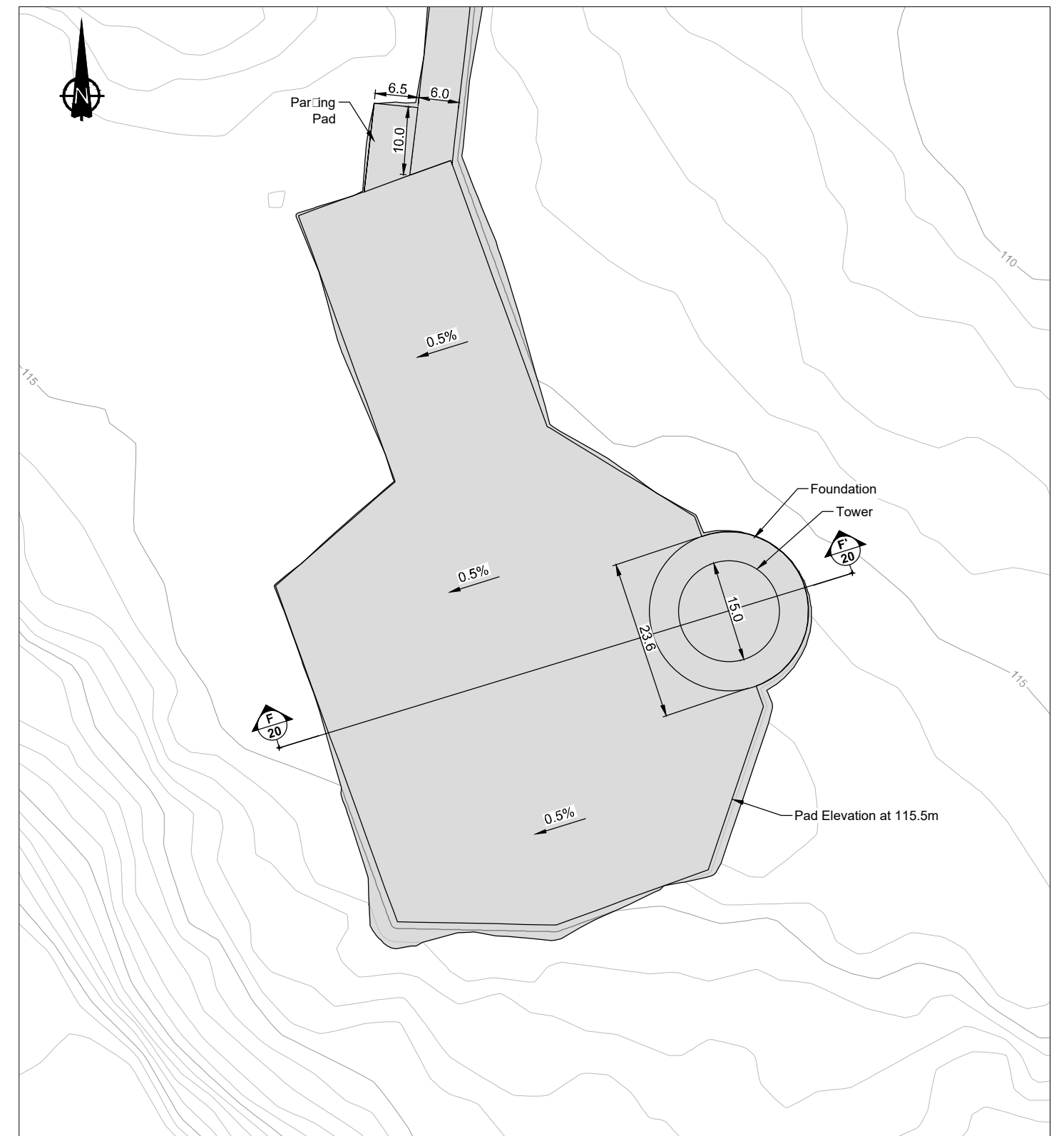
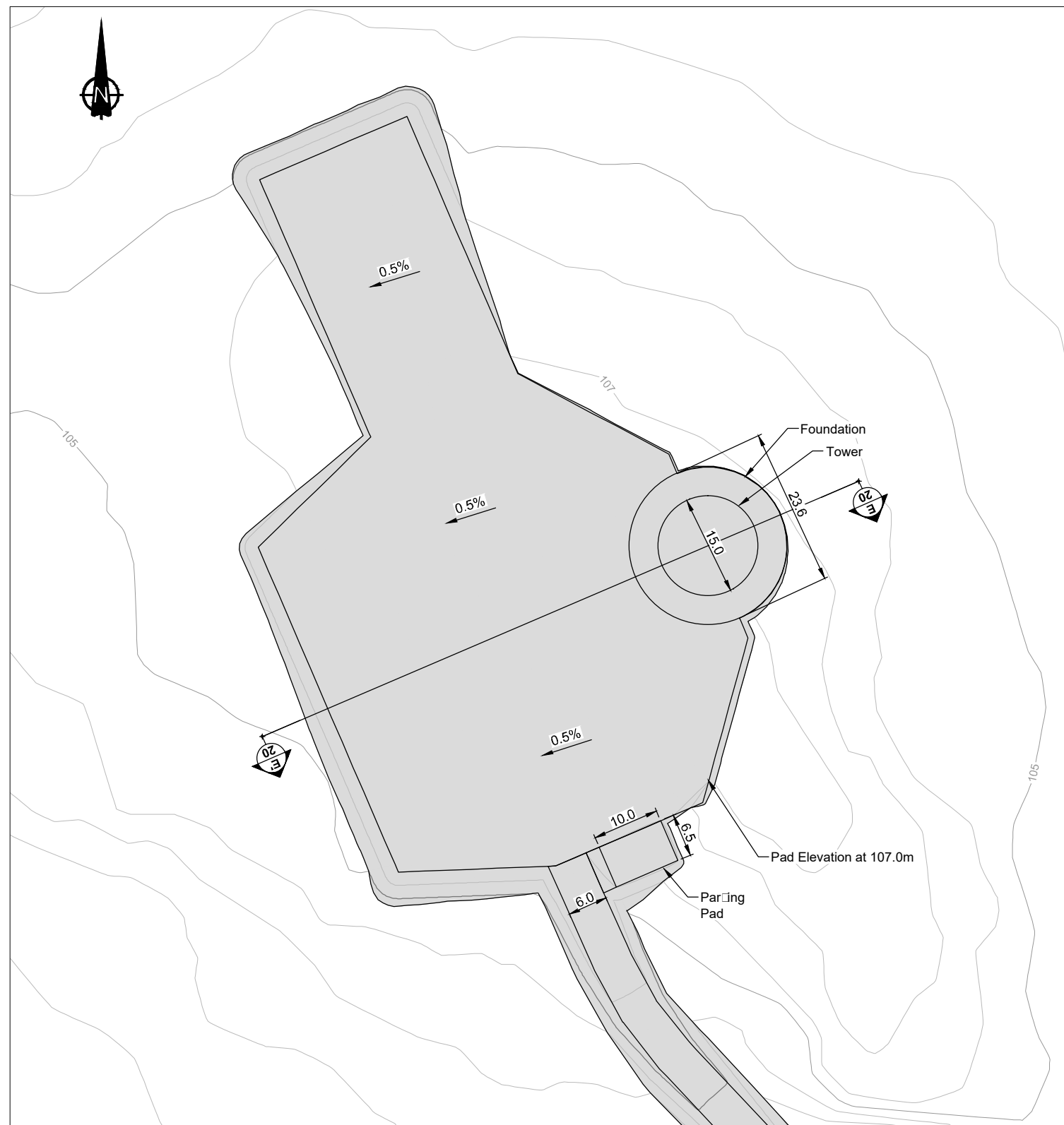
Boston Turbine #6
Access Road Plan ☐ Profile

DRAWING NO.

TB-18

SHEET
18 of 26

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A



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REFERENCE DRAWINGS					REVISIONS				



HOPE BAY PROJECT

DESIGN: CH	DRAWN: NV	REVIEWED: CH
CHECKED: CH	APPROVED:	DATE: Sept. 22, 2017

SRK JOB NO.:	1CT022.013
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Wind Energy Project

DRAWING TITLE:

Boston Turbine Pad Layouts

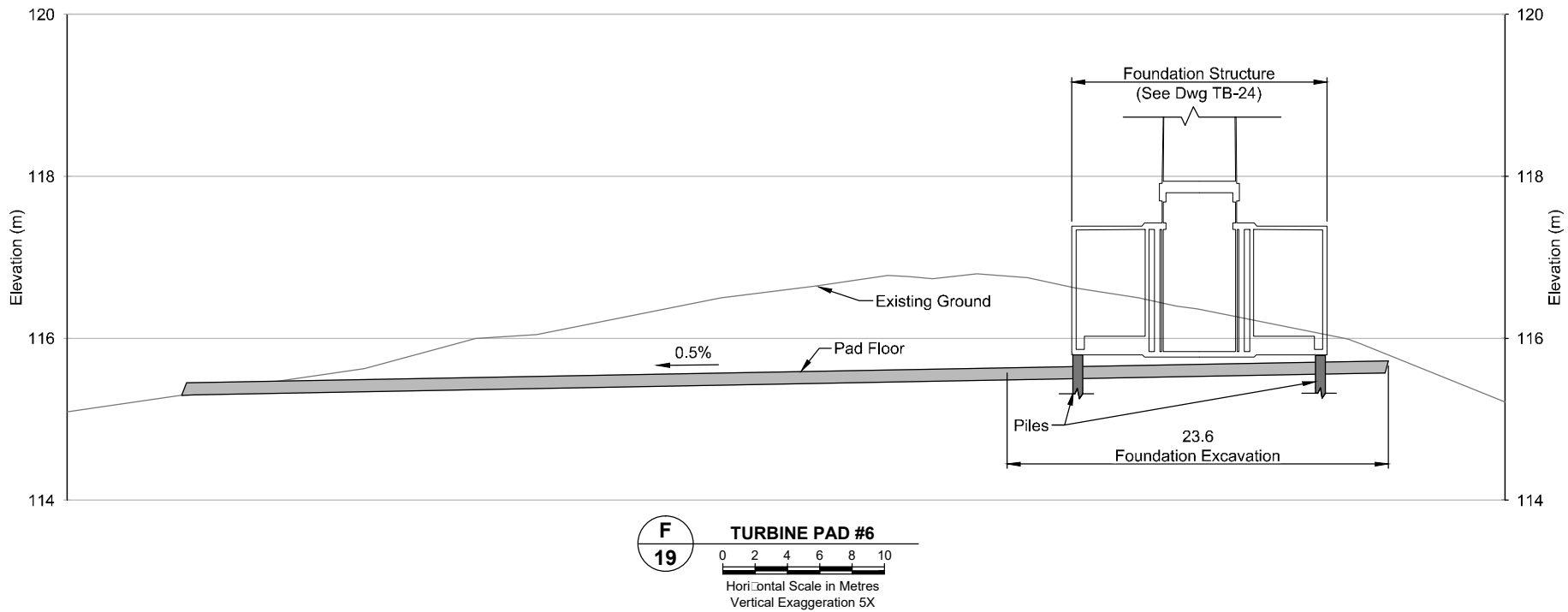
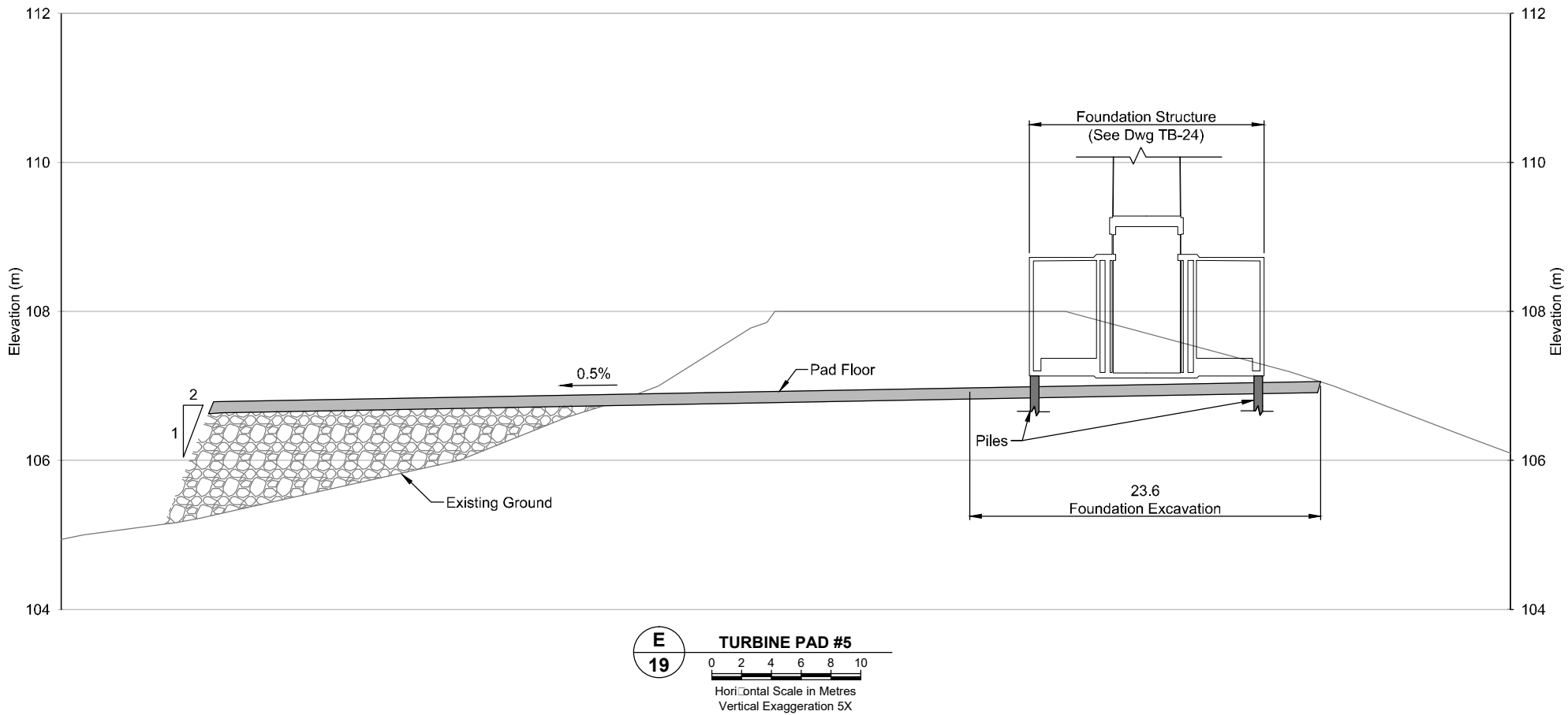
DRAWING NO.

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- LEGEND**
- Surfacing Material
 - Run of Quarry Material

																																								Wind Energy Project									
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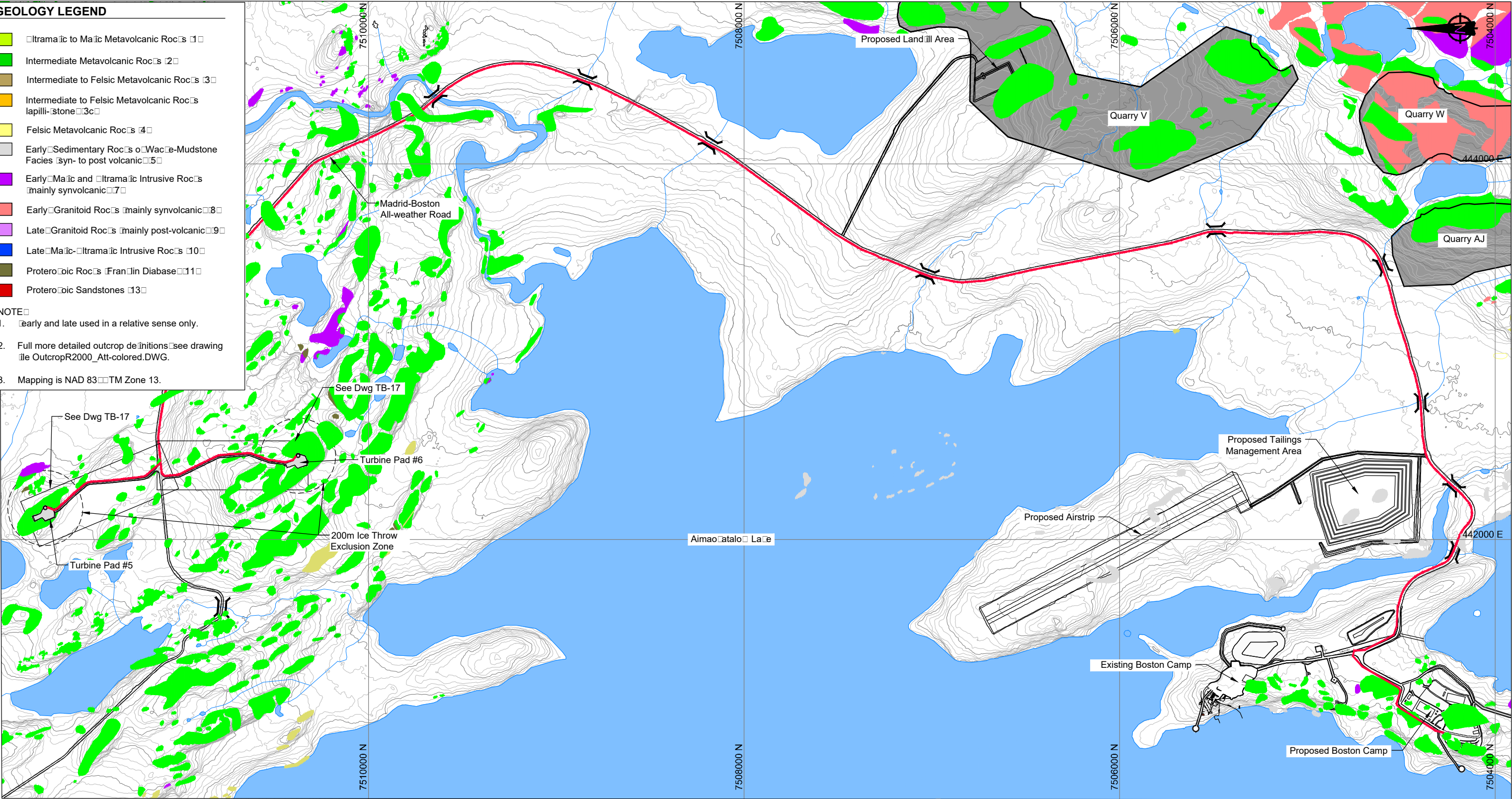
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- Intermediate Metavolcanic Roc's 2□
- Intermediate to Felsic Metavolcanic Roc's 3□
- Intermediate to Felsic Metavolcanic Roc's lapilli-stone 3c□
- Felsic Metavolcanic Roc's 4□
- Early□Sedimentary Roc's o□Wac□e-Mudstone Facies □syn- to post volcanic□5□
- Early□Maic and □Itramaic Intrusive Roc's □mainly synvolcanic□7□
- Early□Granitoid Roc's □mainly synvolcanic□8□
- Late□Granitoid Roc's □mainly post-volcanic□9□
- Late□Maic-□Itramaic Intrusive Roc's 10□
- Proteroic Roc's □Fran□in Diabase□11□
- Proteroic Sandstones 13□

- NOTE□
1.

□early and late used in a relative sense only.
2.

Full more detailed outcrop deinitions□see drawing file OutcropR2000_Att-colored.DWG.
3.

Mapping is NAD 83□TM Zone 13.

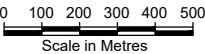


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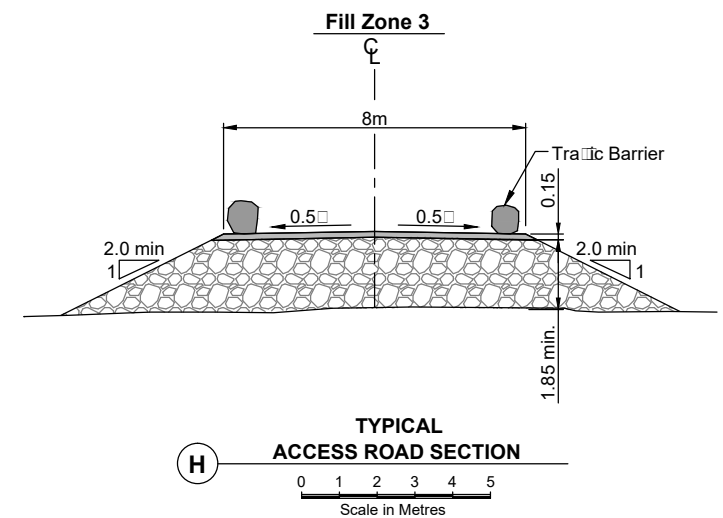
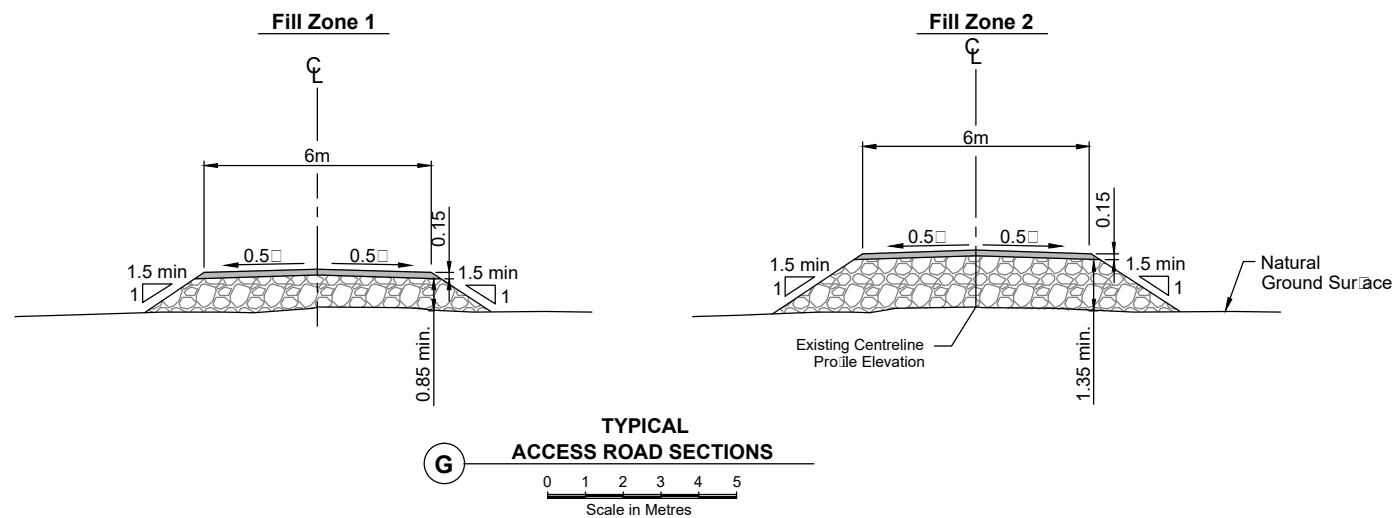
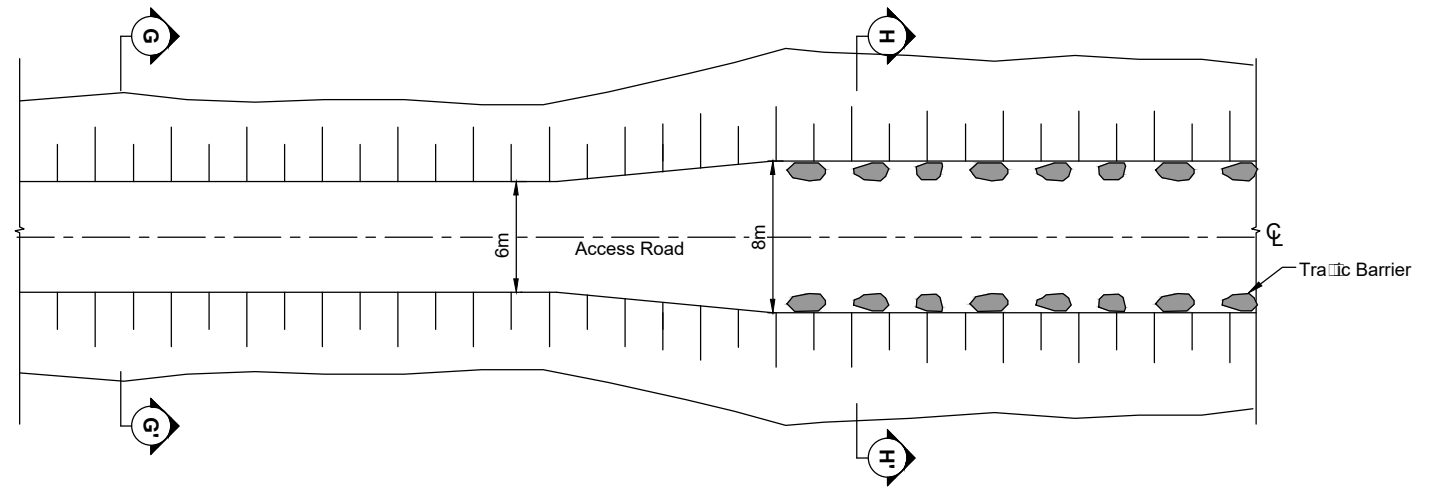
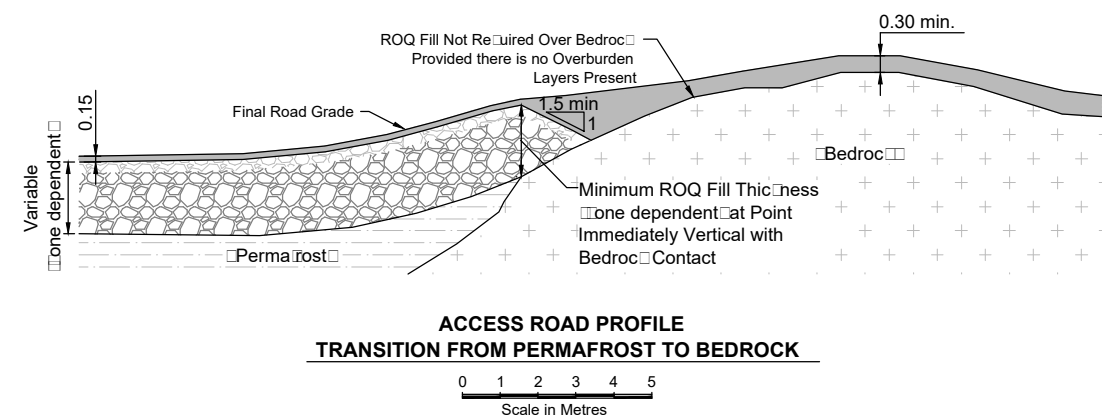
1.

The co-ordinate system is □TM NAD 83□Zone 13.
2.

All dimensions are in metric units□unless otherwise specified.



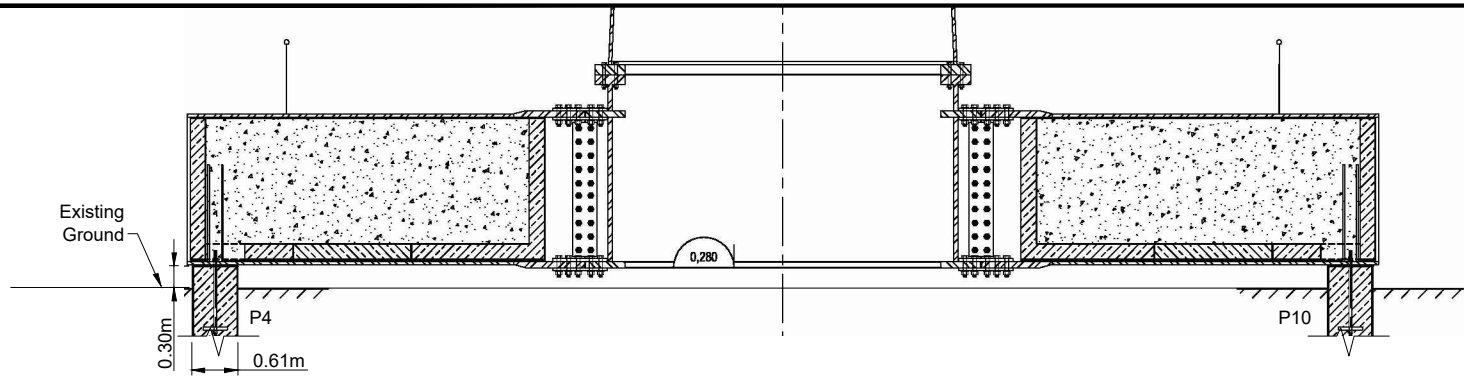
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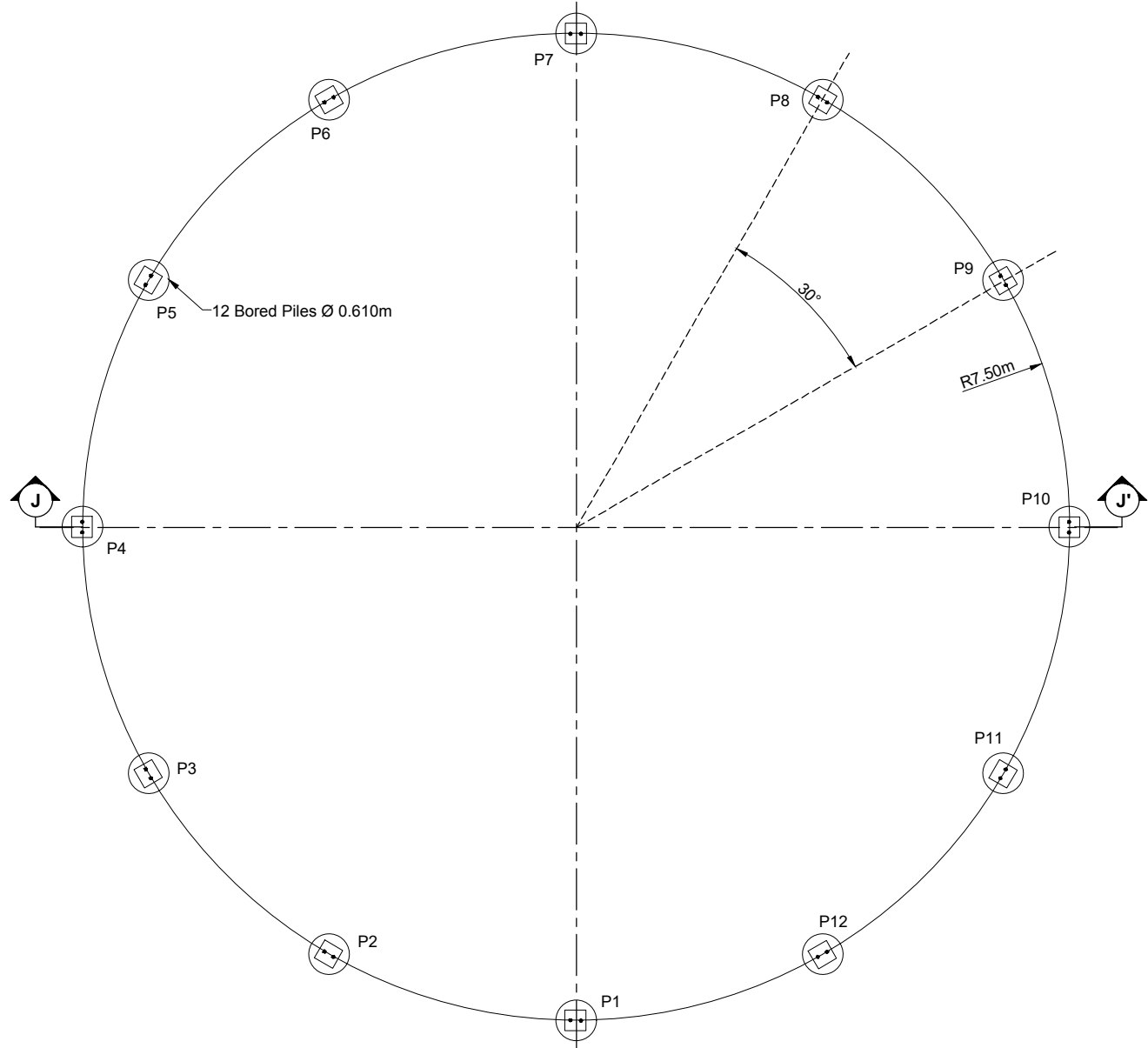
- LEGEND**
- Surfacing Material
 - Run of Quarry Material

- NOTES**
- All dimensions in metres unless noted otherwise.
 - Minimum design thickness must be maintained for all sections of the all-weather road including turnouts.
 - Notes in this drawing apply to all other active drawings.

																																								Wind Energy Project									
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																																								Typical Road Plan and Sections									
																																								HOPE BAY PROJECT									



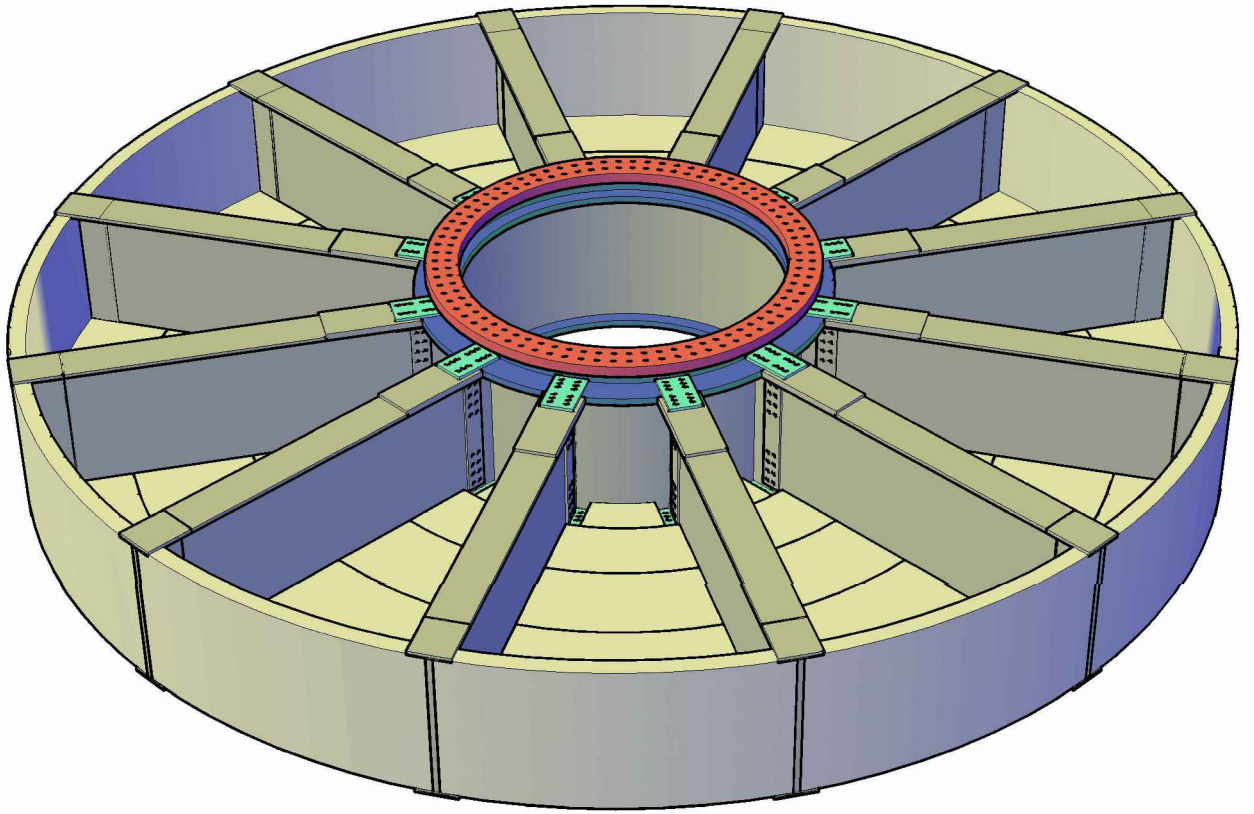
J FOUNDATION PILE SECTION
0 0.5 1 1.5 2 2.5
Scale in Metres



BORED PILE LAYOUT PLAN
0 0.5 1 1.5 2 2.5
Scale in Metres

REFERENCES

1. Bored Pile Layout and Foundation Pile Section from WSP Global Inc. titled "E-82 E4 S79.5F01 Steel Beam Foundation Position Drawing Bored Piles" Raglan Project drawing no. 111-15582-08-RGN-S-002 dated April 24 2014.
2. Steel Spider Foundation view from ENERCON Canada Inc. titled "Steel Spider Foundation E-82 E4 S77.5F01" Raglan Project drawing no. 00219 dated Jan. 14 2014.



STEEL SPIDER FOUNDATION
Not to Scale

\\non-srv\Projects\01_SITES\Hope Bay\1CT022.013_Misc_Doc's_Licence_Modifications\040_AutoCAD\Wind Turbine Project\1CT022.013-2_Wind Turbine.dwg

								srk consulting				TMAC RESOURCES				Wind Energy Project			
								DESIGN: CH DRAWN: NV REVIEWED: CH				DRAWING TITLE:				Foundation Details			
								CHECKED: CH APPROVED: DATE: Sept. 22, 2017				DRAWING NO.				TB-24			
DRAWING NO.				DRAWING TITLE				HOPE BAY PROJECT				SRK JOB NO.: 1CT022.013				SHEET 24 of 26			
REFERENCE DRAWINGS				REVISIONS				PROFESSIONAL ENGINEER'S STAMP				REVISION NO. A							
A				Issued for Discussion				CH				22Sep17							
NO.				DESCRIPTION				CHK'D				APP'D				DATE			

						Wind Energy Project			
	DESIGN: CH			DRAWN: NV		REVIEWED: CH		DRAWING TITLE: Wind Turbine Schematic	
	CHECKED: CH			APPROVED:		DATE: Sept. 22, 2017			
						HOPE BAY PROJECT			
PROFESSIONAL ENGINEER'S STAMP	FILE NAME: 1CT022.013-2_Details.dwg			SRK JOB NO.: 1CT022.013		DRAWING NO. TB-25		SHEET 25 of 26	REVISION NO. A

\\Vn-rs-rv0\Projects\01_SITES\Hope Bay\1CT022.013_Misc_Doris_Licence_Modifications\040_AutoCAD\Wind Turbine Project\1CT022.013-2_Wind Turbine.dwg

Doris Area: Materials List and Quantity Estimates

Item	Quantity / Area / Volume		Description
1. Run o□Quarry Material	Pad 1	4.095m ³	Approximate In-Place Neat-line Volume □3D volume based on Civil 3D sur□ces - no allowance has been made for losses and/or tundra embedment□
	Pad 1 Access Road	10.100m ³	
	Pad 1 Par□ing Pad	-	
	Pad 2	6.960m ³	
	Pad 2 Access Road	5.280m ³	
	Pad 2 Par□ing Pad	150m ³	
	Total	26.585m ³	
2. Sur□acing Material	Pad 1	695m ³	Approximate In-Place Neat-line Volume
	Pad 1 Access Road	520m ³	
	Pad 1 Par□ing Pad	10m ³	
	Pad 2	695m ³	
	Pad 2 Access Road	535m ³	
	Pad 2 Par□ing Pad	10m ³	
	Total	2.465m ³	
3. Cut Volumes	Pad 1	3.350m ³	Approximate In-Place Neat-line Volume
	Pad 1 Access Road	12m ³	
	Pad 1 Par□ing Pad	110m ³	
	Pad 2	154m ³	
	Pad 2 Access Road	-	
	Pad 2 Par□ing Pad	-	
	Total	3.626m ³	

Madrid Area: Materials List and Quantity Estimates

Item	Quantity / Area / Volume		Description
1. Run o□Quarry Material	Pad 3	2.805m ³	Approximate In-Place Neat-line Volume □3D volume based on Civil 3D sur□ces - no allowance has been made for losses and/or tundra embedment□
	Pad 3 Access Road	1.695m ³	
	Pad 3 Par□ing Pad	50m ³	
	Pad 4	7.465m ³	
	Pad 4 Access Road	3.795m ³	
	Pad 4 Par□ing Pad	70m ³	
	Total	15.880m ³	
2. Sur□acing Material	Pad 3	760m ³	Approximate In-Place Neat-line Volume
	Pad 3 Access Road	200m ³	
	Pad 3 Par□ing Pad	10m ³	
	Pad 4	760m ³	
	Pad 4 Access Road	355m ³	
	Pad 4 Par□ing Pad	10m ³	
	Total	2.095m ³	
3. Cut Volumes	Pad 3	105m ³	Approximate In-Place Neat-line Volume
	Pad 3 Access Road		
	Pad 3 Par□ing Pad		
	Pad 4	225m ³	
	Pad 4 Access Road	-	
	Pad 4 Par□ing Pad	-	
	Total	330m ³	

Tolerances on 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 uni□ormly high or low.

Boston Area: Materials List and Quantity Estimates

Item	Quantity / Area / Volume		Description
1. Run o□Quarry Material	Pad 5	2.355m ³	Approximate In-Place Neat-line Volume □3D volume based on Civil 3D sur□ces - no allowance has been made for losses and/or tundra embedment□
	Pad 5 Access Road	7.190m ³	
	Pad 5 Par□ing Pad	90m ³	
	Pad 6	320m ³	
	Pad 6 Access Road	6.545m ³	
	Pad 6 Par□ing Pad	20m ³	
	Total	16.520m ³	
2. Sur□acing Material	Pad 5	760m ³	Approximate In-Place Neat-line Volume
	Pad 5 Access Road	570m ³	
	Pad 5 Par□ing Pad	10m ³	
	Pad 6	760m ³	
	Pad 6 Access Road	625m ³	
	Pad 6 Par□ing Pad	10m ³	
	Total	2.735m ³	
3. Cut Volumes	Pad 5	1.430m ³	Approximate In-Place Neat-line Volume
	Pad 5 Access Road		
	Pad 5 Par□ing Pad		
	Pad 6	2.460m ³	
	Pad 6 Access Road	-	
	Pad 6 Par□ing Pad	-	
	Total	3.890m ³	

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Attachment 2: Technical Data for E-126 EP4 Turbine

Technical data E-126 EP4

General	
Manufacturer	ENERCON GmbH Dreekamp 5 D-26605 Aurich
Type designation	E-126 EP4
Nominal power	4200 kW
Hub heights	approx. 135 m and approx. 144 m
Rotor diameter	127 m
IEC wind class (ed. 3)	IIA
Extreme wind speed at hub height (10-min. mean)	42.5 m/s Corresponds to a load equivalent of approx. 59.5 m/s (3-sec. gust)
Annual average wind speed at hub height	8.5 m/s
Rotor with pitch control	
Type	Upwind rotor with active pitch control
Rotational direction	Clockwise (downwind)
Number of rotor blades	3
Rotor blade length	59.7 m (segmented blade)
Swept area	12668 m ²
Rotor blade material	GRP/epoxy resin/wood
Lowest power feed speed to nominal speed	~ 3 - 11.6 rpm
Tip speed	Up to ~ 77 m/s
Power reduction wind speed	28 - 34 m/s (with optional ENERCON storm control)
Conical angle	0°
Rotor axis angle	5°
Pitch control	One independent electrical pitch system per rotor blade with dedicated emergency power supply

Drive train with generator	
WEC concept	Gearless; variable speed; full-scale converter
Hub	Rigid
Bearing	Double-row tapered/cylindrical roller bearing
Generator	Direct-drive ENERCON annular generator
Grid feed	ENERCON inverters with high frequency IGBT switching and sinusoidal current
IP Code/insulation class	IP 23/F
Brake system	
Aerodynamic brake	Three independent pitch systems with emergency power supply
Rotor brake	Electromechanical
Rotor lock	Latching every 5°
Yaw control	
Type	Electrical with yaw motors
Control system	Active via yaw gears
Control system	
Type	Microprocessor
Grid feed	ENERCON inverter
Remote monitoring system	ENERCON SCADA
Uninterruptible power supply (UPS)	Integrated