FWS Geological & Geo-Environmental Consultants

SIRIUS MINERALS PLC - DISCHARGE OF PLANNING CONDITIONS FOR PLANNING PERMISSION NYM/2014/0676/MEIA (AS VARIED BY NYM/2017/0505/MEIA), NORTH YORKSHIRE POLYHALITE PROJECT

CONDITION	NYMNPA 47
REPORT	GROUNDWATER MANAGEMENT SCHEME (NYMNPA 47 – PHASE 7)
SITE	PHASE 7 DEVELOPMENT WORKS AT WOODSMITH MINE, NORTH YORKSHIRE
DOCUMENT NUMBER	40-FWS-WS-70-WM-PL-0018

1433DevOR401 Rev2/August 2018

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PROJECT NUMBER	1433	
PROJECT TITLE	North Yorkshire Polyhalite Project	
CLIENT	Sirius Minerals Plc Resolution House Lake View Scarborough YO11 3ZB	
REPORT TITLE	Groundwater Management Scheme (NYMNPA 47 – Phase 7)	
REPORT REFERENCE	1433DevOR401	
DOCUMENT NUMBER	40-FWS-WS-70-WM-PL-0018	
REVISION	**Date**	**Approved**
Rev 01	23/08/2018	RIL
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CONTENTS

APPENDICES

GROUNDWATER MANAGEMENT SCHEME (NYMNPA 47 – PHASE 7)

1 INTRODUCTION

1.1 General Background

This document has been prepared on behalf of Sirius Minerals Plc (Sirius Minerals) and provides the Groundwater Management Scheme for the Phase 7 Works (the Works) at Woodsmith Mine, as required to discharge Condition 47 of the North York Moors National Park (NYMNP) planning permission NYM/2014/0676/MEIA (as varied by NYM/2017/0505/MEIA).

1.2 Phase 7 Works

Construction of the Phase 4, 4a, 5 and 6 works, as detailed in their Hydrogeological Risk Assessments (Refs. 1 to 4), are ongoing. Provided below are details of the Works, which will be undertaken concurrently with these ongoing Phase 4 to 6 works.

- Completion of Service Shaft Headgear Chamber.
- Completion of Service Shaft to 83.17m AOD via Vertical Shaft –Sinking Machine (VSM) Method.
- Excavation of Production Shaft Headgear Chamber.
- Excavation from base of Production Shaft Headgear Chamber to 83.66m AOD.
- Surface Water Run-Off Silt Treatment Facility Building.
- Erection of temporary facilities to enable mobilisation of deep shaft sinking contractor.
- Earthworks and Drainage.
- Contingency Grouting of the MTS Shaft.

1.3 Compliance with Conditions

Table 1 sets out the wording of Planning Condition 47 to Planning Permission NYM/2014/0676/MEIA (as varied by NYM/2017/0505/MEIA) and details where the relevant material is presented in the report to comply with this condition:-

Table 1 - Summary of Planning Condition 47 and where Relevant Details are provided in the Report

NYMPA Condition 47	Compliance with Condition 47
Following the approval of the Revised Hydro-Geological Risk Assessment but prior to the commencement of development, a Groundwater Management Scheme (covering construction, operation and post-operation phases), shall be submitted to and approved in writing by the Local Planning Authority in consultation with the Environment Agency.	This document 1433DevOR401 dated August 2018.
The Scheme shall include technical drawings detailing the conceptualised hydrogeology with the final detailed designs of the proposed mitigation measures outlined in the Environmental Statement and in accordance with the details in the York Potash Project: Habitats Regulations Assessment prepared by Amec Foster Wheeler dated June 2015 with document reference 35190CGos064R, and the final design details of the lining systems for the proposed shaft.	Final designs, technical details, a conceptualised hydrogeological cross section, plans of the mitigation measures, and details of the compliance monitoring and reporting to validate their implementation for the Phase 7 Groundwater Management Scheme are provided in Section 2.
Development shall thereafter proceed only in strict accordance with the approved Scheme and a timetable to be included within it.	The timetable for implementing the Phase 7 Works Groundwater Management Scheme is presented in Section 3.

2 GROUNDWATER MANAGEMENT MEASURES – PHASE 7 WORKS

2.1 General

The Works will include the following groundwater management measures:-

- Dewatering of the Service and Production Shafts Platform utilising the existing (Phase 3) well array to maintain groundwater levels below the base of excavations for the Winder foundations, basement and shaft capping beam construction at an elevation of around 196m AOD.
- Localised dewatering by sump pumping, to keep excavations dry to the Production shaft winder basement area and to remove water trapped during excavation within the diaphragm walls to the Headframe Chambers to the Production and Service Shafts.
- During VSM walling for the Service Shaft from an elevation of 162.17m AOD to 83.17m AOD, groundwater levels are to be monitored and restricted to 85m above the VSM cutting head. On completion of installing the segmental liner, grouting will be carried out between the wall annulus and host rock to maintain hydraulic separation between the Cloughton and Saltwick aquifers. Once fully grouted, the remaining water in the shaft will be pumped to a settlement tank at the surface, prior to discharge through an interceptor into the Platform drainage system.
- In the event that grouting works at the MTS shaft are determined necessary, to progress the shaft below the completed Phase 4a VSM section, a grout curtain will be formed around the perimeter zone for future shaft excavation to a depth of 83m AOD (i.e. 20 m into the Whitby Mudstone). This grout curtain will be installed to restrict groundwater ingress into the shaft excavation from the Ravenscar Formation, as shown in Drawing Nos. 1433DevOD338 Appendix 1.
- In order to capture construction run off and infiltration through future landscaped fill placed in subsequent construction phases into Bund F, a basal drainage layer will be installed and piped to the surface water drainage system. In addition, as part of these preparatory works to Bund F, the groundwater collection layer approved under the Phase 3 Groundwater Management Plan (Ref 12) will be installed.

2.2 Temporary Well Dewatering

2.2.1 General

Temporary dewatering will continue using the pumping wells installed around the Service and Production Shaft Platforms (Ref. 5 and 6), to facilitate excavation of the winder basement, foundations and diaphragm wall capping beam, as illustrated in Drawings 1433DevOR360 and 361. This pumping will be used to maintain groundwater below the target levels detailed in Table 2.

Table 2 - Summary of Target Groundwater Dewatering Levels

Shaft Structure	Platform Level (m AOD)	Seasonal High Water Table (m AOD)	Target Groundwater level (m AOD)
Winder foundations	203.66	202	196
Winder basement and lower capping beam	203.66	202	194

2.2.2 Operational Management

Groundwater level monitoring during these construction works will be carried out of the wells listed in Table 3, as shown in drawing 1433DevOR360, supplemented with monitoring of the dewatering well array and by visual inspection for groundwater seepages within the excavation areas. This monitoring will be undertaken to evaluate when supplementary sump pumping is required to maintain the excavations dry. Trigger Control values are provided to enable assessment of when dewatering should be implemented to maintain the excavations dry.

Table 3 - Summary of Construction Phase Monitoring Wells

Shaft Location	Temporary Monitoring Well	Trigger Control Value (m bspl) [m AOD]
Winder Foundation and Basement	505, 507 and MW03	(7m bspl) [196 m AOD]

Groundwater generated from this dewatering will be pumped to a settlement tank at surface level to remove particulates. This water will then discharge to the surface water drainage system, under the same methodology as used in Phase 3 (Ref 5).

2.2.3 Documentation and Reporting

The Contractor will be responsible for maintaining daily records of the dewatering operations and of flow rates discharged from the system to surface water drainage.

2.3 Temporary Sump Dewatering

2.3.1 General

Temporary sump dewatering will be undertaken, where necessary, to maintain excavations dry, during construction of the winder basement, foundations and capping beam.

For the Service and Production shafts chamber excavations, base failure from plug uplift, has been determined to present a potential risk to construction, if vertical connectivity has developed between the Saltwick Formation and the overlying aquifers, as a result of the ongoing

construction works (Ref 7), if groundwater levels rise above a maximum elevation of around 176m AOD.

Table 4 presents the groundwater levels for each structure, at which supplementary dewatering will need to be considered.

Table 4 - Groundwater Levels at which Additional Dewatering may be required

Shaft Structure Excavations	Base of Excavation (m AOD)	Seasonal High Water Table (m AOD) In Adjacent Aquifer	Target Groundwater Level (m AOD)
Base of Service Chamber during excavation	157	152 (Saltwick)	155
Production Shaft Winder foundations	197	202 (Moor Grit)	196
Production Shaft Winder basement and lower capping beam	194	202 (Moor Grit)	194
Base of Production Chamber during excavation	158	152 (Saltwick)	155

2.3.2 Operational Management

Winder Basement, Foundations and Capping Beam Excavations

During construction, sumps will be excavated to facilitate groundwater sump pumping. Where necessary, drainage channels will be cut into the floor of the excavations to promote drainage towards sumps. Groundwater generated from these sumps will be pumped to a settlement tank at surface level to remove particulates. This water will then be passed through an oil/water interceptor prior to discharge to the surface water drainage system, under the same methodology as used in Phase 4a (Ref 2).

Headframe Chamber Excavations

During excavation of the headframe chambers, sumps will be formed in the floor of the excavation to facilitate groundwater pumping to maintain the excavation dry. Groundwater generated from these sumps will be pumped to a settlement tank at surface level, as detailed above.

For the Service Shaft Headframe Chamber, a pressure relief well has been formed in the centre of this area for excavation by reaming out the shaft pilot hole SM11 and backfilling this to the upper surface of the Whitby Mudstone with gravel, beneath which is a cement / bentonite grout. As such, should an increased pressure develop in the Saltwick Formation within the diaphragm wall, this should equilibrate and drain off into the base of the headframe chamber excavation without the requirement for installation of additional wells. Such water should then be accommodated for by sump pumping from the base of the excavation.

To assist in managing groundwater levels within the Service and Production headframe chamber excavations, monitoring will be undertaken from Vibrating Wire Piezometers (VWP) installed beneath the toe of the diaphragm walls within the Saltwick Formation, as shown in Drawing No. 1433DevOR360. These VWP's have been installed to determine whether groundwater levels at

this elevation present a risk of causing base failure from plug uplift. The Control and Compliance Trigger Values to be adopted at these locations are summarised in Table 5:

Table 5 - Summary of Target Groundwater Levels

Structure	Borehole	Piezometer Location In Diaphragm Wall Panels	Control Values Groundwater Level (m AOD)			Compliance Values Groundwater Level (m AOD)
			Amber	Red	Black	
Base of Service Chamber during excavation	704B 705B	Panel 14 VWP:- SS-PZ-14-SW-133 Panel 40 VWP:- SS-PZ-40-SW-133	155(1)	165(1)	173 (1)	176 (1)
Base of Production Chamber during excavation	TBC* TBC* TBC* TBC*	Panel 2 VWP:- TBC* Panel 10 VWP:- TBC* Panel 18 VWP:- TBC* Panel 30 VWP:- TBC*	TBC*	TBC*	TBC*	TBC*

Notes

(1) Design values specified in (Ref 7).

* Design and installation of the boreholes, vibrating wire piezometers and Control and Compliance values are to be confirmed, subject to detailed design.

If groundwater levels in the Saltwick Formation in the Service headframe chamber are determined above the Control Trigger Values during its excavation, dewatering will be undertaken from the dewatering well installed inside the diaphragm wall in BH706, as shown on Drawing No. 1433DevOR360.

If elevated groundwater levels are determined above the Control Trigger Values in the Saltwick Formation in the Production headframe chamber during its construction, either; passive relief wells will be installed in or outside the diaphragm wall or additional wells will be installed around the perimeter for pumping. Groundwater generated from these supplementary dewatering works will be pumped to the dewatering settlement tank at surface level, as detailed in Section 2.2.2.

2.3.3 Documentation and Reporting

The Contractor will be responsible for maintaining daily records of the dewatering operations and flow rates discharged from the system to surface water drainage.

2.4 Groundwater Head Management during VSM Works

2.4.1 General

From the Hydrogeological Baseline Report (Ref. 8), groundwater levels in the Ravenscar aquifers within the Service Shaft VSM construction depth are anticipated at 11m bspl (192m AOD) in the Cloughton aquifer, 51m bspl (152m AOD) in the Saltwick aquifer, as shown in Drawing No. 1433OD361 Appendix 1.

During the VSM excavation to a depth of 120m bspl, the head of water will be maintained at ambient groundwater level within the adjacent aquifer. Should significant fracture zones be

encountered, causing water loss from the cutting zone, an external potable water source will be used to maintain a 10m minimum head above the VSM cutter.

Following installation of the segmental liner to 55m bspl, the annulus will be grouted up.

2.4.2 Operational Management

Management of Groundwater Levels

Groundwater level monitoring within the excavation will be carried out on a daily basis to record the cutter depth below the platform level and the water level within the excavation.

Groundwater levels in the excavation should be at or around the ambient water level in the relevant aquifer. Should groundwater levels drop to a level of less than 10m above the cutting head during excavation then additional bentonite slurry, supplemented by wood chippings, gravel or concrete, will be introduced to seal up permeable fractures and then potable water added to raise water levels in the excavation close to the ambient water level in the relevant aquifer.

Management of Construction Waters

During the VSM works to 120 m bspl, it is anticipated that groundwater levels in the shaft excavation should be at or around the ambient water level in the Saltwick aquifer (i.e. at a depth of 50m bspl (150m AOD)). In the event of excess water developing above the maximum permitted head within the VSM excavation during the cutting process, then this will be pumped out to a settlement tank at surface level to remove particulates. This water will then be passed through an oil/water interceptor prior to discharge to the surface water drainage system, under the same methodology as used in Phase 4a (Ref 2).

Following completion of liner installation to 120m bspl, the construction water remaining within the lined structure will be pumped into the VSM water treatment system, comprising de-sander and de-silter units, a silt buster and an oil separator prior to discharge to the Shaft Platform surface water drainage system. The discharge point for this treated construction water will be monitored in situ on a daily basis during the periods of discharge for the following suite of parameters:-

- pH.
- Conductivity.
- Temperature.
- Total Dissolved Solids.
- Dissolved oxygen.
- Total hydrocarbons.

Grouting

On completion of lining, the annulus of the precast concrete rings will be grouted to seal the void and prevent hydraulic connectivity between the different aquifers. The grout will be introduced at the base of the void via a pipe connecting to a fill hole in the lowest ring. This will enable grout injection from the toe of the cutting shoe in a manner to displace the bentonite from the top of the segmental rings. Proof drilling with grout pressure testing will then be carried out over the

full height of the segmental liner and additional grouting will be undertaken, where necessary, to maintain a competent seal between the host rock and the concrete lining wall.

2.4.3 Documentation and Reporting

The Contractor will be responsible for recording the construction phase water level monitoring and the use of additional water to maintain the minimum required water head during construction. A weekly summary report will be provided to Sirius Minerals identifying potential contamination issues caused by the works (i.e. loss / spillage of lubricant oils or hydraulic fluids) and sustained drops in water level within the excavation that may impact on groundwater levels within the adjacent aquifers.

Sirius Minerals will undertake the water quality monitoring of the construction water discharge from the VSM works into the surface water drainage system, in accordance with the surface water monitoring scheme (Ref. 9) and will report this data in accordance with the remedial action plan (Ref. 10).

On completion, the Contractor will provide to Sirius Minerals a Construction Validation Report of "as built" records of the works to 83m AOD, including plans sections of the segmental wall, grouting and proof grouting, and details on concrete and grout plugs installed.

2.5 Grouting at MTS Shaft

2.5.1 General

If VSM shaft lining terminates before 83m AOD, grouting will be undertaken to provide groundwater control during the shaft construction through the remaining section of the Ravenscar aquifers. A schematic hydrogeological cross section through the full depth of the shaft construction works to 83m AOD, is shown in Drawing Nos. 1433DevOD338.

The grout curtain, comprising an inner and outer grout ring, will be formed by injecting cementitious grout through primary and secondary holes, drilled from the surface, as summarised below and detailed in the CEMP (Ref 11):-

<u>Grout Injection Management</u>

The grout injection will be carried out through 150mm diameter holes, drilled in 5 m long stages to enable a descending sequence of grout injection beneath an inflated packer, from 5m above the toe depth of the VSM segmental lined shaft to key into the Whitby Mudstone aquitard at around 83m AOD. All of the secondary grout positions within the inner and outer grout rings will then be drilled to the full depth of grouting (i.e. 83m AOD) and then grouted in an ascending sequence over 10 m long stages from the base upwards, using an inflated packer to permit grouting of each stage.

To prevent hydraulic fracturing during grout injection, hydraulic conductivity tests (IHCT) will be performed prior to grout injections. This data will be used to analyse the amenability coefficient and to determine the grout type and injection controls required. Where the rock strata is of low permeability (<1 $x10^{-7}$ m/s), ultrafine cement based grout will be injected at restricted pressures. The maximum effective grouting pressure will be controlled at the surface using the GIN method, by monitoring the gauge pressure, hydrostatic pressure, line losses through the

injection system and the head pressure. Adjustments to the grout injection pressure will be made to prevent hydro fracturing of the strata. Grout will be injected until refusal is obtained at the maximum allowable injection pressure after which, no further treatment will be undertaken.

Management of Drilling Arisings

All solid drilling arisings will be collected to a temporary stockpile for subsequent reuse as landscape fill within the extractive material management facilities. All water flush arisings will be collected within drainage channels and recycled through a treatment plant, comprising de-sander and de-silter units, a silt buster and an oil separator prior for either reuse or discharge to the Shaft Platform surface water drainage system.

Validation of Grouting

Validation of the groundwater control provided by the grout curtain will be undertaken by the volume, flow and pressure monitoring of each stage of the grouting process and by 7No. permeability tests undertaken on completion of each stage of grouting.

2.5.2 Specification

The grout mix will comprise a cement grout, comprising Microcem 650, with 1% Rheobuild2000PF superplasticiser.

The grout curtain is to be formed by two rings of grout, to achieve a 4m wide zone around the perimeter of shaft excavation area with a permeability of less than 1 x 10^{-7} m/s.

2.5.3 Operational Management

The grouting process will be managed using Grout Intensity Number (GIN) grouting techniques, adopting digital monitoring of the grout pressure, flow and volumes to manage injection pressures and to check for grout losses into fracture zones in the host rock. Where losses occur, remedial actions will be implemented by means of shortening the vertical height of the drilling and grouting stages and by modifying the grout mix design including use of thixotropic additives, where necessary, in accordance with the Construction Environmental Management Plan CEMP (Ref 11).

The grout injection pressure will be selected by the hydro fracture test, in accordance with BS5930:1999+A2:2010. Before the stage grouting begins, a 5 minute pre-treatment permeability test will be carried out using an in-situ-packer for each stage, using a target pressure of 10 bar. Following grouting, a 10 minute post-treatment permeability testing will be undertaken using an in-situ packer for each grouting stage using a target pressure of 10 bar. The process will be repeated if further treatment is needed.

Permeability testing of the grout curtain will be undertaken in accordance with BS 5930:1999 at a minimum of 7 No. locations per grouting stage, with a target pressure of 10 bar.

2.6 Bund F Basal Drainage Layer

2.6.1 General

Preparatory works, including construction of the groundwater collection layer and a basal drainage layer are to be undertaken to prepare the northern part of Bund F for future placement of extractive materials during subsequent construction phases, as illustrated on Drawing Nos. 40-ARI-WS-7100-CI-18-01007 and 01011.

The groundwater collection layer, incorporating a herringbone pattern of piped drainage, will be constructed in accordance with the Specification, Construction Quality Assurance (CQA), and reporting requirements, as detailed in the Phase 3 Groundwater Management Plan (Ref. 12). In the northern area of Bund F, where no groundwater collection layer is to be constructed, a network of basal drains is to be provided, as illustrated in Drawing No. 40- ARI-WS-7100-CI-18-01007. No placement of extractive material generated from the Phase 7 shaft lining and chamber excavation works will be undertaken in this area as part of this phase.

The following sections provide design details for the basal drainage layer:-

- Specification.
- Construction Quality Assurance.
- Operational Management and Maintenance
- Documentation and Reporting.

2.6.2 Specification

The basal drainage layer is to be constructed to the following specification, as illustrated in Arup Drawing No. 40- ARI-WS-7100-CI-18-01007:-

- The subgrade will be prepared to remove all topsoil and subsoils to a depth of 0.6m to prepare a formation with a minimum gradient of 1 in 100 and profiled drain runs, as illustrated in the Typical Detail for Filter Drain for the Basal Drainage Layer, as shown in Arup Drawing No. 40- ARI-WS-7100-CI-18-01007.
- A basal geotextile, with a minimum pore size of 150µm, burst resistance of 350kPa, a Tensile Strength of 100kPa, puncture resistance of 50N and a permeability of > 100l/m2/s, will be placed around the formation for each of the basal drains aligned in a herringbone arrangement of perforated 225mm Ø HDPE PE80 SDR11 carrier pipes placed on a sand blinding layer and overlain by 0.5m of Type B drainage stone, as shown on Arup Drawing No. 40- ARI-WS-7100-CI-18-01007. All pipes are to be butt fusion welded and the Type B stone is to comply with Clause 505, Table 5/1 of the Specification for Highway Works, compacted in accordance with Table 6/4 method 3. The main carrier pipes are to discharge to the wetland pond via an Althon H3C headwall, or similar.

2.6.3 Construction Quality Assurance

Construction quality assurance of the basal drainage system will include:-

- The Contractor will provide as built records, including a topographic survey of the prepared formation, drainage pipe arrangement, and the compliance records of the pipe, aggregate and geotextile materials used.

- The Contractor will provide a Monitoring and Maintenance Plan for the combined basal drainage system and the groundwater drainage blanket, including details of the inspection and maintenance requirements to ensure long term operation of the drainage pipework installed.

- The Contractor will be responsible for providing all relevant information for auditing and inclusion in the Operational Management Plan.

2.6.4 Operational Management and Maintenance

An Operational Management Plan will be prepared for the combined basal drainage and groundwater collection system installed over the northern area of Bund F, including the "as built" records and the future inspection and maintenance regime (i.e. scope and frequency) to be implemented during construction and subsequent operation of the minesite.

2.6.5 Documentation and Reporting

On completion of installation, the "as built" records and Manufacturers recommendations on maintenance and inspection will be prepared by the Contractor.

An Operational Management Plan will be prepared for the combined basal drainage and groundwater collection system installed over the northern area of Bund F.

3 TIMETABLE FOR IMPLEMENTING THE PHASE 7 WORKS GROUNDWATER MANAGEMENT SCHEME

The timetable for undertaking the Phase 7 Works, including the associated groundwater management scheme, is October 2018 to June 2019.

R IZATT-LOWRY
DIRECTOR

4 REFERENCES

1 FWS Consultants Ltd, May 2017. Hydrogeological Risk Assessment (NYMNPA 46 – PHASE 4) (1433DevOR205).

2 FWS Consultants Ltd, April 2018. Hydrogeological Risk Assessment (NYMNPA 46 – PHASE 4A) (1433DevOR378).

3 FWS Consultants Ltd, May 2018. Hydrogeological Risk Assessment (NYMNPA 46 – PHASE 5) (1433DevOR385).

4 FWS Consultants Ltd, June 2018. Hydrogeological Risk Assessment (NYMNPA 46 – PHASE 6) (1433DevOR396).

5 FWS Consultants Ltd, April 2017. Groundwater Management Scheme (NYMNPA 47 – Phase 3). Doc. Ref. No. 1433DevOR178.

6 FWS Consultants Ltd, March 2018. Phases 2 and 3 Construction Validation of the Groundwater Management Scheme (1433DevOR272).

7 Arup July 2017. Instrumentation & Monitoring Plan – Service Shaft Headgear Chamber excavation.

8 FWS Consultants Ltd, 2016. Hydrogeological Baseline Report for the Doves Nest Farm Minesite, North Yorkshire 2012 to 2016 (1975OR01).

9 FWS Consultants Ltd, April 2018. Construction and Operation Phase Ground and Surface water Monitoring Scheme (NYMNPA 47 – Phase 4a). Doc. Ref. No. 1433DevOR379.

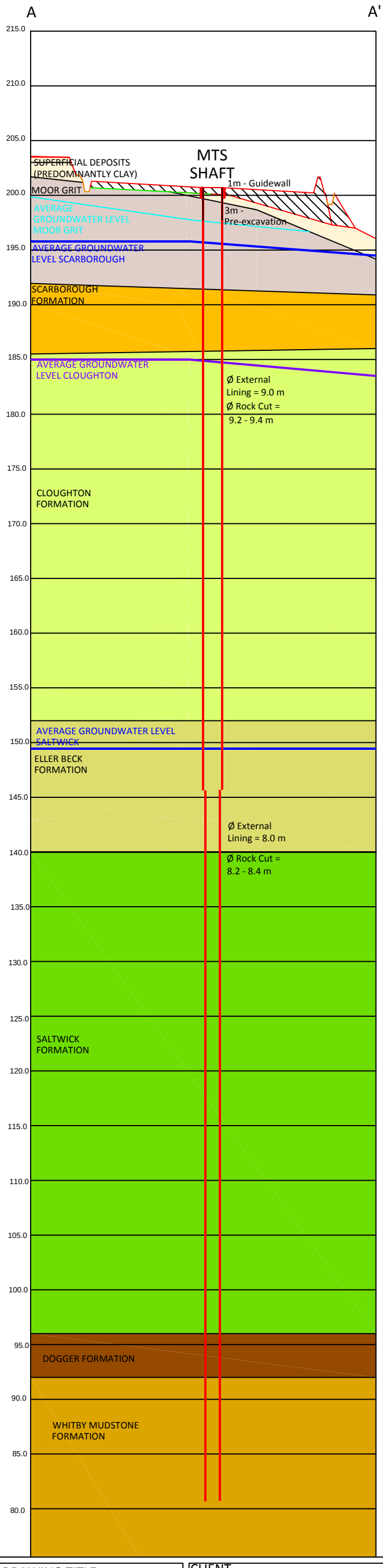
10 FWS Consultants Ltd, April 2018. Remedial Action Plan (NYMNPA 46 – Phase 4a). Doc. Ref. No. 1433DevOR380.

11 Phase 7 – Woodsmith Mine Construction and Environmental Management Plan Ref O-RHD-WS-70-EN-PL-029

12 FWS Consultants Ltd, April 2017. Groundwater Management Scheme (NYMNPA 47 – Phase 3). Doc. Ref. No. 1433DevOR178.

APPENDIX 1

DRAWINGS



NOTES / KEY

PHASE 2&3 WORKS
GEOMEMBRANE
LINED DRAINAGE DITCH

GEOLOGY
EXISTING GRANULAR PLATFORM CONSTRUCTION
NEW GRANULAR PLATFORM CONSTRUCTION
COHESIVE SUPERFICIAL DEPOSITS
MOOR GRIT
SCARBOROUGH FORMATION
CLOUGHTON FORMATION
ELLER BECK
SALTWICK FORMATION
DOGGER FORMATION
WHITBY MUDSTONE FORMATION

DRAWING TITLE
SCHEMATIC DRAWING OF VSM EXCAVATION FOR MTS SHAFT

PROJECT TITLE
NORTH YORKSHIRE POLYHALITE PROJECT

CLIENT
SIRIUS MINERALS PLC

STATUS
FINAL

PROJECT NUMBER
1433Dev

DRAWN BY
CB

DATE
March 2018

SCALE
AS SHOWN

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1433DevOD338

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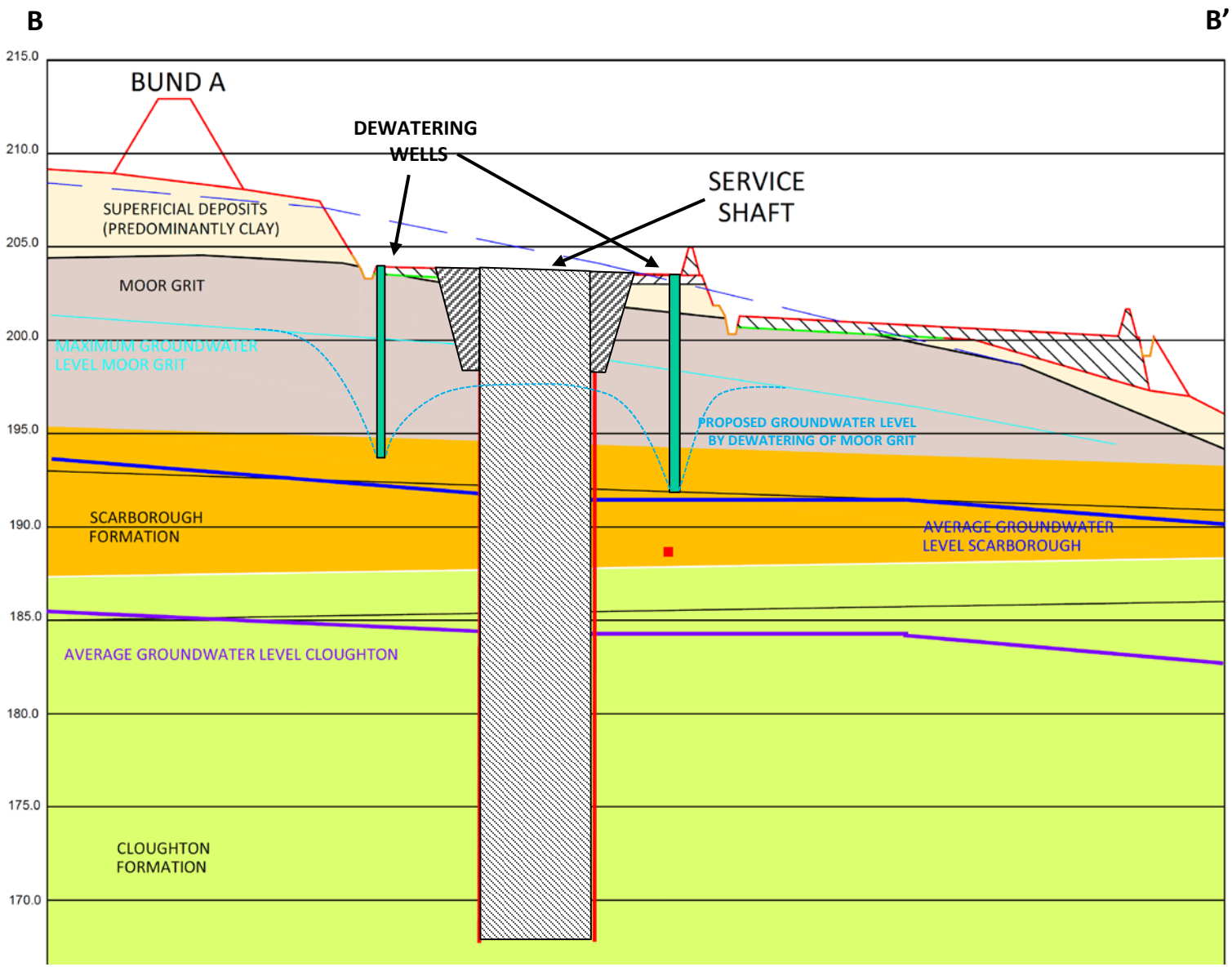

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NOTES / KEY

GEOLOGY

- EXISTING GRANULAR PLATFORM CONSTRUCTION
- NEW GRANULAR PLATFORM CONSTRUCTION
- COHESIVE SUPERFICIAL DEPOSITS
- MOOR GRIT
- SCARBOROUGH FORMATION
- CLOUGHTON FORMATION

CLIENT

SIRIUS MINERALS PLC

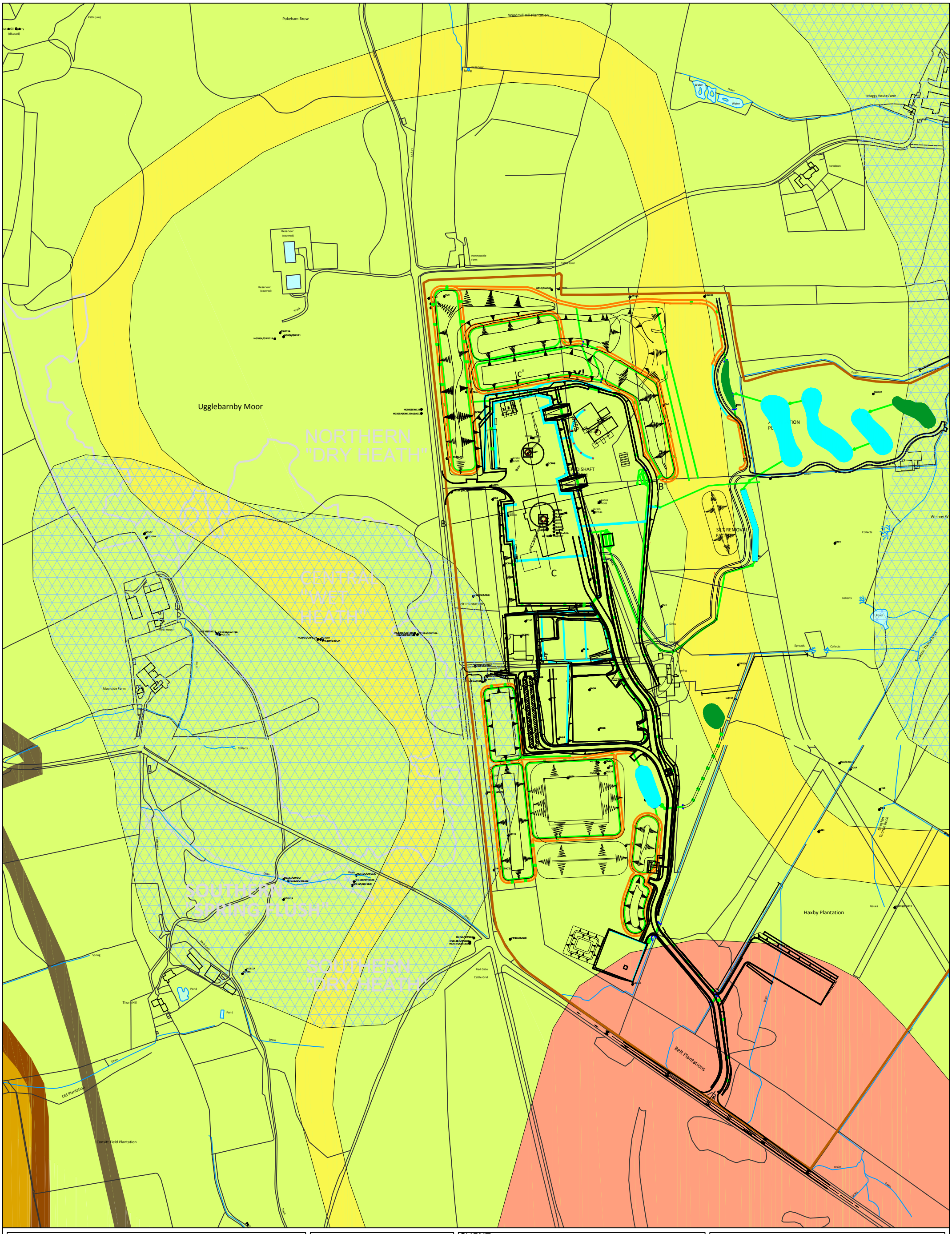
DRAWING TITLE

SCHEMATIC HYDROGEOLOGICAL SECTION (EAST TO WEST) THROUGH SERVICE SHAFT SHOWING DEWATERING GROUNDWATER MANAGEMENT

PROJECT TITLE

YORK POTASH PROJECT

STATUS	PROJECT NUMBER
FINAL	1433Dev
DRAWN BY	DATE
ML	May 2018
SCALE	DRG. No.
NOT TO SCALE	1433DevOD349



NOTES / KEY

SITE OWNERSHIP BOUNDARY
NYM SAC
SURFACE WATER
BOREHOLES GCBH01
HYDROGEOLOGICAL RECPTORS MF2
LINE OF CROSS SECTION
CROSS SECTION A-A' and B-B' DRAWING 1433DevOD244
CROSS SECTION A-A' DIAPHRAGM WALL DRAWING1433DevOD268
CROSS SECTION C-C' DRAWING 1433DevOD266
CROSS SECTION D-D' DRAWING 1433DevOD267

GEOLOGY
GLACIAL TILL
LONG NAB
MOOR GRIT
SCARBOROUGH FORMATION
CLOUGHTON & SALTWICK FORMATION
ELLER BECK FORMATION
DOGGER FORMATION
WHITBY MUDSTONE

DRAWING TITLE
GEOLOGICAL MAP AND LINE OF CROSS SECTIONS

PROJECT TITLE
NORTH YORKSHIRE POLYHALITE PROJECT

CLIENT
SIRIUS MINERALS PLC

STATUS
FINAL

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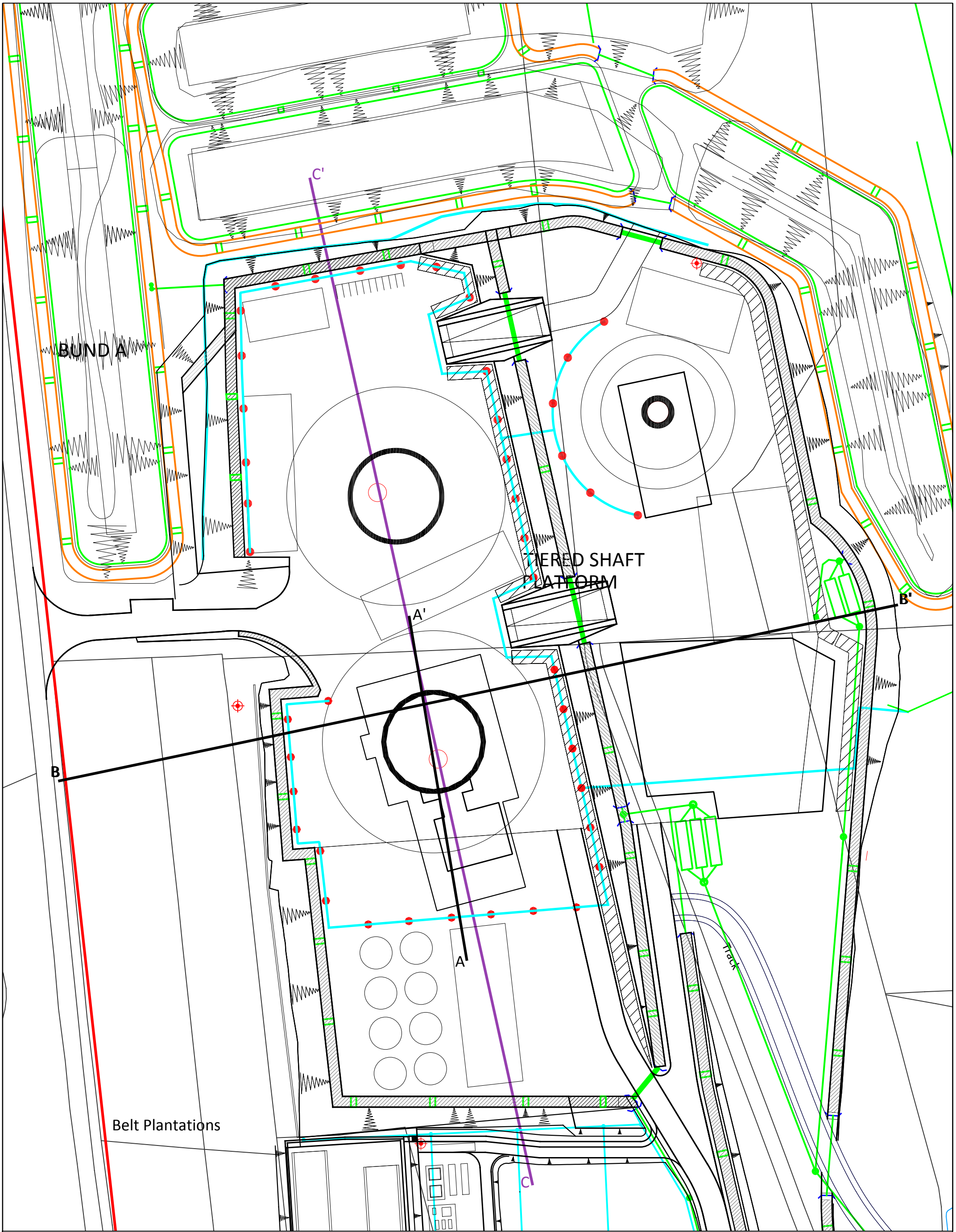

NOTES / KEY

C - C' Drawing 1433OD361

DRAWING TITLE

WELL ALIGNMENT AND LINE OF CROSS SECTIONS

PROJECT TITLE

NORTH YORKSHIRE POLYHALITE PROJECT

CLIENT
SIRIUS MINERALS PLC

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CM	August 2018
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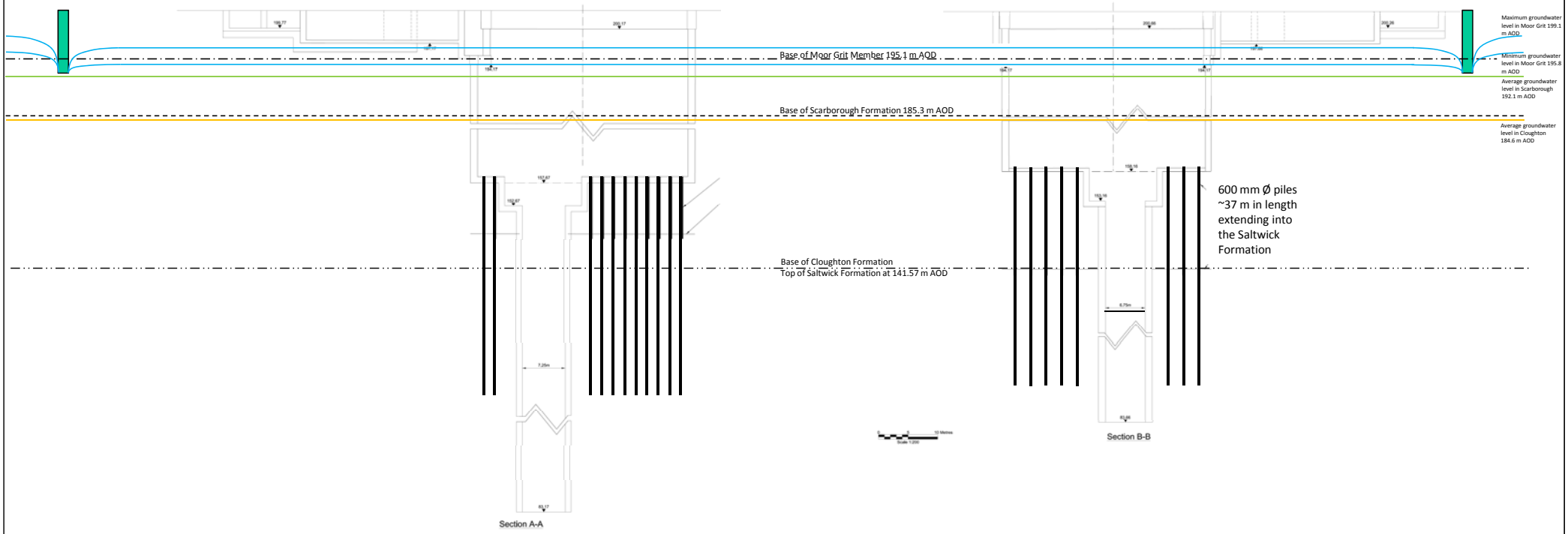

NOTES / KEY

SITE LOCATION

N

DRAWING TITLE
SCHEMATIC HYDROGEOLOGICAL SECTION (NORTH TO SOUTH) THROUGH THE SERVICE AND PRODUCTION SHAFTS SHOWING GROUNDWATER MANAGEMENT

PROJECT TITLE
NORTH YORKSHIRE POLYHALITE PROJECT

CLIENT
SIRIUS MINERALS PLC

STATUS	PROJECT NUMBER
/FINAL	1433Dev
DRAWN BY	DATE
CM	August 2018
SCALE	DRG. No.
NOT TO SCALE	1433DevOD361 REV1

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