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SIRIUS MINERALS PLC - DISCHARGE OF PLANNING CONDITIONS FOR PLANNING APPLICATION NYM/2014/0676/MEIA, NORTH YORKSHIRE POLYHALITE PROJECT

CONDITION	NYMNPA 46
REPORT	CONSTRUCTION AND OPERATION PHASE GROUND AND SURFACE WATER MONITORING SCHEME
SITE	PHASE 4 WORKS AT WOODSMITH MINE, NORTH YORKSHIRE
DOCUMENT NUMBER	40-FWS-WS-70-WM-PL-0008 Rev2

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REPORT TITLE	Construction and Operation Phase Ground and Surface Water Monitoring Scheme for Phase 4 Works At Woodsmith Mine, North Yorkshire
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CONSTRUCTION AND OPERATION PHASE GROUNDWATER AND SURFACE WATER MONITORING SCHEME FOR PHASE 4 WORKS AT WOODSMITH MINE, NORTH YORKSHIRE

1 INTRODUCTION

1.1 General Background

This document has been prepared on behalf of Sirius Minerals Plc (Sirius Minerals) and provides the Construction and Operation Phase Groundwater and Surface Water Monitoring Scheme for the Phase 4 Works at Woodsmith Mine (Phase 4 Works). This is required to discharge Condition 46 of the North York Moors National Park (NYMNP) planning permission NYM/2014/0676/MEIA.

This document details the hydrological, hydrogeological and ecological monitoring to be undertaken from commencement of the Phase 4 Works at Woodsmith Mine, as defined in Section 1.2 below.

Subsequent revisions of this document will be issued to present the monitoring schemes to be adopted for future phases of the development, dates of which are to be confirmed.

1.2 Phase 4 Works

This report presents the Construction and Operation Phase Groundwater and Surface Water Monitoring Scheme that relates to the Phase 4 Works, ongoing Phase 3 Works and completed Phase 2 Works. The works completed as part of Phase 4, comprise the following, as shown on Arup Drawing 40-ARI-WS-71-CI-DR-1082:-

Works Completed as Part of Phase 4

A summary description of the principal construction elements of the Phase 4 Works is presented below:-

- Operation of the concrete batch plant;
- Installation, commissioning and operation of the bentonite plant;
- Installation of concrete guide walls (excavate to -3.5m and concrete wall down to -1.5 to -1.75 m);
- Mobilisation to site of diaphragm walling equipment (cutters, cranes, workshops etc.);
- Diaphragm wall construction to -60m below ground level at the Production, Service and Mineral Transport System shafts;
- Limited continuation of earthworks to create an area for future storage of spoil.

1.3 Compliance with Conditions

Table 1 sets out the wording of Planning Condition 46 to Planning Consent Ref No. NYM/2014/0676/MEIA and details where the relevant material, to comply with this condition, has been provided within this report:-

Table 1 - Summary of Planning Condition 46 and where Relevant Details are Provided in the Report

NYMNP 46	Compliance with Condition 46
The scheme shall include: -	
Details of the number, type and location of monitoring points;	Section 3
A protocol for the removal and replacement of any existing monitoring points;	Section 4
Details of the frequency of monitoring during construction and operation;	Section 3.2.3, 3.3.4, 3.4.4, 3.5.3 and 3.6.4
A list of the ground and surface water determinands to be tested for;	Section 3.4.3, 3.5.6 and 3.6.3
Monitoring of ground water levels and spring flows;	Section 3.3.3 and 3.5.4
Monitoring of surface water quality including sediment, BOD, ammonia, pH;	Section 3.6.3
Geomorphology in Sneaton Thorpe Beck	Section 3.6.6
A list of SAC/SSSI habitat measures to be tested for;	Section 3.7.2
Groundwater quality and level triggers;	Section 3.35 and 3.4.5
Surface water quality triggers;	Section 3.6.5
Surface water geomorphology triggers;	Section 3.6.6
SAC/SSSI habitat triggers	Section 3.7.4
Monitoring of groundwater quality against groundwater triggers;	Section 3.4.5
A scheme for periodic review and refinement of the monitoring regime to take account of any approved changes to site layout/design, construction methods and monitoring data;	Section 5
A protocol for notifying the MPA of any breach of the Trigger Values, including the timing of any such notification;	Section 5
Details of the method and frequency with which monitoring results will be shared with the MPA, Natural England and the Environment Agency;	Section 5
The approved scheme shall thereafter be implemented in full, with monitoring continuing in accordance with the approved scheme until such time that it is agreed in writing by the MPA in consultation with Natural England and the Environment Agency that monitoring may cease.	Section 5

2 SITE DETAILS

2.1 Existing Development

The minesite covers an area of approximately 67 ha and slopes gently to the east away from the B1416 road along the western boundary of the site. Along this western boundary the topography rises from around 208 m AOD in the north to 214 m AOD in the south, and falls to around 200 m AOD on the eastern boundary. West and south of the minesite are areas of moorland that are designated as part of the North York Moors Special Area of Conservation (SAC) at Ugglebarnby Moor and Sneaton Low Moor, respectively, as shown on Drawing 1433DevOD215.

By commencement of the Phase 4 minesite construction works, Phase 2 Works will be completed and Phase 3 Works will be ongoing, including:-

- General site clearance and construction of an acoustic fence / environmental barrier, installation of fencing, gates and security demolition of all farm buildings and sheds, and localised tree and scrub clearance;
- Construction of the site road, a site compound and the Welfare Access Road;
- Construction of the Tiered Shaft Platform Area and Platform for the Construction Welfare Facility, Parking Area and Concrete Batching Plant;
- Construction of temporary and permanent soil mounds;
- Construction of surface water drainage including; a silt removal facility, a three permanent attenuation ponds and two wetland areas in the north-eastern area and a temporary surface water attenuation pond and wetland in the southern area and;
- Construction of the drilling platform and lagoon area for the groundwater reinjection well.
- Installation of dewatering wells around the perimeter of the Tiered Shaft Platform, including commencement of dewatering, where necessary, to maintain groundwater levels at 3m below shaft platform level.

2.2 Hydrogeological Receptors

2.2.1 Aquifers

The shallow aquifer units beneath the development are shown on Drawing 1433DevOD280 and detailed in Table 2:-

Table 2 - Summary of Aquifer Receptors

Aquifer	Designation	Description
Superficial Deposits	Non-aquifer	Present across the majority of the site, comprising low permeable firm to stiff clays, with discontinuous granular layers that sustain only limited and discontinuous horizontal and vertical flow through isolated sand lenses.
Moor Grit	Secondary A Aquifer	Present across the southern, central and western parts of Woodsmith Mine Site, extending to the west beneath Ugglebarnby Moor. It comprises interbedded mudstone, sandstone and siltstone of between 6 to 10m thick. The groundwater is locally used for a single dwelling drinking water supply via a spring discharge (Moorside Farm Spring MF2), feeds the hydrogeologically supported spring flush and provides a limited contribution of baseflow to Sneaton Thorpe Beck.
Scarborough Formation	Secondary A Aquifer	Present beneath the majority of the minesite and extends to the west beneath Ugglebarnby Moor. It comprises three horizontal to sub-horizontal bedded weathered mudstone and siltstone units of between 6.5 to 13m thick and some vertical hydraulic continuity with overlying Moor Grit. The groundwater in this aquifer locally supports non-continuous and continuous spring flows used locally for single dwelling drinking water supplies (Soulsgrave Farm Spring SF1), and may provide baseflow to a number of surface water bodies including Knaggy House Farm ponds and Sneaton Thorpe Beck.
Cloughton Formation	Secondary A Aquifer	Present beneath the entire mine site and adjacent SAC. It comprises a series of interbedded sandstones and mudstones with occasional siltstones of between 23.5 to 52 m thick. This groundwater is locally used for borehole drinking water supplies as it is capable of generating a high yield, and provides baseflow to surface water bodies, such as Little Beck.
Saltwick Formation	Secondary A Aquifer	Present beneath the entire mine site and adjacent SAC. It comprises a series of interbedded sandstones and mudstones with occasional siltstones of between 37 and 40 m thick. This groundwater locally provides baseflow to surface water bodies, such as Little Beck.

2.2.2 Abstractions

The following groundwater abstractions shallow aquifer units beneath the development are shown on Drawing 1433DevOD283 detailed in Table 3:-

Table 3 - Summary of Groundwater Abstraction Receptors

Abstractions	NGR coordinates	Geometry and physical properties	Source of groundwater
Moorside Farm Spring (MF2)	489063 504803	Moorside Farm Spring discharges from an elevation of 210m AOD and feeds a domestic water storage tank with an overflow from the tank at an elevation of 202.6 m AOD. A proportion of the flow from the spring provides flow sustaining hydrogeologically supported flora in the Spring Flush area within Ugglebarnby Moor. As the domestic water supply and hydrogeologically supported flora are dependent on this spring flow it has a very limited potential to accommodate chemical change. The spring, however, does not provide continuous flow throughout the year, with very low or no flow observed during the summer months.	Superficials and the Moor Grit aquifer during winter Only low groundwater flows from the Moor Grit during spring and summer.
Soulsgrave Farm Spring (SF1 and SF1)	490198 504380	The storage chamber (SF1) used to collect spring water for Soulsgrave Farm is at an elevation of 198.0 m AOD. SF1 is a spring discharge in an area marked by distinctive rush-dominated vegetation at an elevation of 196.8 m AOD. This groundwater spring is used for drinking water purposes to this individual property and has, therefore, a very limited potential to accommodate chemical change. It does not provide continuous flow throughout the year, with no flow observed during the summer months.	Scarborough Formation

2.2.3 Springs

Spring discharges and groundwater seepages in the area of the Phase 4 Works at Woodsmith Mine are shown on Drawing 1433DevOD283 and summarised in Table 4:-

Table 4 - Summary of Spring Receptors

Base Flow Springs	NGR coordinates	Geometry and physical properties	Source of spring
Doves Nest Farm Springs (DNS1)	489510 505160	Located in the central eastern area of the minesite and discharges from a piped overflow at an elevation of 200 m AOD, from a buried tank into a drainage channel that ultimately outflows to Sneaton Thorpe Beck. Provides a limited and non-continuous discharge to this surface watercourse.	Moor Grit
Ugglebarnby Moor Spring (SP01)	488944 504557	This spring is located in the southern part of Ugglebarnby Moor SAC. It comprises a discharge to surface through moorland peat into a narrow channel that discharges into Little Beck. The ground level at SP01 is 207.3 m AOD. This groundwater spring is located 600 m to the east of Little Beck and provides a limited and non-continuous indirect discharge to this surface watercourse.	Combination of superficial deposits and Moor Grit
Springs North of Woodsmith Mine Site (SP04)	489290 505995	SP04 is located to the north of the minesite. The ground level at SP04 is 195.6 m AOD. This groundwater spring located 550 m south of Buskey Beck provides a limited, potentially indirect discharge to this surface watercourse.	Moor Grit
Springs North of Woodsmith Mine Site (KHF)	489530 505999	The Knaggy House Farm (KHF) spring is located approximately 30 m east of SP04 The ground level at KHF spring is 185.0 m AOD. This groundwater spring located 50 m west of the surface water ponds at Knaggy House Farm (KHF) provides a limited, potentially indirect discharge to this surface watercourse.	Scarborough Formation

2.3 Surface Water Receptors

2.3.1 Surface Water Courses

The surface water course in and around the Phase 4 Works area is summarised in Table 5:-

Table 5 - Summary of Surface Water Receptors

Surface water course	Geometry and physical properties	Water sources
Sneaton Thorpe Beck	The Sneaton Thorpe Beck is located to the east of Woodsmith Mine and its headwaters are located in Haxby Plantation in the southeast of the site. The Woodsmith Mine Site lies within the catchment area of the Sneaton Thorpe Beck The headwaters of the Sneaton Thorpe Beck are located within the Moor Grit and Scarborough Formation whilst the main channel of the beck is within the Cloughton Formation.	Numerous drains, issues, collects and un-named streams discharge into Sneaton Thorpe Beck.

2.3.2 Abstractions

There are no active surface water abstractions or discharges identified within 1 km of the site.

2.4 Ecological Receptors

2.4.1 Spring Flush

There are two principal areas of sensitive ecological receptors in close proximity to the site; Ugglebarnby Moor and Sneaton Low Moor, both of which are part of the North York Moors and are designated as Special Areas of Conservation (SACs), Special Protection Areas (SPA) and Sites of Special Scientific Interest (SSSI). As detailed in Table 6, Within these areas, the only ecological receptor that has been determined as containing flora that is hydrogeologically supported (Ref. 2) is the Spring Flush area within the Southern Dry Heath area of Ugglebarnby Moor (Drawing 1433DevOD281).

Table 6 - Summary of Ecological Receptors

Ecological Receptor	Geometry and physical properties	Water sources
Ugglebarnby Moor Southern Spring Flush	The Spring Flush area in the southern part of Ugglebarnby Moor lies to the southwest of the minesite, where ground levels slope from around 210 m AOD in the east down to around 197 m AOD in the west. Beneath the superficial deposits along the line of the Spring Flush are the Moor Grit, Scarborough Formation and Cloughton Formation.	Surface runoff and shallow groundwater (superficial deposits and Moor Grit)

3 BASELINE CONDITIONS

Meteorological data from January 2017 onwards confirms that conditions have been significantly drier than for the same period during 2016 and 2014, and slightly drier than 2015. This has generally resulted in lower than previously observed groundwater levels and spring flow rates for the time of the year. The current groundwater and spring baseline conditions, comprising drier

than average groundwater levels and spring flow rates, have therefore been considered in the preparation of the Control and Compliance Trigger Values presented in this document..

4 MONITORING

4.1 General

In the following sections, the requirements for undertaking groundwater, surface water and ecological monitoring are presented in terms of the monitoring locations, frequency of monitoring, determinands to be analysed for, Control and Compliance Trigger Values and reporting procedures.

The monitoring requirements have been determined specifically to enable monitoring the Phase 4 Works as outlined in the Groundwater Management Scheme (Ref. 3) and the Surface Water Drainage Scheme (Ref. 4). The following sections present details of the scope, data requirements, frequency and Control and Compliance Trigger Values (where appropriate) to be adopted for monitoring the following elements:-

- Meteorology (Section 3.2),
- Groundwater levels (Section 3.3) and quality (Section 3.4),
- Springs (Section 3.5),
- Surface Water (Section 3.6),
- Ecology (Section 3.7).

The meteorological monitoring is to be undertaken to enable comparison and informed assessment of impacts on groundwater, surface water and ecological conditions. These data are not evaluated in their own right and no Control and Compliance Trigger Values have been set for this purpose.

4.2 Control and Compliance Trigger Values

4.2.1 Environmental Control and Compliance Trigger Values

Environmental Control and Compliance Trigger Values have been set to enable a structured evaluation of monitoring data, as detailed below.

Water Quality

Ground and surface water quality Trigger Values, comprising “Control” and “Compliance” Trigger Values, have been set, in accordance with Environment Agency guidance (Ref. 5), to enable evaluation of whether the works have an adverse chemical impact on water resources, as detailed below:-

- The Control Trigger Values are an early warning system designed to draw attention to the development of adverse trends in the monitoring data that may suggest the mitigation measures incorporated into the Phase 4 Works are not working as anticipated. These values have been derived from the baseline data, and, where the baseline data are less than the detection limit, the Control Trigger value has been set at the detection limit.

- The Compliance Trigger Values are defined as the levels at which significant adverse environmental effects have occurred, i.e. if a compliance value for a specific receptor has been breached there is a chemical impact occurring. These values have been derived from current Statutory Instruments for water quality, where available. Where the detection limit is greater than the Statutory Instrument value, the Compliance Trigger value has been set at the detection limit.

Groundwater Level

Groundwater level Trigger Values, comprising "Control" and "Compliance" values, have been set as summarised below to enable evaluation of whether the Phase 2 to 4 Works have an adverse impact on spring discharges from Soulsgrave Farm Spring and from Moorside Farm Spring, which both support a spring drinking water abstraction and in the case of Moorside Farm Spring also provides surface flows to the hydrogeologically supported flora in the Spring Flush area:-

- The Control Trigger Values are an early warning system designed to draw attention to the development of adverse trends in the monitoring data that may be contrary to the groundwater level conditions anticipated from groundwater modelling of the Phase 4 Works (Ref 2). These values have been derived by consideration of the monthly baseline data and the results of the ESI modelling (Ref 2).

- The Compliance Trigger Values are defined as the levels at which significant adverse environmental effects have occurred at Moorside Farm Spring, i.e. if the compliance value at this receptor has been breached there is an adverse physical impact occurring. These values have been derived from evaluation of the historical monthly values determined from the baseline data.

Spring Flow Rate

Spring flow rate Trigger Values, comprising "Control" and "Compliance" values, have been set as summarised below to enable evaluation of whether the works have an adverse impact on spring discharges:-

- The Control Trigger values are an early warning system designed to draw attention to the development of adverse trends in the monitoring data that may be contrary to the spring flow conditions anticipated from groundwater modelling of the Phase 4 Works (Ref 2). These values have been derived by consideration of the mean monthly baseline data for the spring receptor.

- The Compliance Trigger values are defined as the levels at which significant adverse environmental effects have occurred at a spring receptor, i.e. if the compliance value at this receptor has been breached there is an adverse physical impact occurring. These values have been derived by consideration of the minimum monthly baseline data for the spring receptor.

Surface Water Geomorphology

For the geomorphological monitoring of Sneaton Thorpe Beck, it is proposed that a qualitative assessment of erosion and siltation conditions will be undertaken by comparison against pre-commencement geomorphological conditions at a number of locations in the stream banks and bed downstream of the consented discharges to this water course. As such, no Control and Compliance Trigger Values will be established for this purpose.

Ecological

Ecological habitat Trigger Values have been set, as summarised below, to enable evaluation of whether the works have an adverse impact on the flora within the Spring Flush area. The Habitat Trigger values are an early warning system designed to draw attention to the development of adverse trends in the monitoring data that may be contrary to the vegetation baseline surveys (Ref 2):-

- Change in National Vegetation Classification (NVC) class;
- Change in percentage cover (loss of 5%) of the key indicator species;
- Colonisation by new species.

4.2.2 Construction Control and Compliance Trigger Values

During the temporary dewatering, to be undertaken to maintain groundwater levels at 3m below shaft platform level, Compliance Trigger Values have been set, above which a rise in groundwater levels may adversely impact on the stability of the trench excavation. Control Trigger values are proposed to indicate when dewatering should be implemented, to maintain water levels below the maximum permissible Compliance Trigger Values

4.3 Meteorology

4.3.1 Objectives

The objectives of the meteorological monitoring are to provide rainfall and evapotranspiration information to confirm water balance inputs and outputs and to enable correlation with groundwater level, spring flow, surface water geomorphological and ecological data.

4.3.2 Monitoring Location

Meteorological monitoring will be undertaken of the following parameters (Section 3.4.4) from the automated permanent weather station to be located at the minesite.

4.3.3 Monitoring Frequency

The monitoring frequency will be set for 30 minute intervals for all parameters and the data recorded to a data logger to be downloaded on a weekly basis.

4.3.4 Meteorological Data

Meteorological monitoring will consist of:-

- Rainfall (mm);
- Evapotranspiration (mm);
- Temperature (°C);
- Wind Speed (km/hr) and Direction; and
- Barometric Pressure (m/bar).

4.3.5 Assessment & Compliance Values

None.

4.4 Groundwater Level Monitoring

4.4.1 Objectives

The purpose of the groundwater level monitoring strategy is three fold:-

1 To detect physical impacts on groundwater levels within the Moor Grit and Scarborough Formation Secondary A Aquifers that could impact on the hydrogeologically supported flora within the Spring Flush and Moorside Farm spring water supply (MF2) caused by the completed Phase 2 and 3 Works and ongoing Phase 4 Works, so that appropriate remedial measures can be adopted should potentially detrimental impacts arise.

2 To detect physical impacts on groundwater levels within the Scarborough Formation Secondary A Aquifer that could impact on the Soulsgrave Farm spring water supply (SF2) caused by the completed Phase 2 and 3 Works and the Phase 4 Works, so that appropriate remedial measures can be adopted should potentially detrimental impacts arise.

3 To detect changes in the groundwater levels within the Moor Grit Aquifer that could impact on the trench stability of diaphragm walling for the Service, Production and MTS Shaft construction works.

4.4.2 Monitoring Locations

From the design layout of the Phase 4 Works, monitoring of construction stage boreholes with response zones within the Moor Grit and Scarborough aquifers will be undertaken as summarised below, for which the monitoring well positions are shown on Drawing 1433DevOD281 Appendix 1:-

1 Groundwater levels will be monitored in the Moor Grit and Scarborough aquifers using the series of monitoring wells detailed overleaf that are orientated in a line approximately north to south between the Shaft Platform development and the Spring Flush and Moorside Farm Spring target receptors, as shown on Drawing 1433DevOD281 Appendix 1.

2 Groundwater levels will be measured within the superficial deposits using the series of monitoring wells detailed overleaf within the Spring Flush area, as shown on Drawing

1433DevOD281 Appendix 1, to identify potential variations in the soil moisture conditions in comparison with the baseline conditions.

3 Groundwater levels will be monitored in the Moor Grit aquifer using the series of monitoring wells detailed in Table 7 that are located around the Service, Production and MTS Shafts, as shown on Drawing 1433DevOD286 Appendix 1.

Table 7 - Groundwater Level Monitoring Locations

Monitoring Well	Historical BH No.	NGR Coordinates	Purpose
GW132 GW132B GW132C GW132D GW132E	HG112 HG112B HG112C HG112D HG112E	488933.66, 504800.88 488940.91, 504799.24 489042.06, 504807.25 489038.61, 504798.07 489035.65, 504791.81	Monitor potential changes in the groundwater levels within the Superficial deposits within the Spring Flush and Moorside farm Spring target receptors.
GW122A (SAC1) GW124 (SAC3) GW125 (SAC4) GW129 (SAC5) GW118 GW130 (SAC6) GW131 (SAC7) GW116 (SAC8) GW133A	HG105A -- -- -- HG122 -- -- -- HG111A	489138.52, 505493.71 489184.48, 505377.01 489215.70, 505221.78 489219.39, 505118.00 489229.54, 505094.83 489236.10, 504928.69 489246.93, 504815.46 489270.51, 504711.77 489211.10, 504706.07	Monitor potential changes in the groundwater levels within the Moor Grit between the shaft platform development and the Spring Flush and Moorside Farm Spring target receptors.
GW126A GW117 GW139	HG108A -- HG5	489132.71, 505164.63 489236.66, 505102.82 489240.44, 504965.21	Monitor potential changes in the groundwater levels within the Scarborough Formation between the shaft platform development and the Spring Flush and Moorside Farm Spring target receptors.
GW112	HG119	489843.0, 504759.0	Monitor potential changes in the groundwater levels within the Scarborough Formation between the shaft platform development and Soulsgrave Farm Spring.
HG135 BH521 BHSS2		489335.7, 505348.0 489292.0, 505328.0 489340.8, 505315.6	Monitor groundwater levels in the Moor Grit influencing the stability of diaphragm wall construction for the Service Shaft.
BH505 BH507 BH520		489272.5, 505422.8 489305.3, 505457.3 489318.0, 505422.0	Monitor the groundwater levels in the Moor Grit influencing the stability of diaphragm wall construction for the Production Shaft.
HG116 BH515 BH522		489206.5, 505526.0 489400.2, 505469.1 489388.0, 505456.0	Monitor the groundwater levels in the Moor Grit influencing the stability of diaphragm wall construction for the MTS Shaft.

If any of the above monitoring locations is damaged or lost as part of the Phase 2, 3 or 4 Works, they will be re-installed.

4.4.3 Monitoring Frequency

From evaluation of the Moor Grit sandstone permeability data and the distance between the tiered Shaft Platform and Moorside Farm Spring/Spring Flush area, it is determined that physical draw down impacts on groundwater levels supporting the spring area, caused by natural groundwater drawdown at the platform, would take over three months to cause a noticeable change to spring flow conditions. On this basis, it is determined that whilst groundwater level data will be collected by the divers on an hourly basis, implementing a weekly collation of that

data will be an adequate review period to enable detection of significant changes in groundwater levels and correlation with spring flow rates at Moorside Farm and Soulsgrave Farm Springs.

Monitoring of the groundwater levels around the future shafts is essential for their safe and effective construction, which requires the groundwater levels to be maintained, through dewatering, at a depth of 3 m below shaft platform level (bspl). On this basis, it is determined that whilst groundwater level data will be collected by the divers on an hourly basis, implementing a daily collation of that data will be an adequate review period to enable detection of significant changes in groundwater levels that may requiring changes to the dewatering rates being implemented to maintain trench stability for diaphragm wall construction.

During the Phase 4 Works groundwater level monitoring will be undertaken at the intervals detailed in Table 8.

Table 8 - Groundwater Level Monitoring Frequency

Receptor	Monitoring phase	Duration	Frequency
Spring Flush and Moorside Farm Spring	Phase 4 Works	Duration of works	The data loggers will be set at an hourly interval of reading and the data will be downloaded and reviewed on a weekly basis.
	Post Phase 4 Works	1 Month	
Soulsgrave Farm Spring	Phase 4 Works	Duration of works	The data loggers will be set at an hourly interval of reading and the data will be downloaded and reviewed on a weekly basis.
	Post Phase 4 Works	1 Month	
Shaft Construction and Dewatering	Phase 4 Works	Duration of works	The data loggers will be set at an hourly interval of reading and the data will be downloaded and reviewed on a daily basis.

Phase 4 Works are scheduled to follow directly after completion of the Phase 3 Works. Consequently an assessment of any Control and Compliance Trigger Values breaches will evaluate the cumulative impact of Phases 2 to 4 to determine the cause and appropriate remedial actions.

4.4.4 Groundwater Level Data

To meet the monitoring objectives, groundwater levels will be monitored using diver data loggers, calibrated against an onsite barometer, installed within the monitoring wells to provide continuous groundwater level data for comparison with the Control and Compliance Trigger Values.

4.4.5 Environmental Assessment Control and Compliance Trigger Values

Groundwater level (GWL) “Control and Compliance Trigger Values” have been set, as detailed in Table 9 to 11, for all monitoring well locations detailed in Section 3.3.2, by consideration of the baseline groundwater level data and the ESI modelled impact of the Phase 4 Works on groundwater levels at these locations (Ref. 2).

Monitoring for Spring Flush and Moorside Farm Spring Receptors

The GWL Control Trigger Values in the superficial deposits, the Moor Grit strata and the Scarborough Formation have been derived for each monitoring location adopting the following methodology:-

Control Trigger Value	=	mean baseline value	-	2 x the standard deviation of baseline data (equivalent to 95%ile) [1]	-	the modelled impact

Note [1] The monitoring undertaken within the pre-commencement and ongoing Phase 2 works has demonstrated that a GWL Control Trigger Value derived using one standard deviation is overly conservative for the natural variation that has been observed. As such, the methodology for setting control values has been amended to use two standard deviations (which is equivalent to the 95th percentile), which is considered more appropriate for this site.

The above methodology for setting the GWL Control Trigger Values has been adopted for most of the monitoring wells (i.e. HG112, HG112B, HG112C, HG112D, HG112E, HG105A, HG122, HG111A, HG108A and HG5) where a comprehensive baseline was available. To address the short fall in baseline data for boreholes GW116, GW117, GW124, GW125, GW129, GW130 and GW131 which only have baseline data for a reduced period, GWL Control Trigger Values have been derived using realistic assumed standard deviations, applied to those months for which an inadequate data set is currently available, and extrapolated where no baseline data is available.

The GWL Compliance Trigger Value has been set for the monitoring well, installed within the Moor Grit aquifer (GW133A; previously HG11A) immediately up hydraulic gradient of Moorside Farm Spring, adopting the following methodology:-

Compliance Trigger Value	=	mean baseline value	-	3 x the Standard Deviation of baseline data (equivalent to 99%ile)[2]	-	the modelled impact

Note [2] The monitoring undertaken within the pre-commencement and ongoing Phase 2 works has demonstrated that a GWL Compliance Trigger Value derived using two standard deviation is overly conservative for the natural variation that has been observed. As such, the methodology for setting control values has been amended to use three standard deviations (which is equivalent to the 99th percentile), which is considered more appropriate for this site.

Table 9 - Control Trigger Values - Superficial Deposits

Monitoring Well	GW132	GW132B	GW132C	GW132D	GW132E
	HG112	HG112B	HG112C	HG112D	HG112E
Modelled Impact	N/A	N/A	N/A	N/A	N/A
GWL Control Trigger Value (m AOD)					
January	196.04	197.52	201.29	201.36	201.51
February	196.14	197.59	201.23	201.44	201.47
March	196.18	197.57	201.25	201.32	201.50
April	195.92	197.56	201.23	201.17	201.49
May	196.02	197.51	201.08	201.18	201.16
June	195.53	197.23	200.86	200.96	201.04
July	195.11	196.79	200.65	200.78	200.58
August	195.10	196.83	200.68	200.67	200.65
September	195.11	196.63	200.62	200.74	200.49
October	195.31	196.88	200.82	200.89	201.01
November	195.71	197.56	201.25	201.26	201.45
December	196.18	197.45	201.30	201.38	201.53

Table 10 - Control and Compliance Trigger Values - Moor Grit

Monitoring Well	GW122A (SAC1)	GW124 (SAC3)	GW125 (SAC4)	GW129 (SAC5)	GW118	GW130 (SAC6)	GW131 (SAC7)	GW116 (SAC8)	GW133A	
	HG105A	--	--	--	HG122	--	--	--	HG111A	
Modelled Impact (m)	-0.82	-1.38	-075	-0.77	-1.01	-1.18	-0.01	-0.23	-0.1	
(m OD)	**GWL Control Trigger Value**									**GWL Compliance Trigger Value**
January	203.52	200.89	204.17	203.49	203.27	205.71	204.09	209.90	210.53	209.89
February	203.31	201.51	204.52	204.37	203.84	206.32	205.95	210.59	211.09	210.65
March	204.26	201.75	204.56	204.37	203.83	205.59	205.97	210.84	210.71	210.21
April	202.42	201.10	204.56	203.94	203.35	205.16	205.28	210.25	209.23	208.38
May	202.73	200.45	204.56	203.52	203.30	204.72	204.58	209.66	209.57	209.06
June	201.88	199.81	204.56	203.09	202.80	204.28	203.89	209.07	207.98	206.77
July	200.61	199.16	204.56	202.66	203.03	203.84	203.19	208.48	208.95	208.44
August	200.16	198.51	204.56	202.24	202.80	203.40	202.50	207.89	208.79	208.40
September	200.20	197.86	204.56	201.81	202.61	202.96	201.80	207.30	208.81	208.56
October	200.28	197.68	202.47	201.49	202.13	202.37	201.81	207.31	208.96	208.75
November	201.98	197.87	202.63	201.60	201.83	203.52	203.57	208.18	209.14	208.47
December	204.64	200.04	203.55	202.35	202.73	204.47	203.81	209.44	210.96	210.72

Table 11 - Control Trigger Values - Scarborough Formation

Monitoring Well	GW126A	GW117	GW139	GW 112
	HG108A	--	HG5	HG119
Modelled Impact	-0.13	-0.55	-1.0	0.02
(m OD)	**GWL Control Trigger Value**			
January	196.55	200.32	186.61	195.59
February	197.21	199.94	186.88	195.88
March	197.32	200.19	185.93	195.70
April	198.17	201.79	186.10	195.49
May	198.03	201.42	186.58	195.56
June	197.61	201.04	185.80	195.20
July	197.33	200.66	185.76	195.08
August	197.25	200.29	186.12	195.02
September	197.19	199.91	185.64	195.02
October	197.14	197.15	185.59	195.14
November	197.15	197.80	185.34	195.18
December	196.08	197.50	186.10	195.47

4.4.6 Dewatering Control and Compliance Trigger Values

Table 12 defines the dewatering GWL Control Trigger Values that are proposed to indicate when dewatering should be implemented to maintain water levels below the maximum permissible Compliance Trigger Values, at which trench instability issues could arise to the diaphragm walling process.

Table 12 - Control and Compliance Trigger Values - Dewatering

Shaft Location	Temporary Monitoring Well	Control Trigger Value (m bspl) [m AOD]	Compliance Trigger Value (m bspl) [m AOD]
Production	BH 505, BH 507, BH520	4 m bspl [199.66 m AOD]	3 m bgl [200.66 m AOD]
Service	SS2, HG 135, BH 521	4 m bspl [199.17 m AOD]	3 m bgl [200.17 m AOD]
MTS	HG116, BH 515, BH 522	4 m bspl [196.66 m AOD]	3 m bgl [197.66 m AOD]

4.5 Groundwater Quality Monitoring

4.5.1 Objectives

From the results of the Hydrogeological Risk Assessment (Ref. 2), the objectives of the groundwater quality monitoring is to determine the following:

1 Whether the completed Phase 2 to 4 Works have an adverse chemical impact on groundwater quality in the Moor Grit, Scarborough or Cloughton aquifers from hydrocarbon and salt pollution by construction surface water runoff in the vicinity of the tiered Shaft Platform, and platform extension, the working platform and compound areas that could infiltrate into the Moor Grit and Scarborough aquifers.

2 Whether migration of bentonite slurry losses from the diaphragm trenching operations is occurring warranting adoption of contingency measures to limit further slurry loss from the trench that may cause temporary total dissolved solids, turbidity, alkaline pH and elevated conductivity pollution within the Ravenscar aquifers local to the Production, Service and MTS Shaft locations.

3 Whether migration of the bentonite slurry into the Moor Grit aquifer has caused turbidity pollution to the groundwater abstracted from the temporary dewatering wells, warranting corrective action to the slurry management system and discharge of the polluted waters to the siltation and attenuation ponds within the main drainage system.

4.5.2 Monitoring Locations

Groundwater Quality Monitoring for the General Minesite Development

As determined from the Hydrogeological Risk Assessment (Ref 2), due to the northeasterly hydraulic gradient across the Woodsmith Mine, should groundwater pollution arise from the completed Phase 2 and 3 Works or the Phase 4 Works, this would cause a chemical impact on groundwater receptors down hydraulic gradient of the works comprising the Secondary A Moor Grit and Scarborough aquifers. Such chemical impacts would, however, not occur to the more sensitive receptors up hydraulic gradient of the works, including Moorside Farm Spring, Soulsgrave Farm Spring or the Spring Flush vegetation habitat.

In accordance with current guidance (Ref. 5), groundwater quality sampling will be undertaken at a location up hydraulic gradient of the receiving aquifer and at two locations down hydraulic gradient within that aquifer of the potentially polluting activities associated with the Phase 3 works. As such, groundwater quality will be monitored in the Moor Grit, Scarborough and Cloughton aquifers using a series of boreholes both up and down gradient of the development areas, as listed in Tables 13 and 14, at the positions shown on Drawing 1433DevOD283, Appendix 1. Water quality at each location will be assessed individually, as well as in relation to their up and down gradient positions to the Shaft Platform, Platform Extension, Working Platform, Access Roads and Compound Area.

Table 13 - Monitoring Wells around the Shaft Development Platform

Monitoring Well		NGR Coordinates	Reason
GW101 GW124 (SAC3) GW125 (SAC4)	-- -- --	489152.62, 505656.51 489184.48, 505377.01 489215.70, 505221.78	Monitor changes in the groundwater quality within the Moor Grit up gradient of the development areas
GW101A GW126A GW117	-- HG108A --	489152.93, 505650.83 489132.71, 505164.63 489236.66, 505102.82	Monitor changes in the groundwater quality within the Scarborough Formation up gradient of the development areas
GW139A	HG5A	489243.5, 504952.9	Monitor changes in the groundwater quality within the Cloughton Formation up gradient of the development areas
GW103	--	489342.55, 505678.83	Monitor changes in the groundwater quality within the Moor Grit down hydraulic gradient of the tiered Shaft Platform.
GW105	--	489449.41, 505667.32	Monitor changes in the groundwater quality within the Scarborough Formation down hydraulic gradient of the tiered Shaft Platform.
GW137 GW106 GW108	HG2 -- --	489498.55, 505506.42 489559.62, 505668.15 489658.09, 505397.27	Monitor changes in the groundwater quality within the Cloughton Formation down hydraulic gradient of the tiered Shaft Platform.

Table 14 - Monitoring Wells around the Working Platform and Compound Area

Name		NGR Coordinates	Reason
GW129 (SAC5) GW130 (SAC6)	-- --	489219.39, 505118.00 489236.10, 504928.69	Monitor changes in the groundwater quality within the Moor Grit up gradient of the development areas
GW117	--	489236.66, 505102.82	Monitor changes in the groundwater quality within the Scarborough Formation up gradient of the development areas
GW139A	HG5A	489243.5, 504952.9	Monitor changes in the groundwater quality within the Cloughton Formation up gradient of the development areas
GW109 GW140	-- HG120	489610.08, 505119.60 489606.05, 505068.86	Monitor changes in the groundwater quality within the Scarborough Formation down hydraulic gradient of the areas access road and site compound.
GW138	HG4	489496.28, 505206.94	Monitor changes in the groundwater quality within the Cloughton Formation down hydraulic gradient of the areas access road and site compound.

Groundwater Quality Monitoring to Identify Impacts from Slurry Losses Associated with Diaphragm Wall Trenching Operations

Seventeen new groundwater quality monitoring locations will be established around the diaphragm walling operations. These will be installed to enable water quality monitoring of indicator parameters to identify where changes to the slurry management and adoption of contingency measures are necessary to limit further slurry loss causing local impact on groundwater quality.

These monitoring locations will consist of four “distal” positions located at a distance of around 120m from the diaphragm walling works and close to the development boundary, and thirteen “proximal” positions located at a distance of approximately 50m distance and spacing from the diaphragm wall as shown on Drawing 40-AMC-WS-10-CI-DR-0001. The exact position of these

wells will be confirmed onsite, with due consideration to locating them in positions that can be maintained throughout the duration of the works.

Each monitoring location will have two drilled boreholes to install two nests of three, 2-inch diameter PVC standpipe piezometers installed in maximum of 10m length screened intervals per nest at each proposed location to target the Moor Grit, Scarborough and Cloughton Aquifer Units. The intervals will be separated from one another by 10 m of hole plug (i.e., bentonite pellets) within each nest. The exact design of the response zone for each well is to be designed onsite appropriate to the ground level and aquifer profile specific to each location.

Water from the temporary pumped dewatering well system will discharge to a holding tank (Arup Drawing 40-ARI-WS-71-CI-DR-1058). Visual monitoring will first be carried out of the water quality within the holding tank. Where evidence of bentonite slurry is observed in the holding tank, samples will be taken from the monitoring ports installed on each of the groundwater abstraction wells.

4.5.3 Monitoring Frequency

Groundwater Quality Monitoring for the General Minesite Development

On the basis that the all construction activities will be managed in accordance with the Construction Environmental Management Plan (CEMP), the likelihood of pollution arising from these works is considered low and a monthly frequency for groundwater quality monitoring is therefore considered appropriate for these works and sampling for ground water quality analysis will be undertaken at the following intervals.

Table 15 - Groundwater Quality Monitoring Frequency for the General Minesite Development

Monitoring phase	Duration	Frequency
Phase 4 Works	Duration of works	Monthly
Post Phase 4 Works	1 Month	Monthly

Monitoring of groundwater quality will continue for a minimum period of one month following completion of the Phase 4 Works and until it has been demonstrated that no significant variance from the Control Trigger Values or exceedance above the Compliance Limits detailed below has been detected.

Phase 4 Works are scheduled to follow directly after completion of the Phase 3 Works. Consequently an assessment of any Control and Compliance Trigger Value breaches will evaluate the cumulative impact of Phases 2, 3 and 4 to determine the cause and appropriate remedial actions.

Groundwater Quality Monitoring to Identify Impacts from Slurry Losses Associated with Diaphragm Wall Trenching Operations

The distal and proximal well arrays will be installed boreholes installed with either a AquaTROLL400 or AquaTROLL600 Multi-parameter Probe to enable real time monitoring for indicator parameters. This data will be stored to a data logger.

Prior to construction baseline data obtained for a minimum of 4 weeks prior to commencement will be assessed for each monitoring location, to enable evaluation of appropriate Control Trigger Values.

During the diaphragm wall trenching operations the real time monitoring will be reviewed at regular 2 hourly intervals each day.

Water from the dewatering system, discharged to the holding tank (Arup Drawing 40-ARI-WS-71-CI-DR-1058) will be monitored visually on a 2 hourly basis for evidence of turbidity. Should evidence of bentonite be observed, a water sample will be taken from the sampling tap of each active well to identify the source of the bentonite.

4.5.4 Groundwater Quality Data

Groundwater Quality Analysis for the General Minesite Development

To meet with the groundwater monitoring objectives, the minimum baseline suite of analysis will include both onsite water analysis and laboratory testing, as detailed below. The suite of determinands will include the specific Contaminants of Concern (CoC) identified by the Hydrogeological Risk Assessment (Ref 2) associated with the Phase 2 and 3 Works and the Phase 4 Works.

Presented below are details of the onsite monitoring and of the sampling and laboratory testing that will be undertaken to obtain the groundwater quality data for the Phase 4 Works. All chemical analysis will be undertaken by an MCERTS accredited laboratory.

Onsite Water Analysis

On site monitoring, using appropriately calibrated field equipment, will be undertaken for the following determinands:-

- Temperature,
- pH,
- Electrical Conductivity; and,
- Total Dissolved Solids.

Sampling

Prior to sampling of the up and down gradient boreholes, each well will be developed by pumping and either purged to three well volumes or the establishment of stable pH and conductivity readings (typically three consecutive field measurements of +/- 0.1 pH units and +/- 250 µS/cm) to ensure the groundwaters sampled are representative of the surrounding groundwater quality in accordance with current guidance (Ref. 5).

Unfiltered samples will be collected in two 1-litre coloured glass jars, and one 100 ml vial and as required by the laboratory, to complete the specified testing suites.

Laboratory Analysis

The chemical analysis will be undertaken for the following suite of determinands:-

- pH;
- Conductivity;
- Chloride;
- Sodium;
- Total Petroleum Hydrocarbons (C10 – C40)

Groundwater Quality Real Time Monitoring to Identify Impacts from Slurry Losses Associated with Diaphragm Wall Trenching Operations

Each of the monitoring wells will be installed with a real time multi-paramter probe capable of analysis for the following parameters:

- pH;
- Conductivity;
- Salinity
- Total dissolved solids
- Resistivity
- Density
- Dissolved oxygen
- Oxidative Redox potential

Visual observation of the discharge into the holding tank (Arup Drawing 40-ARI-WS-71-CI-DR-1058) will be made to identify evidence of turbidity indicative of bentonite slurry pollution.

Where turbidity is observed in the holding tank a water sample will be taken from each of the dewatering wells sampling tap and visually inspected for evidence of bentonite slurry pollution. Should evidence of bentonite be observed, the affected well or wells will be temporarily isolated and the discharge from the dewatering system monitored to confirm that the flow is now free from bentonite. In the event that flow remains contaminated with bentonite step 1 will be repeated.

The affected well or wells will be restarted once corrective action has been taken to prevent bentonite losses from the D-wall trench.

4.5.5 Assessment Control and Compliance Trigger Values

Groundwater Quality Control and Compliance Trigger Values for the General Minesite Development

Groundwater Quality (GWQ) Control Trigger Values have been set for all monitoring well locations (as detailed in Section 3.4.2, above) for the determinands to be analysed by consideration of the baseline groundwater level range and typical variation. The GQW Control Trigger value has been set at a value equivalent to the mean baseline value plus 2 x the Standard Deviation for that dataset. The GWQ Compliance Trigger Value has been set at the equivalent Drinking Water Standard (DWS), Environmental Quality Standard (EQS) or the baseline value determined where the current baseline value exceeds the EQS value. Where the analytical

detection limit (MRV) has been adopted as the Compliance Trigger Value, then no Control Trigger Value is included, as presented below.

Table 16 - Control and Compliance Trigger Values for the Moor Grit

Contaminant of Concern	Detection Limit	Groundwater Quality Control Trigger Value	Groundwater Quality Compliance Trigger Value	Source of Compliance Trigger Value
pH (Laboratory)		5.5 – 6.9 (+1SD)	5.0 – 7.5	Max Baseline Range
Conductivity (Laboratory)	1 µS/cm	3,944 µS/cm	4,170 µS/cm	Max Baseline Value
Chloride	5 mg/l	1,167 mg/l	1,200 mg/l	Max Baseline Value
Sodium	70 µg/l	--	290 mg/l	Max Baseline Value
Total TPH	10 µg/l	33.9 µg/l	74 µg/l	Max Baseline Value

Table 17 - Control and Compliance Trigger Values for the Scarborough Formation

Contaminant of Concern	Detection Limit	Groundwater Quality Control Value	Groundwater Quality Compliance Value	Source of Compliance Value
pH		5.9 – 7.1	5.2 – 8.0	Max Baseline Range
Conductivity	1 µS/cm	1,816 µS/cm	2,500 µS/cm	EQS
Chloride	5 mg/l	622 mg/l	630 mg/l	Max Baseline Value
Sodium	70 µg/l	--	290 mg/l	Max Baseline Value
Total TPH	10 µg/l	29.9 µg/l	63 µg/l	Max Baseline Value

Note – Values thought to represent a hydrocarbon plume detected November/December 2015 have been excluded from the Baseline data.

Table 18 - Control and Compliance Trigger Values for the Cloughton Formation

Contaminant of Concern	Detection Limit	Groundwater Quality Control Value	Groundwater Quality Compliance Value	Source of Compliance Value
pH		6.1 – 7.4	4.9 – 8.4	Max Baseline Range
Conductivity	1 µS/cm	722 µS/cm	2,500 µS/cm	EQS
Chloride	5 mg/l	137 mg/l	250 mg/l	EQS
Sodium	70 µg/l	49 mg/l	200 mg/l	DWS
Total TPH	10 µg/l	26.9 µg/l	70 µg/l	Max Baseline Value

Groundwater Quality Control and Compliance Trigger values for Real Time Monitoring to Identify Impacts from Slurry Losses Associated with Diaphragm Wall Trenching Operations

Process to Derive Groundwater Quality Control and Compliance Trigger Values for use During Diaphragm Walling

To establish Control and Compliance Trigger Values that may be adopted during the diaphragm walling process, to identify when slurry losses have impacted on groundwater quality in the receiving aquifers, review has been undertaken of the baseline groundwater quality data for pH and conductivity, from boreholes installed within the Moor Grit, Scarborough and Cloughton Formation aquifers local to the proposed diaphragm walling operations.

No existing baseline data is available for the proposed parameters of Salinity, Total Dissolved Solids, Resistivity, Density, Dissolved Oxygen or Oxidative Redox Potential and, therefore, a groundwater quality baseline will need to be established prior to the commencement of diaphragm walling operations. As such, the proposed monitoring wells should be installed with the data loggers at the least one month prior to diaphragm commencement, to allow a pre-works groundwater quality baseline to be established.

The review of the existing baseline data determined there is no significant monthly or seasonal variation in relation to the parameters pH or conductivity.

It is therefore proposed that following completion of the pre-works groundwater quality baseline monitoring, the available baseline quality data should be reviewed in conjunction with the existing pH and conductivity baseline data to derive GWQ Control Trigger Values using the methodology provided below.

- The GWQ Control Trigger value will be set at a value equivalent to the mean baseline value plus 1 x the Standard Deviation for that dataset.

Based on the current data available the following values are proposed for pH and Conductivity,

Table 19 - Control Trigger Values for Real Time Monitoring of Indicator Parameters in the Moor Grit Aquifer

Contaminant of Concern	Detection Limit	Groundwater Quality Control Trigger Value
pH	0 to 14	Lower 5.3 / Upper 6.5
Conductivity	0.1µS/cm	2,100
Salinity	0.1 PSU	To be confirmed
Total Dissolved Solids	0.1 ppt	To be confirmed
Density		To be confirmed
Dissolved Oxygen	0.01 mg/l	To be confirmed
Oxidative Redox Potential	0.1 mV	To be confirmed

Table 20 - Control Trigger Values for Real Time Monitoring of Indicator Parameters in the Scarborough Formation

Contaminant of Concern	Detection Limit	Groundwater Quality Control Trigger Value
pH	0 to 14	Lower 5.3 / Upper 6.5
Conductivity	0.1µS/cm	1,610
Salinity	0.1 PSU	To be confirmed
Total Dissolved Solids	0.1 ppt	To be confirmed
Density		To be confirmed
Dissolved Oxygen	0.01 mg/l	To be confirmed
Oxidative Redox Potential	0.1 mV	To be confirmed

Table 21 - Control Trigger Values for Real Time Monitoring of Indicator Parameters in the Cloughton Formation

Contaminant of Concern	Detection Limit	Groundwater Quality Control Trigger Value
pH	0 to 14	Lower 5.3 / Upper 6.6
Conductivity	0.1µS/cm	520
Salinity	0.1 PSU	To be confirmed
Total Dissolved Solids	0.1 ppt	To be confirmed
Density		To be confirmed
Dissolved Oxygen	0.01 mg/l	To be confirmed
Oxidative Redox Potential	0.1 mV	

The tables above will be populated in full utilising the pre-commencement baseline data and finalised prior to start of diaphragm walling works.

4.6 Springs

4.6.1 Objectives

The purpose of the spring water monitoring strategy is to detect chemical and physical impact on Soulsgrave Farm and Moorside Farm springs caused by the Phase 2 to 4 Works, so that appropriate remedial measures can be adopted should potentially detrimental impacts arise.

From the results of the Hydrogeological Risk Assessment (Ref. 2), the principal impact on spring receptors that could arise from these works, is the alteration of groundwater flow paths and levels in the shallow aquifers sustaining spring flows to Moorside Farm (MF2) and Soulsgrave Farm (SF1).

Due to the northeasterly hydraulic gradient in the vicinity of Woodsmith Mine, chemical impacts would, however, not occur up hydraulic gradient of the works. Therefore pollution of surface water runoff by hydrocarbon spillage/leakage in the vicinity of the shaft platform and compound areas that infiltrates into the shallow aquifers is inferred to result in a negligible impact on water quality at the spring receptors at Moorside Farm (MF2) and Soulsgrave Farm (SF1).

As such, the objectives of the spring monitoring are to enable evaluation of the impacts on both the flow rates and water quality at these receptors. As these two springs provide a domestic water supply and as Moorside Farm Spring also supports the vegetation within the Spring Flush habitat they are classified as having a high sensitivity to both physical and chemical impacts. Due to the negligible risk of groundwater pollution from these works impacting on these receptors up hydraulic gradient, in particular since dewatering operations will concentrate groundwater flow into the shaft platform area and away from the receptors up hydraulic gradient, therefore further reducing the risk of pollution impact offsite, it is proposed that a monthly monitoring frequency is adopted. Due to the low risk of the construction and dewatering works impacting on groundwater levels and spring flow rates, a weekly monitoring frequency is proposed to enable rapid evaluation and implementation of remedial actions, should contravention of the Control Tigger Values arise.

4.6.2 Monitoring Locations

From the design layout of the Phase 3 Works, monitoring of the spring receptors at Moorside Farm (MF2) and Soulsgrave Farm (SF2) will be undertaken at the locations listed below and shown in Drawing 1433DevOD283 (Appendix 1). Due to the diffuse nature of the Moorside Farm spring (MF2) discharge, it is not possible to monitor either the flow or water quality at this location and, therefore, the first collection chamber at MF1 is to be used as a surrogate representation of the spring.

Table 22 - Spring Monitoring Locations

Name	NGR Coordinates	Purpose
Moorside Farm Spring (MF1)	489063 504803	Monitor potential changes in the spring flow rate and water quality providing a discharge collected for domestic water and supporting the spring flush target receptor.
Soulsgrave Farm (SF2)	490198 504380	Monitor potential changes in the spring flow rate to domestic water supply.

4.6.3 Monitoring Frequency

Spring flow rate and water quality monitoring will be undertaken at the following intervals.

Table 23 - Spring Monitoring Frequency

Monitoring phase	Duration	Flow Rate Frequency	Water Quality Frequency
Phase 4 Works	Duration of works	Weekly	Monthly
Post Phase 4 Works	1 Month	Weekly	Monthly

Monitoring of spring flow rates and water quality shall continue for a minimum period of one month following completion of the Phase 2 to 4 Works and until it has been demonstrated that no significant variance from the Control Trigger Values has occurred and no exceedance above the Compliance Limits detailed below has been detected.

Phase 4 Works are scheduled to follow directly after completion of the Phase 3 Works. Consequently an assessment of any Control and Compliance Trigger Value breaches will evaluate the cumulative impact of Phases 2 to 4 to determine the cause and appropriate remedial actions.

4.6.4 Spring Flow Rate Data

To meet the monitoring objectives, spring flow (SpWF) rates will be monitored by manual measurement for comparison with the SpWF Control and Compliance Trigger Values derived from the baseline data.

4.6.5 Assessment Control and Compliance Trigger Values

SpWF Control and Compliance Trigger Values have been set for the two spring monitoring locations, as detailed below, by consideration of the baseline flow rate range and typical variation. Due to the relatively narrow natural variation/range of flow rates recorded, the SpWF Control Trigger value has been set at a value equivalent to the mean baseline flow rate value for that dataset and the SpWF Compliance Trigger Value as the minimum baseline flow rate value recorded, as presented below. It should be noted that baseline monitoring of flow from these springs has demonstrated intermittent flows in response to seasonal conditions. As such, where baseline monitoring has demonstrated sustained “No flow” conditions can occur during a month, no SpWF Compliance Trigger Value is deemed appropriate.

Table 24 - Spring Flow Control and Compliance Trigger Values

Monitoring Location	SpWF Control Trigger Value (l/s)	SpWF Compliance Trigger Value (l/s)
Moorside Farm (MF1)		
January	0.05	0.03
February	0.06	0.05
March	0.06	0.03
April	0.05	0.02
May	0.10	0.04
June	0.04	0.03
July	0.03	*
August	0.03	0.02
September	0.02	*
October	0.02	*
November	0.03	*
December	0.06	0.03
Soulsgrave Farm (SF2)		
January	0.25	0.05
February	0.28	0.09
March	0.24	0.05
April	0.12	0.02
May	0.16	0.03
June	0.17	0.01
July	0.04	*
August	0.05	*
September	0.01	*
October	0.01	*
November	0.27	*
December	0.32	0.11

Note - * No Compliance Trigger Value is appropriate as no flow conditions have been recorded

4.6.6 Spring Water Quality Data

To meet with the spring water quality monitoring objectives, the minimum baseline suite of analysis will include onsite analysis and sampling for laboratory testing, as detailed below. The suite of determinands will include the specific Contaminants of Concern (CoC) associated with the Phase 2 to 4 Works, as detailed in Section 3.5.1.

Onsite Monitoring

On site monitoring using calibrated field equipment will be undertaken for the following determinands:-

- Temperature;
- pH;
- Turbidity;
- Electrical Conductivity; and
- Total Dissolved Solids.

Sampling

Unfiltered samples will be collected in two 1-litre coloured glass jars, and one 100 ml vial, or as required by the laboratory to complete the specified testing suites.

Laboratory Analysis

All chemical analysis will be undertaken by an MCERTS accredited laboratory and will include the following:-

- pH,
- Conductivity,
- Chloride,
- Total Petroleum Hydrocarbons

4.6.7 Assessment Control and Compliance Trigger Values

Spring specific water quality (SpWQ) Control SpWFValues have been set for the two springs by consideration of their respective baseline water quality and typical variation. The SpWQ Control Trigger Value has been set at a value equivalent to the mean baseline value plus 1 or 2 x the Standard Deviation for that dataset, dependent on the magnitude of variation of the data. The SpWQ Compliance Trigger Value has been set at the equivalent Environmental Quality Standard (EQS) or the minimum baseline value determined where baseline data exceeds the EQS value. Where the analytical detection limit has been adopted as the SpWQ Compliance Trigger Value, then no SpWQ Control Trigger Value is included, as presented below.

Table 25 - Springwater Quality Control and Compliance Trigger Values for the Moorside Farm Spring (MF1)

Contaminant of Concern	Detection Limit	Spring Quality Control Trigger Value	Spring Quality Compliance Trigger Value	Source of Compliance Trigger Value
pH (Laboratory)		5.7 – 6.3 (+1SD)	5.4 – 6.8	Max Baseline Range
Conductivity (Laboratory)	1 µS/cm	263 µS/cm	2,500 µS/cm	EQS
Chloride	5 mg/l	60 mg/l	250 mg/l	EQS
Total TPH	10 µg/l	--	10 µg/l	Detection Limit

Table 26 - Springwater Quality Control and Compliance Trigger Values for the Soulsgrave Farm Spring (SF1)

Contaminant of Concern	Detection Limit	Spring Quality Control Trigger Value	Spring Quality Compliance Trigger Value	Source of Compliance Trigger Value
pH		5.4 – 6.5 (+1SD)	5.5 – 7.4	Max Baseline Range
Conductivity	1 µS/cm	658 µS/cm	2,500 µS/cm	EQS
Chloride	5 mg/l	169 mg/l	250 mg/l	EQS
Total TPH	10 µg/l	--	10 µg/l	Detection Limit

4.7 Surface Water

4.7.1 Objectives

The purpose of the surface water monitoring strategy is to detect chemical and physical impact on surface waters within Sneaton Thorpe Beck caused by the Phase 2 to 4 Works, so that appropriate remedial measures can be adopted should potentially detrimental impacts arise.

From the results of the Revised Hydrogeological Risk Assessment (Ref. 2) and the Surface Water Drainage Scheme (Ref. 4), potential impacts on Sneaton Thorpe Beck that could arise from the Phase 2 to 4 Works, and therefore require evaluation by the surface water monitoring strategy include:-

- Chemical pollution in the form of hydrocarbon (fuel, hydraulic oil, lubricant oil) spillage or leakage from construction plant, silt/particulate suspended solids and slurry materials from diaphragm walling operations entering surface water drainage via runoff and discharging into controlled waters.
- Physical impacts of the groundwater and surface water discharges to the surface water outfall system on Sneaton Thorpe Beck by causing siltation, scour or erosion of the stream bed.

4.7.2 Monitoring Locations

To meet the above objectives, the surface water monitoring locations have been designed to provide:-

a) a baseline (Pre Phase 4 Works) survey of Sneaton Thorpe Beck,
b) early monitoring of surface water drainage within the onsite construction activities,
c) monitoring of surface water outfalls at downstream compliance points prior to discharge to Sneaton Thorpe Beck,
d) An end of Phase 4 Works survey of Sneaton Thorpe Beck.

From the design layout of the Phase 4 Works, monitoring of the construction stage discharges up and down stream of the surface water drainage outfall points will be undertaken as summarised below and shown in Drawing 1433DevOD282 (Appendix 1):-

- Surface drainage discharge points from key outfalls from the construction works denoted OF2, OF5, OF7 and OF8, to monitor the water quality from the works area prior to discharge to Sneaton Thorpe Beck;

Table 27 - Surface Water Monitoring Locations - Outfalls

Monitoring Location	Coordinates	Monitoring
OF2	499621, 505388	Outfall from Silt Removal Facility
OF5	499497, 504743	Outfall from Reinjection Well Platform
OF7	499629, 505517	Outfall from Groundwater Drainage Layer
OF8	499583, 505078	Outfall from Working Platform post Attenuation Pond and Wetland

- Downstream Sneaton Thorpe Beck (STB1, STB2, STB3, and STB4A) to monitor the water quality and impacts on stream geomorphology of surface drainage discharges (STB2 and STB1) downstream of the Phase 4 works and exiting the development site.

Table 28 - Surface Water Monitoring Locations – Sneaton Thorpe Beck

Monitoring Location	Coordinates	Monitoring
STB1	499621, 505388	Sneaton Thorpe Beck
STB2	499497, 504743	Sneaton Thorpe Beck Off Site
STB3	499629, 505517	Drain Tributary to Sneaton Thorpe Beck
STB4A	499583, 505078	Outfall Wetland

4.7.3 Monitoring Frequency

Sampling for surface water quality analysis will be undertaken at the following intervals.

Table 29 - Surface Water Monitoring Frequency

Monitoring phase	Duration	Frequency
Phase 4 Works - Quality and Geomorphology	Duration of works	Weekly
Post Phase 4 Works - Quality and Geomorphology	1 Month	Weekly

Monitoring of surface water quality shall continue for a minimum period of 1 month following completion of the Phase 4 Works and until it has been demonstrated that no significant variance from the Control Trigger Values has occurred and no exceedance above the Compliance Trigger Values detailed below has been detected.

Phase 4 Works are scheduled to follow directly after completion of the Phase 3 Works. Consequently an assessment of any Control and Compliance Trigger Values breaches will evaluate the cumulative impact of Phases 2 to 4 Works to determine the cause and appropriate remedial actions.

4.7.4 Surface Water Data

To meet with the surface water monitoring objectives, the minimum baseline suite of analysis will include onsite analysis, sampling and laboratory testing, together with geomorphological inspection will be carried out as detailed below.

The suite of determinands to be analysed to evaluate construction related pollution will include the specific Contaminants of Concern (CoC) associated with the Phase 4 Works, as detailed in Section 3.6.1. In addition, NYMNPA have advised within Condition 46 that they also require the surface water quality analysis to include pH, sediment (suspended solids), Biological Oxygen Demand (BOD) and ammonia (Section 1.3).

Sampling

During the sampling visits, surface water sampling of the downstream monitoring points (STB1, STB2, STB3, and STB4A) will be collected first, to minimise disturbed sediment impacting on the results. These samples are to be taken from sections of fast flowing water, where possible. The specific monitoring locations of the outfall piped discharge points (OF2, OF5, OF7 and OF8) will be confirmed during the first monitoring visit after each water feature has been constructed.

Unfiltered samples will be collected in two litre coloured glass jars, and one 100 ml vial, or as required by the laboratory to complete the specified testing suites.

Onsite Monitoring

Visual inspection will be undertaken of the construction works surface water drainage systems to observe for evidence of high suspended solids, discolouration or hydrocarbon pollution.

On site monitoring using calibrated equipment will be undertaken for the following determinands:-

- Temperature;
- pH;
- Electrical Conductivity;
- Total Dissolved Solids; and
- Turbidity.

Laboratory Analysis

All chemical analysis will be undertaken by an MCERTS accredited laboratory.

From the expected potentially polluting activities associated with Phase 4 Works the CoC that are to be analysed will include:-

- pH;
- Conductivity;
- Suspended Solids;
- Biological Oxygen Demand;
- Free ammonia (NH_3);
- Chloride;
- Sodium and
- Total Petroleum Hydrocarbons.

Geomorphological Data

A baseline geomorphological survey of the full length of Sneaton Thorpe Beck, which may be impacted by the works, will be undertaken at the end Phase 2 Works/beginning of the Phase 3 Works, and again at the end of the Phase 4 Works. The extent of this survey will be from its source to its confluence with Rigg Mill Beck (approximately 4 km in total), including the tributary to the west, as shown on Drawing 1433DevOD282.

Geomorphological stream surveys will also be undertaken at weekly intervals during Phase 4 works at two downstream locations (STB01 and 02) on Sneaton Thorpe Beck , which will entail the geomorphological survey of a 100 m long section of the stream banks at these locations. At STB02 the survey will cover a 100m reach on both Sneaton Thorpe Beck and of the western tributary, as shown on Drawing 1433DevOD282. The survey will be undertaken in accordance with current guidance (Ref. 8), utilising a reconnaissance record sheet adapted from current guidance (Ref. 9). The data that will be obtained from this inspection will include:-

- A photographic record of the stream section in the form of fixed point photography (Locations shown in Drawing 1433DevOD282;
- A description of the channel;
- A description of the stream bed sediment;
- A description of the left and right bank characteristics;
- A description of the left and right bank face vegetation;
- A description of visual evidence of left and right bank erosion;
- A description of visual evidence of left and right bank geotechnical failure;
- A description of visual evidence of left and right bank toe sediment accumulation;
- Visual evidence of construction related debris within or adjacent to the stream;
- A visual description of evidence of pollution/discolouration; and
- A Geomorphological map recording the bed and bank features present in the channel.

Flow rates won't be routinely monitored; however, consideration will be made of climatic conditions, particularly after high runoff storm events.

4.7.5 Assessment Control and Compliance Trigger Values

Surface Water Quality Control and Compliance Trigger Values

Surface Water Quality (SWQ) Control Trigger Values have been set for all of the determinands to be analysed for by consideration of the baseline surface water quality testing undertaken to date from Sneaton Thorpe Beck. The SWQ Control Trigger Value has been set at a value equivalent to the mean baseline value plus 2 x the Standard Deviation for that dataset. The Compliance Value has been set at the appropriate Environmental Quality Standard (EQS) or the minimum baseline value where this exceeds the EQS value. Where the analytical detection limit (MRV) has been adopted as the Compliance Trigger Value, then no Control Trigger Value is included, as presented below.

A Control Trigger Value will be derived for turbidity based on the initial three months monitoring data using the same methodology.

Table 30 - Surface Water Quality Control and Compliance Trigger Values

Contaminant of Concern	Detection Limit	Surface Water Quality Control Trigger Value	Surface Water Quality Compliance Trigger Value	Source of Compliance Trigger Value
pH		6.5 – 7.5	6.1 – 8.1	Max Baseline Range
Conductivity	1 µS/cm	1,180 µS/cm	2,500 µS/cm	EQS
Chloride	5 mg/l	69.9 mg/l	250 mg/l	EQS
Turbidity	TBC	26 ftu (+1SD)	26 ftu	Max Baseline Value
Suspended Solids	5 mg/l	10 mg/l*	25 mg/l*	EQS
Biological Oxygen Demand (BOD)	1 mg/l	4.7 mg/l	6.4 mg/l	Max Baseline Value
Free Ammonia (NH_3)	0.02 mg/l	0.23 mg/l (+1SD)	0.29 mg/l	Max Baseline Value
Total TPH	10 µg/l	14 µg/l	18 µg/l	Max Baseline Value

Surface Water Geomorphology Control and Compliance Trigger Values

The stream reconnaissance survey to monitor the visual evidence of physical impacts of the Phase 4 Works on the geomorphology of Sneaton Thorpe Beck is a qualitative assessment and no specific Control and Compliance Trigger Values are appropriate. As such, this visual assessment will provide a qualitative evaluation of observed changes in relation to the baseline conditions observed, during the baseline monitoring period.

4.8 Ecological Monitoring

4.8.1 Objectives

The objective of the ecological monitoring is to determine whether the Phase 3 to 4 Works are impacting on the groundwater dependant flora in the Spring Flush. Any changes in the habitat or its diversity in this area will be compared to changes in the groundwater levels and spring flow rates monitored at Moorside Farm Spring to determine whether these changes in habitat conditions are related to hydrogeological changes.

4.8.2 Scope of Monitoring

The key indicator species to be monitored in the Spring Flush are:-

- purple moor grass;
- deer grass;
- cross leaved heath;
- sharp flowered rush; and
- bog mosses.

The monitoring is not to be limited to these species and the presence of all species, and changes in their populations, will be assessed.

Monitoring Locations

The survey area will be the Spring Flush area shown in Drawing 1433DevOD283. A series of ten fixed monitoring locations for quadrat sampling will be identified on site during the first baseline sampling visit and a wooden stake left to demarcate the location for future monitoring. The grid coordinates for these locations will be identified by the use of GPS and a photographic record will be used to enable identification for all future sampling. The areas for sampling will be selected based on those areas where habitats show more diversity although some areas of lesser diversity will also be selected.

4.8.3 Monitoring Frequency

The window for National Vegetation Classification (NVC) surveys is April to September with the optimal time for monitoring being July to September when the plants are in bloom. All NVC monitoring will be undertaken in accordance with the NVC methodology set out in the NVC guidance (Ref. 11). Following preconstruction baseline monitoring, undertaken in April 2017, prior to Phase 2 Works, and a further survey will be undertaken in August or September 2017. Surveys will be undertaken in August or September for each subsequent construction year.

4.8.4 Assessment Control and Compliance Trigger Values

The ecological habitat Control Trigger Values will be set on the following basis:-

Table 31 - Summary of Ecological Habitat Control Trigger Values

Change in NVC class	The quadrats will allow the detailed definition of NVC class(es) for each habitat type and location. A change in NVC class will indicate a change in assemblage sufficient to cause a change in vegetation thereby impacting the interest of the site.
Change in percentage cover (loss of 5%) of the key indicator species	The quadrats will allow determination of the percentage cover. Should the coverage of the key indicator species drop by 5% or more, this will trigger a review of the significance of the change in the context of the wider habitat conditions.
Colonisation by new species	An evaluation will be undertaken to determine evidence of colonisation by new species. Where colonisation by a new species has been identified a review will be carried out of the significance and consequence of the change;

5 REMOVAL AND REPLACEMENT OF EXISTING MONITORING POINTS

No boreholes are currently designated for decommissioning during Phase 4. If any boreholes do require decommissioning it will be undertaken in accordance with current guidance (Ref. 7) and will adopt one of the three decommissioning options detailed below:-

Table 32 - Summary of Options for the Removal and Replacement of Monitoring Wells

OPTION 1	In boreholes where there is 1m or less of plain pipework	Grout up standpipe from the base to 1.5m below ground level. Remove headworks and plain pipe from 0-1m bgl. Remove the gravel pack and slotted pipework from 1.0-1.5m and replace with a bentonite/grout plug. Replace upper section 0-1.0m bgl with appropriate topsoil/arisings mix.
OPTION 2	In boreholes where there is greater than 1 m of plain pipework	Grout up standpipe from the base to 1m below ground level. Remove headworks and plain pipe from 0-1m bgl and replace with appropriate topsoil mix.
OPTION 3	In boreholes located on land that may be ploughed:-	Where boreholes are located on land that may be ploughed then guidance recommends that installations are removed to a minimum of 2.0 m bgl. Grout up standpipe from base to 2 m bgl. Remove headworks and plain pipe from 0-2m bgl . Remove the gravel pack and slotted pipework from 2.0-2.5m and replace with a bentonite/grout plug. Replace upper section 0-2.0m bgl with appropriate topsoil/arisings mix.

On completion of the decommissioning, a report of the works undertaken will be prepared.

6 MONITORING REPORTING

6.1 Scope

Reporting will assess the monitoring results against the Control and Compliance Trigger Values to highlight breaches and to record if remedial action is required as outlined in the Remedial Action Plan (compiled to discharge Condition 46 of planning permission NYM/2014/0676/MEIA).

In compliance with Condition 46 of planning permission NYM/2014/0676/MEIA, should any monitoring result exceed those Control and Compliance Trigger Values set out within this

document, the Local Planning Authority, the Environment Agency and Natural England will be informed as soon as practicable, and the approved Remedial Action shall be implemented in accordance with the Remedial Action Plan.

Summary reports will review the weekly/monthly monitoring reports, and review the adopted Control Trigger Values, and where necessary, suggest amendments.

6.2 Frequency

Monitoring reports will be prepared on a weekly basis during the Phase 4 Works, and for one month thereafter. Where breaches are recorded above the agreed Control and Compliance Trigger Values, the monitoring report will be issued to the NYMNPA, the Environment Agency and Natural England.

Monthly summary reports will be issued during the Phase 4 Works and on completion of the works. A final report will be issued to the NYMNPA, the Environment Agenc and Natural England one month after the completion of the Phase 4 Works.

6.3 Format

The format for the weekly/ monthly reports will include:-

- Summary of weekly construction activities;
- Record of monitoring positions decommissioned;
- Summary of meteorological data;
- Comparison of monitoring data to Control and Compliance Trigger Values;
- Conclusions; and
- Recommendations for remedial actions.

The format of the summary reports will include:-

- Summary of monthly activities;
- Summary of meteorological data;
- Comparison of monitoring data to Control and Compliance Trigger Values;
- Analysis of baseline data and review of control values;
- Review of any remedial actions taken;
- Conclusions; and
- Recommendations for remedial actions.

7 REFERENCES

1 FWS Consultants Ltd, 2016. Hydrogeological Baseline Report for the Dove's Nest Minesite, North Yorkshire 2012 to 2016 (1975OR01)

2 FWS Consultants Ltd, March 2017. Revised Hydrogeological Risk Assessment for Woodsmith Mine Phase 4 Works, North Yorkshire. Doc. Ref. No. 1433DevOR205.

3 FWS Consultants Ltd, March 2017. Groundwater Management Scheme for Woodsmith Mine Phase 4 Works. Doc. Ref. No. 1433DevOR208.

4 Arup, December 2017. NYMNPA 60 & 79 Surface Water Drainage Scheme. Ref. REP-P10-WS-CD-004

5 Environment Agency, 2010. Hydrogeological Risk Assessments for Landfills and the Derivation of Groundwater Control and Trigger Values

6 Arup, December 2017. NYMNPA 60 and 79: Surface Water Management Plan. Ref. REP-P10-WS-CD-003.

7 Environment Agency, 2012. Good practice for decommissioning redundant boreholes and wells.

8 Environment Agency 2007. Geomorphological Monitoring Guidelines for River Restoration.

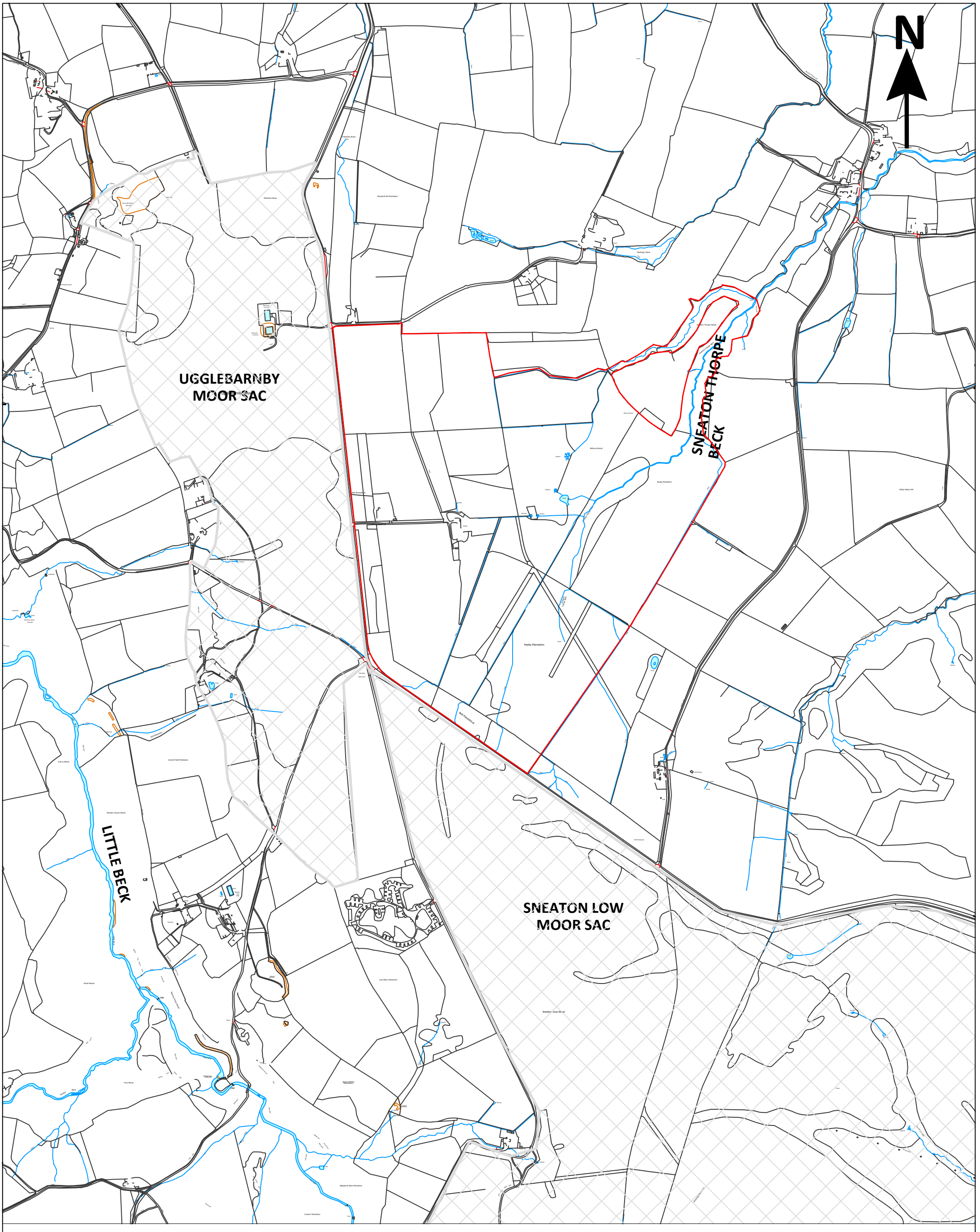
9 Thorne, 1998. Stream Reconnaissance Guidebook – Geomorphological Investigation and Analysis of River Channels

10 FWS Consultants Ltd, March 2017. Remedial Action Plan for the Phase 3 Works At Woodsmith Mine, North Yorkshire. Doc. Ref. No. 1433DevOR177.

11 Rodwell, J.S., 2006. National Vegetation Classification:Users' handbook

APPENDIX 1

DRAWINGS



NOTES / KEY

SITE OWNERSHIP BOUNDARY

NYM SAC

SURFACE WATER

DRAWING TITLE
WOODSMITH MINE
LOCATION PLAN

PROJECT TITLE
THE NORTH YORKSHIRE POLYHALITE PROJECT

CLIENT
SIRIUS MINERALS PLC

STATUS
FINAL

PROJECT NUMBER
1433

DRAWN BY
CB

DATE
March 2017

SCALE
1:10,000 @ A3

DRG. No.
1433DevOD215Rev2

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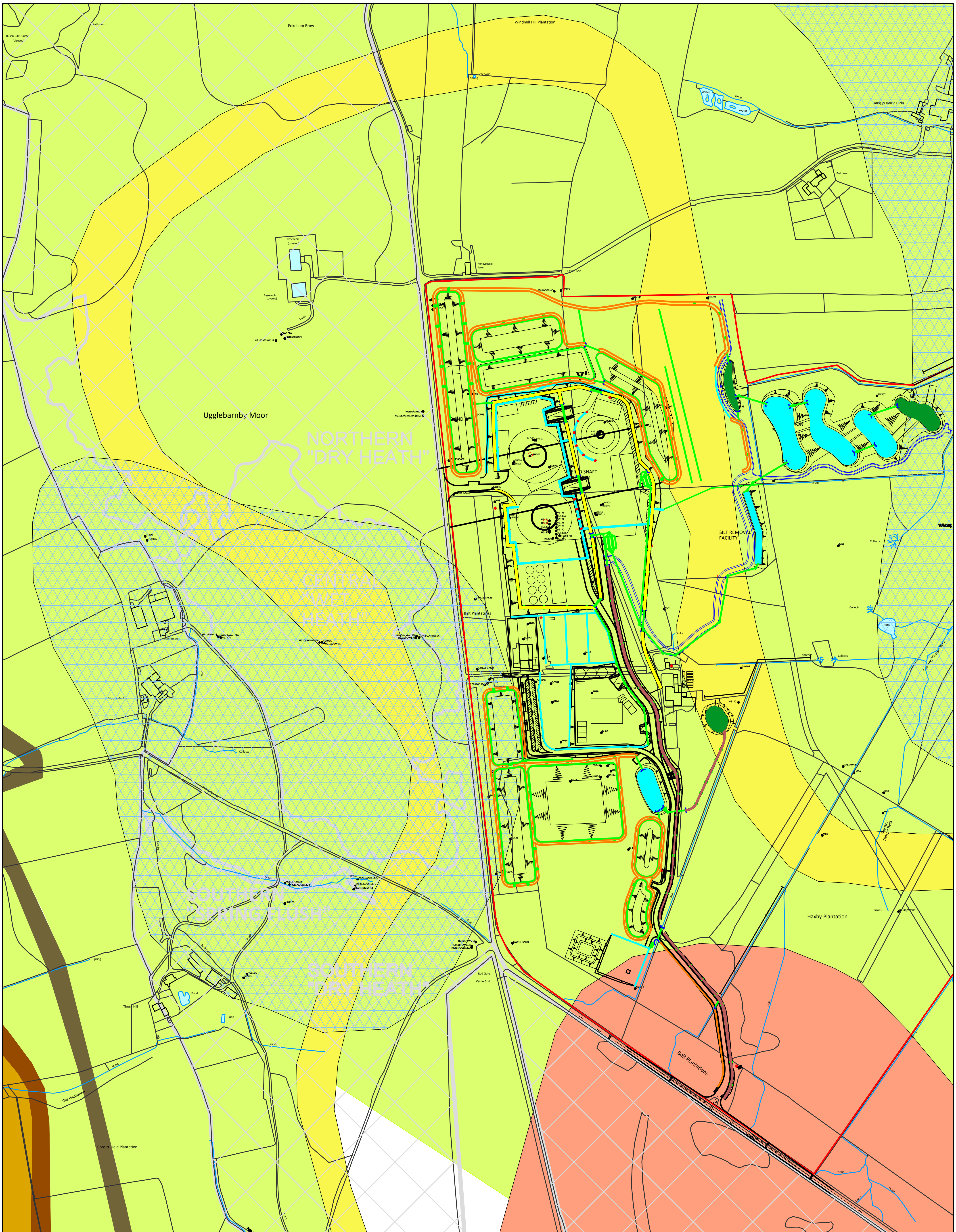

NOTES / KEY

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
PROJECT NUMBER	1433Dev
DRAWN BY	CB
DATE	May 2017
SCALE	1:5,000@A3/1:2,500@A1
DRG. No.	1433DevOD280

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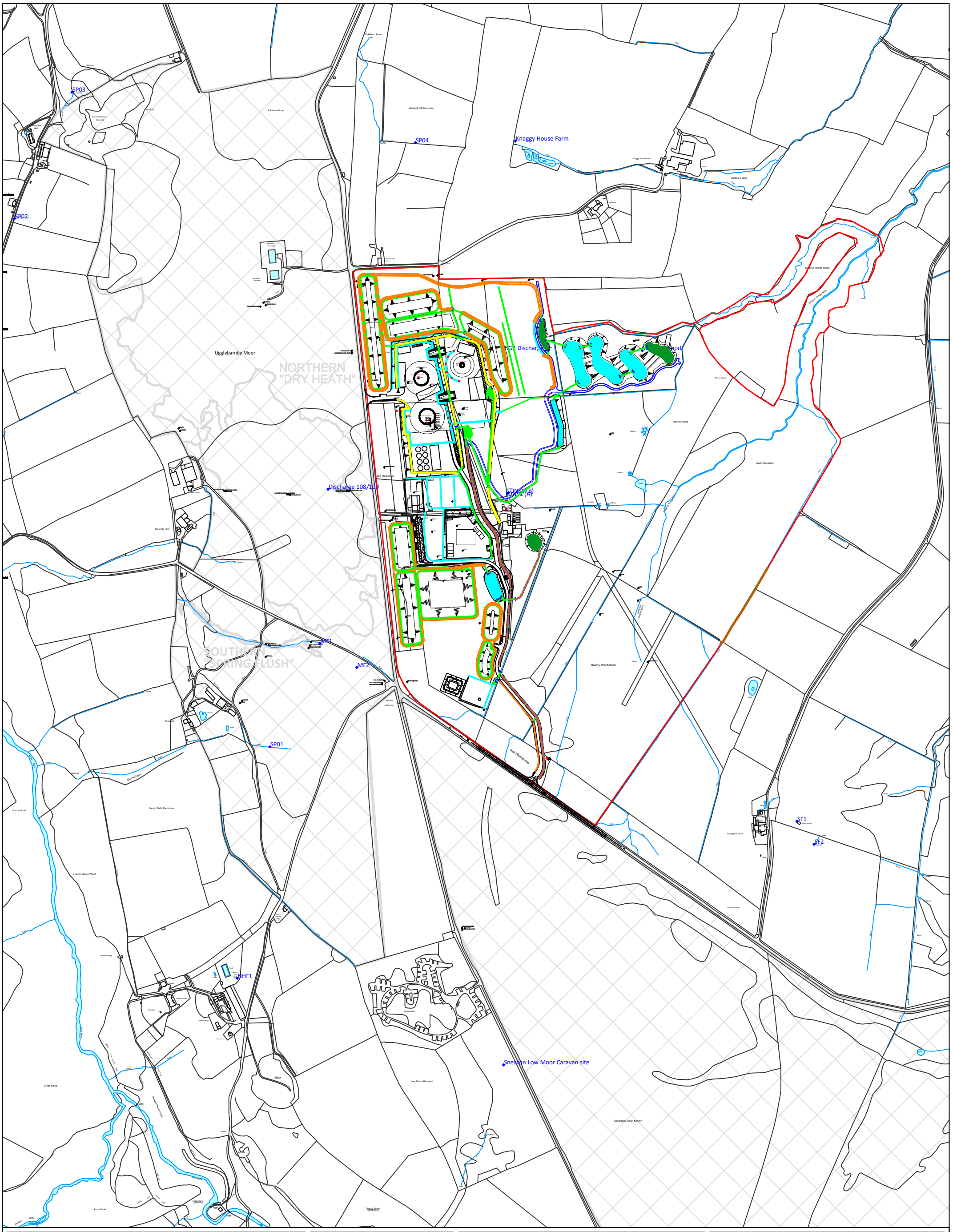

NOTES / KEY

SITE OWNERSHIP BOUNDARY

NYM SAC

SURFACE WATER

BOREHOLES GCBH01

HYDROGEOLOGICAL RECEPTORS MF2

DRAWING TITLE

HYDROGEOLOGICAL RECEPTORS - PHASE 4

PROJECT TITLE

NORTH YORKSHIRE POLYHALITE PROJECT

CLIENT
SIRIUS MINERALS PLC

STATUS
FINAL

PROJECT NUMBER
1433Dev

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CB

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1433DevOD281

FWS Geological & Geo-Environmental Consultants

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Ugglebarnby Moor

NORTHERN "DRY HEATH"

SOUTHERN "SPRING FLUSH"

Haxby Plantation

Belt Plantations

Soulsgrave Farm

Whitney Wood

Honeysuckle Farm

Cattle Grid

Red Gate Cattle Grid

Reservoir (covered)

Reservoir (covered)

Track

Drain

Collects

Pond

Spreads

Sinks

Issues

Wind Pump

Spring

Tank

Smeaton Thorpe Beck

HG2 Discharge

Discharge 108/109

DNS1 (B)

DNS1 (A)

SF1

SF2

SP01

MF1

MF2

GW123 (SAC2)

GW124 (SAC3)

GW125 (SAC4)

GW129 (SAC5)

GW130 (SAC6)

GW116 (SAC8)

GCBH1 GCBH2 GCBH3 GCBH4 GCBH5 GCBH6 GCBH7 GCBH8 GCBH9 GCBH10 GCBH11 GCBH12 GCBH13 GCBH14 GCBH15 GCBH16 GCBH17 GCBH18 GCBH19

BH1A BH1B BH2A BH2B BH3A BH3B BH4A BH4B BH5A BH5B BH6A BH6B BH7A BH7B BH8A BH8B BH9A BH9B BH10A BH10B BH11A BH11B BH12A BH12B BH13A BH13B BH14A BH14B

GW101 GW102 GW103 GW104 GW105 GW106 GW107 GW108 GW109

HG1 HG2 HG3 HG4 HG5 HG6 HG7 HG8 HG9 HG10 HG11 HG12 HG13 HG14 HG15 HG16 HG17 HG18 HG19 HG20 HG21 HG22 HG23 HG24 HG25 HG26 HG27 HG28 HG29 HG30 HG31 HG32 HG33 HG34 HG35 HG35A HG35B HG35C HG36 HG37 HG38 HG39 HG40 HG41 HG42 HG43 HG44 HG45 HG46 HG47 HG48 HG49 HG50 HG51 HG52 HG53 HG54 HG55 HG56 HG57 HG58 HG59 HG60 HG61 HG62 HG63 HG64 HG65 HG66 HG67 HG68 HG69 HG70 HG71 HG72 HG73 HG74 HG75 HG76 HG77 HG78 HG79 HG80 HG81 HG82 HG83 HG84 HG85 HG86 HG87 HG88 HG89 HG90 HG91 HG92 HG93 HG94 HG95 HG96 HG97 HG98 HG99 HG100 HG101 HG102 HG103 HG104 HG105 HG106 HG107 HG108 HG109 HG110 HG111 HG112 HG113 HG114 HG115 HG116 HG117 HG118 HG119 HG120 HG121 HG122 HG123 HG124 HG125 HG126 HG127 HG128 HG129 HG130 HG131 HG132 HG133 HG134 HG135 HG136 HG137 HG138 HG139 HG140 HG141 HG142 HG143 HG144 HG145 HG146 HG147 HG148 HG149 HG150 HG151 HG152 HG153 HG154 HG155 HG156 HG157 HG158 HG159 HG160 HG161 HG162 HG163 HG164 HG165 HG166 HG167 HG168 HG169 HG170 HG171 HG172 HG173 HG174 HG175 HG176 HG177 HG178 HG179 HG180 HG181 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MB1 MB2 MB3 MB4 MB5 MB6 MB7 MB8 MB9 MB10 MB11 MB12 MB13 MB14 MB15 MB16 MB17 MB18 MB19 MB20 MB21 MB22 MB23 MB24 MB25 MB26 MB27 MB28 MB29 MB30 MB31 MB32 MB33 MB34 MB35 MB36 MB37 MB38 MB39 MB40 MB41 MB42 MB43 MB44 MB45 MB46 MB47 MB48 MB49 MB50 MB51 MB52 MB53 MB54 MB55 MB56 MB57 MB58 MB59 MB60 MB61 MB62 MB63 MB64 MB65 MB66 MB67 MB68 MB69 MB70 MB71 MB72 MB73 MB74 MB75 MB76 MB77 MB78 MB79 MB80 MB81 MB82 MB83 MB84 MB85 MB86 MB87 MB88 MB89 MB90 MB91 MB92 MB93 MB94 MB95 MB96 MB97 MB98 MB99 MB100

NOTES / KEY

- SITE OWNERSHIP BOUNDARY
- NYM SAC
- SURFACE WATER
- BOREHOLES - GROUNDWATER LEVEL MONITORING GCBH01
- BOREHOLES - GROUNDWATER QUALITY MONITORING GCBH01
- BOREHOLES - GROUNDWATER LEVEL AND QUALITY MONITORING GCBH01
- HYDROGEOLOGICAL RECEPTORS MF2

DRAWING TITLE
PHASE 4 - GROUNDWATER AND SPRING MONITORING LOCATIONS

PROJECT TITLE
NORTH YORKSHIRE POLYHALITE PROJECT

CLIENT
SIRIUS MINERALS PLC

STATUS	PROJECT NUMBER
FINAL	1433Dev
DRAWN BY	**DATE**
CB	May 2017
SCALE	**DRG. No.**
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WEEKLY GEOMORPHOLOGICAL SURVEY POINTS

STB2/Peg7
STB2/Peg6
STB2/Peg5
STB2
STB2/Peg1
STB2/Peg2
STB2/Peg3
STB2/Peg4
Ford
Sneaton Thorpe Wood
Sneaton Thorpe Beck
Issues
STB4A
Whinny Wood
Haxby Plantation
STB1/Peg4
STB1/Peg3
STB1/Peg2
STB1/Peg1
STB1
Sneaton Thorpe Beck
Ditch
Mortar Hall Farm
Sneaton Thorpe
Whinny Wood Farm
Catwick House farm
Sneaton Thorpe Beck
Sneaton Thorpe Wood
Whinny Wood
Haxby Plantation
Belt Plantations
White Moor Hill
Soulgrave Farm
ATTENUATION POND
SILT REMOVAL FACILITY
SHAFT
RAM
STB4A
STB1
OF5

FULL GEOMORPHOLOGICAL SURVEY REACH

NOTES / KEY

SITE OWNERSHIP BOUNDARY

NYM SAC

SURFACE WATER

BOREHOLES GCBH01

SURFACE WATER MONITORING LOCATIONS OF1

GEOMORPHOLOGY SURVEY

DRAWING TITLE
PHASE 4 SURFACE WATER QUALITY MONITORING POINTS AND PRE & POST GEOMORPHOLOGICAL SURVEY REACH

INSET - WEEKLY GEOMORPHOLOGICAL SURVEY REACH

PROJECT TITLE
NORTH YORKSHIRE POLYHALITE PROJECT

CLIENT
SIRIUS MINERALS PLC

STATUS	PROJECT NUMBER
FINAL	1433Dev
DRAWN BY	DATE
CB	May 2017
SCALE 1:8,000@A3 Inset 1:5,000@A3	DRG. No. 1433DevOD282

FWS Geological & Geo-Environmental Consultants
Merrington House
Merrington Lane Industrial Estate
Spennymoor
County Durham
DL16 7UT

NORTHERN "DRY HEATH"

CENTRAL "WET HEATH"

SOUTHERN "SPRING FLUSH"

Ugglebarnby Moor

Discharge 108/109

MF1

MF2

P2 P3 P4 P7 P11 P14 P19

Dry Heath
Gorse
Go
Bracken
Br/Bil
Wet Heath (> Purple Moor-grass)
Wet Heath (< Purple Moor-grass)
Wet Heath (Mosaic with some Dry Heath)
Birch
Dry Heath
DH
Wood (mixed)
Woodland (Mixed)
Woodland (Birch/Willow)
Woodland (Willow)
Mire
Bracken
Gr Spring/ Stream
Dry Heath/ Patchy Bracken
Br
Wet Heath
Belt Plantations
Moor House
Moor House Farm
Collects
Louvsy Hill Ln
Track
Path (Um)

N SHAFT
GCBH8
GCBH5
GCBH6
GCBH6R
GCBH4
GCBH3
GCBH2
BH1B
BH2A
BH3B
BH5A
BH5B
BH6A
BH7A
HG135
HG135A
HG127
HG128
HG129
HG130
HG135B
HG135C
HG131
HG132
HG133
HG137
HG136
S Shaft BH
HG125
HG126
HG121
HG3
GW125 (SAC4)
GW123 (SAC2)
GW124 (SAC3)
GW117
GW117A
HG122/GW118
GW116 (SAC8)
HG111/GW133
HG105/GW122
HG105A/GW122A (SAC1)
HG106/GW121
HG106A/GW121B
HG107
HG107A
HG108/GW126
HG108A/GW126A
HG108B/GW126B
HG109/GW127
HG109A
HG109B/GW127A
HG110/GW128
HG110A
HG110B/GW128B
HG112A
HG112D/GW132B
HG112E/GW132I
GW132
GW121A
GW121B

NOTES / KEY

- SITE OWNERSHIP BOUNDARY
- NYM SAC
- SURFACE WATER
- BOREHOLES GCBH01
- HYDROGEOLOGICAL RECEPTORS MF2
- SPRING FLUSH MONITORING AREA

DRAWING TITLE	SPRING FLUSH MONITORING AREA
PROJECT TITLE	YORK POTASH PROJECT
CLIENT	SIRIUS MINERALS PLC
STATUS	FINAL
PROJECT NUMBER	1433Dev
DRAWN BY	CB
DATE	May 2017
SCALE	1:2,500@A3/1:1,250@A1
DRG. No.	1433DevOD284

FWS Geological & Geo-Environmental Consultants
Merrington House
Merrington Lane Industrial Estate
Spennymoor
County Durham
DL16 7UT

A1

B 1416

Existing drainage pipe.

Existing drainage ditch.

Discharge from dewatering system to existing ditch.

Standby discharge to slit removal facility for turbid groundwater.

Dewatering system discharge to existing drainage pipe via holding tank.

Notes:

1. Dewatering during phase 3 to a maximum of 3m below platform level.

Key:

- Approximate location of dewatering wells. Actual number and location to be determined by specialist dewatering contractor.
- Temporary dewatering pipeline
- Existing culvert

Issue	Date	By	Chkd	Appd
3	26/05/17	JB	CW	AH
	Issue for Planning			
2	25/05/17	JB	CW	AH
	Issue for Planning			
1	25/05/17	JB	CW	AH
	Issued for Planning			
0	31/03/17	JB	CW	AH
	Issued for Planning			

ARUP

Admiral House, Rose Wharf,
78 East Street, Leeds, LS9 8EE

www.arup.com

Client
Sirius Minerals Plc

Job Title
Woodsmith Mine
Proposed Minehead

Woodsmith Mine
Construction Phase 3 and 4
Platform Dewatering
Infrastructure

Scale at A1 1:1250

Discipline Civil

Job No 253285

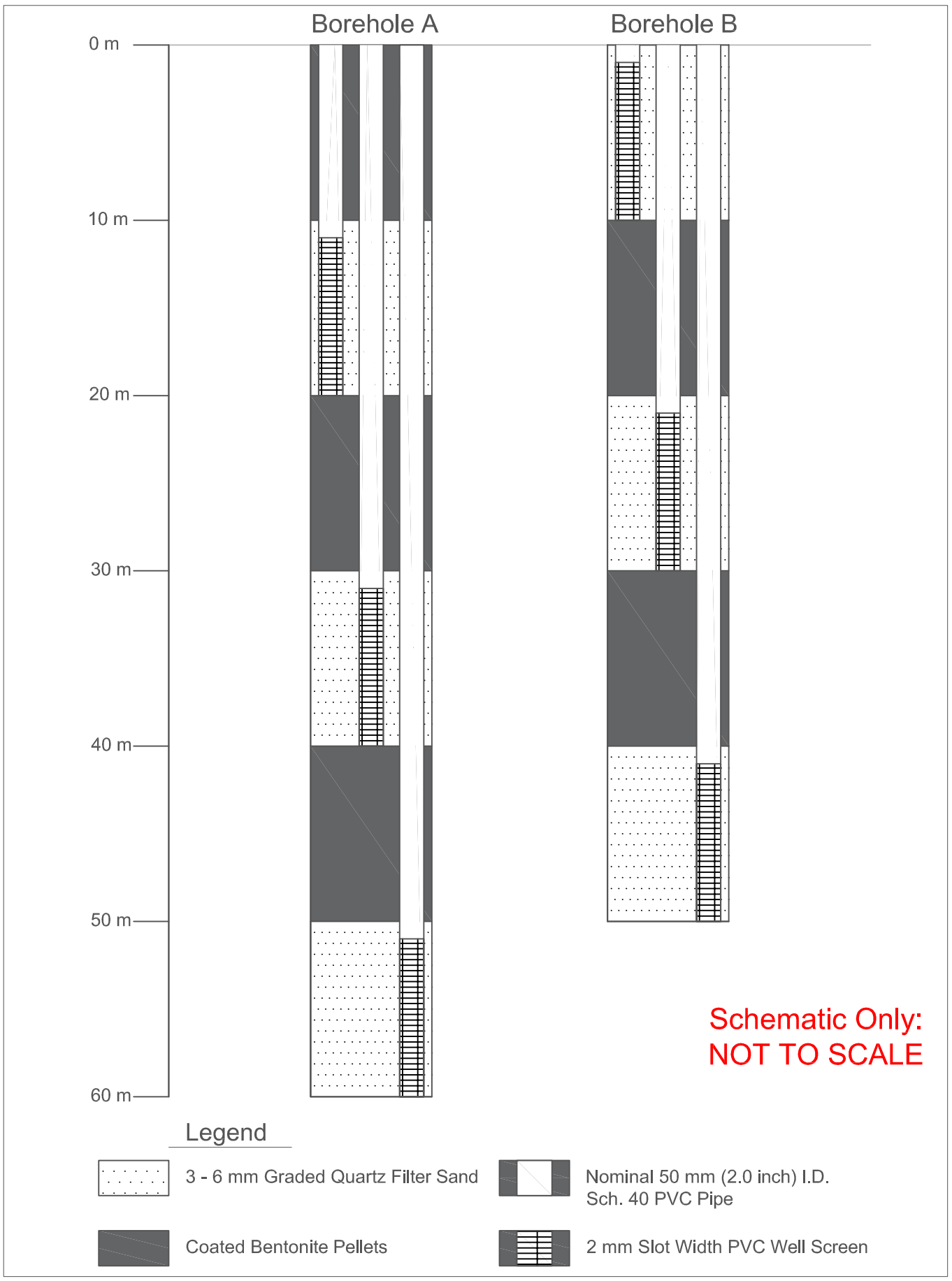
Drawing Status Planning

Drawing No 40-ARI-WS-71-CI-DR-1058

Issue 3

Do not scale

\\Global\europe\Leeds\Jobs\250000\253285-001\2-Arup - P10 Platform Redesign\0-20 CAD P10 - Platform Redesign\0_Drawings\40-ARI-WS-71-CI-DR-1058.dgn



Rev.	Revision Description	Drawn by	Date	Checked by	Date	Approved by	Date
A	Issued for Sirius M. Review	Dobr	17.05.2017				

Client: SIRIUS MINERALS PLC

amc uk

Consultant: Golder Associates

Consultant DRAWING NO.:

ISSUED FOR REVIEW
NOT FOR CONSTRUCTION

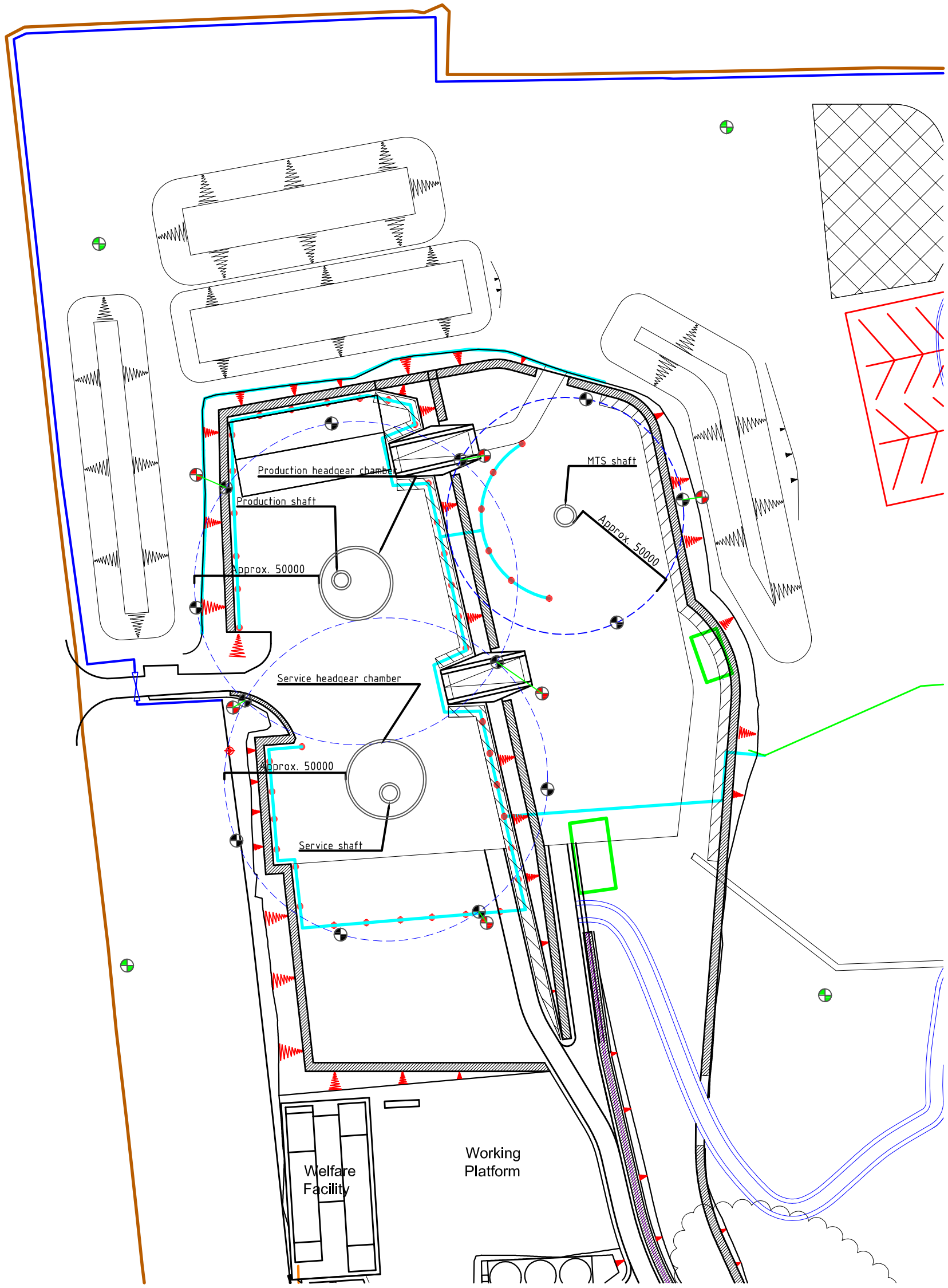
NORTH YORKSHIRE POLYHALITE PROJECT - MINE SHAFT

EARLY CONTRACTOR INVOLVEMENT

CIVIL ENGINEERING

Detail Of Monitoring Wells

Drawn by:	Checked by:	Approved by:	SMP Approved by:	SCALE	SIZE	DRAWING NO.	REV.
Dobr					A3H	40-AMC-WS-10-CI-DR-0002	A
Date: 17.05.2017	Date:	Date:	Date:				



Legend

- Near-Field Groundwater Monitoring Locations
- Adjusted Near-Field Groundwater Monitoring Locations
- Far-Field Groundwater Monitoring Locations

ISSUED FOR REVIEW
NOT FOR CONSTRUCTION

Rev.	Revision Description	Drawn by	Date	Checked by	Date	Approved by	Date
A	Issued for Sirius M. Review	Dobr	16.05.2017				

Client: SIRIUS MINERALS PLC

amc uk

Consultant: Golder Associates

Consultant DRAWING NO.:

NORTH YORKSHIRE POLYHALITE PROJECT - MINE SHAFT

EARLY CONTRACTOR INVOLVEMENT

CIVIL ENGINEERING

Monitoring Programme Layout

Drawn by:	Checked by:	Approved by:	SMP Approved by:	SCALE	SIZE	DRAWING NO.	REV.
Dobr				1:2000	A3H	40-AMC-WS-10-CI-DR-0001	A
Date: 16.05.2017	Date:	Date:	Date:				