REPORT

Woodsmith Mine Phase 3 - Construction Vehicle and Plant Management Plan

Woodsmith Mine Phase 3 CVPMP

Client: Sirius Minerals Plc

Reference: 40-RHD-WS-70-CI-PL-0003 REV 0

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Enhancing Society Together

HASKONINGDHV UK LTD.

Rightwell House
Rightwell East
Bretton
Peterborough
PE3 8DW
Industry & Buildings
VAT registration number: 792428892

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Author(s):	Wendy Johnston
Drafted by:	Charlotte Goodman
Checked by:	Matthew Edwards
Date / initials:	30/03/2017 ME
Approved by:	Matthew Hunt
Date / initials:	30/01/2016 MH

Classification
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MANAGEMENT SYSTEM CERTIFICATION
DNV·GL
ISO 9001 = ISO 14001
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1 Introduction

1.1.1 In 2014 a planning application (reference NYM/2014/0676/MEIA) was submitted to North York Moors National Park Authority (NYMNPA) for permission to develop a polyhalite mine and underground Mineral Transport System (MTS). Planning consent was subsequently granted in 2015, subject to conditions.

1.1.2 This document has been prepared on behalf of Sirius Minerals plc (Sirius Minerals) and details the requirements with respect to construction vehicles and plant for Phase 3 of the development at Woodsmith Mine (see paragraph 1.1.5 below). This document is required to partially discharge condition 92 of the NYMNPA planning permission NYM/2014/0676/MEIA and has been prepared in accordance with current good practice. The planning condition states that:

"Prior to the commencement of development at either Dove's Nest Farm or Lady Cross Plantation, a Construction Vehicle and Plant Management Plan (CVPM) shall be submitted to and approved in writing by the MPA. The CVPM shall include details of monitoring locations and baseline particulate emissions; predicted traffic movements into/out of the sites including levels at the A171/Mayfield junction; predicted particulate emissions from plant and HGVs during the construction period; proposed particulate control levels; proposed avoidance or mitigation measures to comply with control levels, and arrangements for monitoring over the construction period. Development shall only occur in strict accordance with the measures set out in the CVMP [sic], *unless otherwise agreed in writing with the MPA."*

1.1.3 The specific requirements of the planning condition are detailed in **Table 1-1**.

Table 1-1 Condition NYMNPA-92 Construction Vehicle and Plant Management Plan

Condition NYMNPA-92	Compliance with Condition NYMNPA-92
Details of monitoring locations and baseline particulate emissions	Section 2
Predicted traffic movements into/out of the sites including levels at the A171/Mayfield junction	Section 3
Predicted particulate emissions from plant and Heavy Goods Vehicles (HGVs) during the construction period	Section 4
Proposed avoidance or mitigation measures to comply with control levels	Section 5
Proposed particulate control levels	Section 5
Arrangements for monitoring over the construction period	Section 2

1.1.4 This management plan details only the Phase 3 Works at Woodsmith Mine and does not include any activities at Lady Cross Plantation, as these works are deferred. Updates to this plan will be prepared for subsequent construction phases and following any design review or method change. The NYMNPA has confirmed that it supports this approach.

1.1.5 The activities required for the Phase 3 Works comprise the following:

- General site clearance including demolition of all farm buildings and sheds, and localised tree and scrub clearance, as shown on drawing 40-ARI-WS-71-CI-DR-1051.
- Excavation and construction of the south western extension of the upper tiered working platform at around 203m AOD, as shown on drawing 40-ARI-WS-71-CI-DR-1053.
- Excavation and construction of the Platform for the Construction Welfare Facility, Parking Area and Concrete Batching Plant, as shown on drawing 40-ARI-WS-71-CI-DR-1053.
- Construction of temporary and permanent soil mounds, including the basal liner for a future storage facility in the northeast corner of the site for non-hazardous non-inert spoil and three topsoil, subsoil and inert material storage bunds in the southwestern area of the site, as shown on drawings 40-ARI-WS-71-CI-DR-1053 and 40-ARI-WS-71-CI-DR-1055, with earthworks volumes presented in 40-ARI-WS-71-CI-DR-1054.
- Construction of surface water drainage, a temporary surface water attenuation pond and temporary wetland in the southern area and two permanent attenuation ponds and two wetland areas in the north eastern area, as shown on Drawing 40-ARI-WS-71-CI-DR-1050;
- Construction of a spring and groundwater drainage layer in the north eastern area, discharging into a wetland area, as shown in drawing 40-ARI-WS-71-CI-DR-1080.
- Installation and commissioning of temporary dewatering as shown in drawing 40-ARI-WS-71-CI-DR-1058.
- Erection on site of the Concrete Batching Plant as shown in drawing 40-ARI-WS-71-CI-DR-1050, complete with reticulated water supplies and tanks.
- Construction of the drilling platform and temporary saline lagoon area for the groundwater reinjection well as shown in drawing 40-ARI-WS-71-CI-DR-1057.
- Establishment of construction welfare and security facilities - complete with hook-up of power, communications & water supplies and new waste water collection facilities as shown on drawing 40-ARI-WS-71-CI-DR-1050.

1.1.6 Meetings were held with the Environmental Health Officer (EHO) of Scarborough Borough Council (SBC) and NYMNPA on 17 March 2016 and 27 April 2016 respectively. At these meetings, the scope and content of the document to discharge planning condition NYMNPA-92 was agreed. The scope was re-confirmed with the EHO in a meeting on 1 December 2016.

1.1.7 The agreed approach was to consider the requirements of the Condition in four parts, as detailed in **Table 1-1**. The structure of this document follows the agreed approach, and the structure of the CVPMP previously submitted to partially discharge planning condition NYMNPA-92 in respect of the Phase 2 Works.

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2 Baseline Conditions

2.1 Definitions of Dust and Fine Particulate Matter

2.1.1 Definitions of dust and fine particulate matter are provided in **Appendix A1**.

2.2 Site-Specific Dust Deposition Survey

2.2.1 Baseline dust deposition monitoring was undertaken at eight locations around the boundary of the Woodsmith Mine site between February and August 2014 using frisbee dust gauges. The locations at which monitoring was undertaken are shown in **Figure 1**. Key results of the six month monitoring are detailed in **Table A1** in **Appendix A2**. These results informed the full air quality assessment presented in the Environmental Statement (ES) which supported the planning application.

2.2.2 The monitoring results show that dust deposition varies at locations around the boundary of Woodsmith Mine. Of the valid measurements recorded, the average dust deposition value was 42 mg/m^2/day (range 14 – 94 mg/m^2/day; average deviation 18 mg/m^2/day; standard deviation 22 mg/m^2/day). Slightly higher average deposition was measured at locations M5 and M7, located at the south-east of the site boundary, within wooded areas, where deposition rates are likely to be attributable to influences from vegetation and resuspension of material from the nearby road network. The lowest deposition rates were measured at locations M2 and M8, located to the west and north of the site respectively. These locations are surrounded by open fields. Results from the comparable location M1 are higher, and agricultural activity and distant road traffic are likely to have contributed to the measured values.

2.2.3 Wind roses of hourly sequential meteorological data from the Fylingdales recording station were provided in the ES[1]. The predominant wind direction is from the south-west, therefore locations downwind of particulate sources are likely to experience the greatest deposition, as indicated at locations M5 and M7.

2.2.4 Regulatory authorities conventionally consider a threshold of 200 mg/m^2/day[2,3] to be the dust deposition rate, above which complaints are likely[4]. The measured dust deposition rates are all well below 200 mg/m^2/day, as would be expected in a rural and relatively undeveloped location.

[1] Royal HaskoningDHV (2014) York Potash Project Mine, MTS and MHF Environmental Statement: Part 2 Chapter 9 Air Quality
[2] Environment Agency (2013) Technical Guidance Note (Monitoring) M17 Monitoring Particulate Matter in Ambient Air around Waste Facilities
[3] Institute of Air Quality Management (2012) Guidance on Air Quality Monitoring in the Vicinity of Demolition and Construction Sites
[4] Vallack & Shillito (1998) Suggested guidelines for deposited ambient dust, Atmospheric Environment **16** (32), 2737-2744

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2.3 Background Particulate Matter Concentrations

2.3.1 Background PM_{10} and $PM_{2.5}$ concentrations were sourced from pollutant maps provided by Defra[5] for a 1km x 1km resolution of the UK. The relevant 2017 background pollutant concentrations at Woodsmith Mine were obtained for the grid squares covering the area, and are detailed in **Table A2** in **Appendix A3**.

2.3.2 Background PM_{10} and $PM_{2.5}$ concentrations at Woodsmith Mine are well below the annual mean Air Quality Objectives (in England) of 40µg.m^{-3} and 25µg.m^{-3} respectively. The main contributor to PM_{10} concentrations within the above grid squares is secondary PM_{10} (aerosols formed in atmospheric condensation reactions), sea salt and calcium and iron rich dusts, reflecting the proximity of Woodsmith Mine to the coast.

2.4 Additional Monitoring

2.4.1 It was agreed in the consultation meetings with SBC and the NYMNPA that the existing monitoring data, re-presented in **Appendix A2**, provide a suitable and sufficient characterisation of baseline particulate conditions at the site and that no additional monitoring would therefore be required. Further passive deposition sampling during construction activities would provide only retrospective data, and correlation of monitored particulate concentrations with construction phase activities and generated emissions would not provide a meaningful management and control technique.

2.4.2 Nevertheless, the construction activities will be subject to a range of dust and vehicle management measures, as set out in the Construction Environmental Management Plan (CEMP), submitted to partially discharge planning condition NYMNPA-93. The measures detailed in the CEMP include regular visual site inspections to monitor compliance with dust control procedures set out within the document. The results of the inspections will be recorded within the site log book, and included in monthly reporting. A Dust Management Plan (DMP) is included as part of the CEMP.

2.4.3 This approach was agreed with SBC and the NYMNPA during the respective meetings (as detailed in **Section 1**).

[5] Defra (2014) 2011-based background maps https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2011

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3 Predicted Traffic Movements Associated with Phase 3 Works

3.1 Construction Phase Road Traffic Movements

3.1.1 The anticipated traffic movements associated with Phase 3 align with those presented in the Construction Traffic Management Plan (CTMP), submitted to partially discharge planning condition NYMNPA-34. The Phase 3 Works will be undertaken over a 22 week period, totalling 154 working days between June and October 2017.

3.1.2 The number of traffic movements generated during the Phase 3 Works is detailed in **Table 3-1**.

Table 3-1 Traffic Movements Generated During Phase 3 at Woodsmith Mine

Vehicle Type	Number of Vehicles During Phase 3 (Two-Way)*	Maximum Number of Vehicles per Day (Two-Way)
HGV	16,896	126
Light Goods Vehicles (LGVs)**	18,480	120

*HGVs are restricted on Sundays and therefore the total number of HGVs during Phase 3 does not equate to the duration multiplied by the number of HGVs per day
**Includes cars, minibuses and vans

3.1.3 All HGVs will travel through the A171/Mayfield junction, as the primary source of construction materials within the area will be from Teesside, using the A171 corridor to access Woodsmith Mine (via the B1416 south to avoid Ruswarp).

3.1.4 It is not possible to quantify exact total numbers of vehicles that will travel through the A171/Mayfield junction; however, to provide a conservative approach, if it were assumed that all LGVs and HGVs were to travel through the A171/Mayfield junction, this would result in a maximum increase in vehicles of 246 per day (35,376 vehicles over the duration of Phase 3).

3.2 On-Site Plant

3.2.1 The number and types of plant that would be operating for the duration of Phase 3 at Woodsmith Mine are provided in **Table 3-2**.

Table 3-2 Plant Required During Phase 3

Plant Type	Number of Units	Duration of Phase 3 That Plant Will Be Used
20T excavator	2	100%
30T excavator	4	100%
9T dumper	2	100%
30T dumper	6	100%
Dozer	2	80%
20T roller	3	100%
Tractor	2	100%

Plant Type	Number of Units	Duration of Phase 3 That Plant Will Be Used
73T truck crane	4	1%
5m^3 front end loader	2	47%
6T telehandler	2	15%
0.76m^3 excavator	2	3%
18m telescopic boom lift	2	6%
8m^3 concrete trucks	8	19%
1.25MVA generator	1	50%
350kVA generator	1	100%
50kVA generator	1	100%
50kVA generator	10	50%
20kVA generator	2	100%
10kVA generator	1	50%

4 Predicted Particulate Emissions from Plant and HGVs during Phase 3

4.1 Methodology

4.1.1 Particulate matter will be generated by the combustion of fuel and brake and tyre wear associated with the following activities during Phase 3:

- Transportation of workforce to site;
- HGV deliveries and movements; and
- The operation of on-site plant (referred to as Non-Road Mobile Machinery (NRMM)) and generators.

4.1.2 Data on the above activities are provided where the required information is known. Where data were not available, information used in the assessments undertaken for the Environmental Statement are used, which included the average trip length and speeds. This is considered to be a reasonable worst case scenario.

4.1.3 The quantification of emissions from road traffic was undertaken using the Defra Emission Factor Toolkit (version 7.0). The Emission Factor Toolkit is regularly updated to reflect the latest vehicle technologies and fleet compositions, and is the primary method of deriving emissions from road transport in the UK. The standard UK fleet composition for 2017, built into the Emission Factor Toolkit, was utilised.

4.1.4 The Emission Factor Toolkit does not provide specific emission factors for NRMM. As such, emissions of NRMM were calculated using the methodology detailed in European Environment Agency (EEA) Guidance[6]. This document details specific emission factors for NRMM, based on the power rating of the plant and the various emission stages, which correspond to the emission standards set out in relevant EU Directives.

4.1.5 The guidance provides three tiers of emission factors; the appropriate tier for use is dependent on the level of information available on the types of plant. As specific information on the make and model of plant used at Woodsmith Mine were provided by the Contractors, Tier 3 emission factors were used.

4.1.6 Emissions associated with generators were derived using the Tier 1 approach in EEA Guidance[7]. Fuel consumption was derived using the electrical power of the plant, the electrical efficiency, the anticipated utilisation rate and hours of use per day as provided by the Contractors. Emission factors were obtained from the EEA Guidance.

4.2 Assumptions

4.2.1 The following assumptions were made in the assessment of particulate emissions from NRMM and vehicle movements:

- NRMM used for the site preparation works was assumed to be in operation for 80% of the working day;
- Phase 3 will take place in 2017 – emission factors for this year were therefore used;
- For the site preparation works, there will be one 12-hour shift pattern per day Monday – Friday, and a 10-hour shift on Saturday and Sunday;
- The concrete batching works will require 12 hour working;
- Where load factors for generators were not provided by the Contractor, it was assumed that they would be operating at full power load;
- All generators were assumed to operate at 40% efficiency;
- The duration of Phase 3 will be 22 weeks, with all Sundays worked; and
- HGV deliveries are restricted to 10% of weekday volumes on Sundays (as per the CTMP). It was therefore assumed that, on Sundays, HGV deliveries would be 10% of weekday trips.

4.2.2 A sensitivity test was undertaken with regard to the load factor of the NRMM whilst in use. Load factors of 0.5 and 0.7 were used in the calculation of emissions from NRMM to represent 50% and 70% engine load.

4.2.3 Average HGV speeds were obtained from GIS smartphone data[8] on the road links that comprise the haul route, and average speeds of vehicles from the park and ride locations and cars were obtained from route mapping and estimated distance over time.

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[6] EMEP/EEA (2016) *Emission Inventory Guidebook – Non-Road Mobile Sources and Machinery*
[7] EMEP/EEA (2016) *Emission Inventory Guidebook – Small Combustion*
[8] Journey times were extracted from www.arcgis.com. Arcgis uses historic smartphone data to inform live traffic route planner services such as 'Google traffic'. The average speeds were calculated by dividing the measured distance by the recorded journey time.

4.3 Emissions from Construction Phase Road Traffic Movements

4.3.1 The quantification of particulate emissions generated by construction-phase traffic movements was undertaken using the following input data:

- Number of daily HGV and car movements;
- Average trip lengths (km);
- Average speed vehicles will be travelling; and
- Emission factors for each vehicle type.

4.3.2 Input and output data from the Emission Factor Toolkit are detailed in **Table A3** and **Table A4** in **Appendix A4**.

4.4 Emissions from the Operation of On-Site NRMM and Generators

4.4.1 The input data used to calculate particulate (PM_{10}) emissions from NRMM and generators are detailed in **Appendix A5** and **Appendix A6**. The calculated particulate emissions from NRMM, using average load factors of 0.5 and 0.7, and generators are detailed in **Table 4-1**.

Table 4-1 Total PM_{10} Emissions from NRMM during Phase 3

Plant	Total PM_{10} Emission (tonnes)	
	Load Factor = 0.5*	Load Factor = 0.7*
20T excavator (2 units)	0.0068	0.0095
30T excavator (4 units)	0.0189	0.0265
9T dumper (2 units)	0.0291	0.0407
30T dumper (6 units)	0.0418	0.0585
Dozer (2 units)	0.0078	0.0110
20T roller (3 units)	0.0117	0.0164
Tractor (2 units)	0.0104	0.0146
73T truck crane (4 units)	0.0039	0.0055
5m^3 front end loader (2 units)	0.0147	0.0206
6T telehandler (2 units)	0.0022	0.0031
0.76m^3 excavator (2 units)	0.0003	0.0005
18m telescopic boom lift (2 units)	0.0005	0.0007
8m^3 concrete trucks (8 units)	0.0303	0.0424
1.25MVA generator (1 unit)	0.0241	0.0241
350kVA generator (1 Unit)	0.0270	0.0270
50kVA generator (1 Unit)	0.0108	0.0108
50kVA generator (10 units)	0.0154	0.0154
20kVA generator (2 units)	0.0068	0.0068
10kVA generator (1 unit)	0.0015	0.0015

*Specific load factors were provided by the Contractor for the generator plant >=350kVA. Generators <350kVA were assumed to be operating at full load

4.5 Total Particulate Emissions Generated During Phase 3

4.5.1 The total particulate predicted to be generated during Phase 3 as a result of emissions from construction-phase traffic, NRMM and generators is detailed in **Table 4-2**.

Table 4-2 Total PM Emissions from Construction Traffic, NRMM and Generators

Source	Total PM Emission (tonnes)	
	Load Factor = 0.5	Load Factor = 0.7
Construction Traffic	0.179	0.179
NRMM and Generators	0.264	0.336
TOTAL	**0.443**	**0.515**

4.5.2 The total PM_{10} emission within the SBC area was derived from National Atmospheric Emission Inventory (NAEI) mapping[9], as detailed in **Figure 2**.

4.5.3 The total PM_{10} emission within the whole SBC area of jurisdiction was 404.96 tonnes in 2014. Particulate emissions generated during Phase 3 will therefore contribute 0.065% to 0.083% of the total emissions, (using a load factor range of 0.5 to 0.7 respectively).

4.5.4 The area of the Woodsmith Mine site within the works perimeter is $0.8km^2$. Whilst a proportion of PM emissions from construction traffic will occur off-site on the local road network, the total emission of PM_{10} generated by Phase 3 as a result of NRMM and generators is 0.330 tonnes $PM_{10}.km^{-2}$ to 0.420 tonnes $PM_{10}.km^{-2}$ using load factors between 0.5 and 0.7 respectively. The emission of PM_{10} across the SBC area ($826.km^{-2}$) is 0.49 tonnes $PM_{10}.km^{-2}$.

5 Mitigation Measures

5.1 Construction Dust and NRMM Mitigation Measures

5.1.1 Details of mitigation measures to minimise construction phase dust emissions are included in the CEMP.

5.1.2 All NRMM and plant will be well maintained. If any emissions of dark smoke occur then the relevant machinery will stop immediately and any problem rectified. In addition, the following controls will apply to NRMM:

- All NRMM should use fuel equivalent to ultralow sulphur diesel (fuel meeting the specification within EN590:2004);
- As of 1st January 2017, all NRMM will comply with regulation (EU) 2016/162810 of the European Parliament and of the European Council. All NRMM will be fitted with Diesel Particulate Filters (DPF) conforming to defined and demonstrated filtration efficiency (load/duty cycle permitting);

[9] National Atmospheric Emission Inventory (2014) Emission Maps for the UK http://naei.defra.gov.uk/data/map-uk-das?pollutant_id=24&emiss_maps_submit=naei-20160526090831

[10] Regulation (EU) 2016/1628 of the European Parliament and of the Council of 14 September 2016 on requirements relating to gaseous and particulate pollutant emission limits and type-approval for internal combustion engines for non-road mobile machinery, amending Regulations (EU) No 1024/2012 and (EU) No 167/2013, and amending and repealing Directive 97/68/EC

- The ongoing conformity of plant retrofitted with DPF, to a defined performance standard, will be ensured through a programme of onsite checks; and,
- Fuel conservation measures will be implemented, including instructions to (i) throttle down or switch off idle construction equipment; (ii) switch off the engines of trucks while they are waiting to access the site and while they are being loaded or unloaded and (iii) ensure equipment is properly maintained to ensure efficient fuel consumption.

5.1.3 The vehicle fleet accessing Woodsmith Mine will be fitted with DPFs, which will control particle emissions[11].

5.2 Junction and Road Improvements

5.2.1 Several junction and road improvements are part of the Sirius Minerals North Yorkshire Polyhalite Project. The improvements are being made primarily for transport or safety reasons; however there will be air quality benefits. The improvements are detailed below, to address the requirement of the planning condition to detail '*avoidance or mitigation measures'* implemented as part of the development.

5.3 Provision of Right Turn Lane on the A171

5.3.1 The junction of the A171/B1416 is a T-junction with no dedicated right-turn lane. HGVs access Woodsmith Mine by turning right onto the B1416 from the A171. The works involved the provision of a right turn lane at the A171/B1416 junction for traffic turning right on to the B1416. The addition of the right-turn lane will reduce queuing on the A171 as HGVs turn. Vehicle exhaust emissions are lower in free-flowing traffic and are higher under stop-start conditions, therefore this measure will reduce particulate emissions locally. These works were undertaken as part of Phase 1, and will be complete prior to the commencement of Phase 3.

5.4 Improvements to Signals at the A171/Mayfield Junction

5.4.1 Improvements were made to the A171/Mayfield Junction to upgrade the signalling system, improve the provision for pedestrians and improve junction capacity. The improvements to the traffic signals at this location, which is anticipated to experience an increase in vehicle flows as a result of Phase 3, will have benefits for air quality by encouraging the flow of traffic around the junction and reducing waiting times.

5.5 Widening of the Carriageway of the A171 at Normanby Bends

5.5.1 There is a series of bends along the A171 at Normanby, which forms part of the primary HGV haul route. The road will be widened at this location to accommodate two HGVs passing each other safely, however this will not be undertaken before the completion of Phase 3.

[11] DPFs are commonly fitted to cars and commercial vehicles to reduce particulate emissions and ensure compliance with the latest Euro standards. It is an offence under the Road Vehicles (Construction and Use) Regulations (1986) to use a vehicle that has had the DPF removed.

Figures

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Figure 1 – Baseline Dust Deposition Monitoring Locations (as presented in the ES)

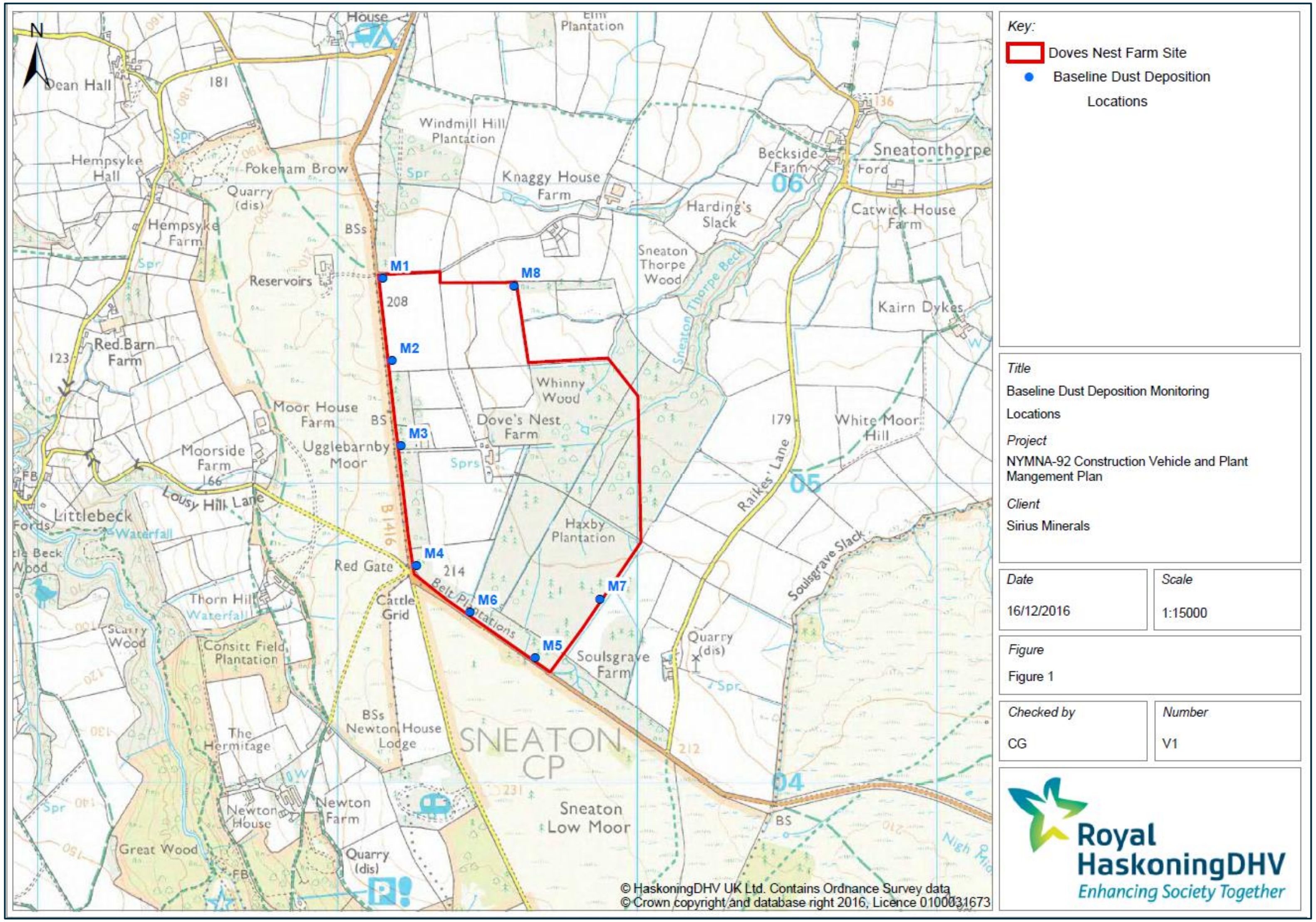
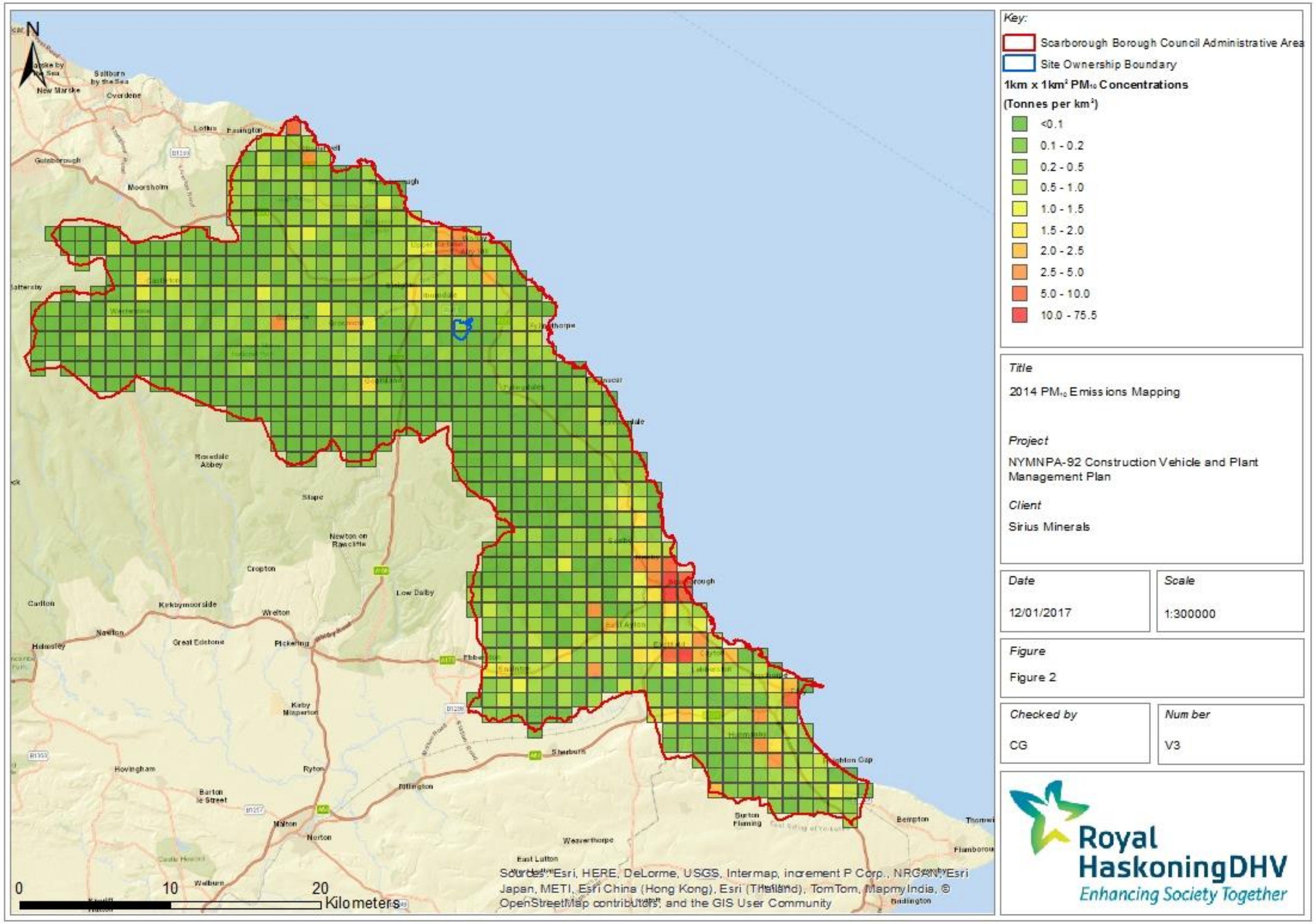


Figure 2 – 2014 PM_{10} Emissions Mapping



Appendix A

A1 Definitions of Dust and Fine Particulate Matter

Atmospheric particles are generally categorised by size fraction and by their source, and are usually measured by mass concentration (although particle number and 'black carbon' techniques are available). The generic term of 'dust' and the two size fractions most commonly used to consider human health environmental effects are defined below.

'Dust' is considered to be the mass of solid particles that are suspended in air, or have settled out onto a surface after having been suspended in air. In IAQM Guidance[12] and within this document, the term 'dust' has been used to include the particles that give rise to soiling, and to potential human health and ecological effects. BS 6069:1993 provides a definition of dust as particles up to 75µm in diameter.

The smaller size fractions considered in the UK Local Air Quality Management regime are defined in Regulations[13] as follows:

- "PM_{10}" means particulate matter which passes through a size-selective inlet as defined in the reference method for the sampling and measurement of PM_{10}, EN 12341, with a 50% efficiency cut-off at 10µm aerodynamic diameter; and,
- "$PM_{2.5}$" means particulate matter which passes through a size-selective inlet as defined in the reference method for the sampling and measurement of $PM_{2.5}$, EN 14907, with a 50% efficiency cut-off at 2.5µm aerodynamic diameter.

The term 'aerodynamic diameter' is a reference to the terminal velocity in air of a spherical particle of unit density, therefore this is a way of standardising the range of irregular airborne particle loading for measurement and standard-setting.

Particulate matter is generally described by source as being either 'primary' or 'secondary'. Primary particles such as carbon particles from fuel combustion, sea salt and mineral particles derived from construction activities are released directly into the air, whereas secondary particles are formed in the atmosphere by chemical reactions that lead to the formation of low volatility compounds that condense into particles.

The main sources of primary particulate are road transport (combustion emissions, brake and tyre wear and re-entrainment of dust from road surfaces); stationary combustion (such as domestic coal burning); and industrial processes (production of metals, cement, lime, coke and chemicals, bulk handling of dusty materials, construction, mining and quarrying).

[12] Institute of Air Quality Management (2014). Guidance on the assessment of dust from demolition and construction.
[13] The Air Quality Standards Regulations 2010 (SI 2010 No.1001)

Secondary particles are less easy to ascribe to their original sources. They are comprised mainly of ammonium sulphate and nitrate, originating from the oxidation of sulphur and nitrogen oxides in the atmosphere to acids, which are then neutralised by atmospheric ammonia derived mainly from agricultural sources. The chemical processes involved in their formation are relatively slow and their persistence in the atmosphere is prolonged. Thus, secondary particles are distributed more evenly throughout the air with fewer differences between urban and rural areas. They can also travel large distances, resulting in the transport of particles across national boundaries (AQEG, 2005)[14].

[14] Air Quality Expert Group (AQEG), (2005). Particulate Matter in the United Kingdom. Defra, London

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A2 Dust Deposition Monitoring Results

Table A1 Dust Deposition Monitoring Results

Site ID	Site Description	Monthly Dust Deposition Rate ($mg/m^2/d$)						
		Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Period Mean
M1	On open grassland on north-west corner of site	32	62	66	18	39	74	49
M2	On open grassland on western perimeter of site, adjacent to bund	19	30	37	17	19	22*	24
M3	Within woodland on western perimeter of site	21	68	44	17	34	56	40
M4	On open grassland, adjacent to light woodland on the south-west corner of the site	9*	18*	59	-	19	36	38
M5	Within light woodland on southern perimeter of site	22	42	86	44	32	87	52
M6	Within woodland on southern perimeter of site	21	55	84	48	27	47	47
M7	Within light woodland on eastern perimeter of site	46	46	94	66	34	76	60
M8	On open grassland on northern perimeter of site	14	-	25	-	30	42	28

*foam particle trap taken from gauge during sample period. Therefore result does not include mass of material lost with trap, and these values have not been used to calculate the period mean deposition rate.

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A3 Background Particulate Matter Concentrations

Table A2 2017 Background Particulate Matter Concentrations

Grid Square	PM_{10} Background Concentration ($\mu g.m^{-3}$)	$PM_{2.5}$ Background Concentration ($\mu g.m^{-3}$)
489500,504500	9.87	7.02
489500,505500	11.10	7.66
490500,504500	10.53	7.36
490500,505500	11.44	7.82

A4 Inputs and Outputs of the Emission Factor Toolkit

Table A3 Input Data into the Emission Factor Toolkit

Vehicle Type	Number of Vehicles During Phase 3	Number of Vehicles per Day (Averaged over Phase 3)	Speed (kph)	Trip Length (km)
HGV	16,896	110	69	64
Cars	18,480	120	60.4	50

Table A4 Output from the Emission Factor Toolkit

Vehicle Type	Emissions of PM_{10} over Phase 3 (kg)
HGV	353
Cars	72
Total	425

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A5 Calculation of Emissions from NRMM

The European Monitoring and Evaluation Programme (EMEP)/European Environment Agency (EEA) Emission Inventory Guidebook 2016[15] provides the following equation to calculate emissions from NRMM:

$$E = N \times HRS \times P \times (1+DFA) \times LFA \times EF_{(base)}$$

Where:

- E = mass of emissions generated
- N = source population
- HRS = hours of use over the period
- P = engine size (kW)
- DFA = deterioration factor adjustment
- LFA = load factor adjustment
- $EF_{(base)}$ = base emission factor (g/kWh).

The average horsepower (HP) and kilowatt (kW) power ratings for the proposed NRMM are provided in **Table A5**.

Table A5 Power Ratings of Required Plant During Phase 3 at Woodsmith Mine

Plant	Average Rated HP	Power in kW
20T excavator	175	130
30T excavator	245	183
9T dumper	94	70
30T dumper	360	268
Dozer	253	189
20T roller	202	151
Tractor	269	201

The input data used to calculate emissions from NRMM are detailed in **Table A6**.

Table A6 Input Data Used to Calculate Particulate Emissions from NRMM

Plant	kW	Hours of Use During Phase 3	Number of Units	Load Factor		Emission Factor Stage	Emission Factor (g/kWh)
20T excavator	130	1408	2	0.5	0.7	IV	0.025
30T excavator	183	1408	4	0.5	0.7	IV	0.025
9T dumper	70	1408	2	0.5	0.7	IIIA	0.200
30T dumper	268	1408	6	0.5	0.7	IV	0.025
Dozer	189	1126	2	0.5	0.7	IV	0.025
20T roller	151	1408	3	0.5	0.7	IV	0.025
Tractor	201	1408	2	0.5	0.7	IIIB	0.025

[15] EMEP/EEA (2016) *Emission Inventory Guidebook – Non-Road Mobile Sources and Machinery*

Plant	kW	Hours of Use During Phase 3	Number of Units	Load Factor		Emission Factor Stage	Emission Factor (g/kWh)
73T truck crane	335	40	4	0.5	0.7	IIIB	0.100
5m^3 front end loader	232	1724	2	0.5	0.7	IV	0.025
6T telehandler	106	566	2	0.5	0.7	IV	0.025
0.76m^3 excavator	88	108	2	0.5	0.7	IV	0.025
18m telescopic boom lift	62	216	2	0.5	0.7	IV	0.025
8m^3 concrete trucks	291	707	8	0.5	0.7	IV	0.025

A6 Calculation of Emissions from Generators

The EMEP/EEA Emission Inventory Guidebook 2016[16] provides the following equation to calculate emissions from combustion sources such as generators:

$$E_{pollutant} = AR_{fuelconsumption} \times EF_{pollutant}$$

Where:

$E_{pollutant}$ = the emission of the specified pollutant ($g.h^{-1}$)
$AR_{fuelconsumption}$ = the activity rate for fuel consumption ($GJ.h^{-1}$)
$EF_{pollutant}$ = the emission factor for the pollutant (g/GJ)

The fuel consumption (AR) of each generator was derived using the power rating of the generators, the load, the electrical efficiency and the utilisation percentage. The EF was taken from EMEP/EEA Guidance. The inputs are detailed in **Table A7**.

Table A7 Input Data Used to Calculate Particulate Emissions from Generators

Number of Generators	Power (kVA)	Power (kW*)	Power Load (%)	Utilisation (%)	Efficiency (%)	AR Fuel Consumption ($GJ.h^{-1}$)	EF (Emission Factor) PM_{10} (g/GJ)**
1	1250 kVA	1000	25	0.5	40	2.25	11.60
1	350 kVA	280	50	100	40	1.26	11.60
1	50 kVA	40	100	70	40	0.25	11.60
10	50 kVA	40	100	20	40	0.07	11.60
1	20 kVA	16	100	20	40	0.03	11.60
1	20 kVA	16	100	100	40	0.14	11.60
1	10 kVA	8	100	100	40	0.07	11.60

*Based on kVA to kW conversion of 0.8
** The Emission Factor for diesel oil was used

[16] EMEP/EEA (2016) *Emission Inventory Guidebook – Small Combustion*