LANDFILL GAS GENERATION AND RISK ASSESSMENT

TABLE OF CONTENTS

DRAWINGS

Drawing ESSD2 Site Setting

Drawing ESSD7 Landfill Gas Management Plan

1.0 INTRODUCTION

1.1 Report Context

Enviroarm Limited were instructed by Chadwich Lane Quarry Limited, the owners and operators of Chadwich Lane Quarry to provide supporting information for an environmental permit for the site by way of restoration by inert waste landfilling infilled within designated phases within the planning permission boundary.
Hydrogeological Risk Assessment
Site Stability Assessment
Environmental Site Setting and Design

The site is south-western fringe of Birmingham at National Grid reference SO 395448 276819 is the centre of the site and the site entrance is SO 396373 276818 see Figure 1 and Drawing ESID 1.

The Site comprises 10.5 hectares of agricultural land located near Bromsgrove, Worcestershire. The Site includes a rectangular area which immediately abuts the former Chadwich Lane Quarry together with a linear strip of land to the south-east of the quarry.

The mineral extraction, landfill area covers some 140,000m^2 (14 hectares).

This report presents a review of the Landfill Gas potential for generation within the site and in relationship to the surrounding environment.

1.2 Conceptual Site Model – Landfill Gas

To include summary details cross referenced to ESSD report relating to the following.

Sources

- The nature of the waste proposed to be landfilled at Billown Quarry Landfill is inert waste producing negligible volumes of methane and carbon dioxide. Therefore there is no likelihood of gas production, and gas extraction will not be required and utilisation is not feasible due to the inert nature of the wastes.
- The design of the containment, collection and treatment systems is not applicable.

Pathways

- The primary pathways are direct aerial emissions of migration through the sub strata towards the receptors identified in the ESSD Report and detailed on Drawing ESSD 2.

Receptors

The identification of all potential receptors.

Table LFGRA 1 Receptor List identified on ESSD 2.

Type of Receptor	Receptor Name	Location to site	Elevation m AOD
Domestic Dwelling Receptor	**DR1**	Group of houses located 575 metres north of the permit boundary.	179m AOD
Domestic Dwelling Receptor	**DR2**	Group of houses 540 metres north-west of the site.	171m AOD
Domestic Dwelling Receptor	**DR3**	Group of houses 340m north of the site	179m AOD
Domestic Dwelling Receptor	**DR4**	Group of houses 390m north of site	183m AOD
Domestic Dwelling Receptor	**DR5**	Group of houses 345m from site	167m AOD
Domestic Dwelling Receptor	**DR6**	Group of houses located 165m north west of site	167m AOD
Domestic Dwelling Receptor	**DR7**	Farm located 295 metre north -east of site.	190m AOD
Domestic Dwelling Receptor	**DR8**	Group of houses located 490m west of site.	152m AOD
Domestic Dwelling Receptor	**DR9**	Group of houses located 265 metres from site.	170m AOD
Domestic Dwelling Receptor	**DR10**	Houses directly to west of site 25 metres	170m AOD
Domestic Dwelling Receptor	**DR11**	House of side of site 2 m	175m AOD
Domestic Dwelling Receptor	**DR12**	House 335m south of site	335m AOD
Domestic Dwelling Receptor	**DR13**	Houses to south of site 520m	160m AOD
Domestic Dwelling Receptor	**DR14**	Houses to south of site 550m	160m AOD

Surface Water Receptor	**SW1**	A pool to west of site	100m AOD
Surface Water Receptor	**SW2**	A pool east of the site.	320m AOD
Surface Water Receptor	**SW3**	A pool to south of site	180m AOD
Surface Water Receptor	**SW4**	Pond to south Sandy Lane landfill site	570m AOD
Major roads and highways	**H1**	Heath End Road	171m AOD
Major roads and highways	**H2**	Quantry Lane	182m AOD
Major roads and highways	**H3**	Chapel Lane	160m AOD
Major roads and highways	**H4**	Bonfire Hill	172m AOD
Major roads and highways	**H5**	The Gutter	198m AOD
Major roads and highways	**H6**	Chadwich Lane	172m AOD
Major roads and highways	**H7**	Harbour Hill	180m AOD
Major roads and highways	**H8**	Sandy Lane,A491	160m AOD
Commercial Activity	**IR1**	Industrial operations at Chadwich Lane Farm.	155m AOD
Commercial Activity	**IR2**	Works to the east of Sandy Lane site	160m AOD
Closed historic landfills	**CL1**	Chadwich Lane landfill site now under restoration	187 -215m AOD
Closed historic landfill	**CL2**	Sandy Lane landfill site	160-180m AOD
Chadwch Lane Landfill	**PH1**	+	
Sandy Lane Landfill	**PH2**		

- The receptors are considered to be of low sensitivity due to the nature of the waste being inert and the distance to the nearest receptors and the fact that passive venting also takes place at the landfill. Baseline data for methane and carbon dioxide will be obtained from the monitoring boreholes prior to commencement of landfilling.

- The prioritisation and initial assessment of the potential impacts on each receptor. No impact is considered on each receptor due to the inert nature of the wastes
- Quantification of emissions and dispersion. It is considered that the limestone will have carbon dioxide within the gas atmosphere but will not effect any properties or farms nearby.

2.0 LANDFILL GAS RISK ASSESSMENT

2.1 The Nature of the Landfill Gas Risk Assessment

Due to the inert nature of the waste a simple assessment has been carried out which simply states that no gas generation is likely. The site will have no impact on the adjoining site. No other assessment has therefore been carried out.

2.2 The Proposed Assessment Scenarios

2.2.1 Lifecycle Phases

The inert landfill has 3 operational phases and each is completed and restored and then undergoes aftercare. There is no long-term change expected to the waste mass composition with time.

All phases will have a basal geological barrier and a side wall seal constructed. The side wall seal will be used to prevent any potential gas migration off site.

2.2.2 Accidents and their Consequences

A primary concern would be due to damage of any internal gas monitoring points. To remove risk it is proposed to retro drill these on completion of each phase.

The justification for whether the specified accidents require quantitative assessment or not is not considered applicable.

Other potential effect include explosion but would require methane concentrations of 5%-15% and is unlikely at an inert landfill site and has been covered in Environmental Management Plans for Accidents and Occurrences and the site has an Emergency Plan.

2.3 The Generated Gases to be Modelled

The actual or potential presence of gases of concern Gas concentrations are set out in Appendix LFGRA 1

No methane gas will be detected on site and only soil gas atmospheres of carbon dioxide within the external monitoring boreholes. The nature of the waste landfilled is inert and no motive force is likely in the waste mass.

2.4 Numerical Modelling

2.4.1 Justification for Modelling Approach and Software

Not applicable

2.4.2 Model Parameterisation

Not applicable

2.4.3 Sensitivity Analysis

Not applicable

2.4.4 Model Validation

Not applicable

2.5 Risks to the Environment and Human Health

The landfill gas risk assessment has addressed each of the considered scenarios (i.e. the different modelled phases of the lifecycle and the potential impact of accidents, which remain constant at an inert landfill site).

2.5.1 Landfill Gas Emissions

Not applicable

2.5.2 Sub-surface Migration and Vegetation Stress

Predicted leakage through proposed barriers. Not applicable

Comparison of predicted levels with background concentrations and the corresponding environmental benchmarks.

2.5.3 Atmospheric Dispersion and Odour

This is considered to be zero, (0)

2.5.4 Exposure

The estimates of concentration or doses to which the population may be exposed are considered at all of the receptors to be zero, (0).

2.5.5 Global Atmospheric Impact

The global impact is therefore considered as negligible from the gas monitoring points.

2.6 Landfill Gas Completion Criteria

Landfill completion requires a consideration of whether the site, as a result of the disposal of controlled wastes, is likely or unlikely to cause pollution of the environment or harm to human health. As the landfill gas risk assessment must be undertaken for the whole lifecycle of the landfill, it follows that the process should result in the initial production criteria that identify when the unmanaged site is unlikely to cause pollution or harm and the licence can be surrendered.

No limits are proposed for the landfill and internal monitoring points will be used during closure to assess gas production and flow potential as criteria for the permit surrender.

3.0 LANDFILL GAS MANAGEMENT PLAN

3.1 Control Measures

Landfill development is to operate the site as an inert landfill.

Emissions standards are not proposed for Chadwich Lane Quarry Landfill due to lack of sensitive receptors.

Collection system (including the year you propose to start collecting landfill gas). Not applicable

Condensate management. Not applicable

Utilisation, flaring and treatment. Not applicable

Inspection, maintenance and servicing. Check that the vents are free from obstruction on a quarterly basis.

3.2 Monitoring and Sampling Plan

Gas monitoring boreholes and internal monitoring points within the waste mass are shown on ESSD7.Gas monitoring will be carried out on a quarterly basis at each of the internal gas monitoring points and gas monitoring boreholes using an infra-red gas analyser. Gas monitoring boreholes and gas monitoring points are summarised in Table LFGRA 2 below:

Sampling will be undertaken by staff appropriately trained in environmental monitoring procedures, and who are familiar with the equipment and its limitations. The Company warrants that the personnel engaged in monitoring activities are trained to undertake the task. These will comprise the companies own technical personnel, the site manager or nominated deputy, following appropriate training by technical personnel. All monitoring staff undergo a period of job training and in addition external courses are used to supplement internal training. Results will be validated by the sampling personnel detailed above.

Monitoring is to be carried out on a quarterly basis using an infra-red gas analyser.

Gas monitoring from outside the waste mass will include for monitoring methane, carbon dioxide, oxygen, atmospheric pressure, relative pressure and the weather.

Internal gas vents will also be monitored for the same determinands

Data will be stored in the form of hard copies on site and an electronic version of the results.

Table LFGRA 2: The nature and location of in-waste landfill gas wells and perimeter monitoring points.

Surface Water		Monitoring Point in waste	Design detail on ESID 7
Phase 1	**LMP1.1,1.2**	Monitoring Point in waste	Design detail on ESID 7
Phase 2	**LPM2.1,2.2**	Monitoring Point in waste	Design detail n ESID 7
Phase 3	**LMP3.1**	Monitoring Point in waste	Design detail n ESID 7
External Boreholes	**3,4,5**	Monitoring Point in waste	Design detail n ESID 7

Table LFGRA 3: Monitoring frequencies for landfill gas

Determinands	**Monitoring Frequencies**	**Units and Accuracies**
Methane (CH_4)	Quarterly	%v/v ±0.5%
Carbon Dioxide (CO_2)	Quarterly	%v/v ±0.5%
Carbon Monoxide (CH_4)	Quarterly	-
Oxygen (O_2)	Quarterly	%v/v ±0.5%
Atmospheric Pressure	Quarterly	±1 mb
Differential pressure	Quarterly	±0.1 mb
Meteorological Data	Quarterly	-

3.3 Action Plan

The criteria used to determine the severity of an event. No compliance limits are set for any of the external boreholes for either methane or carbon dioxide due to lack of sensitive receptors near to inert landfill areas.

Actions taken by the operator as a result of:

abnormal changes observed in collected monitoring data, frequency of monitoring will be increased;

identified operational problems or failures of the gas control system not applicable;

a reported event e.g. an odour complaint, detailed investigation on site including use of a walk over survey using an FID to attempt to identify the source

Emergency procedures and protocols. Retro drilling and or covering and capping or isolate the area

Remedial actions would include changes to routine monitoring etc.

4.0 CONCLUSIONS

The Chadwich Lane Quarry Landfill site will operate as an inert site with the requirements of the Environmental Protection Act 2016. These relate to the following.

The Chadwich Lane Quarry Landfill site is an inert site and will therefore not produce gas and gas migration is therefore not considered an issue.

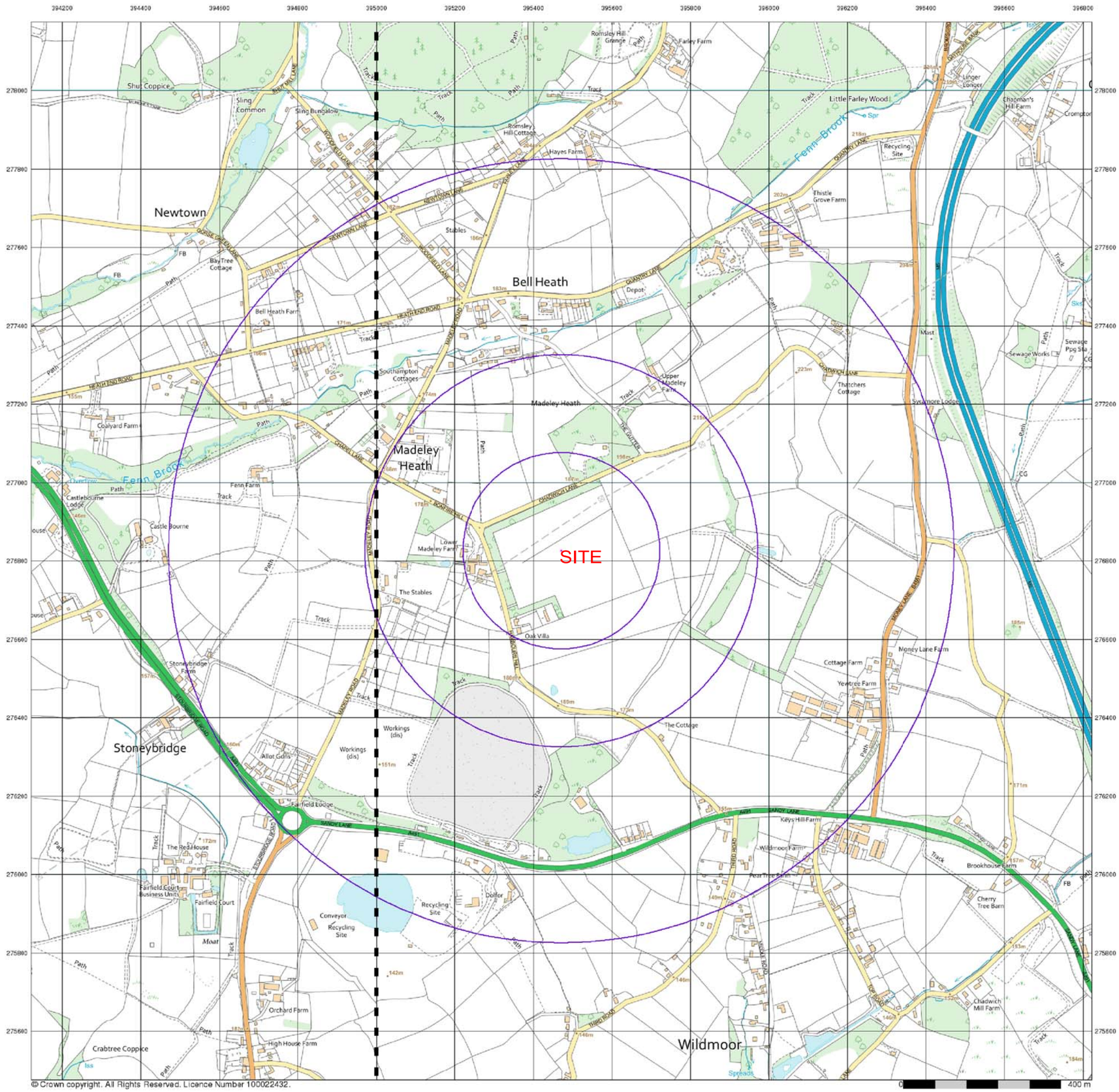
Due to the location of Chadwich Lane Quarry Landfill compliance limits are proposed for methane or carbon dioxide.

APPENDIX LFGRA 1

CHADWICH LANE
Gas Monitoring

	BH1			BH2			BH3			BH4			BH5			mb	RP	Weather	Temperature
DATE	CH4 v/v	CO2v/v	O2v/v	CH4 v/v	CO2v/v	O2v/v	CH4 v/v	CO2v/v	O2v/v	CH4 v/v	CO2v/v	O2v/v	CH4 v/v	CO2v/v	O2v/v				
24/1/2022	0.0	0.1	20.6	0.0	0.5	19.8	0.0	0.1	20.5	0.0	0.1	20.4	0.0	0.1	20.5	1021	0.09	Overcast	7
24/2/2022	0.0	0.1	20.6	0.0	0.5	20.1	0.0	0.1	20.5	0.0	0.1	20.6	0.0	0.1	20.5	995	-0.05	Sun	6
21/4/2022	0.0	0.1	20.6	0.0	0.5	19.8	0.0	0.1	20.6	0.0	0.1	20.6	0.0	0.1	20.6	1020	-0.15	Sun	15
21/4/2022	0.0	0.1	20.6	0.0	2.0	17.8	0.0	0.1	20.6	0.0	0.1	20.5	0.0	0.1	20.5	1003	0.02	Sun	17
26/5/2022	0.0	0.1	20.4	0.0	0.4	19.9	0.0	0.1	20.4	0.0	0.1	20.3	0.0	0.1	20.3	1008	-0.05	Overcast	17
10/6/2022	0.0	0.2	20.2	0.0	1.4	19.2	0.0	0.2	20.0	0.0	0.1	20.1	0.0	0.1	20.1	1005	-0.03	Sun	17
15/7/2022	0.0	0.1	20.5	0.0	0.1	20.5	0.0	0.1	20.5	0.0	0.1	20.5	0.0	0.1	20.5	1011	-0.15	Sun	24
24/8/2022	0.0	0.1	20.5	0.0	0.1	20.5	0.0	0.1	20.6	0.0	0.1	20.5	0.0	0.1	20.5	1004	-0.14	Sun	21
26/9/2022	0.0	0.2	20.5	0.0	1.2	19.2	0.0	0.1	20.5	0.0	0.1	20.5	0.0	0.1	20.5	1002	-0.10	Sun	13
31/10/2022	0.0	0.1	20.4	0.0	0.7	19.7	0.0	0.1	20.3	0.0	0.1	20.3	0.0	0.1	20.2	992	-0.07	Sun	12
Mean	0.0	0.12		0.0	0.74		0.0	0.11		0.0	0.1		0.0	0.1					

DRAWINGS



KEY (Where Applicable)

APPLICATION BOUNDARY

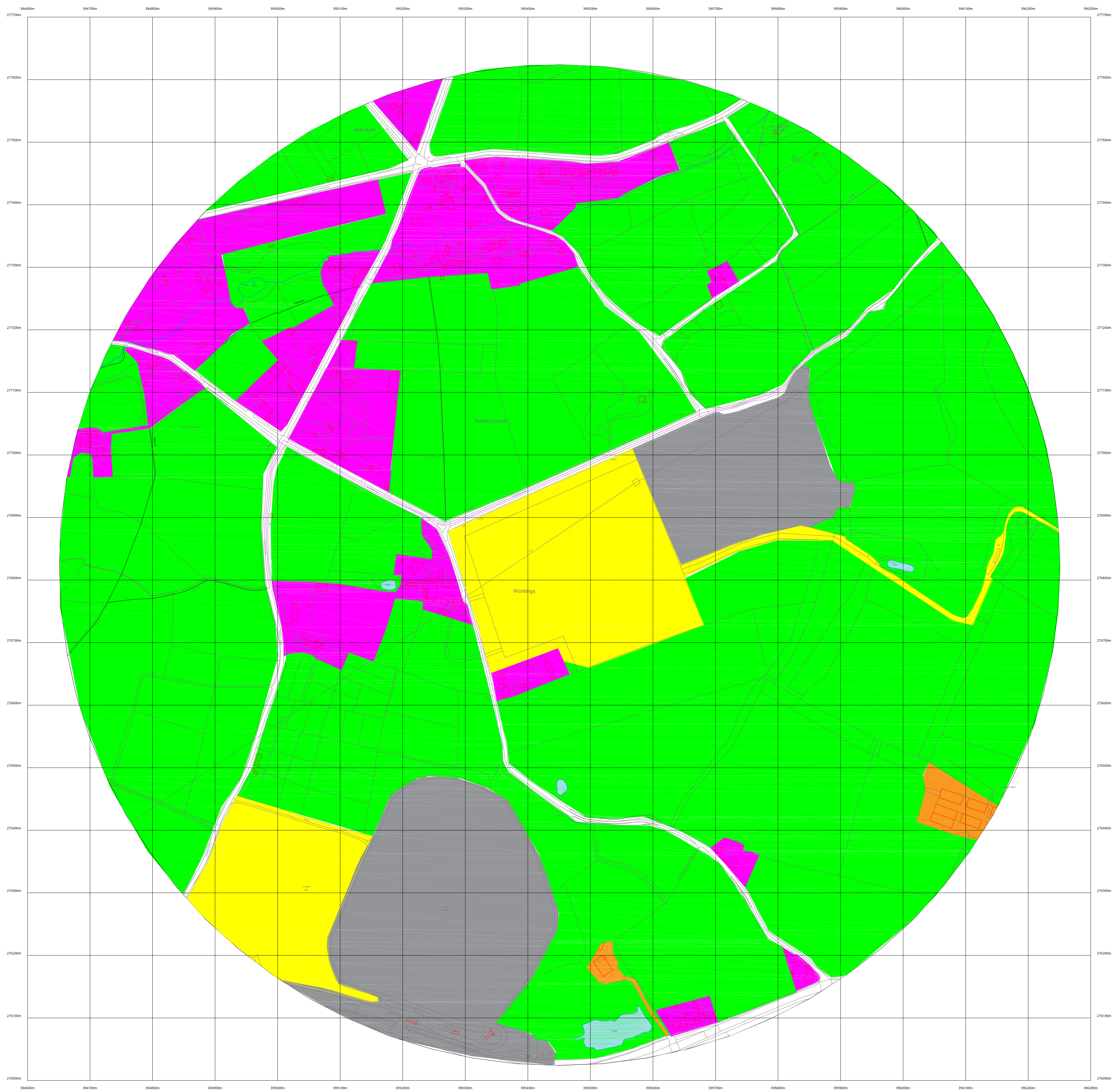
REVISIONS

597 Walsall Road
Great Wyrley
Nr Walsall
STAFFS WS6 6AE
tel 01922-412209
fax 01922-412209
e-mail enviroarm@btconnect.com
ENVIROARM LTD

ENVIROARM LIMITED

CHADWICH LANE QUARRY
BROMSGROVE
LOCATION

1:2000		A3	
08.11.2022			
ARM	AH	ESSD1	



N

APPLICATION BOUNDARY

NOTES

CLARIFICATION OF THE DETAIL SHOWN SHOULD BE BY THE REFERENCE TO THE DIGITAL DATA LAYERING IN THE FIRST INSTANCE.
SERVICE / UTILITY TYPES HAVE BEEN DETERMINED BY INSPECTION OF THE COVER ONLY. SERVICE / UTILITY TYPES SHOULD BE CONFIRMED BY REFERENCE TO UTILITY DRAWINGS OR FURTHER ON SITE INVESTIGATION.

TREES AND AREAS OF VEGETATION HAVE BEEN SURVEYED AS FOLLOWS: ISOLATED TREES BY THEIR TRUNK POSITION AND CANOPY LINE; WOODED AREAS AND GROUPS OF TREES BY THEIR PERIMETER TRUNK POSITIONS AND COMBINED CANOPY LINE; AREAS OF SIGNIFICANT VEGETATION BY THEIR PERIMETER LINE AT GROUND LEVEL AND COMBINED CANOPY IF APPROPRIATE. TREE INFORMATION BEYOND SURVEY BOUNDARY IS SKETCHED / ESTIMATED ONLY.

SURFACE TYPES AND EXTENTS ARE INDICATIVE ONLY

ORDNANCE SURVEY

PROVIDED BY ENVIROARM.

DATUMS

ALL LEVELS RELATED TO ORDNANCE DATUM.
COORDINATES RELATED TO OSGB36(02) AT SURVEY STATION MA1.
DATA PRESENTED ON A LOCAL PLANE GRID.
DATUMS DETERMINED BY GPS/OSNET OBSERVATIONS.

No	INFORMATION	By	Date	Chkd

REVISIONS

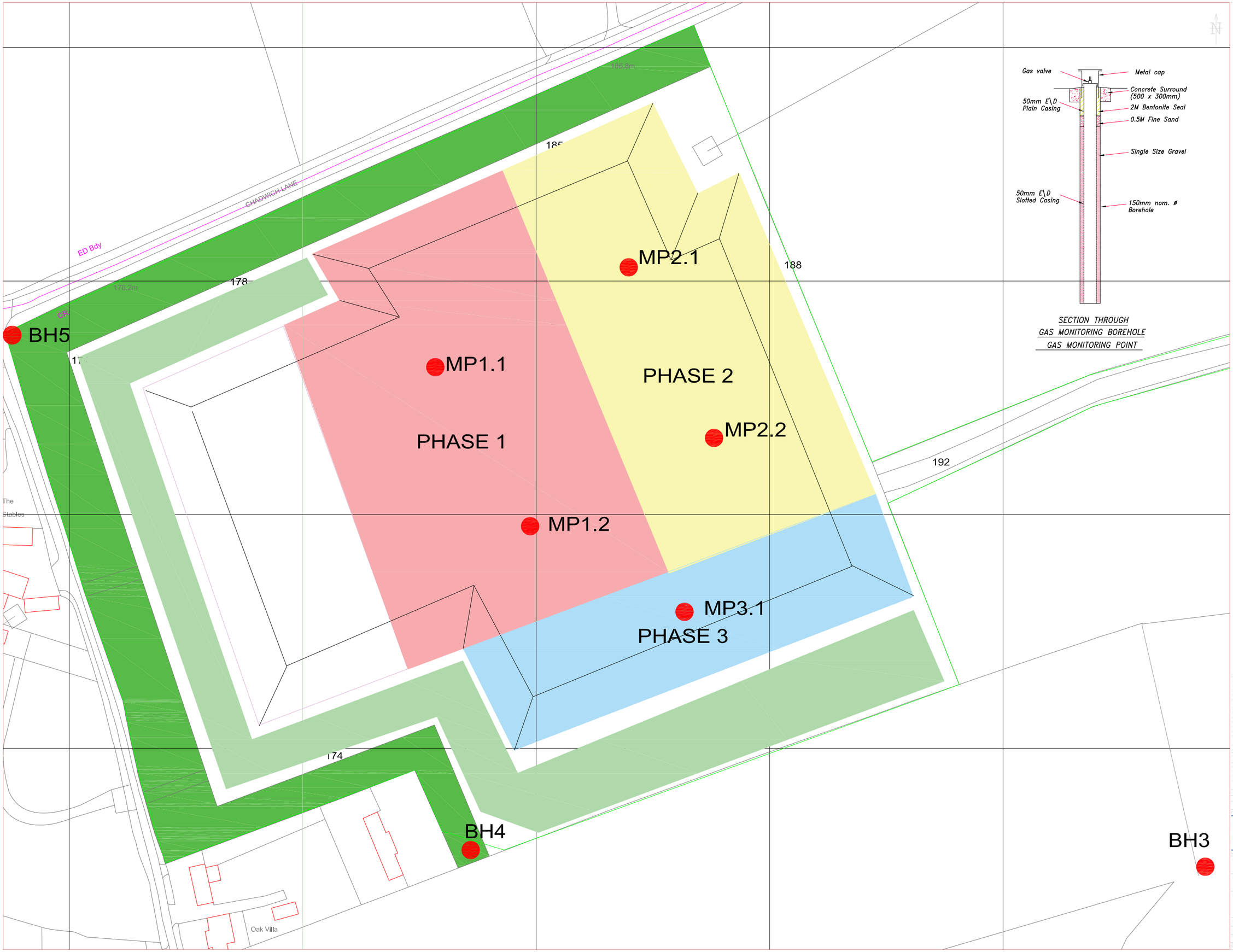
ENVIROARM LTD
597 Walsall Road
Great Wyrley
Nr Walsall
STAFFS WS6 6AE
tel 01922-412209
fax 01922-412209
e-mail enviroarm@btconnect.com

CLIENT: ENVIROARM LIMITED

LOCATION: CHADWICH LANE QUARRY BROMSGROVE

TITLE: ENVIORNMENTAL SETTING

SCALE: 1:2000	SHEET SIZE: A3
DATE: 08.11.2022	DRAWING No: ESSD2 REV
DRAWN BY: ARM / CHECKED BY: AH	



SECTION THROUGH
GAS MONITORING BOREHOLE
GAS MONITORING POINT

APPLICATION BOUNDARY

REVISIONS

597 Walsall Road
Great Wyrley
Nr Walsall
STAFFS WS6 6AE
tel 01922-412209
fax 01922-412209
e-mail enviroarm@btconnect.com
ENVIROARM LTD

ENVIROARM LIMITED

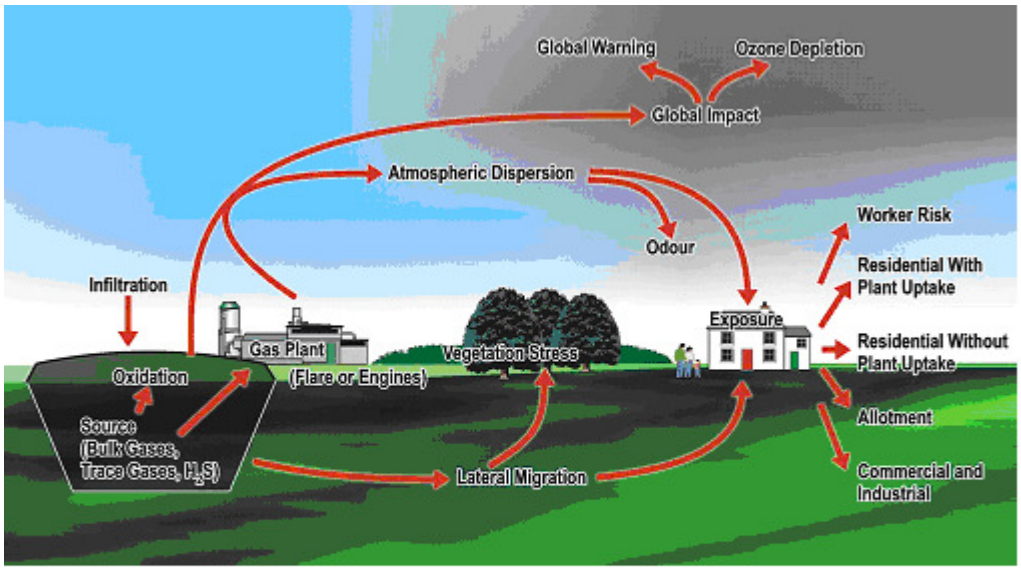
CHADWICH LANE QUARRY
BROMSGROVE
LANDFILL GAS MANAGEMENT

SCALE	PAPER SIZE
1:2000	A3
DATE	DRAWING No.
08.11.2022	ESSD7
ARM	AH

The Conceptual Model

The conceptual model (Figure 1.1) has a modular structure. Each module incorporates the effects of additional processes. Progression to successive modules is only necessary if this information is required, e.g. LFG generation and emissions can be determined without proceeding through subsequent modules to optimise time and data collection constraints.

Figure 1.1 The GasSim Conceptual Model



GasSim considers the landfill as one unit as, unlike leachate, cells are rarely isolated with respect to LFG. The model is probabilistic with the exception of the atmospheric dispersion module. The model is divided into four parts, i.e. the:

- source term;
- emissions model;
- environmental transport; and
- exposure/impact.

The source term determines the generation of LFG for an individual site based on the mass of waste deposited and the waste composition of the waste streams. The waste is degraded following a first-order decay model that calculates the LFG generation for up to 200 years. The emission model takes this output and uses it to calculate LFG emission of bulk and trace gases to the environment after allowing for LFG collection, flaring, utilisation (energy recovery), and biological methane oxidation. This is undertaken by using information on the site gas collection system, flare, engine and engineered barriers (cap and liner), if present. It

is assumed that LFG generated and not collected is in equilibrium and will be emitted from the landfill cap or liner at a steady state, i.e. the model does not consider transient storage of LFG. Additionally the model calculates the concentrations of other major and trace gases emitted from flares and engines following combustion.

The environmental transport modules simulate the dispersion of emitted LFG via both atmospheric dispersion and lateral migration, and it is recommended that these modules are used as a screening tool with more complicated modelling being undertaken if required. Atmospheric dispersion is modelled deterministically to determine the concentration of the species in the air and for both wet and dry deposition for on and off-site receptors, for a given year. GasSim simulates off-site dispersion using the R91 Gaussian plume type model (NRPB 1979 and 1981) determining the impact of emissions from engines, flares and the surface. On-site dispersion, within 20m of the site, is undertaken by a similar process except that the dispersion from surface emissions are slightly simplified by assuming a circular release area. The atmospheric dispersion data is used to determine the point at which odourous substances decline below their odour threshold limits and to assess the exposure on and off-site. **GasSim is designed as a screening tool. Hence R91, instead of a new generation model, is used to produce a rapid assessment. If the environmental risk or impact of the emissions is estimated to be high, a more detailed assessment using a new generation model will be required.**

Lateral migration simulates the transverse migration of landfill gas through the unsaturated subsurface by advection and diffusion. The geosphere has been simplified into one zone, which is simulated using a conservative 1-dimensional linear pathway to provide the maximum concentration at a given point. The gas concentrations along the pathway are then used to determine the potential for vegetation stress and the exposure to humans, including the migration into buildings.

Determining the global warming potential and ozone depletion potential of the emissions assesses the landfill's impact on the global atmosphere.

The exposure module simulates the impact for different critical groups using five exposure pathways:

- residential without plant uptake;
- residential with plant uptake;
- allotments;
- commercial and industrial; and
- worker (on-site).