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Challonsleigh Farm Inert Landfill

Landfill Gas Risk Assessment Report

DDE (SW) Ltd.

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Table	Details	Used
LFGRA1	The proposed conceptual site model, which would include all of the relevant source, pathway and receptor terms	Yes partially – list of potential receptors
LFGRA2	The proposed assessment scenarios, including the lifecycle phases and the possible accidents, and the conceptualisation of these scenarios (i.e. how certain inputs may change with time)	No
LFGRA3	The justification for the generated gases to be modelled	No
LFGRA4	The derivation and justification of the input parameters chosen	Yes
LFGRA5	The results of any sensitivity analysis carried out for the site	No
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LFGRA8	The risk-based control measures for landfill gas management	No
LFGRA9	Internal, gas plant and external monitoring and sampling schedules	Yes
LFGRA10	The proposals for emission limits and landfill gas compliance level concentrations	No
LFGRA11	Compliance with the Landfill Directive	No

List of Drawings – Appendix A

Drawing	Title	Used
DLFGRA1	Conceptual Landfill Gas Model	No
DLFGRA2	Proposed Assessment Scenarios and Numerical Modelling	No
DLFGRA3	Risks to the Environment and Human Health	Yes – as DESSD2 Environmental Setting showing relative receptor locations
DLFGRA4	Landfill Gas Management Plan	Yes – as DESSD7 Gas Monitoring

1. Introduction

Report Context

1.1. DDE (SW) Ltd. has commissioned Atkins Ltd to prepare the environmental permit application and associated supporting documentation and technical studies for a planned inert landfill at Challonsleigh Farm, Smithaleigh near Ivybridge, Devon, PL7 5AZ.

1.2. That follows grant of planning permission on 1st April 2020 by Devon County Council, ref. DCC/4038/2018, for a waste transfer building and associated infrastructure, and landraise operations for the importation inert waste material over a 10 year period requiring a change of use from agriculture and incorporating landscaping. However it is only the inert landfill site which is the subject of the bespoke permit application. The waste transfer building is within an existing waste management facility operated by DDE(SW) Ltd. to the south and west of the planned land raise area, and utilises the same private access road.

1.3. The landraise with inert waste entails filling on a total of approximately 13.5 ha split north and south of an unnamed intermittent ordinary watercourse which will remain open, and also includes filling over approximately 2.7 ha of previous landfill in the south which has scrub vegetation cover and is not used for agriculture. That previous landfill forms raised ground in the south of the planned landfill area and around and under an existing waste management facility.

1.4. This report provides a conceptual model of the planned inert landfill and ensures appropriate measures are planned in order to control the accumulation and migration of potential landfill gas, thereby minimising the potential for damage or deterioration of the environment and risk to human health.

1.5. This report has been prepared in accordance with the Environment Agency's template for an Landfill Gas Risk Assessment and should be read in conjunction with the Environmental Setting and Site Design (ESSD) Report. The focus of this report is the potential for a landfill gas risk from the inert waste to be placed.

Conceptual Site Model - Landfill Gas

1.6. The source, pathway, receptor approach has been used to assess the potential risks of landfill gas from the planned Challonsleigh Farm Inert Landfill site.

Source

1.7. The main potential sources of new landfill gas risk is the inert waste which will be permanently deposited at the Challonsleigh Farm Inert Landfill. The planned inert landfill boundary is shown on drawings DESSD2 and DESSD4 within the ESSD report. DESSD2 is also included herein Appendix A.

1.8. The inert landfill will be a landraise with waste placement in phases progressively from north to south over an area of approximately 13.5 ha (the town planning boundary encompassing approximately 16.25 ha), the southernmost 2.7 ha being underlain by a previous closed and restored landfill. The historical records indicate that landfill was licensed for inert and industrial waste, and closed around 2003.

1.9. A small intermittent unnamed ordinary watercourse runs from west to east through the middle of the planned inert landfill area, with the historical landfill 100m south of that watercourse, and filling will be either side of that watercourse i.e. it will not be culverted. It is estimated that for the proposed restoration profile the maximum thickness of inert waste north of the ordinary watercourse will be 11.2m and south of the watercourse 10.2m, and with approximately 681,000m^3 from existing ground level to the restoration profile.

1.10. Government guidance https://www.gov.uk/guidance/landfill-operators-environmental-permits/landfills-for-inert-waste states that:

"Inert waste is waste that does not undergo any significant physical, chemical or biological transformations.

Inert waste will not dissolve, burn or otherwise physically or chemically react, biodegrade or adversely affect other matter that it comes into contact with, in a way likely to cause environmental pollution or harm to human health.

The total leachability and pollutant content of the waste and the ecotoxicity of the leachate must:

- be insignificant
- not endanger the quality of surface water or groundwater."

1.11. To meet the inert classification, only the wastes which comply with the regulations and site's waste acceptance procedures and as listed in the ESSD report will be accepted at the site. Some wastes may be accepted at the inert landfill without testing if it meets the specific criteria of the Landfill (England and Wales) (Amendment) Regulations 2004 Schedule 1 Part 3 paragraph 10, whereas the paragraph 11 provides limit values for waste acceptable at landfills for inert waste for which Total Organic Carbon is 30,000mg/kg i.e. 3%. A typical proportion of total organic carbon which is degradable is 75% (ref. CIRIA/Environmental Protection UK Ground gas seminar 22nd June and 13th September 2011, G. Card and S. Wilson) and it is essentially the relic organic content within the inert waste, such as small fragments of wood or paper or cardboard or within natural soils or which may occur at the inert landfill during its operation, such as windblown leaves or weeds, which has the potential to biodegrade. Microbial processes degrade organic matter in the absence of oxygen to produce methane and carbon dioxide, and that process of microbial respiration and degradation or organic matter naturally occurs in soils.

1.12. As detailed in the ESSD methane has not been detected in the perimeter boreholes monitored since September 2020. There is no available historical ground gas monitoring data for the former landfill area or ongoing active monitoring and management. But there is a potential the former landfill area will have landfill gas, in part for the reasons outlined in the previous paragraph, and methane has been detected in a monitoring borehole BHL08 installed in September 2020 in Made Ground north of the historical landfill area recorded by the Environment Agency records. At that location the gas screening value for methane concentration times borehole flow rate has been <0.02 l/hr.

1.13. However in terms of the potential for landfill gas generation at the Challonsleigh Farm Inert Landfill 'landraise' it is considered the inert waste accepted will be in compliance with the regulations with negligible organic matter expected, and as such the inert waste materials deposited will not give rise to significant quantities of landfill gas. The site's waste acceptance procedures will ensure that only inert wastes are accepted, and it is necessary for visible organic matter from waste destined to landfill for hazardous or inert waste to have been previously separated and dealt with as a separate stream. That will minimise the risk of acceptance of non-conforming wastes, such as with high organic content biodegradable wastes, which would have the potential to cause the generation of landfill gas.

1.14. Taking into account those factors it is considered unlikely that there will be a source of significant landfill gas generation at the 'landraise' and the potential for the generation of landfill gas is therefore considered to be negligible.

1.15. On completion of filling the inert landfill will be restored with landscaping and planting for agricultural use i.e. grazing.

Pathway

1.16. A number of potential pathways exist which would provide a link between the sensitive receptors and landfill gas generated within the landfill site. The Environment Agency's guidance document LFTGN03 'Guidance on the Management of Landfill Gas' (September 2004) identifies the following generic potential pathways:

- Direct release to atmosphere.
- Sub-surface migration, through the ground or along service ducts or pipelines.
- Indirect release to atmosphere e.g. from sub-surface landfill gas migration.
- Direct release of combustion products to atmosphere e.g. from flares/engines.

1.17. As an inert landfill there will be no source of significant landfill gas generation hence there will be no flares or gas engines at the Challonsleigh Farm Inert Landfill.

1.18. Therefore it is considered that the primary pathway for landfill gas generated within the site will be vertically to atmosphere through unrestored areas of waste. Pathways that are considered to be less preferential are vertically through the restored areas of the inert landfill or laterally through the side slopes.

1.19. The Environment Agency's Report 'Investigation and Quantification of Gas Produced from Landfilling of Inorganic Wastes' (August 2007) considers the potential for landfill gas to migrate from an inorganic or low carbon landfill site. The report acknowledges that inorganic waste does not generate substantial quantities of landfill gas, and that there will generally be an insufficient pressure differential to drive the landfill gas through low permeability waste. Thus, as there will be an insignificant quantity of organic/biodegradable waste deposited within the planned inert landfill 'landraise', it is considered that there will be an insufficient driving pressure for the gas to create a viable pathway through the site's base.

1.20. Furthermore the site will have an enhanced geological barrier formed using recompacted soil material of not less than 0.5m thickness at ≤5 x 10^{-8}m/s hydraulic conductivity to provide the equivalent of 1m at a hydraulic conductivity of 1 x 10^{-7} m/s. That enhanced geological barrier further reduces the likelihood of sub-surface gas migration and over the former landfill area provides internal separation between the inert waste for the new 'landraise'. For the reasons outlined there is not likely to be gas migration up or down through the enhanced geological barrier, and as the former landfill area will remain exposed to the atmosphere on its east side and southern area, landfill gas therein would preferentially migrate to those surfaces if sufficient .

Receptors

1.21. The planned inert landfill in a rural area with the site its surroundings is predominately pasture at present, with the A38 to the north and Ivybridge to the north east, the River Yealm to the east, and operational waste management facilities in the south and west and east of the River Yealm, as shown on drawing DESSD2 within the ESSD report.

1.22. Potential environmental receptors are shown on drawings DESSD2 and DESSD3 and listed in the following table. They include receptor types residential, commercial, agricultural, road, water body and ecological habitat areas.

Table 1-1 – LFGRA1 Potential Environmental Receptors

Potential Receptor / Land Use	Distance and Direction from Site Boundary		Elevation, mOD
Devon Expressway A38 public highway	<20m	N	57-71
Agricultural land.	>55 to >80m	N	67-84
Commercial and residential area between Plymouth Road north bound off slip from the A38, and Moorland Road / New Park Road	90 to 340m	N to NE	62-69
Agricultural land (grazing).	<10m	ENE	44-50
River Yealm	<5 to 250m	E	39-42
Strasleigh Hams waste management facility including inert landfill, with agricultural land further east.	≈100 to 250m	E	49-62
Overhead 400kV power lines.	≈40	S	42-52 (pylon bases)
Mackarell Parks, Southwood Woods & Strasheligh Ham CWS (largely a woodland site with a derelict quarry and quarry lake).	75m	SE	42
Woodland cover over closed landfill which includes in the south west the New England Fields CWS (marshy grassland).	<5m to 350m 550m	S S SSW	44-52

Potential Receptor / Land Use	Distance and Direction from Site Boundary		Elevation, mOD
Unnamed ordinary watercourse which flows west to east to the River Yealm.	≈150m	S	39-48
Waste management facility operated by DDE(SW) Ltd.	0m	S and W	56-60
Private access road to the waste management facility operated by DDE(SW) Ltd.	0m	W	52-72
Agricultural land (grazing).	>20m	W	52->68
Waste management facilities operated by DDE(SW) Ltd.	70-200m	W	55-62
Commercial and residential properties north and south of off slip from A38 south bound.	200-375m	W	73-75
Smithaleigh Caravan and Camping Park	400-600m	W	63-68
Residential property 'Homeleigh'	100m	NW	80-85
Residential property 'Higher Challonsleigh' and to the north Langage Farm.	400m	NNW	93-94

2. LANDFILL GAS RISK ASSESSMENT

The Nature of the Landfill Gas Risk Assessment

2.1. The Landfill Technical Guidance Note LFTGN 03 'Guidance on the management of landfill gas' published by the Environment Agency, provides guidance on risk based strategies for landfill sites, emphasising the importance of a robust conceptual site model at the risk screening state and a need to screen a prioritise actual and potential risks before quantification. The guidance outlines a four stage risk assessment proposed, though states that for potential gas migration "risk screening (Tier 1) should be sufficient to deal with most of the risks from inert sites" (pg. 29).

2.2. That is essentially because the landfill location attributes have already been addressed by the planning authority at the planning application stage, with the Environment Agency as the landfill regulator a statutory consultee, in combination with the fact that the waste will be 'inert', such that the key forward focus should be on the waste acceptance.

2.3. With the environmental permit only allowing specific wastes to be accepted and the application of the site's waste acceptance procedures, for example entailing visual inspections, it is expected that the site may only generate negligible quantities of landfill gas and that uncertainty regarding deposition of non-compliant waste (which may have higher biodegradable characteristics) is minimised.

The Proposed Assessment Scenarios

2.4. For the conceptual site model and the summary in the previous section it is a considered that a qualitative risk assessment is appropriate in order to determine and prioritise the likely level of risk from landfill gas at the site. However that approach has been informed by consideration of the potential for landfill gas production estimated by simple calculations rather than detailed modelling, as outlined in the following sections.

Lifecycle Phases

2.5. There are three lifecycle phases once waste placement commences, namely an Operational period (filling), Closure (after the site has ceased intake of waste and aftercare is ongoing) and Completion when the environmental permit for the landfill is surrendered and the site does not represent a hazard to the environment. It is envisaged for the Operational period the inert waste placement will be carried out in distinct phases from south to north, though with a small area Phase A1 and A3 in the north filled as the first stage to form a northern bund for landscape screening. Each phase will be practically completed before the next is started as outlined within the ESSD report, over a period of ten years to accord with the site's planning permission. Therefore it is broadly expected that the annual waste input will be around a tenth of the site's capacity per year.

Accidents and their Consequences

2.6. The Environment Agency's LFTGN 03 guidance requires a number of accident and failure scenarios to be examined in order to quantify the impact of given events.

2.7. The guidance indicates the following general categories of accident which could affect landfill gas control are:

- Loss of containment e.g. leakage, liner failure, spillage.
- Loss of collection and/or treatment capability e.g. failure of pipework, well, equipment/control system.
- Explosions and fires e.g. deep-seated landfill fire.
- Failure of leachate extraction and the effect on landfill gas management.
- Failure of waste input screening procedures and controls.

2.8. Those accident and failure scenarios have been evaluated for the site using the risk assessment process and scoring system set out in LFTGN 03, with the following table summarising the

evaluation and the subsequent table detailing the justification for the assigned 'likelihood' scores for each of the accident and failure scenarios.

Table 2-1 – Qualitative risk assessment - accident and failure scenarios

Scenario	Likelihood	Severity	Score	Magnitude of Risk
Loss of containment.	Extremely Unlikely (1)	Minor (1)	1	Insignificant
Loss of collection / treatment capability.	Extremely unlikely (1)	Minor (1)	1	Insignificant
Explosions and fire.	Very Unlikely (2)	Significant (3)	6	Insignificant
Leachate system failure	Extremely unlikely (1)	Minor (1)	1	Insignificant
Failure of waste input screening procedures and controls resulting in biodegradable waste input.	Unlikely (3)	Significant (3)	9	Acceptable

Table 2-2 – Justification for selection of assigned 'Likelihood' scores

Scenario	Likelihood score justification
Loss of containment.	The site will be engineered to a high standard and the landfill base will be an artificially enhanced geological barrier formed from recompacted soil which will be subject to Construction Quality Assurance. Therefore it is extremely unlikely that basal containment system will fail or leak suddenly.
Loss of collection / treatment	For inert waste there is expected to be negligible gas production well below a volume which could be collected and flared or utilised, hence there will be no collection system and landfill gas, if it occurs, will passively vent to the local atmosphere.
Landfill fire	The site will only accept inert wastes and as such no active gas abstraction systems will be required as gas production rates will be negligible. The waste types will also not be combustible or explosive, and if unexpected combustible waste such as paper, cardboard or wood was present and caught fire it would be localised with minimal fuel and minimal likelihood of drawing air into the landfill to further fuel a fire, if one occurred.
Leachate system failure.	The proposed waste types are inert in nature and are not expected to generate potentially hazardous leachate. Therefore there will be no collection or management system specifically for leachate within the landfill.
Failure of waste input screening procedures and controls resulting in biodegradable waste input.	The waste types will be 'inert' and will be subject to 'Basic Characterisation' and the site's waste acceptance procedures which will include visual inspection prior to tipping, and prior to incorporation into the landfill. If bio-degradable waste is suspected to have been received and tipped on-site it will be removed to a suitable permitted facility.

The Generated Gases to be Modelled

2.9. Biodegradation of relict organic material could give rise landfill gas likely to comprise varying proportions of methane and carbon dioxide, though potentially other substances could arise such as hydrogen sulphide, sulphur dioxide, carbon monoxide, nitrogen dioxide and volatile substances in trace quantities. However this assessment will just consider the overall potential for landfill gas production.

Numerical Modelling

Justification for Modelling Approach and Software

2.10. Based on the qualitative risk assessment for accident and failure scenarios, which shows that the most significant accident/failure scenario is the acceptance of biodegradable waste into the inert landfill site which would have to arise from the unlikely failure to apply the landfill operator's waste acceptance procedures. Therefore it is considered that complex numerical modelling using specialist software such as GasSim, is not required for this planned inert landfill which will be a landraise.

2.11. However there is a potential for relic organic content such as small fragments of wood or paper or cardboard or within natural soils or which may occur at the landfill during its operation, such as windblown leaves or weeds, and that relic organic content will have the potential to biodegrade causing landfill gas. Therefore a simple approach has been applied to derive an estimate for landfill gas production using the first order kinetic model (exponential decline) given as follows within the LFTGN 03 guidance:

Box 6.1 Estimating rates of gas production from UK landfills

$$\alpha_t = \sum_{i=1}^{n} 1.0846.A.C_i.k_i.e^{-k_i t}$$

Where:

α_t = gas formation rate at time t in m^3/year

A = mass of waste in place in tonnes

C_i = carbon content in fraction 'I' in kg/tonne

k_i = rate constant for fraction 'i' in $year^{-1}$

k_1 = 0.185 $year^{-1}$ (fast)

k_2 = 0.100 $year^{-1}$ (medium)

k_3 = 0.030 $year^{-1}$ (slow)

t = time elapsed since deposit (years)

n = the number of iterations (from 1 until n = t)

Source: Coops *et al.* (1995)

Model Parameterisation

2.12. For the numerical model the parameters used and results are outlined in the following table.

Table 2-3 – LFGRA4 - Model Parameterisation

Parameter	Value	Justification
Planned landfill capacity	699,113 m3	Derived from 3D model from estimated base of artificial geological barrier to planned restoration contour elevation less nominal 0.15m topsoil.
Density conversion factor	1.74 t/m3	Estimated, - 'uk-onversion-factors-for-waste.xlsx' lists density conversion factors developed by the Environment Agency, and the value for EWC 17 05 04 soil and stones is 1.06 t/m3 but with compaction from trafficking by mechanical plant final density is likely to be higher. Value is 90% of average bulk

Parameter	Value	Justification
		density determined from eight compaction tests (2.5kg) of site won soil at natural moisture content.
Mass of waste placed, per year	121645.6 t/yr	Average over ten years.
Total organic carbon content	3%	Maximum limit specified in the regulations.
Degradable organic content	22.56 kg/tonne	Estimated from TOC / 1.33, ref. CIRIA / Environmental Protection UK Ground gas seminar 22nd June and 13th September 2011, G. Card and S. Wilson.
Rate constant, k	0.03 / year	From LFTGN 03 Box 6.1 as organic content, if present in an inert landfill, is likely to be a type which degrades at most 'slowly'.
Time elapsed since inert waste deposit	1 – 50 years	Waste placement during first ten years, so potentially landfill gas could occur in year 2, peak in year 11 and decline thereafter.
Results		***Comment***
Year 1 (after one year of waste placement)	9.9 m3/hr	0.73 l/hr/m2 assuming a tenth of the landfill area of has been filled.
Year 10	79.2 m3/hr	0.65 l/hr/m2 (which for a borehole in the inert waste and assuming the Pecksen correlation between flow rate and surface emission of a 10 m2 radius of influence could imply 6.5 l/h flow rate).
Year 30	49.1 m3/hr	0.36 l/hr/m2
Year 50	26.9 m3/hr	0.20 l/hr/m2

2.13. The landfill gas production values estimated are considered to be peak estimates because they are based on the waste acceptance criteria maximum limit of 3% total organic carbon for the entire waste mass. However that is unlikely because some inert waste will not have organic carbon e.g. EWC 17 01 07 mixtures of concrete, bricks, tiles and ceramics, or 17 02 02, and based on the available data for the in-situ soils (excluding topsoil) at the site, which have an average organic carbon content of <1%, incoming soils from local sources would have a similarly low organic carbon content.

2.14. Hence such gas production rates are not be expected to occur, and if degradable organic matter occurs within the inert waste it would be highly localised not widespread. Furthermore the estimates also assume that 75% of relic organic carbon fully degrades which may not be the case, and that the gas generated will reach the surface which also may not be the case locally depending on the porosity of the inert waste mass, though gas if present will preferentially migrate to surface. The actual composition of the landfill gas, if it occurred, would depend on the nature of the degradable relic organic carbon and will change due to oxidation during migration to surface. Biodegradation processes if they occur would generate more carbon dioxide in aerobic zones and methane as a proportion will be lower or may be absent with spatial and temporal variability likely. In any case the estimates indicate that the simplistic benchmark values for gas flaring or utilised given in LFTGN 03 of 50-100m3/hr methane is not likely to be exceeded because that would require a very high percentage of collectable methane within the gas which is not likely for planned inert landfill.

Sensitivity Analysis

2.15. The landfill gas production estimates are based on 3% total organic content and hence at lower organic content the estimates would be lower and nil for 0% organic content, though that is also not realistic given ground gases occur from natural soils (which subject to basic characterisation can be

accepted without testing). Additionally organic matter such as leaves and weeds may be unavoidably incorporated in the inert waste mass.

2.16. From the trial pit ground investigation carried out in January 2017 by YourEnvironment, the average organic matter content of the in-situ site soils was 1.43%, which divided by 1.72 to estimate organic carbon, gives an organic carbon content of 0.83%. Local incoming inert waste soil material is likely to be similar and hence a total organic carbon content of less than 1% is considered realistic, and that would suggest gas production rates of less than a third of the estimates at 3% total organic carbon content

2.17. The estimates also utilise a 'slow' rate constant for biodegradation as that is considered most likely for the likely relic organic content, if present, but could vary e.g. depending on the moisture condition of the inert waste. If a 'medium' rate constant for biodegradation is assumed then the landfill gas production could be more than two times higher in year 10 (after first waste deposition) but only 62% and 15% respectively of the production in years 30 and 50 compared to that predicted utilising a 'slow' rate constant due to the faster decomposition. If biodegradation occurred its rate could vary, however degradable material will not knowingly be disposed at the planned inert landfill.

Model Validation

2.18. The predictions have not been validated because the planned inert landfill operation has not commenced.

2.19. Rather the estimates represent an indication that landfill gas could occur, such as from natural substances and processes, and compliance with the site's waste acceptance procedures will ensure degradable material will not knowingly be disposed within the planned inert landfill.

Risks to the Environment and Human Health

2.20. The potential hazards from landfill gas emissions are: toxicity, asphyxiation, odour, and fire and explosion and ecotoxicity.

2.21. The trace components of landfill gas pose an odour and toxicity risk whilst the bulk gases pose a risk of explosion and asphyxiation, although carbon dioxide is also toxic and should be considered in the assessment of toxicity. Explosion and asphyxiation risk is generally related to sub-surface migration and accumulations in enclosed spaces, such as residential or commercial properties, or underground services. Environment Agency document LFTGN03 states that whilst this is more difficult to quantify, for the risk screening stage, the impact assessment should be based on:

- The presence of potential pathways and site specific receptors; and
- A qualitative assessment of the severity of the consequences.

Landfill Gas Emissions

2.22. Consideration of the potential for landfill gas to be generated has indicated that although landfill gas may be produced, emissions will be negligible i.e. well below that which could require control by flaring or utilisation. As such no active gas management infrastructure will be required. If landfill gas is produced it would be expected to localised only, and peak within a few years after cessation of the inert waste placement and decline thereafter.

Sub-surface Migration and Vegetation Stress

2.23. As outlined in the conceptual model, it is considered that the primary pathway for landfill gas generated within the site will be vertically to atmosphere through unrestored areas of waste. Pathways that are considered to be less preferential are vertically through the restored areas of the inert landfill or laterally through the side slopes, and as a 'landraise' with an enhanced geological barrier there will be insufficient driving pressure the gas to create a viable pathway through the site's base.

2.24. Hence no sub-surface emissions are expected from the landfill, and as the site will not have an engineered impermeable cap, landfill gas, if produced (in negligible amounts), will have a preferential migration pathway through the landfill surface.

2.25. Once restored that surface will have vegetation cover, and vegetation stress can be caused by landfill gas emissions by two mechanisms. Firstly, the landfill gas, if produced, displaces soil air

from the root zone of plants, and secondly through atmospheric dispersion of nitrogen oxide and sulphur oxide gases. Hence landfill gas could be a hazard to vegetation for restoration of the site, though oxidation in the site's soil layers would occur, and sub-surface migration is not envisaged so vegetation on adjacent land will not be at risk.

Atmospheric Dispersion and Odour

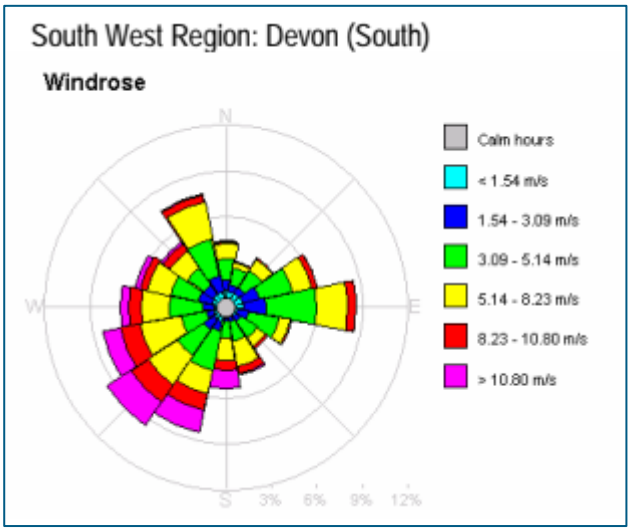
2.26. Atmospheric dispersion modelling has not been carried out. However the planned inert landfill site lies in an area of lower lying land between the A38 and the waste management facility approximately 400m to the south. A small unnamed intermittent watercourse runs from west to east through the broad valley middle of the proposed inert landfill area. Filling will be either side of that watercourse i.e. it will not be culverted.

2.27. There are two fields to the north of the watercourse where the land slopes from 71mOD in the north west to 51mOD in the south and 44.5mOD in the east adjacent to the watercourse. Within that area the planned inert landfill will form a ridge from at 70mOD in the north western third sloping to the south west, grading into existing ground level in each direction.

2.28. There are two fields in a central area south of the watercourse which slope gently from around 49mOD in the west to 42-44mOD in the east to south east near the River Yealm. The former landfill ground surface varies from around 52mOD in the north to a plateau of around 62-64mOD east of the existing waste management facility. Over that area the planned inert landfill will slope from around 65m in the south west and slope gently to the north then steepen slightly before grading into existing ground level in each direction.

2.29. Overall there will be a higher ground mass than existing and as such will be more exposed to the prevailing winds. Being in the south west the prevailing wind direction is from the south west, as shown by the following windrose (from the Gasim manual). Windroses presented for the Plymouth Mountbatten weather sation in the Environment Statement Air Quality, Dust and Odour Impact Assessment for the proposed transfer station and landfill site, are also similar to the following windrose.

Figure 2-1 - Wind Rose for South West Region: Devon (South)



2.30. There will be general dispersion with the strongest winds from the west, south east and north east, though that would lead to considerable dispersion, whereas it would be during relatively calm periods with light winds when gas emissions, if any, would be most likely to concentrate to, and for example if odorous lead a noticeable odour near to a or downwind of a source.

2.31. However there will be negligible landfill gas production and with atmospheric dispersion and no buildings nearby permanently occupied, it is considered that significant exposure is not likely. Furthermore methane and carbon dioxide are odourless and it is not likely that the inert waste would have odorous waste or relic organic material that would biodegrade to cause an odour.

Exposure – Qualitative Risk Assessment

2.32. The evaluation in the previous sections has shown that there is negligible expected gas production, negligible likelihood of sub-surface migration for the landfill as a landraise, and there will be atmospheric dispersion of emissions at surface with prevailing wind from the south west. Based on that a qualitative risk assessment of the potential environmental receptors identified in Section 1 has been carried out to prioritise the potential receptors. That assessment is presented in the following table.

Table 2-4 – Qualitative Risk Assessment with Receptor Prioritisation

Potential Receptor / Land Use	Distance and Direction from Site Boundary		Elevation, mOD	Potential Hazard	Receptor Sensitivity	Likelihood of Exposure	Assigned Priority
Devon Expressway A38 public highway	<20m	N	57-71	Odour	High	Low likelihood	2
Agricultural land.	>55 to >80m	N	67-84	Ecotoxicity	Medium	Unlikely	3
Commercial and residential area between Plymouth Road north bound off slip from the A38, and Moorland Road / New Park Road	90 to 340m	N to NE	62-69	Toxicity, asphyxiation, odour, fire or explosion	High	Low likelihood	2
Agricultural land (grazing).	<10m	ENE	44-50	Ecotoxicity	Medium	Unlikely	3
River Yealm	<5 to 250m	E	39-42	Ecotoxicity	Low	Unlikely	4
Strasleigh Hams waste management facility including inert landfill, with agricultural land further east.	≈100 to 250m	E	49-62	Toxicity, asphyxiation, odour, fire or explosion	High	Unlikely	4
Overhead 400kV power lines.	≈40	S	42-52 (pylon bases)	None			
Mackarell Parks, Southwood Woods & Strasheligh Ham CWS (largely a woodland site with a derelict quarry and quarry lake).	75m	SE	42	Ecotoxicity	Medium	Unlikely	4
Woodland cover over closed landfill which includes in the south west the New England Fields CWS (marshy grassland).	<5m to 350m 550m	S S SSW	44-52	Ecotoxicity	Medium	Unlikely	4
Unnamed ordinary watercourse which flows west to east to the River Yealm.	≈150m	S	39-48	Ecotoxicity	Low	Unlikely	4

Potential Receptor / Land Use	Distance and Direction from Site Boundary		Elevation, mOD	Potential Hazard	Receptor Sensitivity	Likelihood of Exposure	Assigned Priority
Waste management facility operated by DDE(SW) Ltd.	0m	S and W	56-60	Toxicity, asphyxiation, odour, fire or explosion	High	Low likelihood	1
Private access road to the waste management facility operated by DDE(SW) Ltd.	0m	W	52-72	Odour	High	Low likelihood	2
Agricultural land (grazing).	>20m	W	52->68	Ecotoxicity	Medium	Unlikely	3
Waste management facilities operated by DDE(SW) Ltd.	70-200m	W	55-62	Toxicity, asphyxiation, odour, fire or explosion	High	Low likelihood	2
Commercial and residential properties north and south of off slip from A38 south bound.	200-375m	W	73-75	Toxicity, asphyxiation, odour, fire or explosion	High	Unlikely	3
Smithaleigh Caravan and Camping Park	400-600m	W	63-68	Toxicity, asphyxiation, odour, fire or explosion	High	Unlikely	4
Residential property 'Homeleigh'	100m	NW	80-85	Toxicity, asphyxiation, odour, fire or explosion	High	Low likelihood	2
Residential property 'Higher Challonsleigh' and to the north Langage Farm.	400m	NNW	93-94	Toxicity, asphyxiation, odour, fire or explosion	High	Low likelihood	2

Notes:

1. Relative terms for sensitivity of receptor: high, medium, low.
2. Relative terms for likelihood of exposure: high likelihood, likely, low likelihood, unlikely defined as follows (based on Table 11.2 Classification of Probability in 'Guidance on Evaluation of Development Proposals on Sites where Methane and Carbon Dioxide are Present', published by NHBC 2007).

High likelihood	There is a potential pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution.
Likely	There is a potential pollution linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low likelihood	There is a potential pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such event would take place, and is less likely in the shorter term.

Potential Receptor / Land Use	Distance and Direction from Site Boundary	Elevation, mOD	Potential Hazard	Receptor Sensitivity	Likelihood of Exposure	Assigned Priority
Unlikely	There is a potential pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term.					

Global Atmospheric Impact

2.33. The global warming potential and the ozone depletion potential and hence global atmospheric impact of potential landfill gas emissions from the Challonsleigh Farm Inert Landfill are considered to be negligible.

Landfill Gas Completion Criteria

2.34. Active gas extraction is not required for the planned inert landfill based on this assessment. Landfill gas if it occurs will vent to the atmosphere at the surface of the inert landfill. Therefore landfill gas completion criteria are not proposed at this time but will be based on the perimeter borehole monitoring data and assessed risk to the planned restoration land use to demonstrate the site is unlikely to present a hazard to the environment. That will either entail demonstrating the maximum methane and carbon dioxide levels are consistently low and/or by consideration of the gas concentration and flow rate determined from monitoring data over at least two consecutive years, as outlined in the publication 'Additional guidance for Landfill (EPR 5.02) and other permanent deposits of waste: how to surrender your environmental permit', Section 5.3 Landfill gas completion criteria.

3. LANDFILL GAS MANAGEMENT PLAN

Control Measures

3.1. Negligible quantities of landfill gas are envisaged to be generated from the site and therefore no active gas management is proposed within the site. Landfill gas if it occurs would vent passively to atmosphere from the body of the waste.

Monitoring Plan

3.2. Landfill gas monitoring will continue at the boreholes currently installed at the site shown on drawing DESSD7 within the ESSD report, and which are generally at perimeter locations to the planned inert waste placement (BHL01, BHL02, BHL03, BHL04, BHL05, BHL06) and which will be used for compliance. DESSD7 is also included herein Appendix A.

3.3. As the filling progresses in-waste wells will be installed at 2-3 yearly intervals to provide 2 per hectare where the total depth of inert waste is 4 metres or more, for which indicative locations are shown on drawing DESSD7. In areas where waste is less than 4 metres spike tests would be utilised if the monitoring of the boreholes suggests additional areal monitoring would be prudent to provide further understanding.

3.4. The monitoring will be for percent methane by volume, percent carbon dioxide by volume, percent oxygen by volume and atmospheric pressure. Other gases such as carbon monoxide or hydrogen sulphide may also be monitored.

3.5. The monitoring frequency will be quarterly because the inert waste placement will be in areal phases and not at a rate of placement or areal coverage that might necessitate more frequent monitoring.

3.6. Weather conditions will be recorded during monitoring including atmospheric pressure and direction of change, cloud cover, prevailing wind direction and indicative speed (Beaufort scale) and temperature.

The following table summarises the proposed monitoring for potential landfill gas

Table 3-1 - LFGRA9 Proposed Monitoring

Location	Parameter(s) to be Recorded	Frequency	
External			
BHL01, BHL02, BHL03, BHL04, BHL05, BHL08	Methane, carbon dioxide, oxygen, atmospheric pressure, differential pressure, weather conditions including atmospheric pressure, direction of change, cloud cover, prevailing wind direction and indicative speed (Beaufort scale) and temperature.	Quarterly	The inert landfill design with enhanced geological barrier and likely rate of inert waste placement does not merit more frequent monitoring.
Internal			
BHL08 (deep and shallow wells)	As above.	Quarterly	Installed through former landfill.
Future in-waste boreholes	As above.	Quarterly	To be installed as per Government guidance at 2 per hectare where inert waste > 4m.

3.7. The monitoring data will be stored in a digital database, reviewed and the risk evaluated and the Landfill Site Manager informed if there is exceedance of an action or permit compliance level (which may also require notification to the Environment Agency). The monitoring data will be reported to

the Environment Agency at the frequency specified in the permit, and reviewed and reported on annually.

3.8. Should a monitoring location be damaged or be considered too close to the inert waste placement it will be repaired or protected.

3.9. Similarly if in-waste or additional perimeter monitoring boreholes are required they will be installed at a suitable time when waste placement allows, or before nearby waste placement in order to provide background data.

Action Plan

Potential Off-Site Methane Migration

3.10. In the event of flammable gas being detected in compliance boreholes i.e. external boreholes (BHL01, BHL02, BHL03, BHL04, BHL05, BHL06) at concentrations exceeding 0.5% methane by volume (10% LEL) the following action is to be taken:

- Inform the Landfill Site Manager.
- The exceedance value will be checked to see whether it is an outlier, i.e. unusually high in relation to the other values in the data set. The test for outlier will be as detailed in 'Techniques for the Interpretation of Landfill Monitoring Data Guidance Notes, Environment Agency R&D document P1-471'.
- The Landfill Site Manager will assess the risk and may increase the monitoring frequency to determine whether the gas trend is rising, stable or falling and inform the Environment Agency if the trend is considered to be rising.

3.11. In the event of flammable gas being detected in compliance boreholes at concentrations exceeding 1.0% methane by volume (20% LEL) the following action is to be taken:

- Inform the Landfill Site Manager.
- The exceedance value will be checked to see whether it is an outlier, i.e. unusually high in relation to the other values in the data set. The test for outlier will be as detailed in 'Techniques for the Interpretation of Landfill Monitoring Data Guidance Notes, Environment Agency R&D document P1-471'.
- The Landfill Site Manager will assess the risk and may increase the frequency of monitoring to determine whether the gas trend is rising, stable or falling and inform the Environment Agency if there is a rising trend.
- The Landfill Site Manager will make an assessment as to whether receptors are potentially at risk from the elevated methane concentrations and if so, consider the need for receptor monitoring.
- Site Staff shall undertake weekly monitoring of critical boreholes until volumes drop below 1.0% methane by volume (20% LEL) and thereafter until the Landfill Site Manager agrees that normal frequency can be resumed.

3.12. The Landfill Site Manager shall review the wastes types deposited in the vicinity of the compliance borehole and put forward remedial proposals for controlling the gas as necessary.

Carbon Dioxide

3.13. Action Levels for carbon dioxide for external boreholes (BHL01, BHL02, BHL03, BHL04, BHL05, BHL06) will be set based on the background monitoring data obtained prior to the start of waste placement and implemented through a pre-operational condition. It is envisaged the action levels will be derived for each borehole based on a statistical approach as recommended in industry guidance 'Perimeter soil gas emissions criteria and associated management', C&P Environmental Ltd., January 2011. Rather than the Tmax value, for carbon dioxide it is proposed the mean plus

two and half standard deviations of the background data will be determined, (if normal distribution 99% of the data will be less than this value), and the action level will be the higher of that value or the highest background concentration (%v/v) recorded during the pre-operational phase plus 1.0%, rounded up to the nearest whole percent. For the available data set that approach gives carbon dioxide action levels of 4-6%.

3.14. During operation in the event of carbon dioxide being recorded within the perimeter monitoring boreholes at concentrations exceeding the Action Levels, the following action will be taken:

- The Landfill Manager will be informed.
- The exceedance value will be checked to see whether it is an outlier, i.e. unusually high in relation to the other values in the data set. The test for outlier will be as detailed in 'Techniques for the Interpretation of Landfill Monitoring Data Guidance Notes, Environment Agency R&D document P1-471'.
- The Landfill Manager will assess the risk and may increase the frequency of landfill gas monitoring to determine whether there is an increasing trend in gas concentrations. The Manager may inform the Environment Agency if the trend is considered to be rising.

4. CONCLUSIONS

4.1. As a planned inert waste landfill with detailed waste acceptance procedures to ensure that only inert wastes are accepted at the site, the volumes of landfill gas which may be generated will negligible and will certainly be well below Environment Agency benchmarks for the necessary installation of active extraction and treatment systems. As such, passive diffusion of landfill gas, if any occurs, through the surface of the planned inert waste landfill is within best practise guidelines.

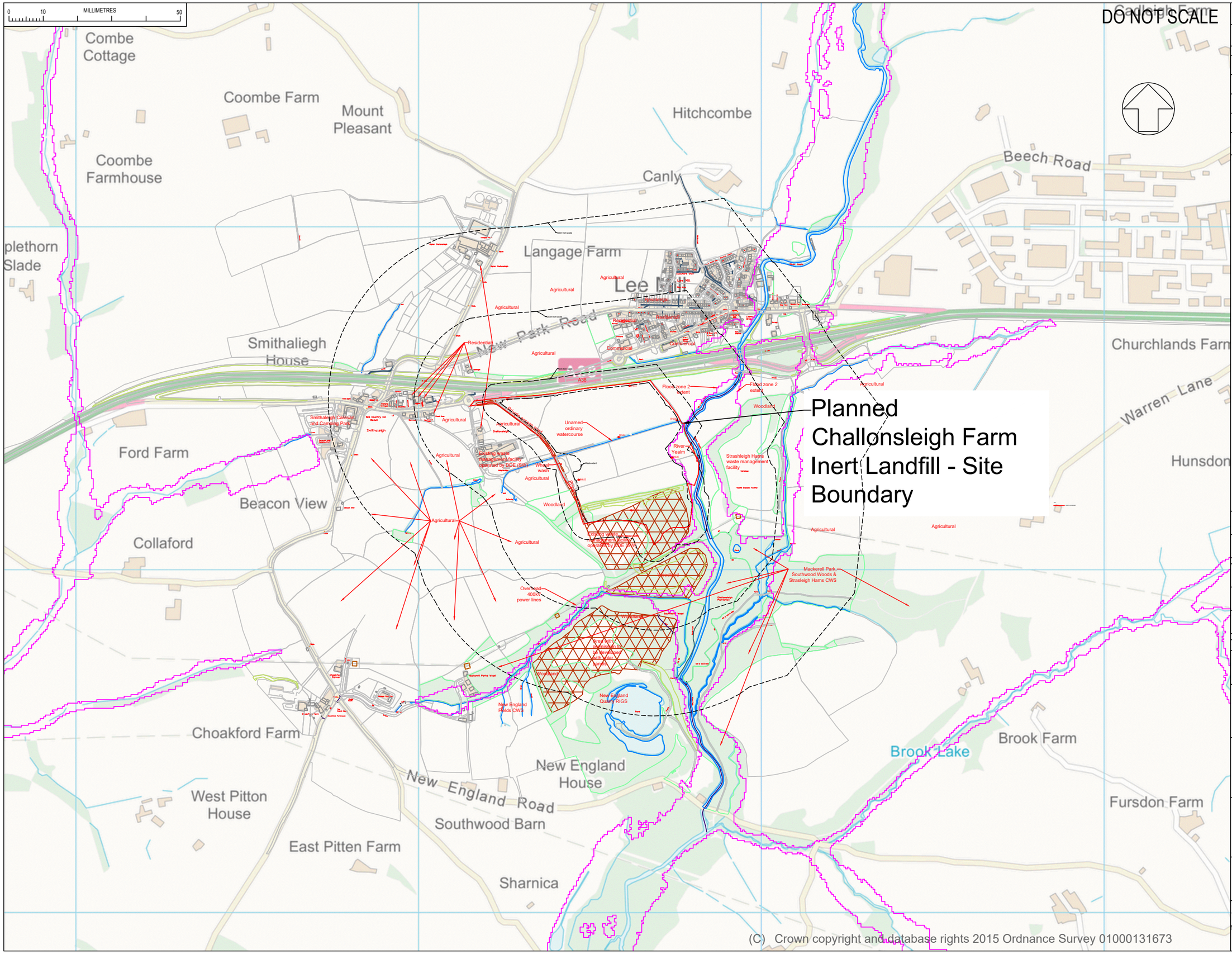
4.2. With the proposed inert landfill design incorporating and enhanced geological barrier, subsurface migration of landfill gas is not likely to occur. However there are perimeter gas monitoring boreholes located between sensitive receptors and the planned landfill area and monitoring at those locations will identify potential gas migration if it occurs through the subsurface. The site will be managed adhering to the guidance within the Environment Agency's 'Guidance on the management of landfill gas' and monitoring or management actions implemented for changes observed or identified to gas production or migration.

Compliance with the Landfill Regulations

4.3. This Landfill Gas Risk Assessment Report has outlined why the planned inert landfill site will not give rise to significant quantities of landfill gas primarily because the waste will be 'inert' with negligible biodegradable organic content. The site will also be engineered in accordance with the requirements of the Landfill Regulations. Therefore it is considered that, with respect to landfill gas, the site will be compliant with the requirements of the Landfill Regulations.

Appendices

Appendix A. Drawings



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SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

IN ADDITION TO THE HAZARDS / RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING:

ITEM	HAZARD	RISK

IT IS ASSUMED THAT ALL WORKS WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WORKING, WHERE APPROPRIATE, TO AN APPROVED METHOD STATEMENT

KEY

- Planned inert landfill boundary
- 50m, 250m & 500m beyond waste
- Flood risk zone 2 boundary
- Area shown as historic landfill by Environment Agency Historic Landfill dataset available from data.gov.uk

REV	DESCRIPTION	BY	DATE	CHK'D	AUTH

DRAWING STATUS: FOR INFORMATION

SUITABILITY: S2

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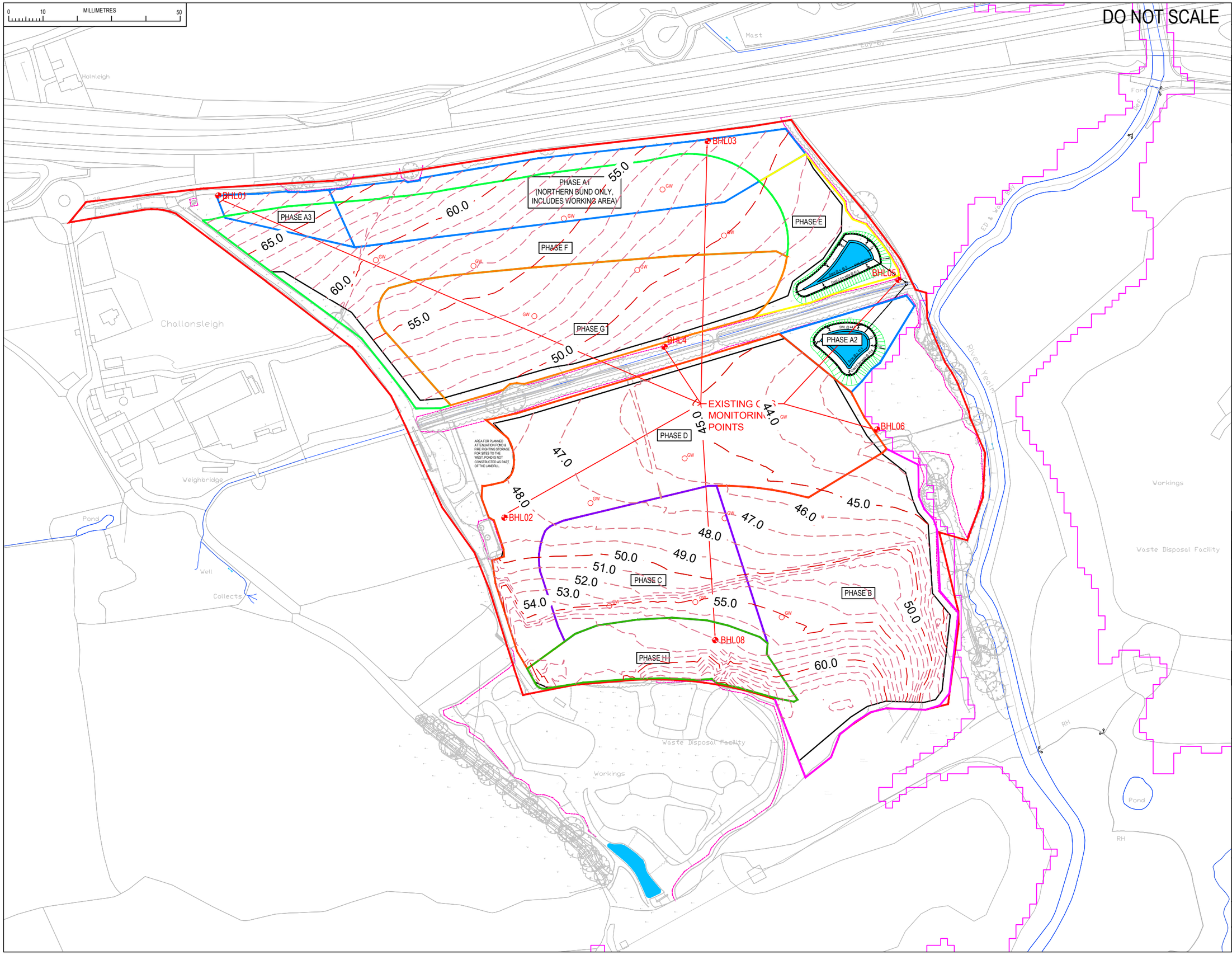
CLIENT:
DDE(SW) LIMITED

PROJECT:
Challonsleigh Farm,
Smithaleigh, near Ivybridge, Plymouth, PL7 5AX
Planned Inert Landfill

TITLE:
ENVIRONMENTAL SITE SETTING

SCALE:	ORIGINAL SIZE:	DESIGNED:	DRAWN:	CHECKED:	AUTHORISED:
1:10,000	A3	TSM	TSM	ATF	ATF
	OFFICE: EXETER	DATE: Nov 2020	DATE: Mar 2021	DATE: 06/04/2021	DATE: 06/04/2021

DRAWING NUMBER: 5149237-ATK-DR- C- DESSD2 P01



SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

IN ADDITION TO THE HAZARDS / RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING:

ITEM	HAZARD	RISK

IT IS ASSUMED THAT ALL WORKS WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WORKING, WHERE APPROPRIATE, TO AN APPROVED METHOD STATEMENT

KEY:

- LANDFILL BOUNDARY
- PHASE A
- PHASE B
- PHASE C
- PHASE D
- PHASE E
- PHASE F
- PHASE G
- PHASE H
- CONTOURS OF BASE OF INERT LANDFILL (INDICATIVE AFTER TOPSOIL/SUBSOIL STRIP PRIOR TO ARTIFICALLY ENHANCED GEOLOGICAL BARRIER)
- PROTECTIVE FENCING AS PER PLANNING CONDITION 30 'TREE PROTECTION & REMOVAL' DRAWING 5149237/LA/DR/100/4901/G
- BHL?? EXISTING MONITORING WELL
- GW INDICATIVE LOCATION FOR IN-WASTE GAS MONITORING WELL, AT 2 PER HA FOR INERT WASTE >4M

REV	DESCRIPTION	BY	DATE	CHK'D	AUTH
P02	Updated phasing.	TSM		ATF	ATF

DRAWING STATUS: FOR INFORMATION

SUITABILITY: S2

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CLIENT:
DDE(SW) LIMITED

PROJECT:
Challonsleigh Farm,
Smithaleigh, near Ivybridge, Plymouth, PL7 5AX
Planned Inert Landfill

TITLE:
GAS MONITORING PLAN

SCALE:	ORIGINAL SIZE:	DESIGNED:	DRAWN:	CHECKED:	AUTHORISED:
1:2,500	A3	TSM	TSM	ATF	ATF
	OFFICE: EXETER	DATE: Nov 2020	DATE: Mar 2021	DATE: 06/04/2021	DATE: 06/04/2021

DRAWING NUMBER:
5149237-ATK-DR- C- DESSD7 P02

Appendix B. LFGRA1 Electronic copies of all models relied upon within the assessment – NOT USED.

Appendix C. LFGRA2 Hard copies of the models and inputs used within the assessment – NOT USED.

Appendix D. LFGRA3 Results of any sensitivity analysis carried out for the site (unless specified within the text) – NOT USED

Appendix E. LFGRA4 The proposed risk-based monitoring and sampling scheme for the landfill (unless specified within the text) – NOT USED

Appendix F. LFGRA5 The derivation of all emission limits and landfill gas compliance levels – NOT USED

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