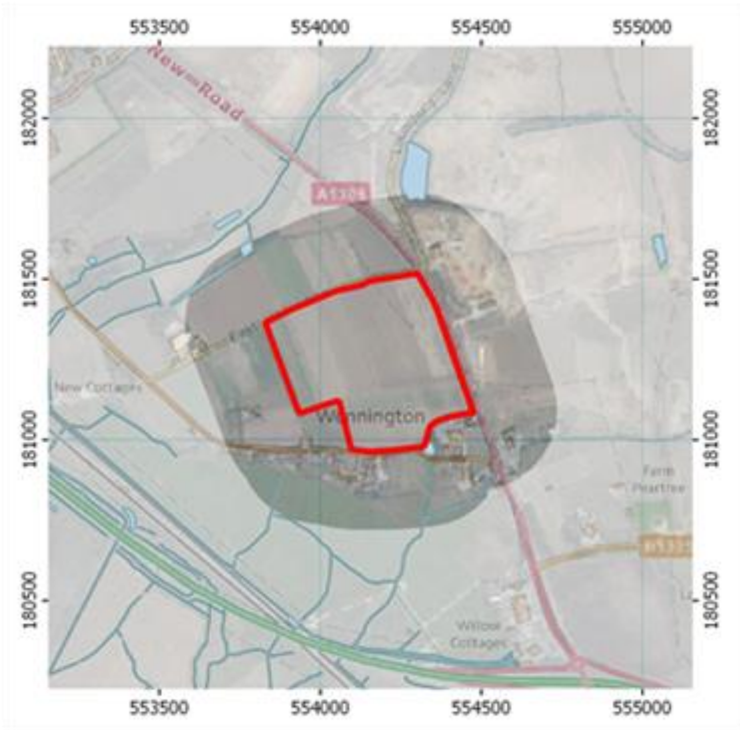

Wennington Quarry Landfill: Stability Risk Assessment

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Prepared for

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Wennington Quarry landfill: Stability Risk Assessment

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1 INTRODUCTION

1.1 Report context

ESI Ltd (ESI) has been retained by Ingrebourne Valley Limited (IVL) to prepare an Environmental Permit (the Permit) application for the proposed restoration by inert landfill, following mineral extraction, of Wennington Quarry (the Site).

This document presents a qualitative Stability Risk Assessment (SRA) to accompany the Permit application. Relevant information describing the Site setting (including geological, hydrogeological, Site monitoring data and development proposed) is detailed in the Environmental Site Setting and Design (ESSD) report (ESI Report 66250R2) which accompanies the Permit application.

The SRA has been prepared as a preliminary assessment of stability and geotechnical risks associated with the proposed inert landfill at the Site. This assessment has followed the principles outlined in Environment Agency (EA) technical guidance (Environment Agency, 2003a and 2003b) with consideration of the EA SRA template (Environment Agency, 2010). It should be noted that detail of components considered in this preliminary SRA will be presented in Construction Quality Assurance (CQA) reports to be submitted to the EA for approval before any construction commences.

1.2 Geo-environmental setting

For the purpose of this report it is considered appropriate to provide a concise summary of key aspects of the Site geo-environmental setting, based upon more detailed information, which is presented in the ESSD.

A series of Drawings are included in the ESSD and should be referred to for detail as required, these include: Site location; Permit boundary; Geology; and Hydrogeology. Table 1.1 provides a summary of the geo-environmental setting for the Site.

Table 1.1 Geo-environmental setting

Site Location	The Site covers an area of approximately 25.3 ha and is located immediately to the north of the small village of Wennington and approximately 750 m to the south east of Rainham within the London Borough of Havering. The Site is centred on National Grid Reference (NGR) TQ 54160 81220.
Topography	The Site is gently sloping with elevations ranging from 3.5 mAOD (metres Above Ordnance Datum) in the south to 7.5 mAOD in the north. The existing Site topography is presented in Plan No 1308/W/A (Appendix B of accompanying ESSD).
Historical Land Use	The Site has not been subject to previous mineral working, landfilling or built development.
Current Land Use	Agricultural land (currently in rotational agricultural use).
Geology	The following geological strata are indicated to underlie the Site: Superficial Deposits: consisting of Sand and Gravel of the Taplow Gravel (River Terrace Deposits) are present with typical thicknesses of between 4.5 m – 7.5 m at the Site. Alluvial deposits are present beyond the Site boundary associated with local water courses. Bedrock: consisting of London Clay proven locally to a thickness of c.40 m. London Clay is underlain in turn by: Lambeth Group and Thanet Sands which overlie the Chalk at depth.

	Man-made deposits: the area surrounding the Site has been subject to historical quarrying and landfilling, notably Willow Farm and Moor Hall Farm landfills to the east of the Site. Historical landfills were commonly not engineered or actively regulated and locally included industrial and domestic wastes.
Hydrogeology	The Taplow Gravels are classified as a Secondary A Aquifer. Alluvium (where present) is classified as a Secondary (undifferentiated) Aquifer. The London Clay is classified as Unproductive Strata. The Chalk at depth is classified as a Principal Aquifer. The Site is not located in a groundwater Source Protection Zone (SPZ). The most relevant on-Site aquifer unit is considered to be the shallow groundwater within the superficial Taplow Gravel (extending to a maximum thickness at the Site of c.7.5 m); this is underlain by more than 40 m of low permeability London Clay (effectively a non-aquifer) which affords significant protection to the underlying Principal, Chalk, aquifer at depth. The average saturated thickness of superficial deposits across the Site is c.3 m. Groundwater monitoring data is available for a network of groundwater monitoring boreholes which are present in and around the adjacent 'Moor Hall' site to the east. In addition, six groundwater/gas monitoring wells (WEN01 to WEN06) have been installed both on and around the perimeter of the Site. Groundwater flow within the superficial sand and gravels is to the south-west, in the direction of the Inner Thames Marshes SSSI and the River Thames. A small groundwater divide may be present at the Site which could lead to a small component of groundwater flow to the north-west, in the direction of the Common Watercourse. Other groundwater discharges to surface water bodies are anticipated within the locality. Three groundwater abstractions are located within 1 km of the Site; all three are to the north and therefore up-gradient of the primary groundwater flow direction within the superficial deposits. Groundwater quality associated with landfilling immediately to the east of the Site is known to be impacted by ammoniacal nitrogen, sulphate, phenol and PAH species, however, the pollution effects are relatively localised and may be of limited significance. Further details of the background hydrochemistry can be found in previous reports prepared and submitted in support of planning.
Hydrology	Shallow drainage ditches are present along the current Site boundary with a larger drainage ditch in the south-east corner of the Site. This ditch drains into a dense network of ditches and land drains which drain towards the Inner Thames Marshes SSSI and the River Thames. Common Watercourse is located approximately 280 m to the north-west of the Site and also drains to the Inner Thames Marshes SSSI.
Designated sites	Designated sensitive sites include Sites of Special Scientific Interest (SSSI), Special Areas of Conservation (SAC) and Ramsar sites. The Site is located within 1,000 m of the Inner Thames Marshes (SSSI). The Inner Thames Marshes SSSI covers an area of 486 ha, designated for the protection of wetland habitats bordering the upper Reaches of the Thames Estuary. The Inner Thames Marches SSSI designation extends to within approximately 400 m from the south-western boundary of the Site as indicated in Plan No 1308/W/SC/1 in (Appendix B of accompanying ESSD). No other designated sites (e.g. SSSI, SAC, or Ramsar sites) are located within 1,000 m of the Site.

1.3 Proposed development

As detailed in the ESSD, the planning consent allows for the winning and working of minerals, the erection of a low-profile processing plant, workshop, site office, welfare unit, weighbridge and wheel cleaner and other ancillary buildings with restoration using pre-treated imported suitable inert materials to return the land to agricultural use.

A summary of key development considerations is presented in Table 1.2. Where approved development plans are referenced in Table 1.2, these can be found within Appendix B of the accompanying ESSD.

Table 1.2 Proposed development

Operational phasing	Mineral extraction to commence in a counter-clockwise direction in the northern half of the Site before moving onto a clockwise direction in the southern half. The mineral will be worked dry to the base of the deposit. Details of phasing progression is provided in Plans: 1308/W/1; 1308/W/2; 1308/W/PO/1; and 1308/W/PO/2 with illustrative cross sections provided in Plan Nos: 1308/W/CS/1 and 1308/W/CS/2. Insitu topsoil and subsoil will be stripped prior to mineral extraction and stored in 2-3 m high bunds during mineral extraction and restoration. The stored soils will be replaced as each phase is completed to return the land back to agricultural land use at original ground levels. The overall lifecycle of the Site is limited by planning to nine years by which time all operations shall have ceased and the Site restored in accordance with Plan No. 1308/W/R/2 and subject to an aftercare period of five years
Access and plant	Access to the Site will be via a dedicated new access point from the A1306 New Road (Plan 44852/P/SK02). A low-profile processing plant will be built within the Site for the purpose of mineral extraction activities. Mobile screening plant will be employed on-Site to recover secondary aggregate from restoration materials (Plan 1308/W/CS/2) A surface mounted weighbridge, wheel-wash and Site offices will be installed at the Site for the duration of all quarrying and restoration works (1308/W/OW/1).
Water management	The Site will be subject to dewatering (by pumping of shallow groundwater) during the operational phases to allow the mineral to be extracted 'dry'. Dewatering will also be required to allow a geological barrier to be engineered prior to restoration by inert landfilling. Pumped water from the Site will be managed in accordance with approved planning and returned to ground via an infiltration pond in the south-east corner of the Site. The requirements of the proposed water management scheme at the Site have been considered in detail, for the purpose of the approved planning, through a series of assessments undertaken by ESI as detailed in the accompanying ESSD.
Restoration	The Site will be progressively restored as landfill by the importation of inert waste in accordance with approved plans (Appendix B of the ESSD). Restoration materials will be strictly limited to inert wastes prior to replacement of indigenous subsoil and topsoil to return the Site to agricultural use. The Site will benefit from a natural basal geological barrier, comprising reworked London Clay, at the base of the sand and gravel excavation which is underlain by the in-situ London Clay. It is considered that this combination of reworked and natural barrier to the Chalk Principal Aquifer beneath provides the requisite depth and low permeability characteristics required to satisfy the requirements of the Landfill Directive. In addition to the basal geological barrier a sidewall geological barrier will be provided around the perimeter of the Site. The sidewall geological barrier will also be constructed from reworked London Clay.

1.4 Stability site conceptual model

Information derived from the ESSD, as summarised in Table 1.1 and Table 1.2, has informed the development of a conceptual site model relating to the physical site setting (the ground model) in the context of this SRA.

1.4.1 Basal subgrade model

Based on intrusive investigations at the Site, which are discussed in more detail in the ESSD, the depth to the base of Sand and Gravel (and the top of the London Clay) at the Site ranges from between 5.5 mbgl (metres below ground level) and 7.8 mbgl. Topsoil/subsoil at the Site has been proven to a depth of between 0.25 mbgl and 1.2 mbgl, therefore the Sand and Gravel mineral to be extracted is anticipated to between 4.5 m and 7.5 m in thickness.

The basal subgrade to the inert landfill will be formed by the in-situ London Clay, the upper surface of which will be exposed as the Sand and Gravel mineral is fully worked to depth in each operational phase.

Shallow groundwater is present across the Site within the superficial Sand and Gravel deposits (the mineral to be extracted). The Site will be subject to dewatering (by pumping of shallow groundwater) during the operational phases to allow the mineral to be extracted, and the void isolated from surrounding groundwater prior to filling by means of side slope geological barrier. Groundwater in each operational phase will continue to be supressed until each cell has been filled sufficiently to counter the risk of any hydrostatic heave against the basal and side slope geological barriers.

1.4.2 Side slope subgrade model

The side slope subgrade will be formed by the extraction side slopes of the in-situ overburden and Sand and Gravel mineral of the Taplow Gravels. As detailed in Section 1.4.1, overburden topsoil and subsoil is anticipated to a depth of between 0.25 mbgl and 1.2 mbgl, therefore the Sand and Gravel mineral to be extracted is anticipated to between 4.5 m and 7.5 m in thickness.

In accordance with Environment Agency (2003b), side slopes will be formed no steeper than 1:2 to facilitate placement of the geological barrier.

1.4.3 Basal geological barrier model

Operational phases of the Site will be progressively restored with inert waste materials to be controlled by strict waste acceptance procedures detailed in the accompanying ESSD and information supporting the Permit application.

As detailed in Section 1.4.1, the mineral to be extracted is underlain by in-situ London Clay which has been proven locally to a thickness of approximately 40 m (Table 1.1). The in-situ London Clay will provide a natural low permeability (equivalent to 1×10^{-7} m/s at 1 m thickness or adjusted permeability at alternative thickness) attenuation layer between the inert waste and Chalk aquifer at depth. Notwithstanding this, the in-situ clay will be excavated, surveyed and replaced in layers to achieve the minimum permeability requirements, as per current guidance. Appropriate confirmatory testing will be applied to ensure the required permeability is met.

Appropriate CQA testing of the in-situ basal geological barrier will be undertaken. CQA testing will comprise the recovery of U100 core samples of the basal geological barrier to demonstrate the target permeability has been achieved (equivalent to $1x10^{-7}$ m/s for 1 m thick barrier) therefore ensuring that these minimum criteria are achieved.

Groundwater in each operational phase will continue to be supressed until each cell has been filled sufficiently to counter the risk of any hydrostatic heave against the basal geological barrier.

1.4.4 Side slope geological barrier model

The side slope geological barrier will comprise of reworked London Clay. Reworking the underlying London Clay will be achieved using mechanical plant to form the site slope barriers in each operational phase.

In accordance with Annex I of the Landfill Directive (1999) for inert waste landfill, placement and compaction of Site-won London Clay will achieve a maximum permeability of 1 x 10^{-7} m/s with a minimum 1 m barrier thickness (or equivalent permeability for increased/reduced thickness i.e. if a wider geological barrier is constructed, for instance a 3.0 m wide barrier to allow tracking of plant, the maximum permeability may be increased whilst still achieving the principal requirement of the Landfill Directive). CQA of the side slope geological barrier will be applied to ensure that these minimum criteria are achieved.

Side slopes will be formed no steeper than 1:2.5 to facilitate placement of the geological barrier.

Groundwater in each operational phase will continue to be supressed until each cell has been filled sufficiently to counter the risk of any hydrostatic heave against the side slope geological barrier.

1.4.5 Waste mass model

Operational phases of the Site will be filled with suitable imported inert wastes placed directly above the basal and side slope geological barrier. The waste mass will be placed 'dry' as operational phases will be dewatered.

As detailed in the ESSD, imported inert waste will be treated by physical means prior to placement to remove oversize material which will be recovered as a secondary aggregate. As such it is anticipated that the material to be deposited will be generally homogeneous comprising predominantly cohesive soils.

Wastes will be placed in typical lifts 'lifts' of 0.25 m before compaction by tracking of Site plant. All works will be undertaken in accordance with a CQA plan to be submitted to the EA for approval before any construction commences.

Groundwater in each operational phase will continue to be supressed until each cell has been filled sufficiently to counter the risk of any pore fluid pressures within the placed soils which may reduce the stability of any temporary waste faces.

1.4.6 Capping system model

Due to the inert nature of the waste mass to be placed in restoration of the Site there is no formal capping system required. As detailed in Table 1.2, in-situ subsoil and topsoil will be stripped, stored and replaced upon completion of each phase. This will ensure that the Site is fully restored to original levels and returned to productive agricultural use in accordance with planning.

2 STABILITY RISK ASSESSMENT

2.1 Risk screening

Each of the six principal components of the stability Site conceptual model (Section 1.4) will be considered and assessed.

Issues relating to stability and integrity of each component are considered by means of preliminary screening review to determine whether further geotechnical stability analysis may be required. The preliminary screening review is presented in the following sub-sections.

2.1.1 Basal subgrade screening

As detailed in Section 1.4.1, the basal sub-grade will be formed by the in-situ London Clay. Each aspect of the stability and deformability of the basal subgrade has been considered in accordance with Section 3.3.1 of Environment Agency (2003b).

Table 2.1 Basal sub-grade stability components

Excessive deformation	**Compression**	It is considered that the basal subgrade (London Clay) will be incompressible in its in-situ condition as the stresses applied by the restoration fill will be no greater than those currently applied by the existing in-situ mineral. As such this component does not require further consideration.
	Basal heave	The basal subgrade (London Clay) is naturally of very low permeability and extends to a thickness of approximately 40 m above underlying aquifer strata. Operational phases will be actively dewatered, with dewatering drawing water from the overlying superficial deposits. It is not considered that there is any likely mechanism by which heave of the basal subgrade may occur and therefore this component does not require further consideration.
	Cavities	Natural cavities are not anticipated within the in-situ London Clay. As such this component does not require further consideration.
Filling on waste	Not applicable	

Based on the preliminary stability screening of the basal subgrade presented in Table 2.1 it considered that the basal subgrade system does not require further consideration or assessment.

2.1.2 Side slope subgrade screening

As detailed in Section 1.4.2, the basal sub-grade of the side slopes will be formed by in-situ overburden (subsoil and topsoils where not stripped) and Sand and Gravel mineral of the Taplow Gravels. Side slope subgrade stability and deformability has been considered in accordance with the requirements for cut slopes of granular soil as detailed in Section 3.3.1 of Environment Agency (2003b).

Table 2.2 Side slope sub-grade stability components

Cut Slope: Granular Soils	**Stability**	With the exception of relatively thin remaining subsoil and topsoil, the side slope sub-grade will wholly be formed by mineral extraction of the Taplow Gravel. As detailed in Section 1.4.2 the side slope subgrade will extend to between 4.5 m to 7.5 m in thickness and will be typically be extracted at a gradient no steeper than 1 in 2.5 (1V:2.5H). Common with other Sites, this is considered to provide an adequate factor of safety (likely in the range of FOS 1.3 – 1.5) for geological deposits of this nature (Environment Agency (2003b). As such this component does not require further consideration.
	Deformability	The side slope sub-grade materials of the Taplow Gravel are considered incompressible, as such this component does not require further consideration.
	Groundwater	Were the mineral to be worked wet (i.e. without dewatering of operation phases) there may be needed to consider more detailed assessment of side slope stability. It is however proposed that each operation phase will be actively dewatered during mineral extraction and until restoration materials have been placed to sufficiently counter any increase in pore pressure or hydrostatic heave against the side slope barrier. Dewatering in each operational phase will also ensure that pore water pressures are limited to ensure an adequate factor of safety (likely in the range of FOS 1.3 – 1.5) Environment Agency (2003b). As such this component does not require further consideration.
Fill Slope	Refer to Table 2.4	

The Site will be operated by an experienced Operator, with particular experience working in the local area and with experience of side slope sub grade conditions anticipated at the Site.

In accordance with prevailing guidance (Environment Agency, 2003b) the Operator will ensure that side slopes are designed and maintained in each operational phase to have factors of safety in the region of FOS 1.3 to 1.5. Environment Agency (2003b) considers factors of this magnitude are obtained by following good-practice and industry guidance for the minerals and waste sector and as such, general case long-term stability should be assured.

Based on the preliminary stability screening of the side slope subgrade presented in Table 2.2, it is considered that the side slope subgrade system does not require further consideration or assessment.

2.1.3 Basal geological barrier system screening

As detailed in Section 1.4.3, the basal geological barrier will comprise reworked, low permeability London Clay with proven permeability equivalent to 1 x 10^{-7} m/s for a 1 m thick barrier and will therefore meet the Landfill Directive requirements of a geological barrier for inert landfill. Further detail will be provided in a CQA Plan, which will be submitted to the EA prior to construction.

Basal geological barrier stability and integrity has been considered, for both the Unconfined and Confined scenarios in accordance with the requirements for mineral only geological barrier systems as detailed in Section 3.3.1 of Environment Agency (2003b).

Table 2.3 Basal barrier stability/integrity components

During construction (Unconfined)	**Mineral only**	Stability	As detailed in Section 1.4.1 the basal subgrade will be formed of insitu London Clay, which will be exposed upon excavation of the Sand and Gravel mineral. Shallow groundwater present within the Sand and Gravel deposits will be dewatered, during these works, meaning the basal subgrade and basal geological barrier placement will be worked in 'dry' conditions.
		Integrity	Groundwater in each operational phase will continue to be supressed until each cell has been filled sufficiently to counter the risk of any hydrostatic heave against the basal geological barrier It is considered that there are no other factors which may affect the integrity of the proposed side slope barrier system assuming reworked, homogeneous, low permeability London Clay is used for this purpose. As such this component does not require further consideration.
	Geosynthetic-mineral	Stability	Not applicable
		Integrity	
Following waste placement (confined)	**Mineral only**	Stability	The assumptions presented for the unconfined scenario are presented above which are assumed to apply to the confined phase. Waste will comprise inert, cohesive and homogeneous (due to physical pre-treatment) soils and will be placed in even layers or 'lifts', applying equal pressure along the basal geological barrier.
		Integrity	As indicated for the unconfined scenario, groundwater will be supressed until each cell has been filled sufficiently. In the confined scenario groundwater rebound will occur however the confining pressure of the waste mass will ensure the long-term integrity of the basal geological barrier as groundwater levels and porewater pressures equilibrate with surrounding strata.
	Geosynthetic-mineral	Stability	Not applicable
		Integrity	

2.1.4 Side slope geological barrier system screening

As detailed in Section 1.4.4, the side slope barrier system will be formed by placement of reworked London Clay to achieve a barrier of no less than 1.0 m in thickness and permeability no greater than 1×10^{-7} m/s.

Side slope geological barrier stability and integrity has been considered, for both the Unconfined and Confined scenarios in accordance with the requirements for mineral only geological barrier systems as detailed in Section 3.3.1 of Environment Agency (2003b).

Table 2.4 Side slope barrier stability/integrity components

During construction (Unconfined)	**Mineral only**	Stability	As detailed in Section 1.4.2 the side slope subgrade will be formed by reworked London Clay which is naturally cohesive and should achieve a FOS >1.0 with slope gradients of less than 1 in 2 (1V:2H) (Environment Agency (2003b). The side slope geological barrier system will be maintained in each operational phase with a slope angle no steeper than 1 in 2.5 (1V:2.5H). It is considered that for cohesive, unsaturated London Clay material this should achieve a FOS of at least 1.3 to 1.5 (Environment Agency (2003b). Environment Agency (2003b) considers factors of this magnitude are obtained by following good-practice and industry guidance for the minerals and waste sector and as such, general case long-term stability should be assured. As such this component does not require further consideration.
		Integrity	Groundwater in each operational phase will continue to be supressed until each cell has been filled sufficiently to counter the risk of any hydrostatic heave against the side slope barrier. It is considered that there are no other factors which may affect the integrity of the proposed side slope barrier system assuming reworked, homogeneous, low permeability London Clay is used for this purpose. As such this component does not require further consideration.
	Geosynthetic-mineral	Stability	Not applicable
		Integrity	
Following waste placement (confined)	**Mineral only**	Stability	The assumptions presented for the unconfined scenario are presented above which are assumed to apply to the confined phase. However, in the confined scenario the side slope barrier will be permanently subject to the pressure of the placed waste mass which will wholly comprise inert, cohesive and homogeneous (due to physical pre-treatment) soils. This confining pressure means that this component does not require further consideration.
		Integrity	As indicated for the unconfined scenario, groundwater will be supressed until each cell has been filled sufficiently. In the confined scenario groundwater rebound will occur however the confining pressure of the waste mass will ensure the long-term integrity of the side slope barrier as groundwater levels and porewater pressures equilibrate with surrounding strata.
	Geosynthetic-mineral	Stability	Not applicable
		Integrity	

The Site will be operated by an experience Operator, with particular experience working in the local area and with experience of side slope sub grade conditions anticipated at the Site.

In accordance with prevailing guidance (Environment Agency, 2003b) the Operator will ensure that side slopes barriers are designed and maintained in each operational phase to have factors of safety in the region of FOS 1.3 to 1.5. Environment Agency (2003b) considers factors of this magnitude are obtained by following good-practice and industry guidance for the minerals and waste sector and as such, general case long-term stability should be assured.

Based on the preliminary stability screening of the side slope subgrade presented in Table 2.4, it considered that the side slope subgrade system does not require further consideration or assessment.

2.1.5 Waste mass screening

As detailed in Section 1.4.5, the waste mass will be placed in operation phases which will be dewatered. As the waste will be physically treated prior to placement, the material to be deposited will be generally homogeneous comprising predominantly low permeability cohesive soils.

Each aspect of the stability of the waste mass and stability and integrity of the waste mass/barrier has been considered in accordance with Section 3.3.1 of Environment Agency (2003b).

Table 2.5 Waste slope stability components

Failure wholly in waste	**Stability**		As detailed in Section 1.4.5 due to the anticipated cohesive and homogeneous nature of waste soils post-treatment, it is anticipated that temporary waste faces will be able to exist at a natural angle of repose, likely 1 in 2 (1V:2H). Exposed waste slopes will be maintained in each operational phase with a slope angle no steeper than 1 in 2.5 (1V:2.5H). For cohesive, unsaturated material this should readily achieve a FOS of at least 1.3 to 1.5. Environment Agency (2003b) considers factors of this magnitude are obtained by following good-practice and industry guidance for the minerals and waste sector and as such, general case long-term stability should be assured. Groundwater in each operational phase will continue to be supressed until each cell has been filled sufficiently to counter the risk of any pore fluid pressures within the placed soils which may reduce the stability of any temporary waste faces. As such this component does not require further consideration.
Failure involving geological barrier and waste	**Mineral only**	**Stability**	Assumptions for the confined scenario presented in Table 2.4 are considered to be equally applicable. As such this component does not require further consideration.
		Integrity	Assumptions for the confined scenario presented in Table 2.2 are considered to be equally applicable. As such this component does not require further consideration.
	Geosynthetic-mineral	**Stability**	Not applicable
		Integrity	Not applicable

Based on the preliminary stability screening of waste slopes presented in Table 2.5 it considered that the waste mass slope system does not require further consideration or assessment.

2.1.6 In-waste infrastructure

As the waste to be deposited at the Site will be inert and controlled by strict waste acceptance procedures, to ensure long term high quality agricultural land use, it is not anticipated that leachate will be generated within the waste mass. This has been further assessed through appropriate Hydrogeological Risk Assessment (HRA) which accompanies the Permit application. In-waste leachate monitoring or collection is therefore not required.

Similarly, as the waste to be deposited will be inert, landfill gas will not be generated as discussed in the accompanying Permit environmental risk assessment. As such in-waste gas extraction infrastructure will not be required.

Any monitoring infrastructure (i.e. boreholes) which are installed at the Site, including existing infrastructure will be monitored and managed in accordance with the accompanying Permit monitoring plan. Any new or replacement infrastructure will be installed in accordance with prevailing EA guidance and CQA requirements.

2.1.7 Capping system screening

As detailed in Section 1.4.6 there is no formal capping system required for the inert landfill. Insitu subsoil and topsoil will be stripped, stored and replaced upon completion of each phase. This will ensure that the Site is fully restored to original levels, which will tie in with the local landscape and ensure that the Site is returned to productive agricultural use in accordance with planning.

As approved by planning, suitable underdrainage will be incorporated into the replaced stored soils, and the restored landform has been designed in accordance with flood risk and drainage assessment as detailed in the ESSD.

The waste mass will be inert and therefore it is highly unlikely that any settlement due to biodegradation of organic material will occur. It should also be noted that the proposed physical pre-treatment of wastes, to remove oversized fraction as a secondary aggregate, will ensure homogeneity of the waste mass, lack of cavities and a low risk of compressibility and therefore long-term settlement.

In light of the above, each aspect of capping system stability defined in Section 3.3.1 and Table 3.39 of Environment Agency (2003b) has been considered and it is therefore considered that stability of the capping system does not require further consideration or assessment.

2.2 Lifecycle phases

As detailed in Table 1.2 and plans appended to the accompanying ESSD, the Site will be progressively worked and restored in a series of seven phases over a nine-year period.

The infilling of the mineral void with pre-treated inert waste soils is likely to result in the development of temporary waste slopes within each phase. Temporary waste slope gradients will be maintained with a slope angle no steeper than 1 in 2.5 and will be controlled by daily waste inputs.

The worst-case scenario for the side slope subgrade, side slope barrier and waste slope components is considered to be where the extracted mineral is thickest following extraction. It is however considered that the nature of the materials at and to be deposited at the Site will allow for stable temporary slopes to be achieved so long as slope angles defined in preceding sections are maintained to achieve a FOS of at least 1.3 to 1.5.

Environment Agency (2003b) considers factors of this magnitude are obtained by following good-practice and industry guidance for the minerals and waste sector and as such, general case long-term stability should be assured.

Daily monitoring of all exposed slopes will be maintained to allow appropriate remedial action to be taken if necessary.

2.3 Monitoring

Based upon the assessments and screening provided in this SRA, a simple risk-based monitoring scheme is considered appropriate as summarised in Table 2.6.

Table 2.6 Monitoring

Basal subgrade	None proposed
Side slope subgrade	Exposed faces within operational phases to be inspected on a daily basis for any signs of failure. Appropriate remedial action will be taken if evident.
Basal geological barrier	CQA validation
Side slope geological barrier system	Construction will apply with CQA requirements
Waste mass	Exposed waste faces within operational phases to be inspected on a daily basis for any signs of failure. Appropriate remedial action will be taken if evident.
Capping monitoring	None proposed. As detailed in the ESSD, the Site will be returned to agriculture and subject to a 5 year aftercare programme to ensure the Site meets the requirements of the approved planning consent and restoration scheme.

2.4 Summary

This SRA has provided a preliminary assessment of the six principal components of the stability Site conceptual model (Section 1.4) in accordance with Section 3.3.1 of Environment Agency (2003b).

Commentary is provided in accompanying text and screening tables which defines appropriate slope angles for various conceptual model components and associated materials which are recognised to regularly provide factors of safety typically in the region of 1.3 to 1.5.

It is also noted that the Site will be operated by an experienced Operator and the conceptual model components described are not considered to be ‘atypical’ and very similar to other landfill sites constructed and operated by IVL. As such it is not considered that further quantitative assessment of any conceptual model component is required.

3 REFERENCES

Environment Agency, 2003a. Stability of Landfill Lining Systems: Report No. 1 Literature Review. R&D Technical Report P1-385/TR1, January 2003.

Environment Agency, 2003b. Stability of Landfill Lining Systems: Report No. 2 Guidance. R&D Technical Report P1-385/TR2, January 2003.

Environment Agency, 2010. Stability risk assessment report template. Version 1, March 2010.

Official Journal of the European Communities, 1999. Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste (Landfill Directive).