The Geo-Environmental Service Provider

STABILITY RISK ASSESSMENT
LOWER HARE FARM
WHITESTONE, EXETER

Prepared for: AA Environmental Limited

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1 INTRODUCTION

In June 2022, ASL was instructed by AA Environmental Limited (AAe) to undertake a Stability Risk Assessment (SRA) in support of the permit application to dispose of inert waste to restore the landscape.

The scope of works for this project was set out in ASL proposal reference 167-22-696.elo.4134 dated 19th July 2018 which was formerly accepted by AAe in their completed Project Award Form dated 7th June 2022.

The purpose of the Stability Risk Assessment (SRA) is to support a permit application to dispose of inert waste and to restore the site to landscaped ground. The current proposals comprise the disposal of inert waste in a controlled operation in accordance with the findings of the hydrogeological risk assessment for the project. The SRA presents the methodology adopted, sources of information used and the results of the stability analyses undertaken.

The methodology adopted for this SRA generally follows the principles outlined in the Environment Agency R&D Technical Report P-385, volumes TR1 and TR2 together with additional analytical techniques as appropriate.

This report has been prepared for the sole benefit of the Client, AAe and their representatives and agents. The report has been written based on the results of data searches and site conditions encountered at the time of the assessment. Future changes in legislation and advances in current best practises or provision of more detailed design proposals will result in this report requiring review and possible further assessment after the date of issue. The general notes section within this report should be noted in relation to the limitations of this assessment.

2 SITE DESCRIPTION

The site is located approximately 0.8km to the west of the village of Whitestone and 0.4km north of the A30 approximately 6km west of Exeter city centre and can be located approximately by National Grid Reference SX 857 934. A site location plan is presented as Figure 1.

The site comprises an irregular shaped parcel of land with maximum dimensions of approximately 375m by 375m and covers an area of approximately 11 hectares.

The site is topographically higher in the north-east (170m AOD) and generally slopes downwards to the south-west (90m AOD). The site is generally undulating and includes a 'valley' feature located in the south aligned approximately east to west.

The site currently comprises areas of sloping agricultural farmland. It is understood that areas of the site have been previously disturbed by the import of inert materials.

The western boundary of the site slopes down to the west towards a valley feature associated with an unnamed watercourse aligned approximately north to south.

An elongated pond feature is present in the west of the site with dimensions of approximately 70m by 15m with the long axis aligned approximately north to south.

The site is accessed via an existing track which enters the southwestern corner of the site from Hare Lane to the west.

The site is generally surrounded by areas of undeveloped agricultural land, with areas of woodland, Dinney Copse and Raddy Cleave Copse located directly to the north-west and south-west respectively.

Limited areas of assumed agricultural and residential development associated with Lower Hare are present approximately 150m to the north-west and Gratton House and Ramslade Farm approximately 50m to the north-east.

It is understood that proposed earthworks/filling operation are to be completed across the central and southern portions of the site, with the northern portion of the site to be used for the storage of topsoil materials. No works are proposed across the westernmost portion of the site and the pond feature in this area is to be retained and incorporated into the completed development following restoration. The Site Layout Plan, produced by AAe, (Drawing No.213189/D/004) is included in Appendix I.

3 GEOLOGICAL SETTING

The British Geological Survey (BGS) Sheet No. 325 – 'Exeter' (Solid and Drift) and the BGS Geoindex indicates the westernmost portion of the site to be underlain by drift geology comprising Head. The Head is generically described as 'Polymict deposit: comprises gravel, sand and clay depending on upslope source and distance from source. Locally with lenses of silt, clay or peat and organic material' by the BGS. The thickness of the Head is not defined by the BGS in the vicinity of the site however, it is anticipated to be of limited thickness.

The Head and the remainder of the site is indicated to be underlain by solid geology comprising the Ashton Mudstone Member. The Ashton Mudstone Formation is generally described as 'Greyish blue, rusty-weathering mudstones with scattered thin sooty goniatite-bearing mudstones. Scattered siltstones and sandstones (up to 7cm thick) form less than 10% of the Member. The sandstones are commonly medium-grained, quartzitic and feldspathic and thought to be derived from the south. Plant fragments are locally abundant' by the BGS. The BGS indicates the Ashton Mudstone Member to be between 210m and 430m in thickness. It is therefore anticipated that this stratum will extend to a significant depth beneath the site.

In addition to the strata summarised above, it is anticipated that limited thicknesses of Topsoil and possible Made Ground materials will be present at the surface across the site given it current usage.

4 BACKGROUND AND MODELLING

4.1 Report Context

Relevant background information describing the site and its environmental context are detailed within AAe, Non-Technical Summary Report (Document Reference 213189/NTS), Importation Protocol and Construction Controls Report (Document Reference 213189/IP, dated May 2022) and McDonnell Cole Ltd, Hydrogeological Risk Assessment Report (Document Reference 1776-HRA-01, dated June 2022). Additional information has been obtained from borehole records, the Conceptual Site Model and proposed scheme drawings provided by AAe.

4.2 Conceptual Stability Site Model

The Conceptual Site Model has been developed from information contained with the previous report and the ground conditions present at the site. The Conceptual Site Model, produced by AAe is presented in Appendix I, together with drawings detailing the proposed nature and phasing of the proposed landfill development.

The ground and groundwater conditions for the study area have been established based on findings of four boreholes together with subsequent groundwater level monitoring. Based on these boreholes the ground conditions are indicated to comprise clay overlying mudstone materials considered to represent solid geology of Ashton Mudstone Member. The clay materials were encountered to depths of between 0.8m and 21m bgl at BH101 and BH103, respectively, with the thickness of the clay materials greatest in the north.

Possible igneous materials were encountered at BH102, located in the south-east of the site area, at a depth of 16m bgl, with these materials present to the termination depth of the borehole at 18m bgl. No igneous rocks are mapped within the vicinity of the site, however intrusive igneous rocks are indicated to be present within the wider surrounding area to the south.

In addition, Topsoil/Made Ground materials was encountered at the surface at BH101, located in the south-west of the site, to a depth of approximately 0.4m bgl.

It is understood that the existing topography of the site together with the previous import of inert soils means the site is currently unsuitable for arable use. The proposed landfill will reshape the site area to allow an end use of arable production.

It is understood that any Topsoil and Made Ground materials present at the site are to be stripped prior to the commencement of any earthworks or filling operations, with any such suitable materials stockpiled onsite for use as restoration soils.

Following the removal of the Topsoil/Made Ground materials, it is understood that earthworks will be locally completed across the site, using suitable engineered materials, to regulate the ground surface and provide a uniform formation layer for the engineering of a Geological Barrier.

A Geological Barrier will be used to provide a low permeability liner in accordance with the requirements of the Hydrogeological Risk Assessment. The geological barrier will be engineered from imported waste materials and will be undertaken as a waste recovery activity. Prior to placement of the geological barrier the existing ground surface is to be regulated by the placement of engineered fill in accordance with an engineering specification or CQA Strategy (engineering specification). The Geological Barrier is to be

placed above the existing in-situ natural materials or engineered fill materials and will be at least 1m in thickness.

The landfill is to be developed in three phases. Drawings detailing the various development phases are presented in Appendix I.

Phase 1, forming the northern third of the site, typically comprises enabling works. Engineered fill will be placed to form the northern boundary of Phase 2, with engineered fill placed to a maximum thickness of approximately 5m. No landfill waste is to be placed in Phase 1.

Phase 2 will form the central portion of the site, with landfill inert waste, placed above the geological barrier, from west to east to a maximum thickness of approximately 8m.

Phase 3 will initially hold surface water lagoons to assist with water management of Phases 1 and 2, which will be removed and replaced with engineered fill as Phase 2 reaches completion. Thereafter landfill inert waste will be placed above the geological barrier in Phase 3 to a maximum thickness of approximately 14m, where an existing valley feature is to be infilled.

The final 1.25m of materials to Phases 1, 2 and 3 will comprise restoration soils placed over the landfill inert waste and engineered fill materials.

4.2.1 Basal Sub-Grade Model

The basal subgrade will be formed from in-situ natural ground of the Aston Mudstone Member comprising stiff cohesive materials. The basal topography will predominantly follow the existing topography of the site. Localised filling will occur in some areas to regulate the ground surface and to allow the placement of the basal liner.

The minimum level that the proposed basal liner is proposed to be installed at is approximately 92m AOD to the base of the liner.

Groundwater has been recorded within the monitoring standpipes at the site at levels of approximately 85m AOD and 132m AOD at BH101 and BH103, with recorded groundwater levels typically between 5.5m and 7.5m below ground level at all borehole locations.

4.2.2 Side Slopes Sub-Grade Model

Given the nature and geometry of the site, the side slope subgrade will generally be similar to that of the basal subgrade, with the exception of the northern boundaries where the side slopes will be formed by placed engineered fill materials.

The engineered fill materials are to be formed from appropriately processed and suitable engineering materials sourced from imported waste materials which will be placed in accordance with an appropriate engineering specification. Based on the information available the engineered fill materials forming the side slope subgrade in the north of the site will be constructed with gradients of approximately 1(v):3(h) to a maximum height of approximately 5m.

4.2.3 Basal Lining System Model

The landfill will have one cell. It will be constructed progressively in advance of the infilling. The basal liner is to be engineered from suitable inert waste placed and compacted to provide a minimum thickness of 1m. In addition, engineered fill will locally be placed beneath the basal liner as a regulating layer to provide a suitable surface on which to place the basal liner. The basal liner will have an engineered hydraulic permeability of 1 x 10^{-7}m/s.

4.2.4 Side Slope Lining System Model

The side slope geological barrier system will be composed of the same material as the basal geological barrier, consisting of suitable engineered inert waste materials.

In the north of the site, the geological barrier will be placed against engineered fill materials constructed as part of Phase 1 works. The side slope geological barrier will be placed at a minimum thickness of 1m and constructed at a maximum gradient of approximately 1(v):3(h).

4.2.5 Waste Mass Model

The waste will comprise inert waste. We have assumed shear strength parameters to allow for a wide range of materials to be accepted.

4.2.6 Capping System Model

Following the placement of inert waste materials, restoration soils will be placed over the waste materials to prepare the site for agricultural use. It is understood that the restoration soils will comprise cohesive Topsoil and Subsoil materials. The restoration soils will have a minimum vertical thickness of approximately 1.25m.

The general and maximum slopes of the capping will be in accordance with the finished design and will generally comprise relatively shallow slopes.

Gas pressure is not anticipated due to the nature of the waste accepted and the waste acceptance controls operated on site.

5 STABILITY RISK ASSESSMENT

Each of the six principal components of the conceptual stability site model have been considered and the various elements of that component have been assessed with regard to stability.

The principal components considered are:

- The basal subgrade
- The side slope subgrade
- The basal geological barrier
- The side slope geological barrier
- The inert waste material
- The capping system

5.1 Risk Screening

Potential stability and integrity issues relating to each component of the proposed landfill have been reviewed to determine the requirements for further detailed geotechnical analyses. The findings of the preliminary risk screening are presented in the following sections.

5.1.1 Basal Sub-Grade Screening

The surface of the basal subgrade will generally follow the existing topography of the site and will comprise in-situ natural cohesive materials of the Aston Mudstone Member (stiff clay and mudstone). Each aspect of the stability and deformability of the basal subgrade identified within the guidance is discussed below in Table 1.

Table 1 Stability Components for Basal Subgrade

Excessive Deformation	Compressible Subgrade	The basal subgrade is formed in Ashton Mudstone Member materials (clay and mudstone). In addition, the basal subgrade will locally be formed in engineered fill materials in Phase 3, following the removal and infilling of the temporary surface water lagoons. The Ashton Mudstone Member and engineered fill materials are considered to be practically incompressible under the limited stresses imposed by the proposed waste height. Therefore, this component does not require further consideration.
	Cavities within the subgrade	No evidence of cavities has been identified based on BGS information and the site investigation data. No further assessment is required.
	Basal Heave	The water table is located within the underlying Ashton Mudstone Member materials and therefore basal heave is not considered to require further assessment.
	Stability	The surface of the basal subgrade will generally follow the existing topography of the site. The site slopes to the south and south-west at a general gradient of approximately 1(v):5(h). However, steeper slopes of approximately 1(v):3(h) are locally present across the site. Whilst slopes of this nature are typically found to be stable, it is considered necessary to undertaken slope stability analysis to determine the stability of the existing basal subgrade.
Filling on Waste	The scheme does not involve any filling on Waste.	

Based on the initial screening it is considered that the basal subgrade requires further assessment to determine its stability.

5.1.2 Side Slopes Sub-Grade Screening

The controlling factors that will affect the stability and the deformability of the subgrade are included in Table 2.

Table 2 Stability / Integrity Components of Side Slope Subgrade

Cut Slope	The scheme does not involve any cut slopes.		
Fill Slope	Rock	The Conceptual Site Model does not include fill slopes in rock.	
	Granular Soils	The Conceptual Site Model does not include fill slopes in granular soils.	
	Cohesive Soils	Stability	The northern side slopes of the landfill are to be formed by engineered fill constructed to a maximum height of approximately 5m and at a gradient of approximately 1(v):3(h). This is considered to provide an adequate factor of safety however, this will be confirmed by further stability assessment.
		Deformability	The side slope subgrade will be formed in engineered fill materials. These are considered to be practically incompressible under the limited stresses imposed by the proposed placement waste. This component does not require further consideration.
		Groundwater	The water table is located within the underlying Aston Mudstone Member beneath the base of the landfill and therefore is not considered to require further assessment.
Natural Slopes	Rock	The Conceptual Site Model does not include natural slopes in rock.	
	Granular Soils	The Conceptual Site Model does not include natural slopes in granular soils.	
	Cohesive Soils	Stability	The geometry of the landfill will generally follow the existing topography of the site. The site slopes at a general gradient of approximately 1(v):5(h), with steeper slopes of up to approximately 1(v):3(h) locally present. It is considered necessary to undertaken slope stability analysis to determine the stability of the existing topography.
		Deformability	The basal subgrade is formed in Ashton Mudstone Member materials (clay and mudstone) which is considered to be practically incompressible under the limited stresses imposed by the proposed waste height. This component does not require further consideration.
		Groundwater	The water table is located within the underlying Aston Mudstone Member beneath the base of the landfill and therefore is not considered to require further assessment.

Based on the initial screening it is considered that the side slope subgrade requires further assessment.

5.1.3 Basal Lining System Screening

The controlling factors that influence the stability and integrity of the basal geological barrier system are included in Table 3.

Table 3 Stability / Integrity Components of Basal Geological Barrier System

Mineral Only	Stability and Integrity	The basal subgrade will comprise and engineered low permeability material placed on in-situ Ashton Mudstone Formation materials or engineered fill placed in accordance with an engineering specification. The overall stability of the side slope and base requires further stability assessment to ensure integrity of the geological barrier is maintained.
	Compressible subgrade	The basal subgrade is formed on in-situ natural materials and locally limited thickness of engineered fill considered to have low compressibility under the limited stresses imposed by the waste height proposed. This component does not require further consideration.
	Cavities	Not applicable.
	Basal Heave	The water table is located within the underlying Ashton Mudstone Member materials beneath the landfill and therefore is not considered to require further assessment.
Geosynthetic/Mineral	The scheme does not include a geosynthetic liner system.	

Based on the initial screening it is considered that the basal geological liner does require further assessment.

5.1.4 Side Slope Lining System Screening

The controlling factors that influence the stability and integrity of the side slope geological barrier system are given below in Table 4.

Table 4 Stability / Integrity Components of Side Slope Geological Barrier System

Unconfined	Mineral only	Stability	The side slope geological barrier will comprise an engineered low permeability material placed to an engineered specification. The overall stability of the side slope and base requires further stability assessment to ensure the integrity of the geological barrier is maintained.
		Integrity	The integrity of the side slope geological barrier will not be compromised in the unconfined condition providing the stability assessment returns a suitable factor of safety. Therefore, this aspect of the assessment does not require further consideration.
	Geosynthetic/ Mineral	Stability	The scheme does not include a geosynthetic liner system.
		Integrity	
Confined	Mineral only	Stability	If the stability in the unconfined condition is satisfactory, the stability of the side slope geological barrier system in the confined condition will be greater due to the buttressing effect of the waste.
		Integrity	If the integrity in the unconfined condition is satisfactory based on the factor of safety the integrity of the side slope geological barrier system in the confined condition will be greater due to the buttressing effect of the waste.
	Geosynthetic/ Mineral	Stability	The scheme does not include a geosynthetic liner system.
		Integrity	

Based on the preliminary screening it is considered that the side slope geological barrier liner requires further assessment.

5.1.5 Waste Mass Screening

The controlling factors that influence the stability of the waste mass are presented below in Table 5.

Table 5 Stability / Integrity Components of Waste Mass

Failure wholly in waste	Stability	The waste will be placed in layers and compacted with a maximum slope of up to 1(h):3(v). Based on the likely nature of the waste (inert materials) this is likely to provide an adequate Factor of Safety, however this will be confirmed by stability analysis. Based on the nature of the waste materials, leachate is not anticipated to be present within the waste mass.
Failure involving Geological barrier and waste	Mineral Only	The development of progressive infilling will result in the generation of a single temporary waste slope in the short term. The proposed method of working is likely to generate a stable temporary waste slope. However, there is the potential for the temporary waste slope to shear through the side or basal geological barriers.

Based on the preliminary screening it is considered that the waste mass requires further assessment.

Due to the nature of the waste to be deposited, a significant volume of leachate will not be generated and therefore a specific leachate collection system will not be installed.

The proposed restoration profile and associated surface water drainage solution will promote surface water run-off to permanent drainage features and limit infiltration into the waste mass. The restoration soils will comprise cohesive Topsoil and Subsoil materials and it is considered that these materials will further limit the infiltration of water, from the surface, into the waste mass. However, there is the potential for the limited infiltration and accumulation of water/leachate within the waste mass during winter months or periods of prolonged rainfall.

It is therefore considered that analysis is required to determine how the stability of the restored landfill profile may be impacted by the limited accumulation of leachate/water within the waste mass associated with infiltration from the surface.

Due to the nature of the waste to be deposited, a significant volume of landfill gas will not be generated. Therefore, a gas extraction system is not required and will not be installed.

5.1.6 Capping System Screening

The controlling factors that influence the stresses in the capping system are provided below in Table 6.

Table 6 Stability Components of Capping System

Soil/Mineral	Stability	Pre-settlement slope inclination	Stability assessment is considered necessary to ensure long term stability of the waste mass and restoration soils at this gradient.
	Integrity	Compressible waste	The inert waste is considered to have limited compressibility and no external factors will be present to cause anything other than deformations normally associated with inert waste settlement. Further assessment is not considered to be required.
		Slope deformation	No external factors will be present to cause anything other than deformations normally associated with waste settlement. This aspect is therefore not considered to require further assessment.
		Construction	The potential effects of construction plant activity during the placement of restoration soils do not require further assessment.
		Cavities in waste	It is proposed that the final waste surface will be graded and inspected prior to placement of the restoration soils. This practice will eliminate the potential for near-surface cavities to be present. As such, this issue does not require further assessment.
Geosynthetic/ mineral	The scheme does not include a Geosynthetic Capping system.		

Based on the initial screening it is considered that the stability of the critical restoration profile slopes requires further assessment.

5.2 Lifecycle Phases

This aspect of the assessment identifies the various critical phases during the development of the landfill. The inert waste will be filled in lifts as part of two phases of infilling.

To ensure stability throughout the life of the landfill, the side slope subgrade, side slope geological barrier and temporary waste slope (short term) stability are all considered.

5.3 Data Summary

The following data is required as input for the analyses undertaken for this Stability Risk Assessment:

- Material unit weight
- Drained and undrained shear strength of soils and waste

It should be noted that there is no laboratory test data relating to the shear strength of the materials available on the site or those proposed for import to site.

The available site investigation data has been used to determine typical assumed soil parameters for the purposes of modelling slope stability. Where specific data is not available conservative parameters have been estimated based on material descriptions, previous experience, and engineering judgment.

5.4 Justification for Modelling Approach and Software

To undertake the detailed SRA, the various components of the landfill development have been considered not only individually but also in terms of the overall model. The assessment and analytical methods should adequately represent all of the considered scenarios, including the different modelled phases of the lifecycle, for both confined and

unconfined conditions (where appropriate). The methodology and the software should also produce the required output results for the assessment, e.g. determination of limit equilibrium factor of safety within geological barrier components.

The analytical methods used in this SRA include:

- Limit equilibrium stability analyses for the derivation of factors of safety for the unconfined subgrade, side slope liner, temporary waste slopes and final restoration profile.

The limit equilibrium analyses have been undertaken using the SlopeW (Geo Studio 2016) package utilising the Bishop simplified method of analysis.

5.5 Justification of Geotechnical Parameters Selected for Analyses

The following sections present a justification for the various parameters used in the stability analyses based on the following criteria:

- site specific information;
- an assessment of the suitability of non-site specific data, where used;
- methods for the derivation of the parameters adopted.

A summary of the geotechnical parameters used in the design and analysis of the development are presented in tabular form for each component of the landfill in Table 7 below. The adopted parameters are based on the available data for the site together with previous experience and engineering judgment.

Table 7 Geotechnical Design Parameters

Material	Unit Weight ɣ (kN/m³)	Effective cohesion c' (kPa)	Angle of Shearing Resistance Ø (°)	Description
Restoration Soils	19	0	24	Cohesive Topsoil and Subsoil materials.
Inert Waste	19	0	25	Inert Waste Fill
Geological Barrier	20	0	25	Low permeability clay
Engineered Fill	20	0	25	Engineered placed and compacted materials
In-situ Clay (Ashton Mudstone Member)	20	0	25	Natural stiff clay

The depth to the underlying mudstone materials of the Aston Mudstone Member has been found to vary significantly across the site. Therefore, the assessment conservatively assumes that the site is solely underlain by cohesive materials of the Ashton Mudstone Member.

5.5.1 Parameters Selected for Basal Sub-Grade Analyses

The parameters for the basal sub-grade are provided within Table 7. The basal subgrade will comprise existing in-situ cohesive materials of the Ashton Mudstone Member. In the absence of any site specific data for these materials, conservative parameters have been assumed based of the material descriptions detailed within the available site investigation data and engineering judgment.

5.5.2 Parameters Selected for Side Slopes Sub-Grade Analyses

The side slope subgrade will comprise existing in-situ cohesive materials of the Ashton Mudstone Member and placed engineered fill materials. The engineered fill materials are to be placed to a maximum height of approximately 5m and constructed at a gradient of approximately 1(v):3(h). It is assumed that the engineered fill will comprise suitable cohesive materials and will be placed in accordance with an engineering specification.

5.5.3 Parameters Selected for Basal Liner Analyses

The parameters required for the basal liner analysis is the typical angle of shearing resistance and effective cohesion of the materials forming geological barrier.

The assumed parameters are presented in Table 7. The adopted parameters are based on the assumption that the geological barrier will be formed using a suitable imported cohesive material and that the materials will be placed in accordance with an engineering specification.

Engineered fill materials may also be placed as part of a regulating layer beneath the proposed geological barrier. It is assumed that the material properties of the engineered fill will be similar to those of the geological barrier and that these materials will be placed in accordance with an engineering specification.

5.5.4 Parameters Selected for Side Slope Liner Analyses

The parameters required for the basal liner analysis are the typical angle of shearing resistance and the effective cohesion of the materials forming geological barrier. It is assumed that the geological barrier and regulating engineered fill materials will comprise suitable cohesive materials placed in accordance with an engineering specification.

5.5.5 Parameters Selected for Waste Analyses

Assumed conservative values of effective shear strength and cohesion parameters for inert waste have been assumed to allow for variations in the waste accepted at the site. The assumed parameters are presented in Table 7 based on the expected nature of the waste.

5.5.6 Parameters Selected for Capping Analyses

As described in Section 4.2.6, restoration soils are to be placed above the waste mass following completion of filling activities. Typical restoration soil parameters are presented in Table 7 and are based on the expected nature of these soils (Subsoils and Topsoil).

5.5.7 Selection of Appropriate Factors of Safety

The factor of safety is the numerical expression of the degree of confidence that exists, for a given set of conditions, against a particular failure mechanism occurring. It is commonly expressed as the ratio of the load or action which would cause failure against the actual load or actions likely to be applied during service.

The factor of safety should be appropriate to the parameters selected and the quality of the site specific data. In this instance there is very limited site specific data and therefore conservative parameters have been assumed where relevant together with an appropriate factor of safety.

The factor of safety adopted for each component of the model is related to the consequences of a failure.

Therefore, prior to determining appropriate factors of safety for the various components of the model, it is necessary to identify key 'receptors' and evaluate the consequences in the event of a failure (relating to both stability and integrity).

Consideration of the following receptors is required.

- Groundwater;
- Other environmental receptors;
- Property - relating to site infrastructure, third party property;
- Human beings (i.e. direct risk).

The factors of safety have been determined based on using a Traditional Approach to the stability assessment and uses material properties and loads in an unmodified state and then apply a factor of safety to the analysis to allow for uncertainty and consequence of failure.

5.5.8 Factor of Safety for Basal Sub-Grade

Based on experience of similar slopes it is considered that a factory of safety of 1.3 is considered appropriate for the overall stability of the existing basal sub-grade.

No evidence of instability has been observed within the existing natural slopes at the site.

5.5.9 Factor of Safety for Side Slopes Sub-Grade

The side slope subgrade is to be formed by in-situ Aston Mudstone Member materials and engineered fill materials and constructed at a maximum gradient of approximately 1(v):3(h).

An acceptable factor of safety is usually considered to be 1.3 for permanent slopes of this nature. However, based on the consequence of failure, limited activity at the base of slope and the non-permanent nature of these features, a factor of safety of greater than 1.0 is considered acceptable. Any failures will be remediated as part of the placement of the geological barrier and the waste will provide a buttress to these slopes and increase the factor of safety for the permanent situation.

5.5.10 Factor of Safety for Basal Lining System

In this case it is considered appropriate to adopt a factor of safety of 1.3.

5.5.11 Factor of Safety for Side Slope Lining System

A factor of safety of 1.3 is considered appropriate when using conservative peak shear strength parameters as long term stability. Where reduced shear strength parameters are adopted (for example, for very long term conditions, involving the 'fully-softened' or residual shear strength of the side slope geological barrier), it is considered that the factor of safety could be reduced to a value greater than unity, in accordance with the advice given in the Guidance.

5.5.12 Factor of Safety for Waste Mass

In this case it is considered appropriate to adopt a factor of safety of 1.3.

5.5.13 Factor of Safety for Capping System

Assessment of the restoration soils and waste mass is considered necessary to ensure long term stability of the final restoration profile. A minimum factor of safety of 1.3 is considered appropriate where peak shear strength conditions are applied for the pre-settlement slopes.

5.6 Analyses

Details of the various SRA analyses undertaken for the site are presented in the following sections.

The analyses have been completed for a typical north-south trending section through the proposed landfill, allowing for the phased placement of inert waste.

In addition, analysis has also been completed for an approximately east-west trending section through the landfill during and after the placement of inert waste fill. Analyses has not been completed for the individual elements of this section as the basal slope gradients present are typically lower than those for the north-south trending sections and therefore are considered less critical.

5.6.1 Basal Sub-Grade Analyses

The stability analysis program SlopeW has been used to analyse the sections using the Bishop simplified method.

The assessment has been completed assuming the material parameters detailed in Table 7.

An assessment of the overall stability of the existing onsite slope (basal sub-grade) has been undertaken assuming and overall slope gradient of approximately 1(v):5(h). In addition, further analysis has been completed for slopes of approximately 1(v):3(h) to represent localised areas of steeper topography at the site.

The results of the analyse indicate a calculated factor of safety (FoS) of 2.264 for a typical 1(v):5(h) slope.

The analysis undertaken for areas of steeper slopes, approximately 1(v):3(h) indicates a calculated FoS of 1.63.

The output plots are presented as Output Plot 1 and 2, included in Appendix II.

The recorded FoS exceed the required factor of safety and are therefore considered acceptable.

5.6.2 Side Slopes Sub-Grade Analyses

The stability analysis has assumed that the side slopes will be formed by engineered fill materials or existing slopes formed within the Aston Mudstone Member materials with slope gradients not exceeding 1(v):3(h). The assessment has therefore been completed for slopes with a gradient of approximately 1(v):3(h) as a worst case scenario.

The FoS is calculated as 1.421 for the side slope constructed in engineered fill. The assessed slope formed within the existing Ashton Mudstone Member materials returned a calculated FoS of 1.630.

The recorded FoS exceed the required factor of safety and are therefore considered acceptable.
The output plot is presented as Output Plot 3 and 4, included in Appendix II.

5.6.3 Basal Liner Analyses

The stability analysis considered the stability of the basal liner prior to filling which is considered the worst case scenario for the proposed profile.

The calculated FoS is calculated as 1.564. The output plot is shown as Output Plot 5, included in Appendix II.

Based on the required factor of safety this is considered acceptable.

5.6.4 Side Slopes Liner Analyses

The calculated factor of safety is 1.495 for a 1(v):3(h) slope where the geological barrier is constructed over engineered fill and 1.601 for an approximately 1(v):3(h) slope where the geological barrier is constructed over natural materials. The output plots are shown as Output Plots 6 and 7, included in Appendix II.

The recorded factors of safety exceed the required factor of safety and are therefore considered acceptable.

5.6.5 Waste Analyses

In considering the stability of the waste mass, the stability and integrity of the geological barrier system has been considered as they are intrinsically linked.

Analyses have been undertaken for the phased deposition of waste and assumes that waste materials will not be placed at slope gradients in excess of 1(v):3(h).

For the north-south section analysed, the minimum FoS calculated for any or a combined circular failure is 1.385 for the waste profile at 1(v):3(h). The output plot is shown as Output Plot 8, included in Appendix II.

The analysis for the east-west section assessed has recorded a minimum FoS of 1.421 for the waste profile at 1(v):3(h). The output plot is shown as Output Plot 9, included in Appendix II.

Based on the required factor of safety this is considered acceptable.

5.6.6 Capping Analyses

Due to the nature of the waste contained in the inert landfill, it is understood that after filling the landfill is to be completed at the surface with an approximately 1.25m thick layer of restoration soils (Topsoil and Subsoil).

Typically, only shallow slopes <1(v):7(h) will be present at the surface following the restoration of the landfill, particularly for north-south sections through the completed

landfill. It is therefore not considered necessary to assess the stability of the restoration soils for this section. However, slightly stepper gradients will be present for the east-west trending section of the completed landfill, which are considered to require assessment.

The calculated FoS for the east-west section through the landfill is calculated as 2.607 following the placement of the restoration soils. The output plot is shown as Output Plot 10, included in Appendix II.

Further analysis has been completed to assess how the infiltration of water into the waste mass from the surface may impact the stability of the landfill. The assessment assumes the presence of water at the base of the waste mass together with a head of approximately 2m of water within the toe of the landfill profile.

As previously stated in section 5.1.5, it is considered that the nature of capping materials, landfill profile and proposed surface water drainage strategy will limit infiltration to the waste mass to very low levels and the completed assessment is considered to represent a 'worst case' scenario.

The analysis for the east-west section through the landfill, assuming the presence of water within the waste mass, has recorded a minimum FoS of 2.361. The output plot is shown as Output Plot 11, included in Appendix II.

Based on the required factor of safety, the recorded results are considered acceptable.

At present the nature of any slopes formed by the capping materials around the boundary of the site are not fully known. It is recommended that any slopes formed with the capping materials do no exceed 1(v):3(h)

5.7 Assessment

5.7.1 Basal Sub-Grade Assessment

It was considered necessary to undertake assessment of the basal subgrade due to the existing topography of the site.

Based on the findings of the analyses, it is considered that the basal subgrade has a suitable factor of safety.

5.7.2 Side Slopes Sub-Grade Assessment

The assessment of this component indicated that the stability of the unsupported side slopes, comprising existing natural materials or engineered fill, requires further assessment. The analysis undertaken considers the short to medium term stability of the worst case side slope geometry, 1(v): 3(h), prior to placement of the side slope geological barrier and waste.

Based on the findings of the analyses, it is considered that the side slope subgrade has a suitable factor of safety.

5.7.3 Basal Liner Assessment

The assessment of the basal liner indicates a suitable factor of safety.

5.7.4 Side Slopes Liner Assessment

The assessment of the side slope geological barrier indicated that the unconfined side slope geological barrier required further assessment. The assessment considers the medium term stability of the liner constructed on slopes not exceeding 1(v):3(h).

The analyses indicates that the side slope liner will have an adequate factor of safety.

The slope will be buttressed by the placement of waste. Based on phased filling the side slope geological barrier will remain unconfined for a relatively short time period and factors of safety will increase with the placement of the waste.

5.7.5 Waste Assessment

This SRA incorporates analyses of side slope geological barrier stability since this component plays a role in waste mass stability. The assessment also considers temporary waste slopes within the inert waste.

The assessment considers failures, solely within the waste materials and within the geological barrier and basal/side subgrades.

The stability assessment demonstrates that temporary waste slopes at a gradient of 1(v):3(h) return an adequate factor of safety in all analysed conditions.

It is recommended that site tipping rules should be used in order to maintain safe working practices. This should include presentation of the results and the approach to the analyses undertaken for this component.

5.7.6 Capping Assessment

Stability analysis of the worst case restoration profile has been carried out. The analysis findings indicate the factor of safety exceeds the minimum required.

Further analysis undertaken allowing for the presence of water within the waste mass indicate the factor of safety exceeds the minimum required.

5.8 Monitoring

5.8.1 The Risk Based Monitoring Scheme

Based on the results of the SRA, a simple risk-based monitoring scheme is considered appropriate for the future development of the landfill. The monitoring is limited to ensuring compliance with the tipping rules and monitoring of groundwater levels.

5.8.2 Basal Sub-Grade Monitoring

No instrumentation is required during construction or post final landscape restoration.

During construction it is recommended that visual inspection is undertaken to determine any areas of weakened or softened materials or areas of anomalous ground conditions. Any such materials should be removed and replaced with appropriately engineered fill materials.

5.8.3 Side Slopes Sub-Grade Monitoring

Monitoring during construction will comprise visual inspection to determine any failed or weakened zones that may require removal and replacement with appropriately engineered fill materials.

No instrumentation required during construction or post final landscape restoration.

5.8.4 Basal Lining System Monitoring

Monitoring during construction will comprise Construction Quality Assurance to ensure compliance with the construction specification.

No additional instrumentation is required during construction or post final landscape restoration.

5.8.5 Side Slope Lining System Monitoring

Monitoring during construction will comprise Construction Quality Assurance to ensure compliance with the construction specification.

No additional instrumentation required during construction or post final landscape restoration.

5.8.6 Waste Mass Monitoring

During infilling, tip faces and surrounding areas should be inspected daily for signs of failure.

No other specific monitoring is required for the waste other than to record waste elevations across the site.

5.8.7 Capping System Monitoring

Monitoring during construction will comprise Construction Quality Assurance to ensure compliance with the construction specification.

No additional instrumentation is required during construction or post final landscape restoration.

REFERENCES

BGS Sheet No. 325 – Exeter (Solid and Drift). 1:50 000 scale.

Geology of Britain viewer.

AA Environmental Limited, Non-Technical Summary - Lower Hare Farm, document reference 213189/NTS.

AA Environmental Limited, Importation Protocol and Construction Controls - Lower Hare Farm, document reference 213189/IP, dated April 2022.

McDonnell Cole Ltd, Hydrogeological Risk Assessment - Lower Hare Farm, Whitestone, Exeter, document reference 1776-HRA-01, dated September 2021.

Stability of Landfill; Lining Systems: Report No. 1 Literature Review - R&D Technical Report P1-385, volume TR1 - Environment Agency

Stability of Landfill; Lining Systems: Report No. 2 Guidance - R&D Technical Report P1-385, volume TR2 - Environment Agency

https://www.gov.uk/guidance/landfill-operators-environmental-permits/how-to-do-a-stability-risk-assessment-landfill-sites-for-inert-waste-or-deposit-for-recovery-activities

www.environment-agency.gov.uk

GENERAL NOTES

The interpretation made in this report is based on the information obtained during the course of the desk study and ground investigation. It should be appreciated that any desk study information is not necessarily exhaustive and that further information relevant to the site and its proposed usage may be available. There may be conditions present on the site that have not been revealed by the ground investigation which as a result have not been addressed within this report.

The accuracy of any map extracts cannot be guaranteed and it should be recognised that different conditions on site may have existed between and subsequent to the various map surveys.

The qualitative assessment of risk presented in this report presents an assessment of potential pollutant linkages between sources, pathways and receptors. A level of risk is attributed to these linkages. However a low or insignificant risk does not imply that elevated concentrations of various determinants are not present on the site when compared to background or 'greenfield' conditions.

The level of risk attributed is based on a number of factors and the interpretation of this risk may be applied in a different manner for a different end use or environmental setting. The presence of contaminants may be assessed in alternative ways by institutional bodies regardless of whether an apparent risk is present based on the identified pollutant linkages in this assessment.

This report may express an opinion on possible configurations of strata underlying the site between or beyond the exploratory holes or on the possible presence of features based on either visual, verbal or published evidence, this is for guidance only and no liability can be accepted for its accuracy.

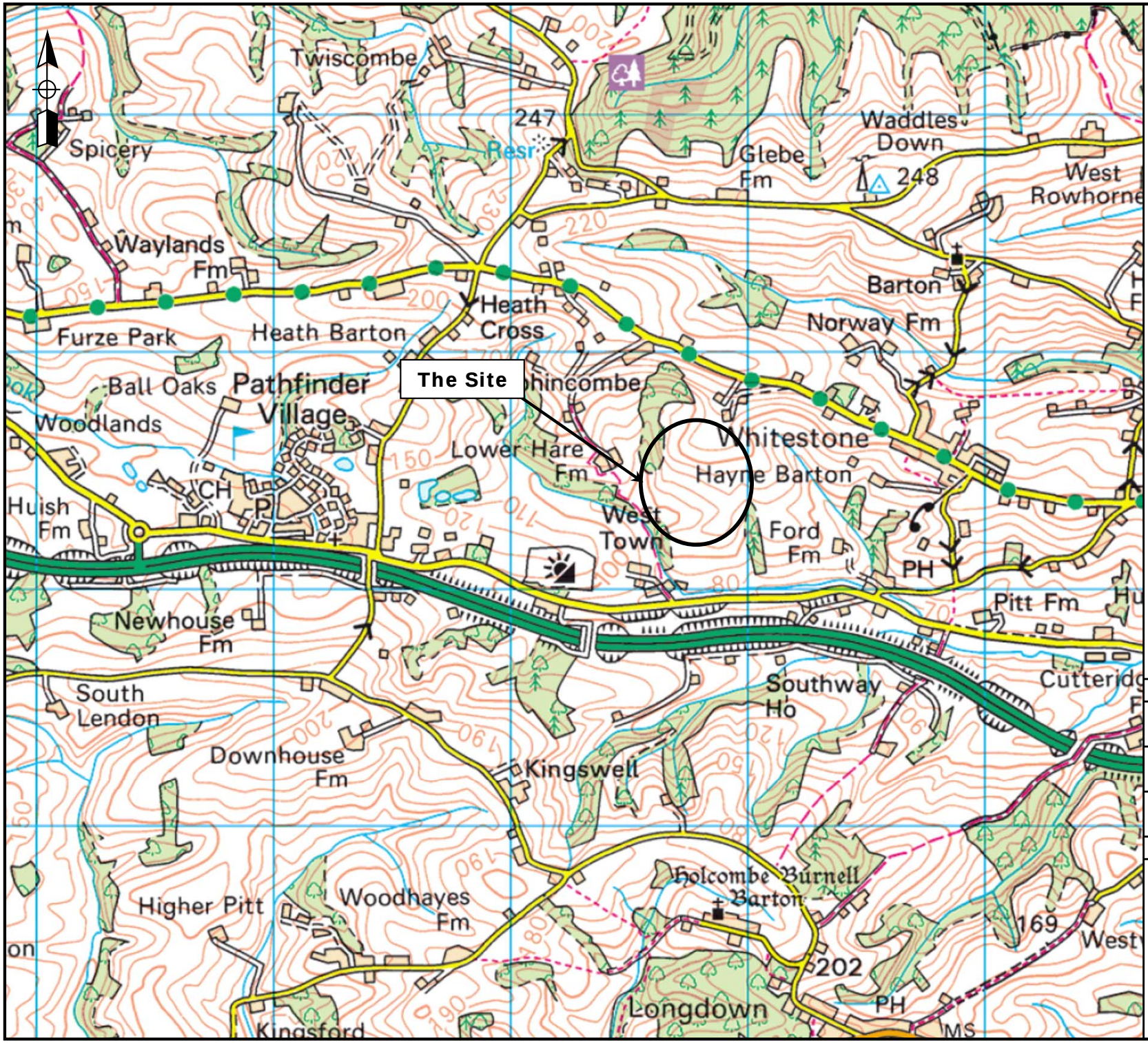
Comments made on ground conditions are based on the observations made at the time of the investigation works. It should be noted that groundwater levels may vary due to seasonal fluctuation or other factors. Observations made with respect to below ground gas concentrations may also vary due to seasonal factors and atmospheric conditions.

This report has been prepared in relation to the proposed development as detailed herein. Should the nature of the development change following the submission of this report a re-assessment of the conditions recorded on the site may be necessary.

This report may not be used in the assessment of the conditions at any site other than the site described herein

This report has been prepared for the sole use of the client and the client's agents and advisors in relation to the proposed development as detailed herein. The issue of this report to third parties not involved in the proposed development as described herein is not permitted without the prior permission being received in writing by ASL. Reproduction of this report to include all figures, drawings and appendices is prohibited without the prior written consent of ASL.

FIGURES



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OS Landranger Map Sheet No. 191 Okehampton & Dartmoor, 1:50,000 Scale

Notes:
Not to Scale

Drawing No.	**Figure 1**
Drawing Name	**Site Location Plan**
Project Name	**Lower Hare Farm, Whitestone, Exeter**
Client Name	**AA Environmental Limited**
Project No.	**167-22-696**

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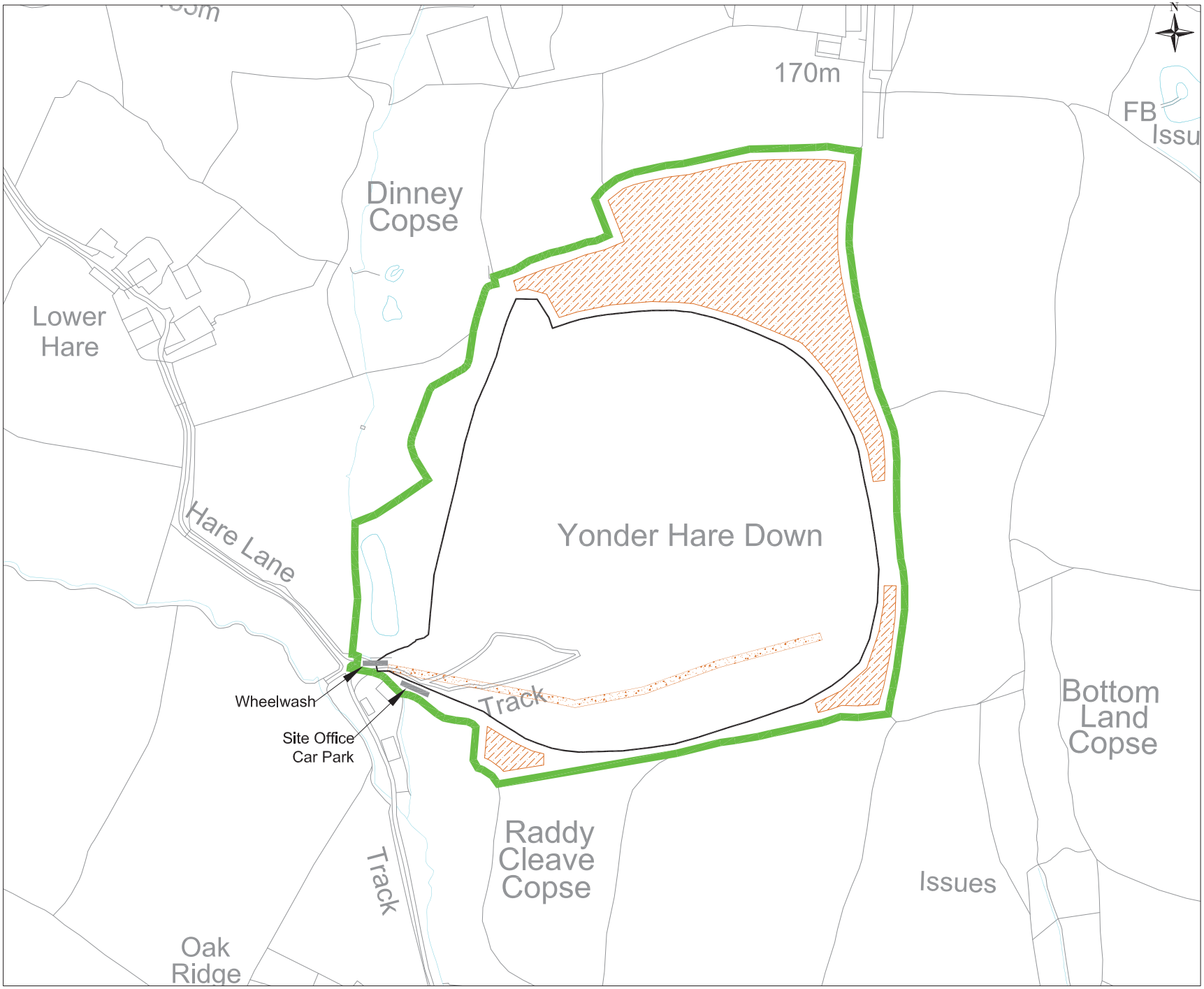
APPENDIX I

DRAWINGS



Key:

- Permit Site Boundary
- Extent of Earthworks
- Haul Route
- Indicative Topsoil Storage

Notes:

1. The Topsoil storage location will be in accordance with the Ecological Mitigation Plan and/or the Planning Permission.
2. Haul route location will change dependent on the phase of work.
3. There is no crushing or screening on site.

Rev.	Details	Drawn / Chkd.	Date

Project
213189
Lower Hare Farm

Title
Site Layout Plan

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Scale	Date	Drg. No.	Rev.
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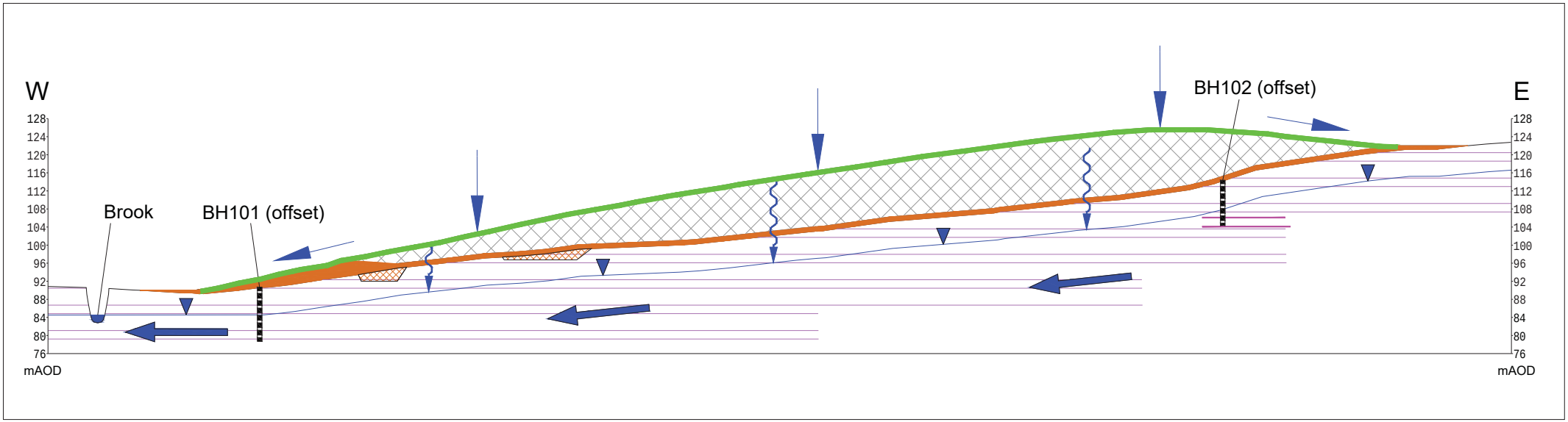
	Drawn: KE / Chkd.: EB		



Key:

- Rainfall/ Infiltration
- Seepage
- Direction of Groundwater Flow
- Groundwater Level (5.5 - 7.5 m bgl)
- Waste
- Geological Barrier
- Restoration Soils (1.25 m agricultural layer)
- Mudstone
- Igneous Rock
- Engineering fill placement within temporary attenuation lagoon

Notes:

1. Extent of Igneous rock is unknown.
2. Depths derived from boreholes and desktop information.

Rev.	Details	Drawn / Chkd.	Date

Project

213189
Lower Hare Farm

Title

Conceptual Site Model Plan

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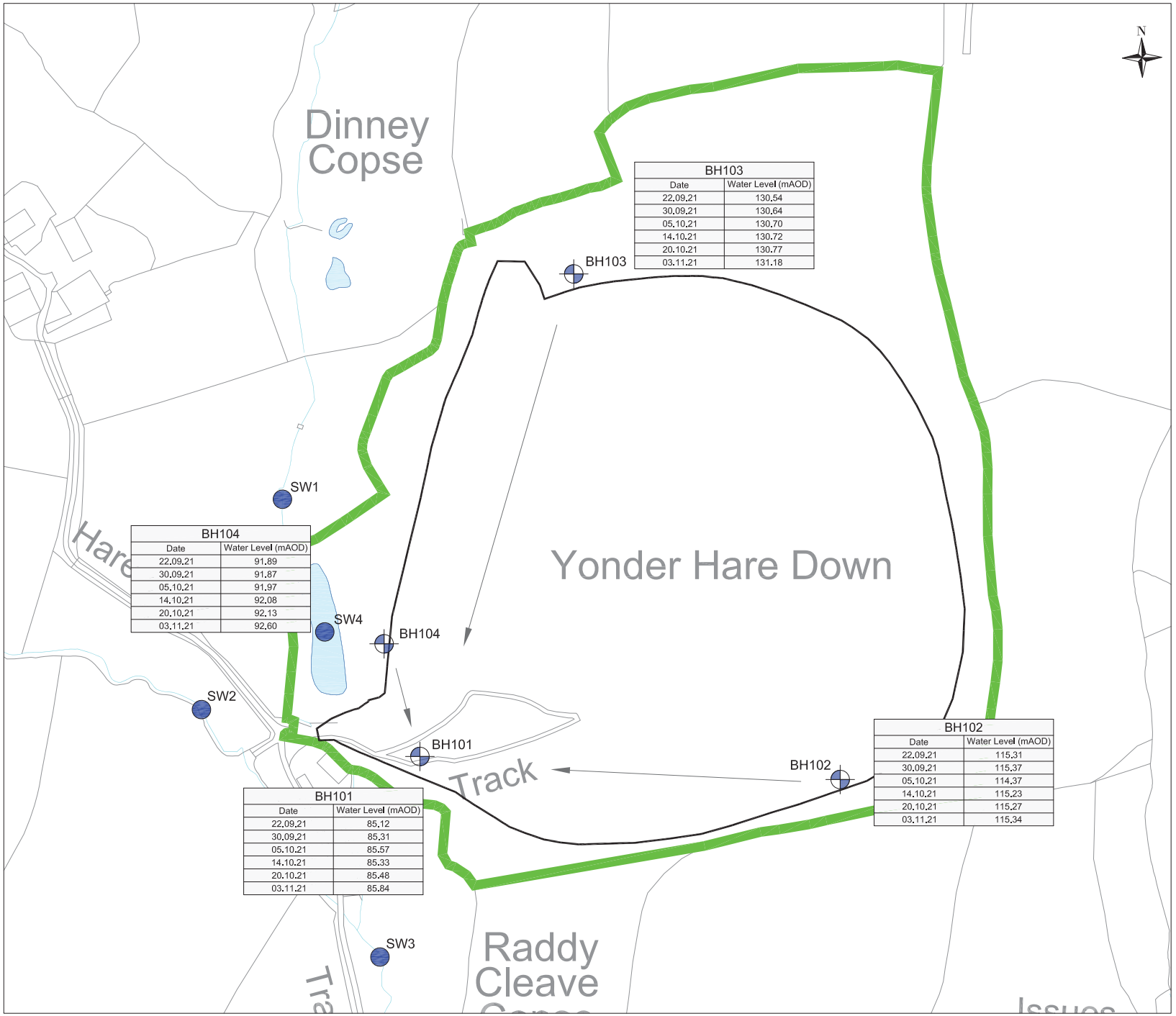
	Drawn: KW / Chkd.: EB		



Key:

- Permit Site Boundary
- Extent of Earthworks
- Groundwater Monitoring Boreholes
- Surface Water Monitoring Location
- Surface Water Pond
- Surface Water Course
- Expected Groundwater Flow

Rev.	Details	Drawn / Chkd.	Date

Project
213189
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Title
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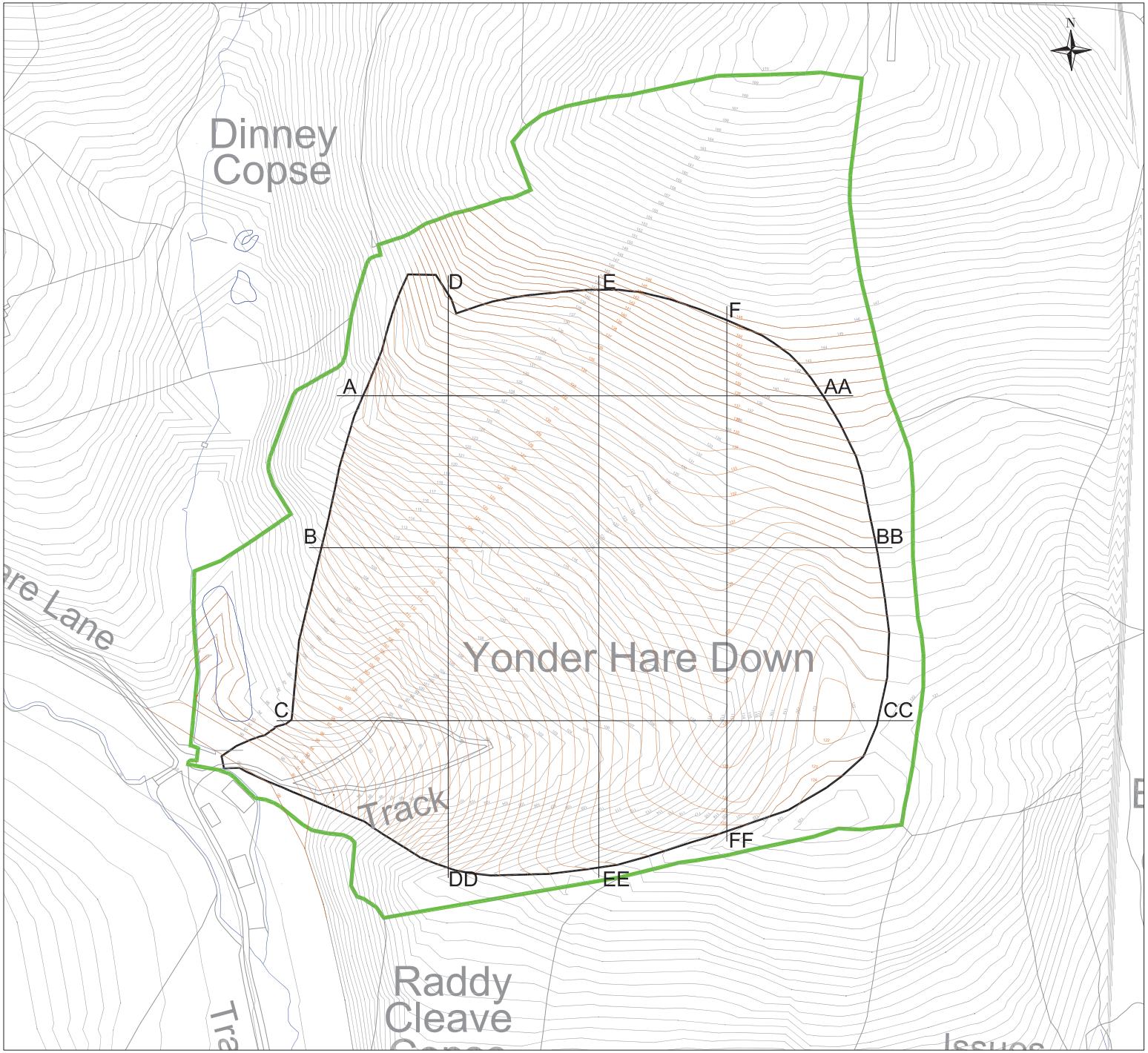

Key:

- Site Boundary
- 100 Existing Ground Level (m AOD)
- 100 Proposed Ground Level (m AOD)
- Area of Earthworks
- A AA Cross Section

Notes:

1. Cross section diagrams A-AA and B-BB are presented in drawing 213189/D/004B.
2. Cross section diagrams C-CC and D-DD are presented in drawing 213189/D/004C.
3. Cross section diagrams E-EE and F-FF are presented in drawing 213189/D/004D.

Rev.	Details	Drawn / Chkd.	Date

Project

213189
Lower Hare Farm

Title

Cross Section Location Plan

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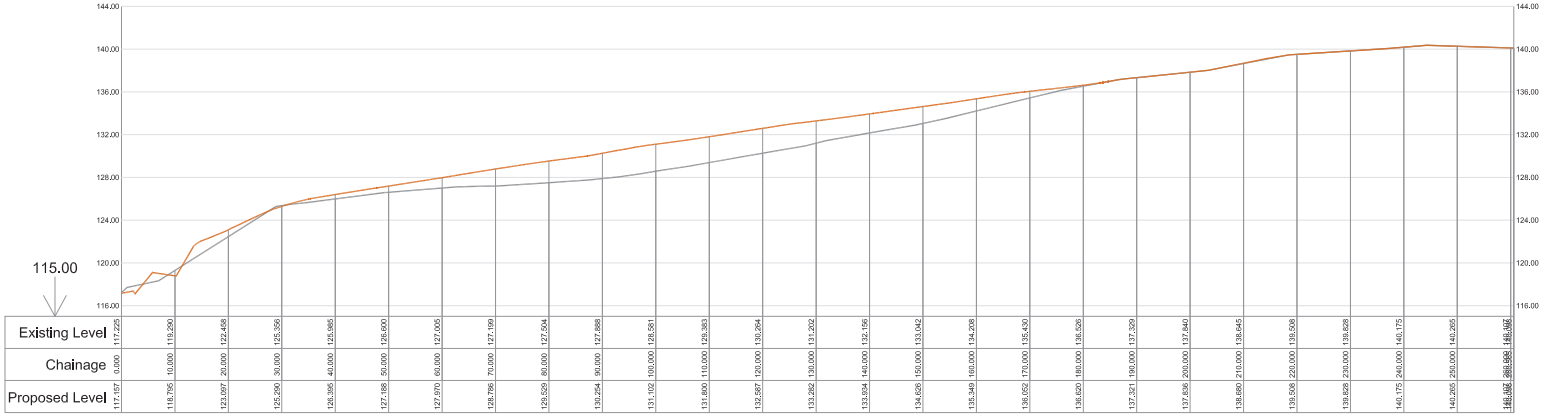
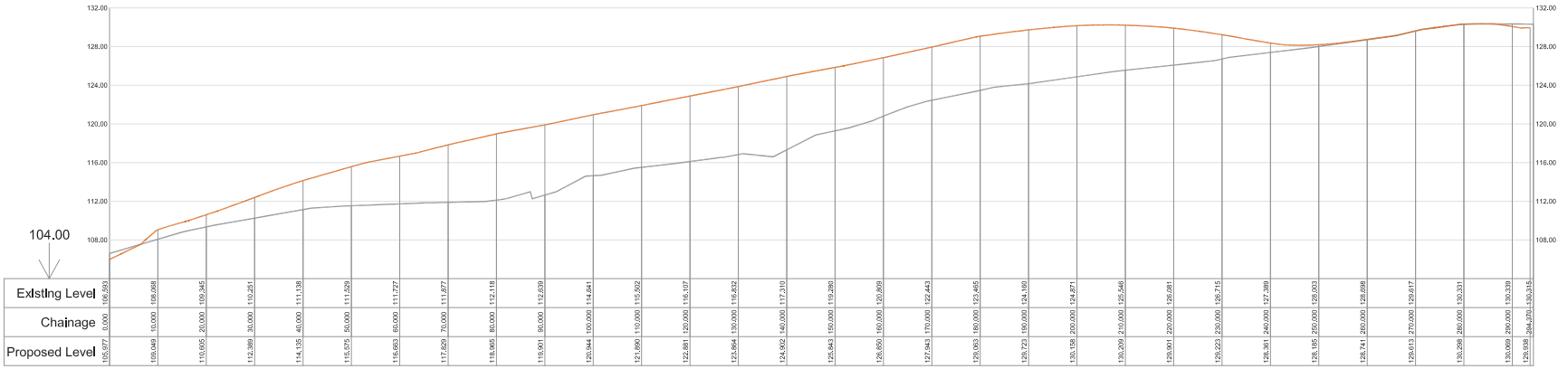


A-AA

Horiz. 1:500
Vert. 1:250



B-BB

Horiz. 1:500
Vert. 1:250

Key:

Existing Ground Level (m AOD)

Proposed Ground Level (m AOD)

Notes:

1. The horizontal and vertical exaggeration for each of the cross section diagrams is 1:1 and 2:1, respectively.

Rev.	Details	Drawn / Chkd.	Date

Project

213189
Lower Hare Farm

Title

Cross Section Diagrams A-AA and B-BB

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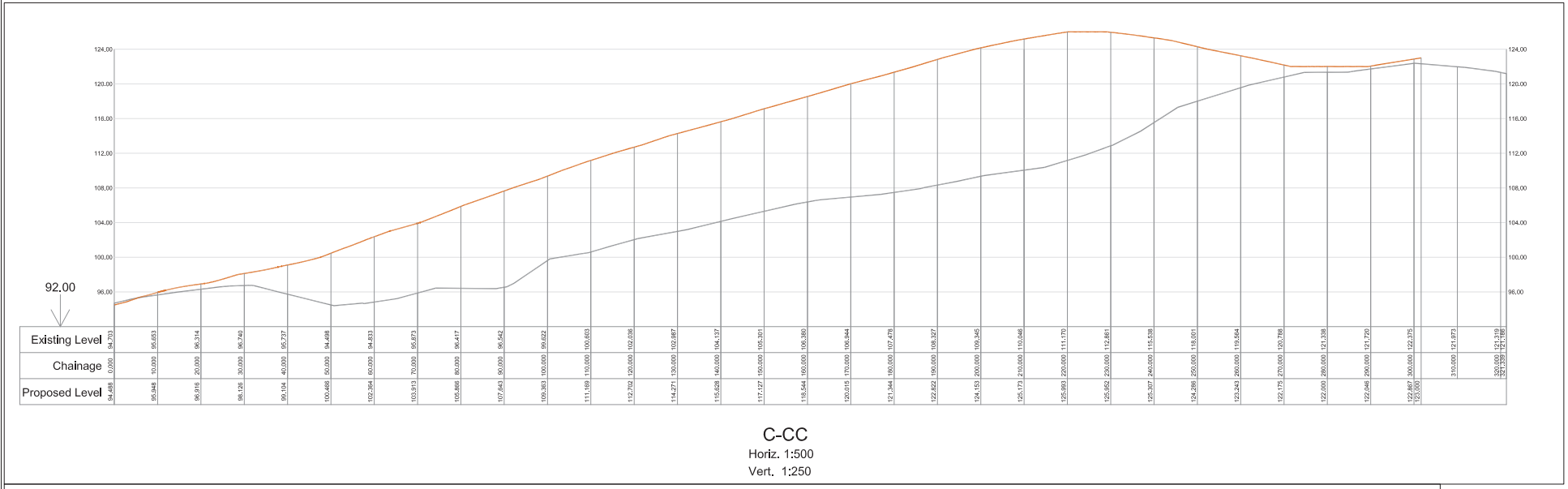
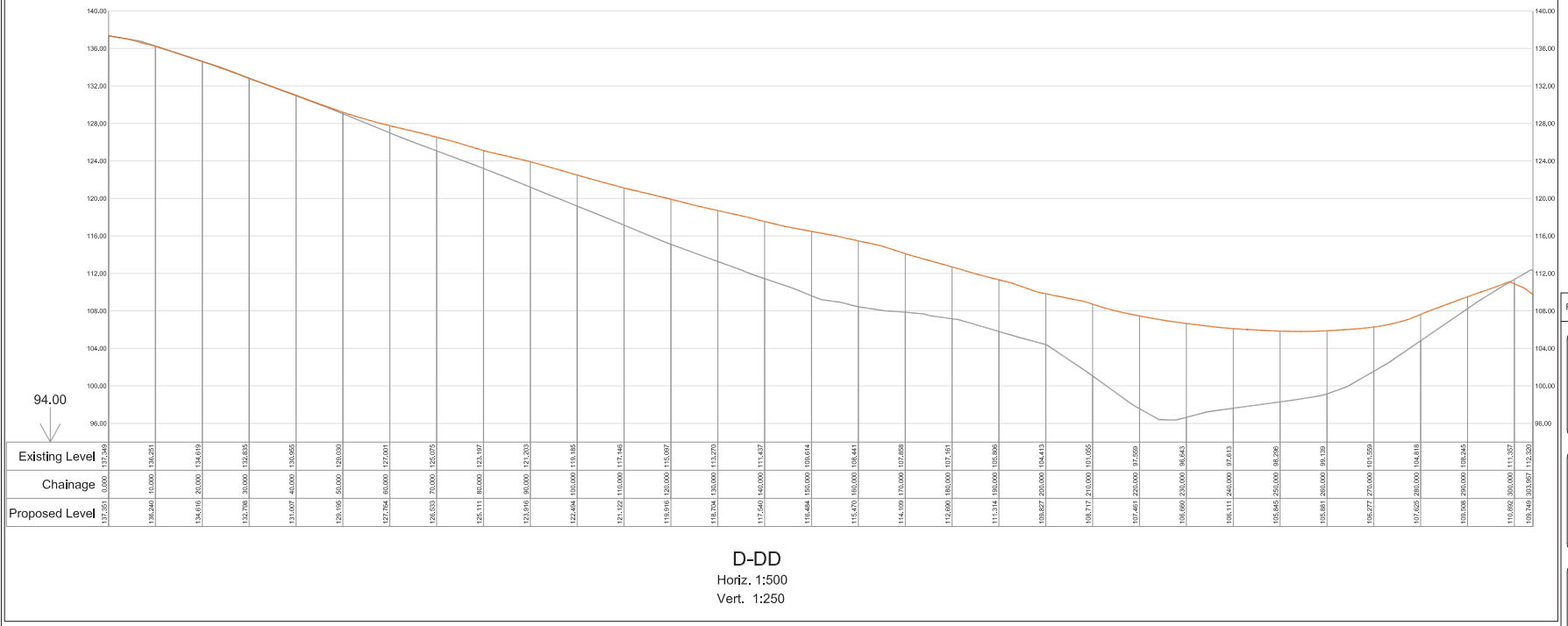


C-CC
Horiz. 1:500
Vert. 1:250



D-DD
Horiz. 1:500
Vert. 1:250

Key:

Existing Ground Level (m AOD)

Proposed Ground Level (m AOD)

Notes:

1. The horizontal and vertical exaggeration for each of the cross section diagrams is 1:1 and 2:1, respectively.

Rev.	Details	Drawn / Chkd.	Date

Project

213189
Lower Hare Farm

Title

Cross Section Diagrams C-CC and D-DD

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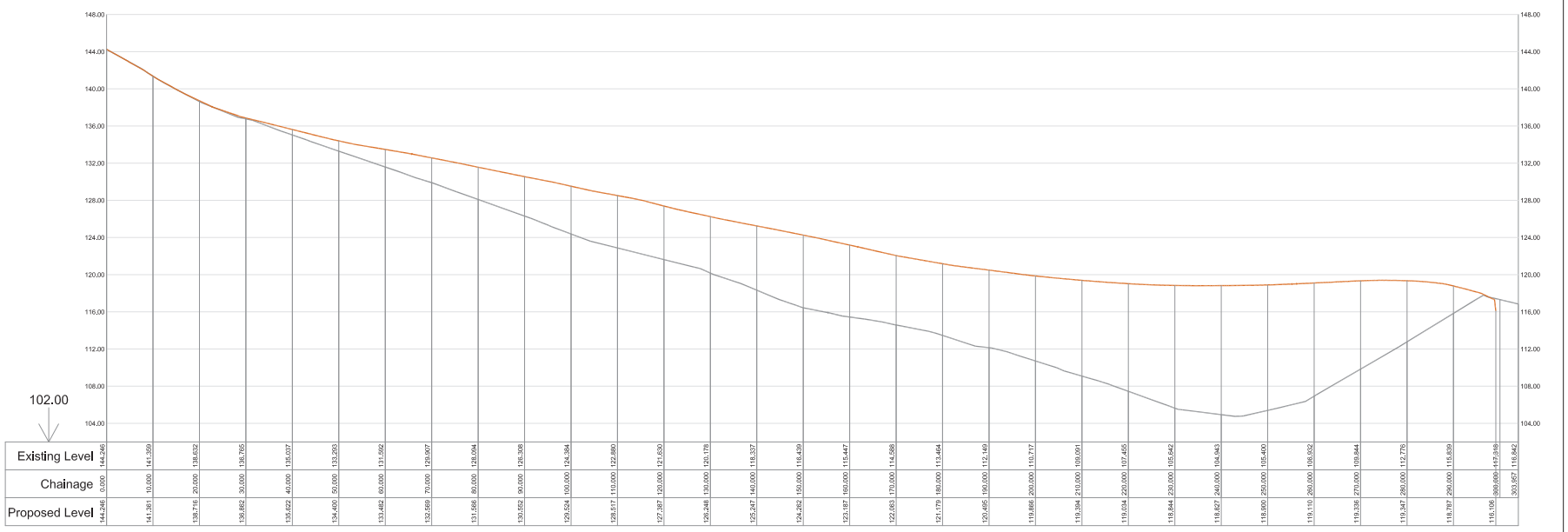

E-EE
Horiz. 1:500
Vert. 1:250

Key:

Existing Ground Level (m AOD)

Proposed Ground Level (m AOD)

Notes:

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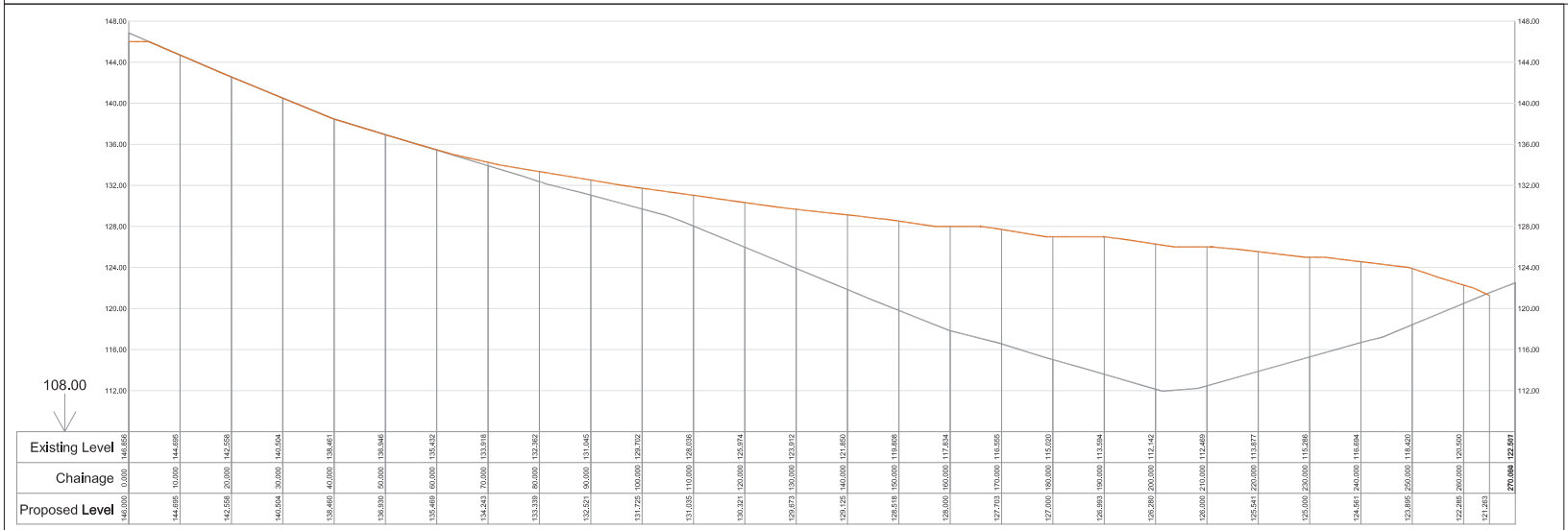

F-FF
Horiz. 1:500
Vert. 1:250

Rev.	Details	Drawn / Chkd.	Date

Project

213189
Lower Hare Farm

Title

Cross Section Diagrams E-EE and F-FF

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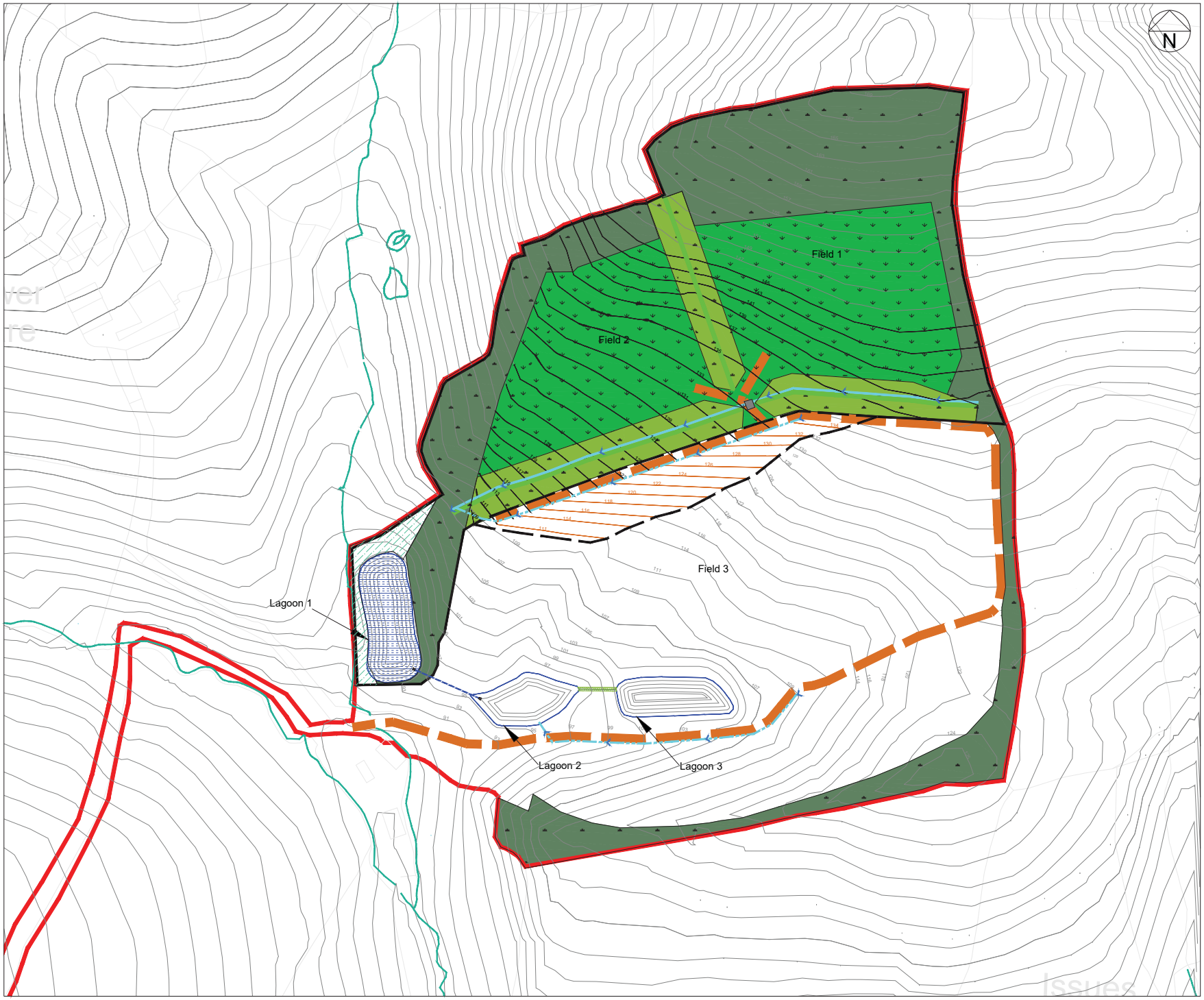

Key:

- Site Boundary
- Phase 1 Boundary
- Area of overlap of Phase 1 & 2 Earthworks
- Existing ground level contours
- Restoration contours
- Basal contours
- Headland (Lowland Meadow Habitat) Buffer Zone
- Headland (Neutral Grassland Habitat) Buffer Zone
- Restored Agricultural Field
- Retained existing trees
- Devon Hedgebank
- Permanent Drainage Swale
- Temporary Drainage Ditch
- Haul Route
- Temporary Drainage Swale
- Surface Water Feature
- Attenuation Pond
- Culvert
- DN450 Twinwall Pipe

Notes:

1. Total site area: 115385 m^2
   Site area fully restored in Phase 1: 53,724 m^2
   Percentage of site fully restored in Phase 1: 46%
2. Phase 1 volume of engineering fill: 32,420 cu m.

Rev.	Details	Drawn / Chkd.	Date

Project

213189
Lower Hare Farm

Title

Phase 1 Overview
Enabling Works

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Scale	Date	Drg. No.	Rev.
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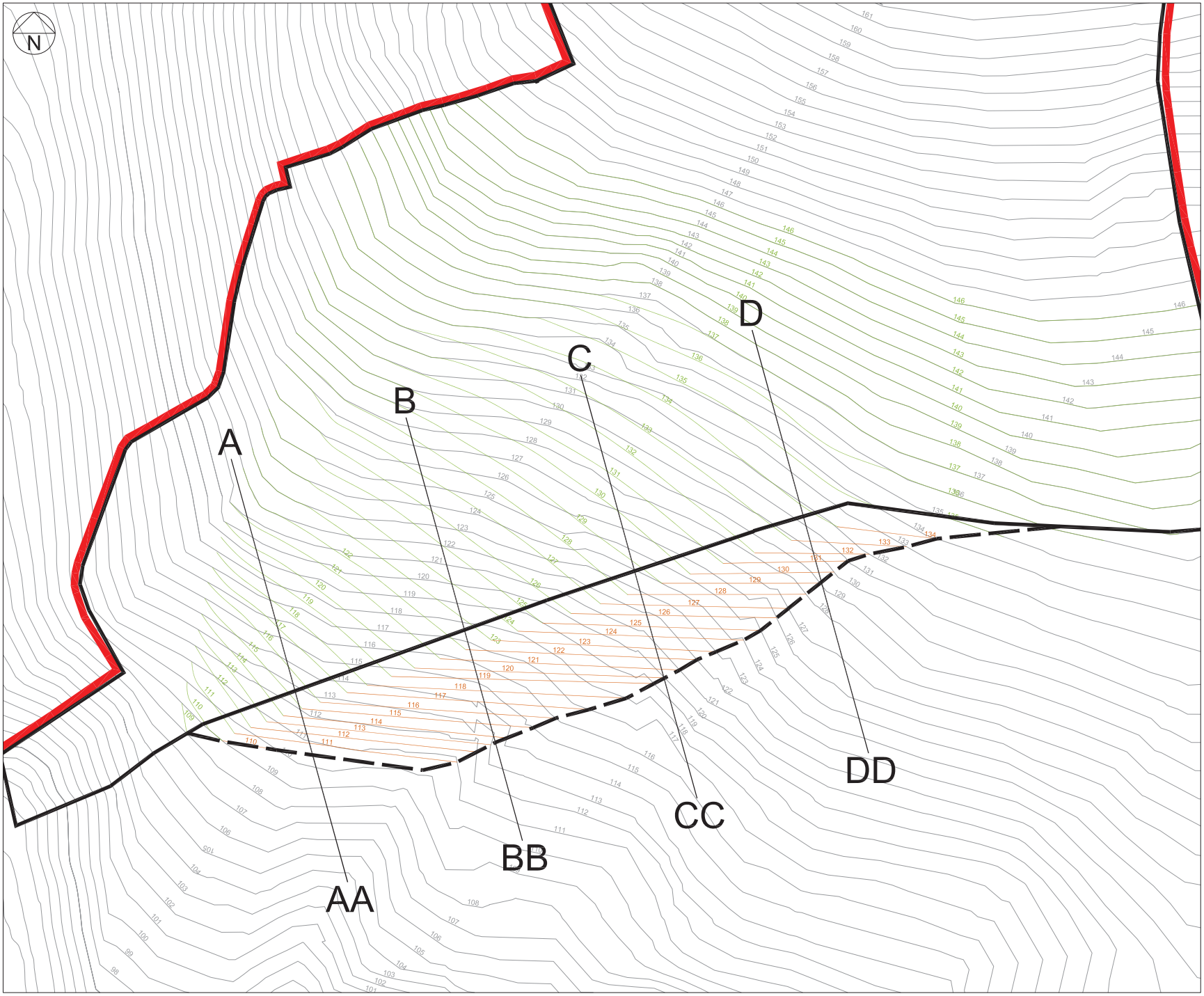

Key:

- Site Boundary
- Phase 1 Boundary
- Extent of Phase 1 Earthworks
- Existing Ground Level Contours
- Restoration Contours
- Basal Contours

Rev.	Details	Drawn / Chkd.	Date

Project

213189
Lower Hare Farm

Title

Phase 1 Topographical Detail

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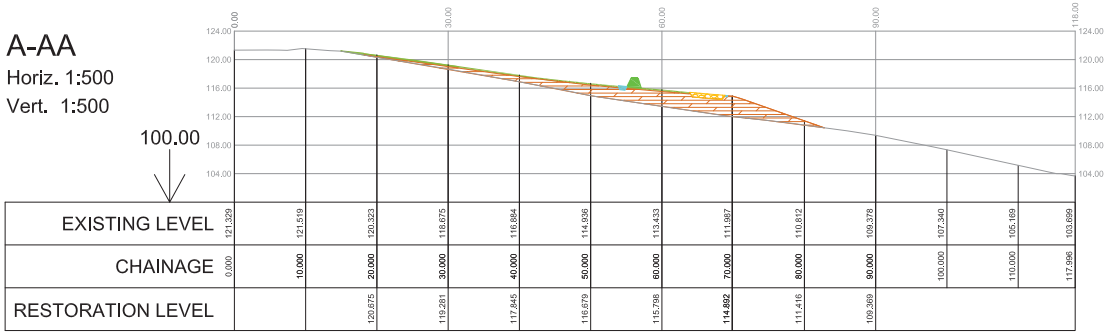
A-AA

Horiz. 1:500
Vert. 1:500

100.00

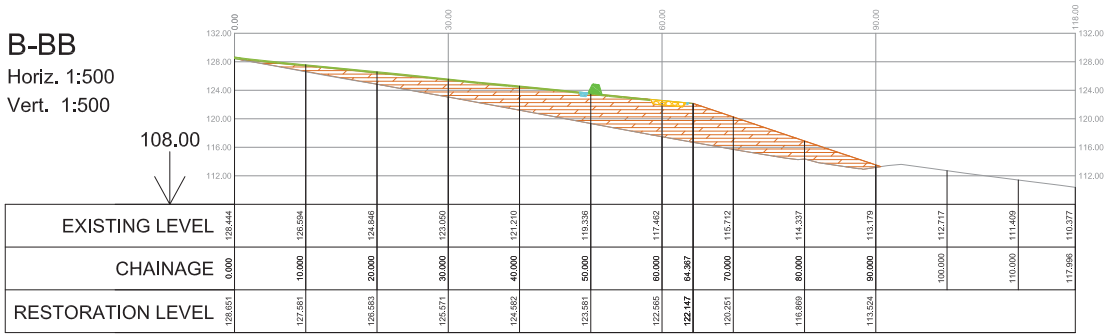


EXISTING LEVEL	121.329	121.519	120.323	118.675	116.884	114.936	113.433	111.987	110.812	109.378	107.340	105.169	103.699
CHAINAGE	0.000	10.000	20.000	30.000	40.000	50.000	60.000	70.000	80.000	90.000	100.000	110.000	117.996
RESTORATION LEVEL			120.875	119.281	117.845	116.679	115.798	114.892	111.416	109.369			

B-BB

Horiz. 1:500
Vert. 1:500

108.00

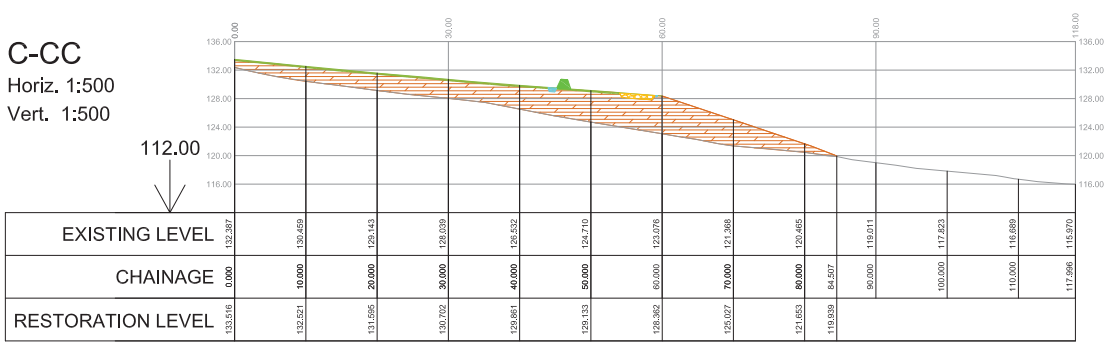


EXISTING LEVEL	128.444	128.594	124.846	123.090	121.210	119.336	117.482	115.712	114.337	113.179	112.717	111.469	110.377
CHAINAGE	0.000	10.000	20.000	30.000	40.000	50.000	60.000	64.367	70.000	80.000	90.000	100.000	110.000	117.996
RESTORATION LEVEL	128.651	127.581	126.563	125.571	124.562	123.581	122.565	122.147	120.251	116.869	113.524			

C-CC

Horiz. 1:500
Vert. 1:500

112.00

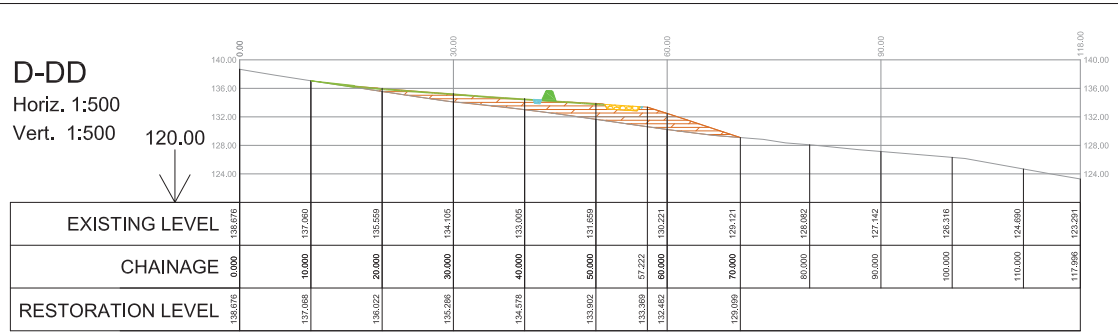


EXISTING LEVEL	132.387	132.459	129.143	128.039	126.532	124.710	123.076	121.368	120.465	119.611	117.823	116.889	115.970
CHAINAGE	0.000	10.000	20.000	30.000	40.000	50.000	60.000	70.000	80.000	84.507	90.000	100.000	110.000	117.996
RESTORATION LEVEL	133.516	132.521	131.595	130.702	129.851	129.133	128.362	125.027	121.653	119.939			

D-DD

Horiz. 1:500
Vert. 1:500

120.00



EXISTING LEVEL	138.676	137.060	135.559	134.105	133.005	131.659		130.221	129.121	128.082	127.142	126.316	124.690	123.291
CHAINAGE	0.000	10.000	20.000	30.000	40.000	50.000	57.222	60.000	70.000	80.000	90.000	100.000	110.000	117.996
RESTORATION LEVEL	138.676	137.068	136.022	135.288	134.578	133.802	133.369	132.482	129.099					

Key:

- Existing Ground Level
- Reinstated Soils
- Engineering Fill
- Devon Hedgebank
- Drainage Swale
- Haul Route
- Surface Water Grip

Rev.	Details	Drawn / Chkd.	Date

Project
213189
Lower Hare Farm

Title
Phase 1 Cross-Section Detail

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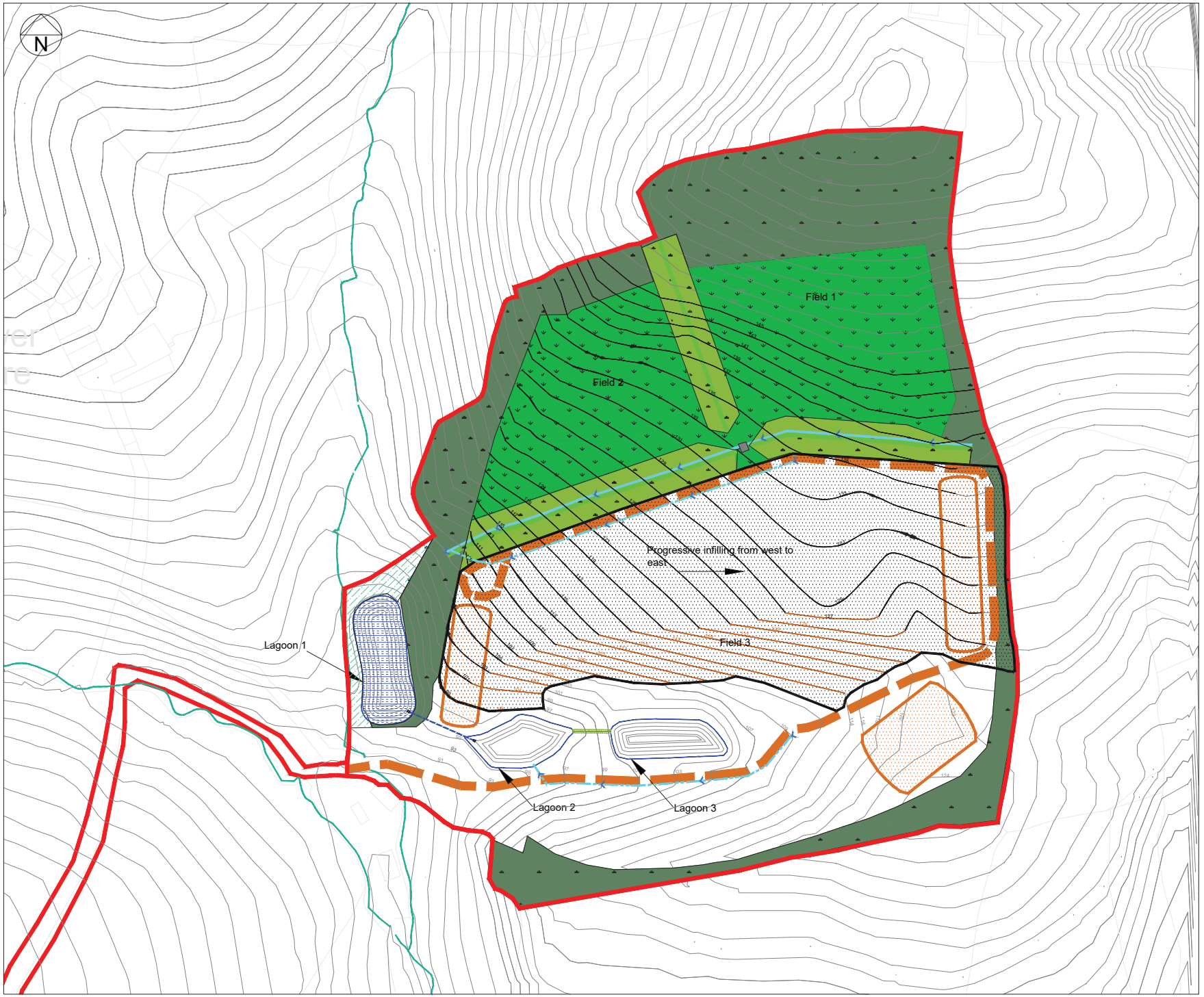
Scale	Date	Drg. No.	Rev.
1:750@A3	Apr'22	213189/D/PH1/003	
	Drawn: KW / Chkd.: ML		



Key:

- Site Boundary
- Phase 2 Area
- Existing ground level contours
- Restoration contours
- Contours in area of P2 and P3 overlap
- Headland (Lowland Meadow Habitat) Buffer Zone
- Headland (Neutral Grassland Habitat) Buffer Zone
- Restored Agricultural Field
- Retained existing trees
- Devon Hedgebank
- Permenant Drainage Swale
- Temporary Drainage Ditch
- Haul Route
- Temporary Drainage Swale
- Surface Water Feature
- Topsoil Stockpile
- Attenuation Pond
- Culvert
- DN450 Twinwall Pipe

Notes:

1. Total site area: 115,385 m^2
   Site area fully restored in Phase 2: 78,091 m^2
   Percentage of site fully restored in Phase 2: 67%
2. Phase 2 volume of engineering fill / geological barrier: 23,260 cu m.
3. Eastern and Western topsoil stockpiles will be progressively used during the restoration of Phase 2.
4. Phase 2 volume of restoration soils: 13,180 cu m.
5. Phase 2 volume of inert waste: 55,820 cu m.

Rev.	Details	Drawn / Chkd.	Date

Project

213189
Lower Hare Farm

Title

Phase 2 Overview
Landfill North Construction

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Scale	Date	Drg. No.	Rev.
1:2,000@A3	Apr'22	213189/D/PH2/001A	
	Drawn: KW / Chkd.: ML		

Key:

- Site Boundary
- Area of overlap of Phase 2 & 3 Earthworks
- Existing ground level contours
- Restoration contours
- Contours in area of P2 and P3 overlap
- Headland (Lowland Meadow Habitat) Buffer Zone
- Headland (Neutral Grassland Habitat) Buffer Zone
- Restored Agricultural Field
- Retained existing trees
- Devon Hedgebank
- Permanent Drainage Swale
- Temporary Drainage Ditch
- Haul Route
- Temporary Drainage Swale
- Surface Water Feature
- Topsoil Stockpile
- Attenuation Pond
- Culvert
- DN450 Twinwall Pipe

Notes:

1. Total site area: 115,385 m^2
   Site area fully restored in Phase 2: 78,091 m^2
   Percentage of site fully restored in Phase 2: 67%
2. Phase 2 volume of engineering fill / geological barrier: 23,260 cu m.
3. Phase 2 volume of restoration soils: 13,180 cu m.
4. Phase 2 volume of inert waste: 55,820 cu m.

Rev.	Details	Drawn / Chkd.	Date

Project

213189
Lower Hare Farm

Title

Phase 2 Overview
Landfill North Restoration

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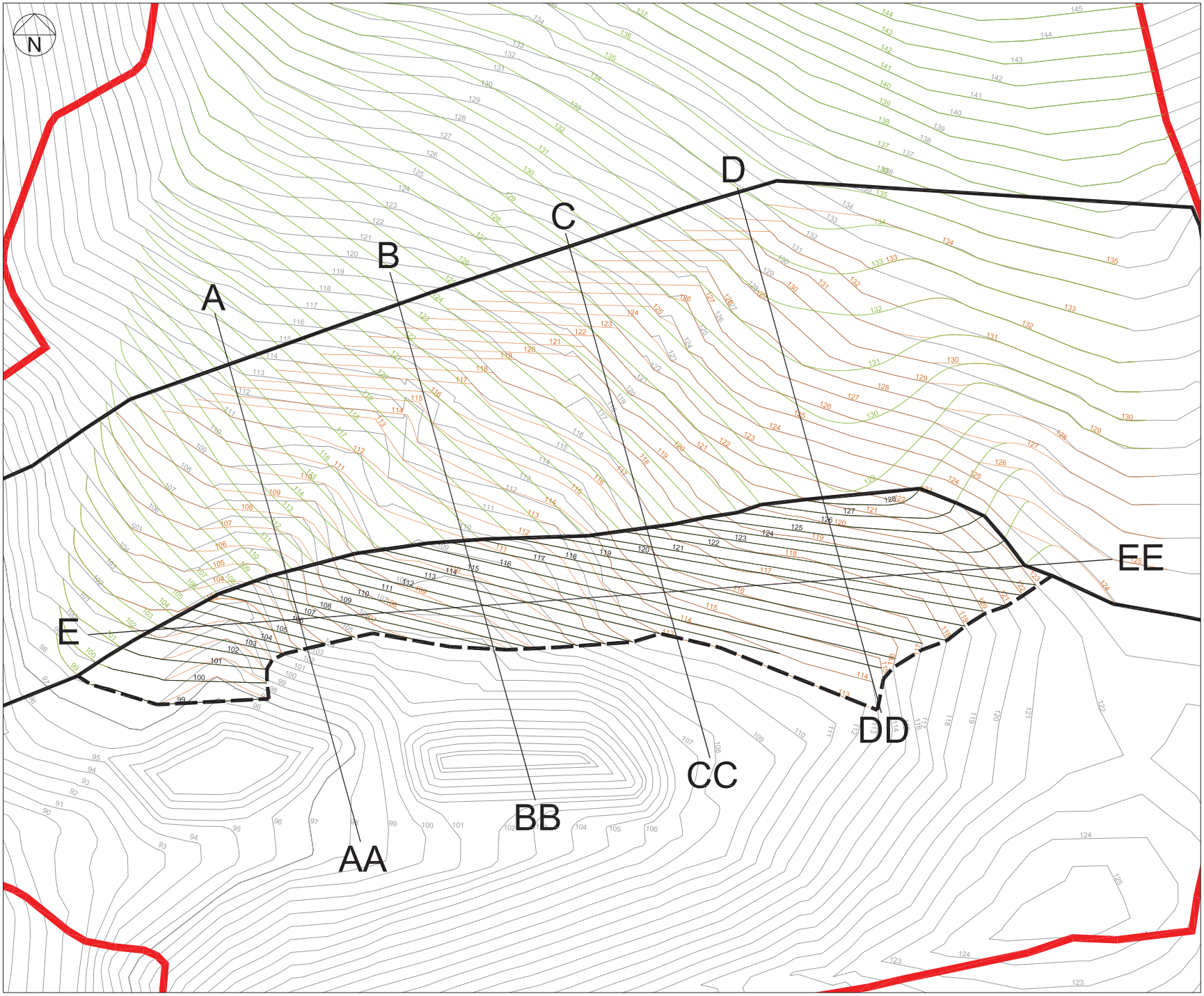
Scale	Date	Drg. No.	Rev.
1:2,000@A3	Apr'22	213189/D/PH2/001B	
	Drawn: KW		
	Chkd.: ML		



Key:

- Site Boundary
- Phase 2 Boundary
- Extent of Phase 2 Earthworks
- Existing ground level contours
- Restoration contours
- Basal contours
- Waste batter contours

Rev.	Details	Drawn / Chkd.	Date

Project

213189
Lower Hare Farm

Title

Phase 2 Topographical Detail

AA Environmental Ltd
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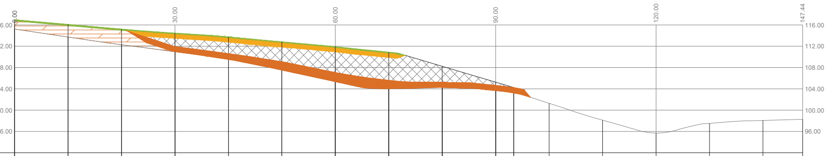
Scale	Date	Drg. No.	Rev.
1:1,000@A3	Apr'22	213189/D/PH2/002	
	Drawn: KW / Chkd.: ML		

A-AA
Horiz. 1:500
Vert. 1:500

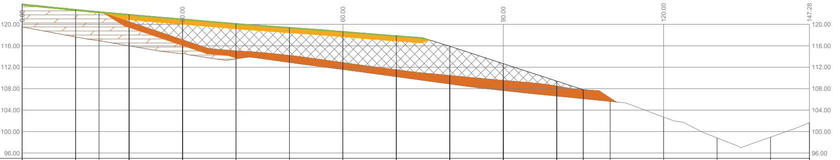
92.00



EXISTING LEVEL	CHAINAGE	RESTORATION LEVEL
115.222	0.000	116.997
113.730	10.000	116.115
112.274	20.059	115.212
110.971	30.000	114.475
109.546	40.000	113.758
107.509	50.000	112.835
105.337	60.000	111.925
103.973	70.000	110.880
104.249	80.000	108.231
103.651	90.000	105.258
	93.372	104.256
101.286	100.000	
98.105	110.000	
95.693	120.000	
97.524	130.000	
98.067	140.000	
98.281	147.437	

B-BB
Horiz. 1:500
Vert. 1:500

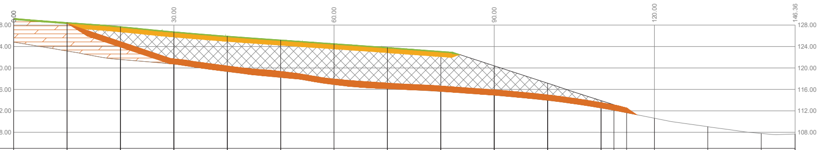
95.00



EXISTING LEVEL	CHAINAGE	RESTORATION LEVEL
119.512	0.000	123.811
117.647	10.000	122.794
	14.387	122.374
115.984	20.000	121.865
114.576	30.000	117.117
113.549	40.000	115.043
112.901	50.000	119.431
111.594	60.000	118.685
110.238	70.000	117.886
108.873	80.000	115.897
107.655	90.000	112.660
106.613	100.000	109.417
	104.953	107.811
105.629	110.000	
102.697	120.000	
98.814	130.000	
98.956	140.000	
101.654	147.282	

C-CC
Horiz. 1:500
Vert. 1:500

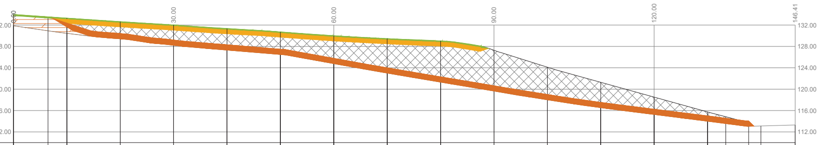
105.00



EXISTING LEVEL	CHAINAGE	RESTORATION LEVEL
124.827	0.000	129.246
123.151	10.000	128.481
121.573	20.000	127.725
120.713	30.000	126.761
119.340	40.000	125.945
118.247	50.000	125.234
116.917	60.000	124.545
116.136	70.000	123.842
115.633	80.000	123.101
114.921	90.000	115.921
113.973	100.000	117.155
112.524	110.000	113.905
	112.428	113.137
	114.792	112.533
110.621	120.000	
109.040	130.000	
107.786	140.000	
107.685	146.356	

D-DD
Horiz. 1:500
Vert. 1:500

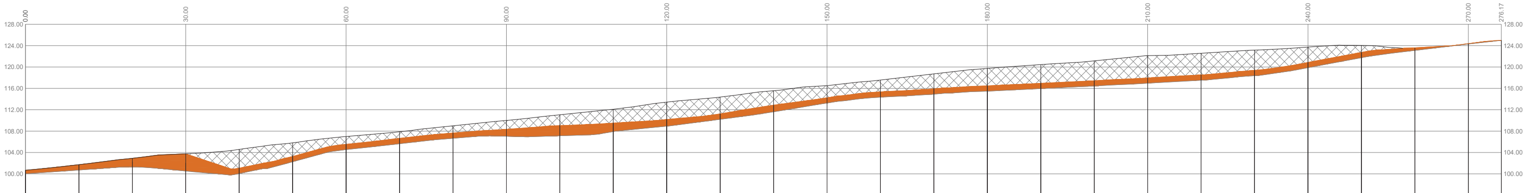
110.00



EXISTING LEVEL	CHAINAGE	RESTORATION LEVEL
131.860	0.000	134.000
	6.474	133.513
130.453	10.000	133.303
129.408	20.000	132.645
128.212	30.000	132.038
127.314	40.000	131.355
126.487	50.000	130.726
124.780	60.000	130.024
123.009	70.000	129.480
121.319	80.000	129.043
119.646	90.000	127.271
118.018	100.000	119.018
116.538	110.000	117.538
115.263	120.000	118.519
114.002	130.000	115.747
	133.415	114.874
	137.704	114.049
113.116	140.000	
113.305	146.412	

E-EE
Horiz. 1:500
Vert. 1:500

96.00



EXISTING LEVEL	CHAINAGE	WASTE SLOPE LEVEL
100.016	0.000	100.676
100.712	10.000	101.723
101.295	20.000	102.915
100.537	30.000	103.760
100.059	40.000	104.579
102.264	50.000	105.804
104.541	60.000	106.961
105.636	70.000	107.862
106.648	80.000	108.987
107.031	90.000	109.997
107.123	100.000	111.055
107.909	110.000	112.094
108.926	120.000	113.424
110.205	130.000	114.371
111.622	140.000	115.561
113.238	150.000	116.508
114.343	160.000	117.561
114.912	170.000	118.715
115.471	180.000	119.733
115.958	190.000	120.450
116.438	200.000	121.148
116.959	210.000	122.128
117.522	220.000	122.570
118.373	230.000	123.170
119.871	240.000	123.712
121.741	250.000	124.037
123.102	260.000	123.598
124.297	270.000	124.386
124.986	276.171	125.000

Key:

- Existing Ground Level
- Reinstated Soils
- Engineering Fill
- Restoration Capping Layer
- Inert Waste
- Geological Barrier

Rev.	Details	Drawn / Chkd.	Date

Project
213189
Lower Hare Farm

Title
Phase 2 Cross-Section Detail

AA Environmental Ltd
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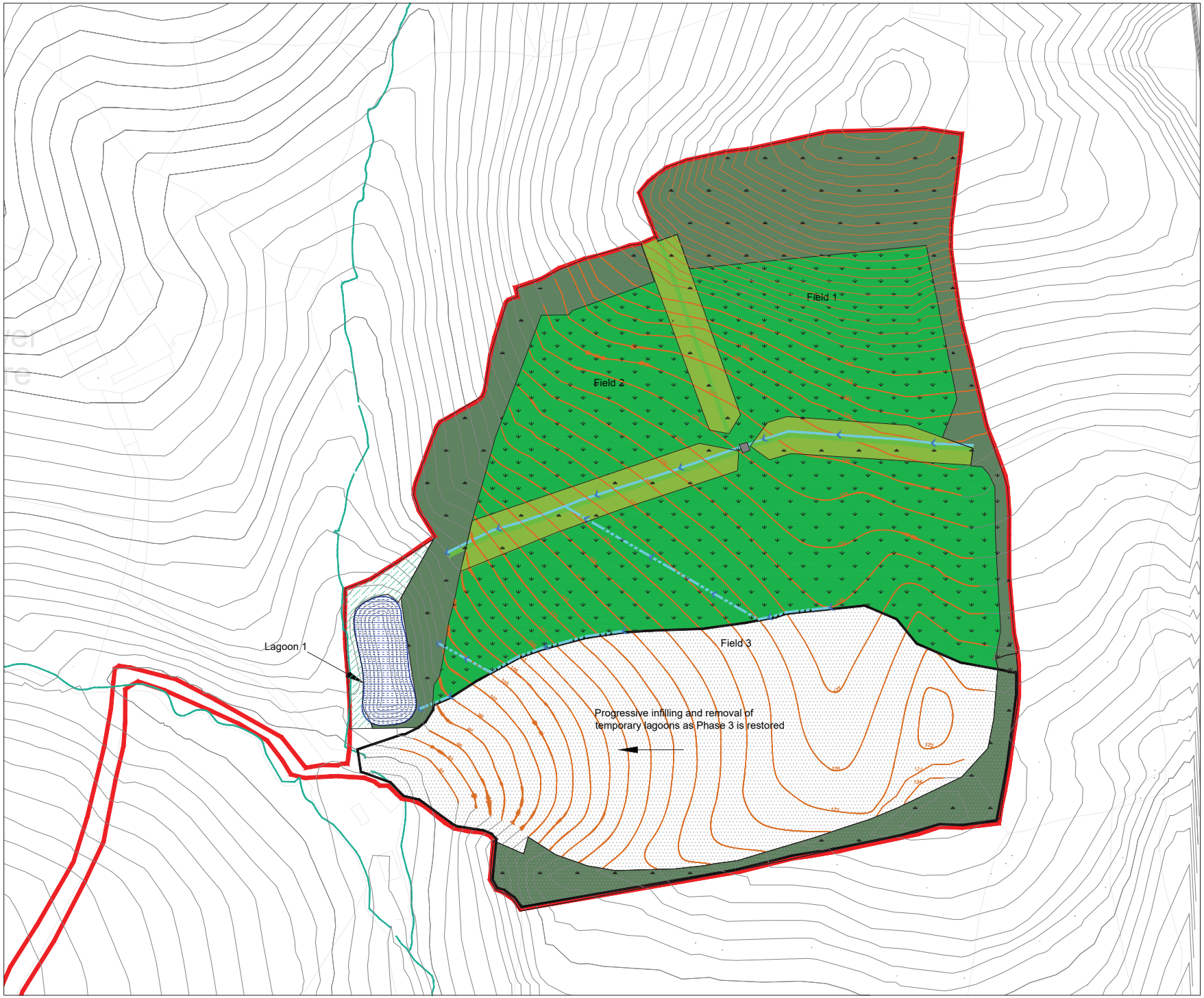
Scale	Date	Drg. No.	Rev.
1:1000@A3	Jul'24; Drawn KW; Chkd. ML	213189/D/PH2/003	



Key:

- Site Boundary
- Phase 3 Boundary
- Existing Ground Level Contours
- Restoration Contours
- Headland (Lowland Meadow Habitat) Buffer Zone
- Headland (Neutral Grassland Habitat) Buffer Zone
- Restored Agricultural Field
- Retained existing trees
- Area of Phase 3 Progressively Restored
- Devon Hedgebank
- Permanent Drainage Swale
- Temporary Drainage Ditch
- Surface Water Feature
- Attenuation Pond
- Culvert
- DN450 Twinwall Pipe

Notes:

1. Phase 3 volume of engineering fill/ geological barrier: 44,280 cu m.
2. Phase 3 volume of restoration soils: 38,520 cu m.
3. Phase 3 volume of inert waste: 123,224 cu m.

Rev.	Details	Drawn / Chkd.	Date

Project

213189
Lower Hare Farm

Title

Phase 3 Overview
Landfill South

AA Environmental Ltd
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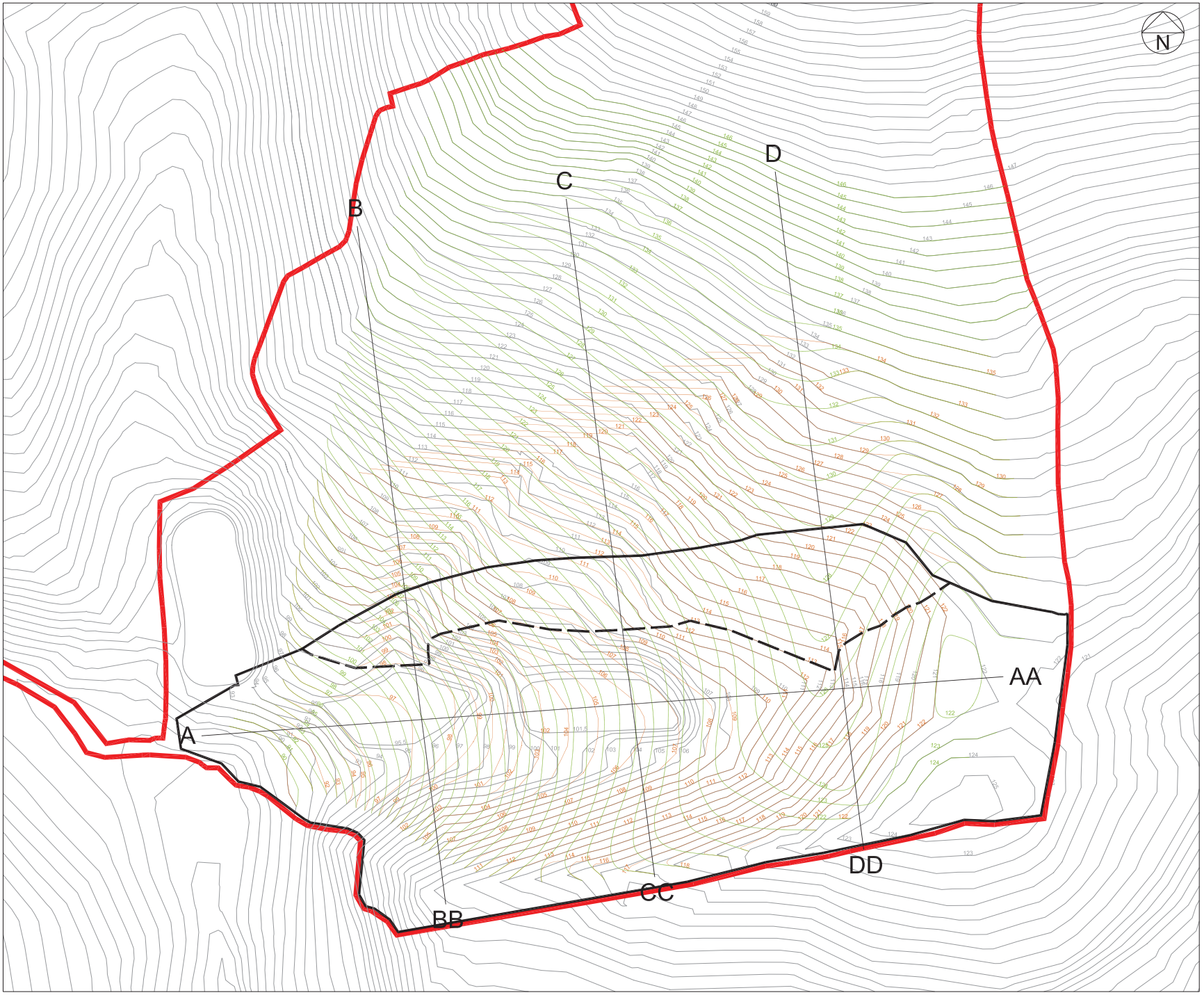
Scale	Date	Drg. No.	Rev.
1:2,000@A3	Apr'22	213189/D/PH3/001	
	Drawn: KW / Chkd.: ML		



Key:

- Site Boundary
- Phase 3 Boundary
- Existing ground level contours
- Restoration contours
- Basal contours

Rev.	Details	Drawn / Chkd.	Date

Project

213189
Lower Hare Farm

Title

Phase 3 Topographical Detail

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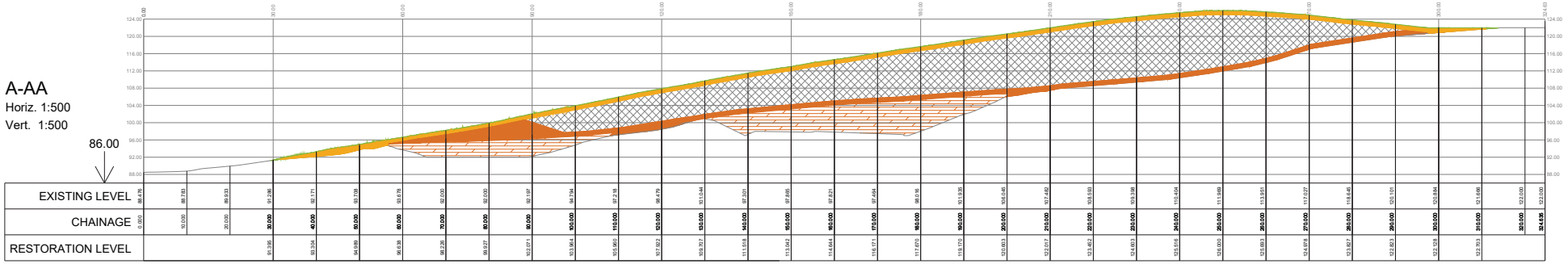
Scale	Date	Drg. No.	Rev.
1:1,500@A3	Apr'22	213189/D/PH3/002	
	Drawn: KW / Chkd.: ML		

A-AA

Horiz. 1:500
Vert. 1:500

86.00



B-BB

Horiz. 1:500
Vert. 1:500

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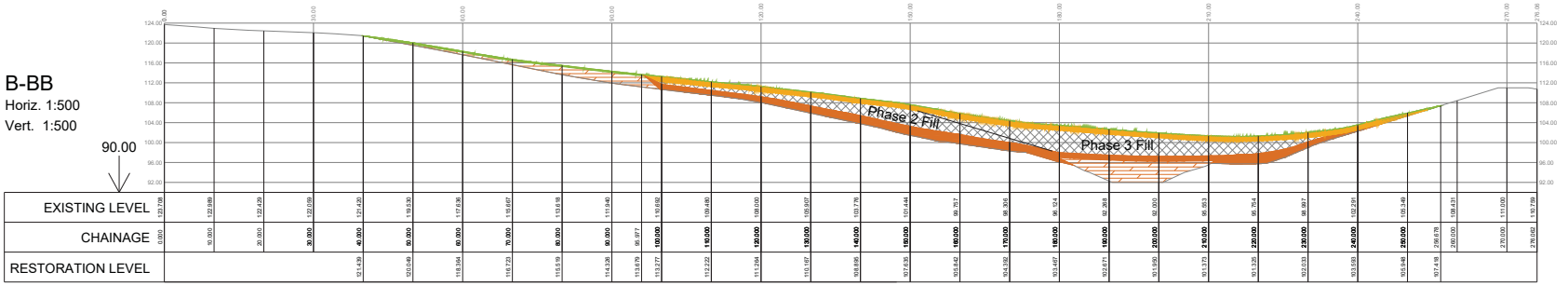

C-CC

Horiz. 1:500
Vert. 1:500

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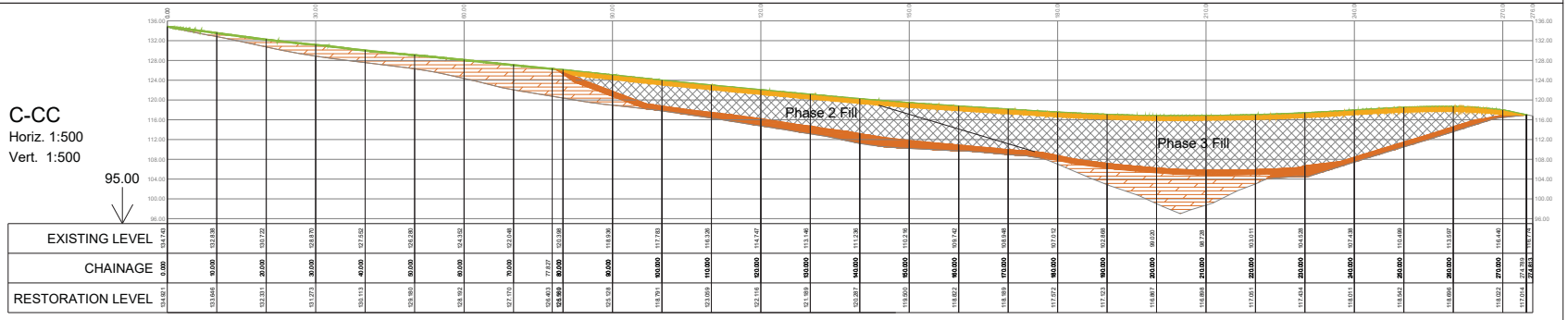
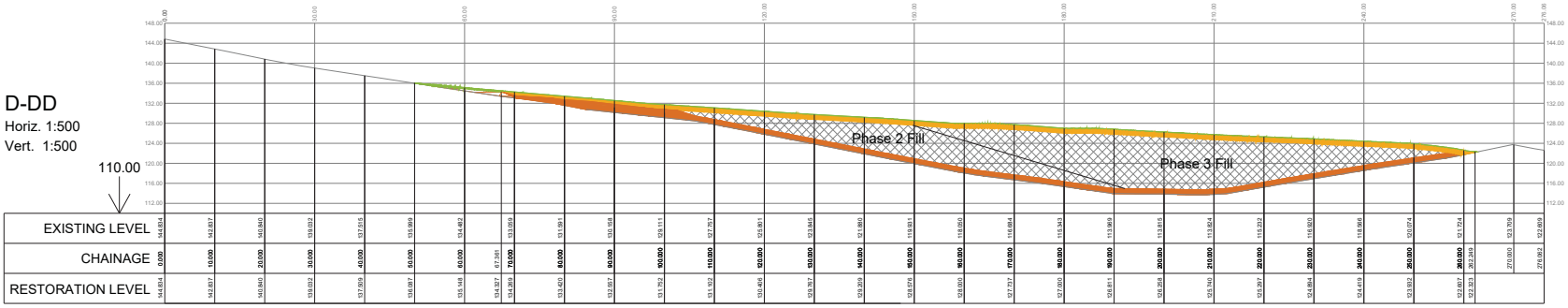


D-DD

Horiz. 1:500
Vert. 1:500

110.00



Key:

- Existing Ground Level
- Reinstated Soils
- Engineering Fill
- Restored Capping Layer
- Inert Waste
- Geological barrier

Rev.	Details	Drawn / Chkd.	Date

Project

213189
Lower Hare Farm

Title

Phase 3 Cross-Section Detail

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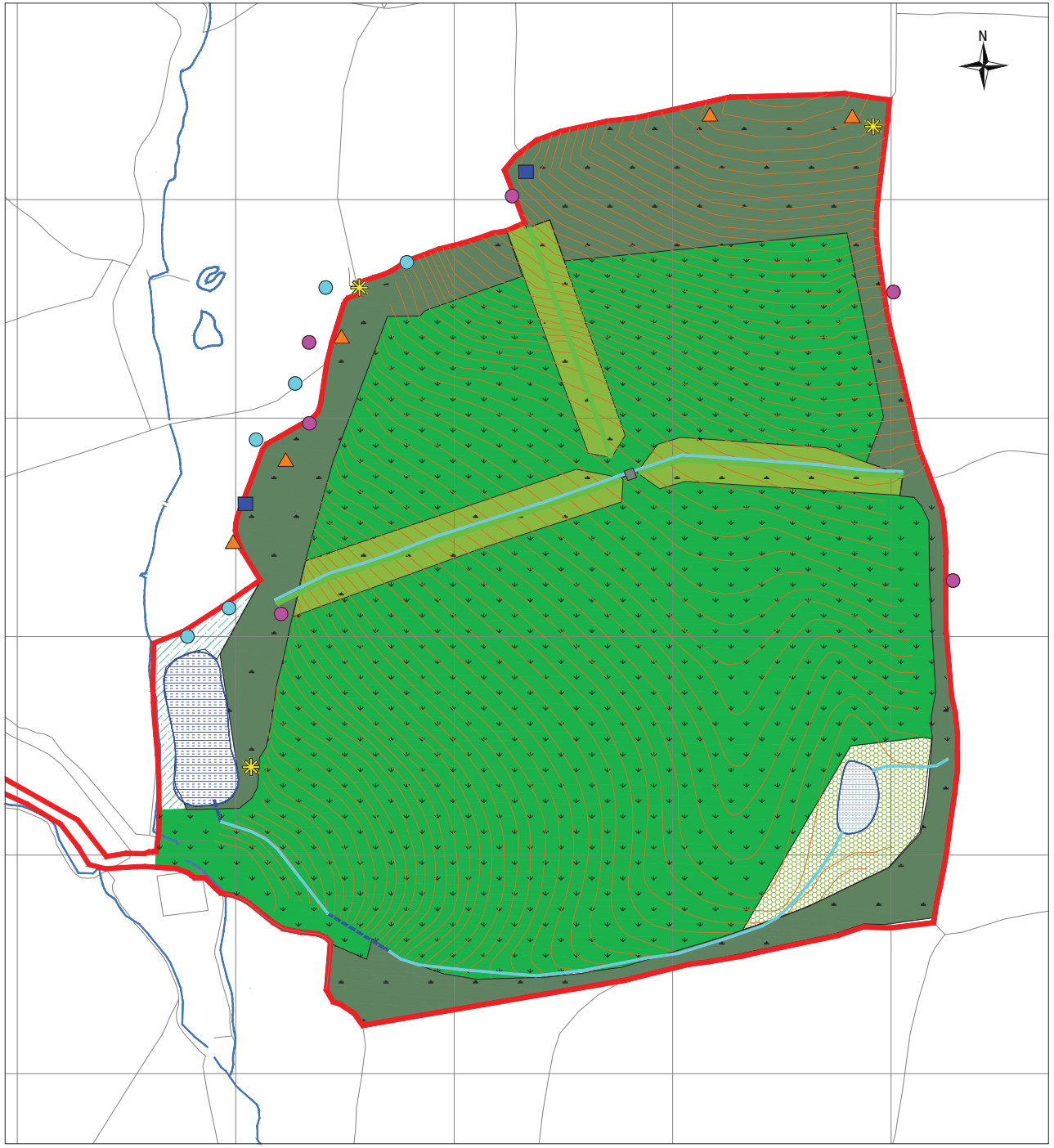
Scale	Date	Drg. No.	Rev.
1:1000@A3	Jul'24	213189/D/PH3/003	
	Drawn: KW / Chkd.: ML		



Key:

- Site Boundary
- Ground Level Contours
- Headland (Lowland Meadow Habitat) Buffer Zone
- Headland (Neutral Grassland Habitat) Buffer Zone
- Restored Agricultural Fields
- Lowland Meadow Habitat Buffer Zone (available from end of Phase 3)
- Retained existing trees
- Devon Hedgebank
- Permanent Drainage Swale
- Piped drainage section
- Ecological Pond
- Attenuation Pond
- Culvert
- Indicative Bat Box Location
- Indicative Bird Box Location
- Indicative Hibernacula Location
- Indicative Log Piles Location
- Indicative Insect Hotel Location

Rev.	Details	Drawn / Chkd.	Date

Project

213189
Lower Hare Farm

Title

Restoration Plan

AA Environmental Ltd
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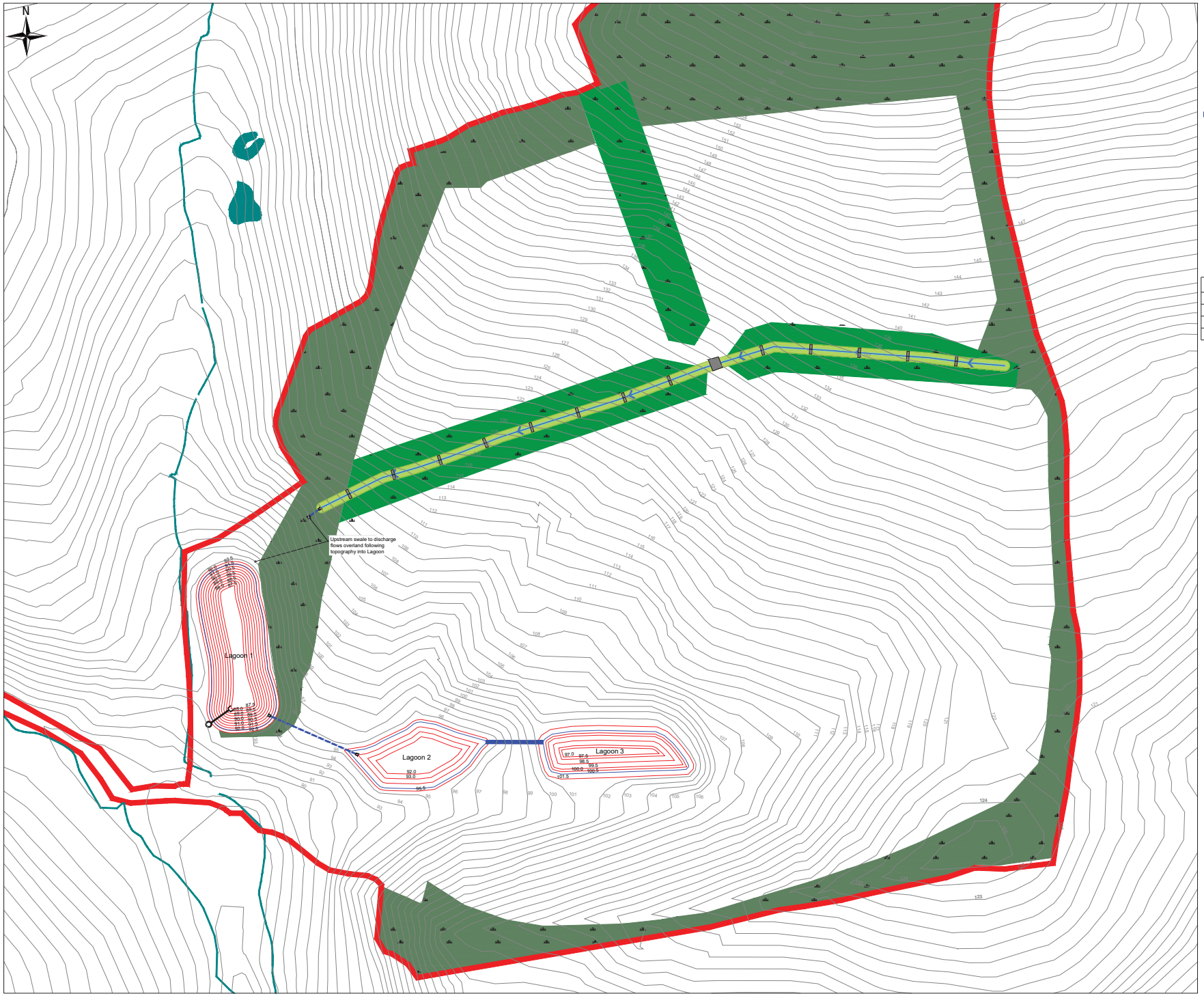
Scale	Date	Drg. No.	Rev.
1:2,000@A3	Apr'22	213189/PL/D/007	

Drawn	Chkd.
KW	ML



Key:

- Site Boundary
- Surface Water Features
- Existing Topographical Level Contours (including contour changes for drainage lagoons) (m AOD)
- Permanent Drainage Swale
- Temporary Drainage Swale
- Lagoon Topographical Level Contours (m AOD)
- Lagoon Water Level Contours (m AOD)
- Headwall to Manhole Drainage Outlets
- Headland (Lowland Meadow Habitat) Buffer Zone
- Headland (Neutral Grassland Habitat) Buffer Zone
- Culvert
- DN450 Twinwall Pipe

Lagoon Details		
ID	Water Level (mAOD)	Water Volume (m^3)
Lagoon 1	91.95	4,040
Lagoon 2	95	1849
Lagoon 3	100.5	1486

Rev.	Details	Drawn / Chkd.	Date

Project

213189
Lower Hare Farm

Title

Temporary Drainage Solution

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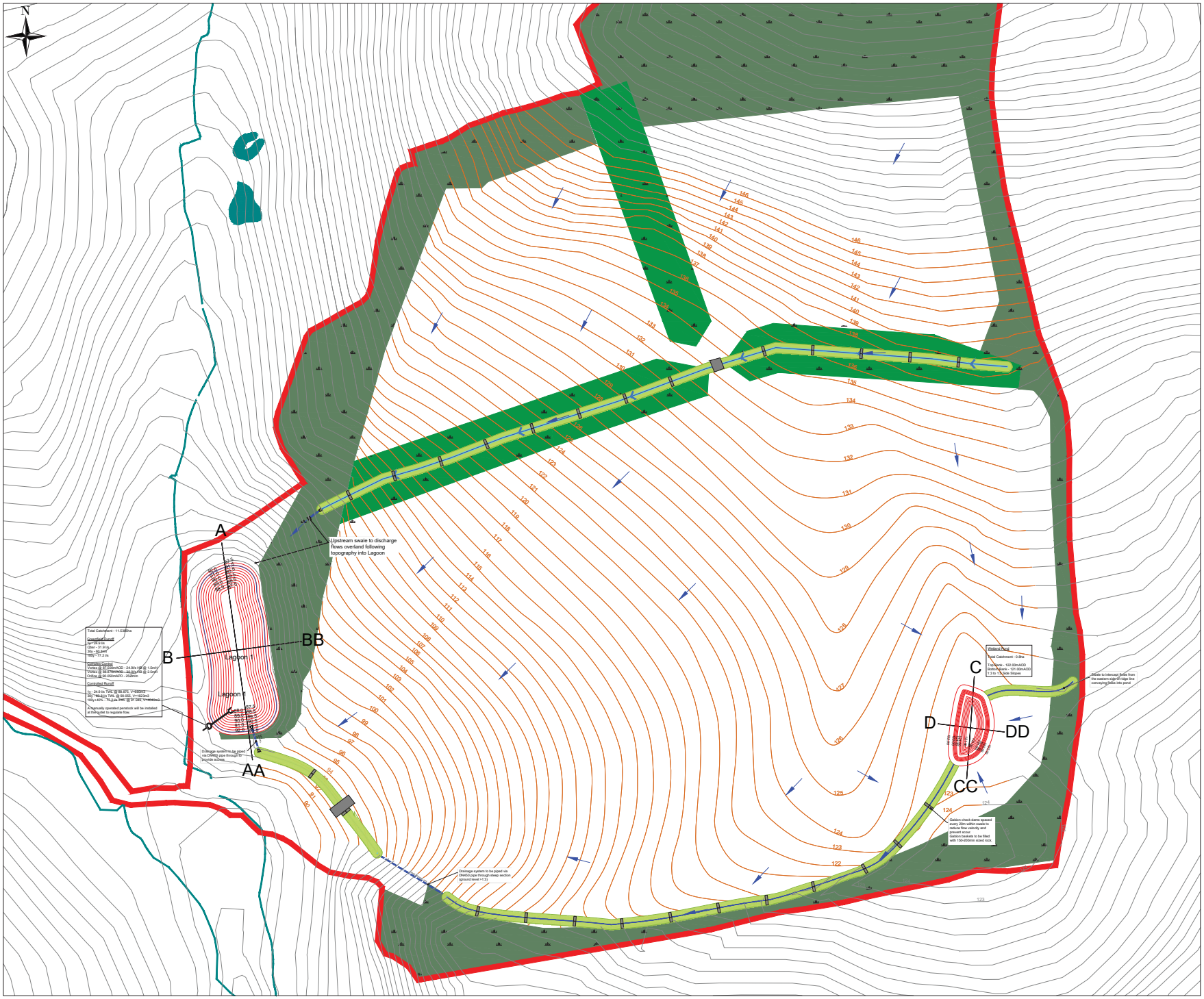
Scale	Date	Drg. No.	Rev.
1:1,500@A3	Apr'22	213189/PL/D/012	
	Drawn: KW / Chkd.: ML		



Key:

- Site Boundary
- Surface Water Features
- Existing Topographical Level Contours (including contour changes for drainage lagoons) (m AOD)
- Proposed Contours (mAOD)
- Drainage Swale
- Lagoon Topographical Level Contours (m AOD)
- Lagoon Water Level Contours (m AOD)
- Headwall to Manhole Drainage Outlets
- Headland (Lowland Meadow Habitat) Buffer Zone
- Headland (Neutral Grassland Habitat) Buffer Zone
- Culvert
- Drainage Flow

Lagoon Details		
ID	Water Level (mAOD)	Water Volume (m^3)
Lagoon 1	90.68	69
Wetland Pond	~121.5	~55

Rev.	Details	Drawn / Chkd.	Date

Project

213189
Lower Hare Farm

Title

Permanent Drainage Solution

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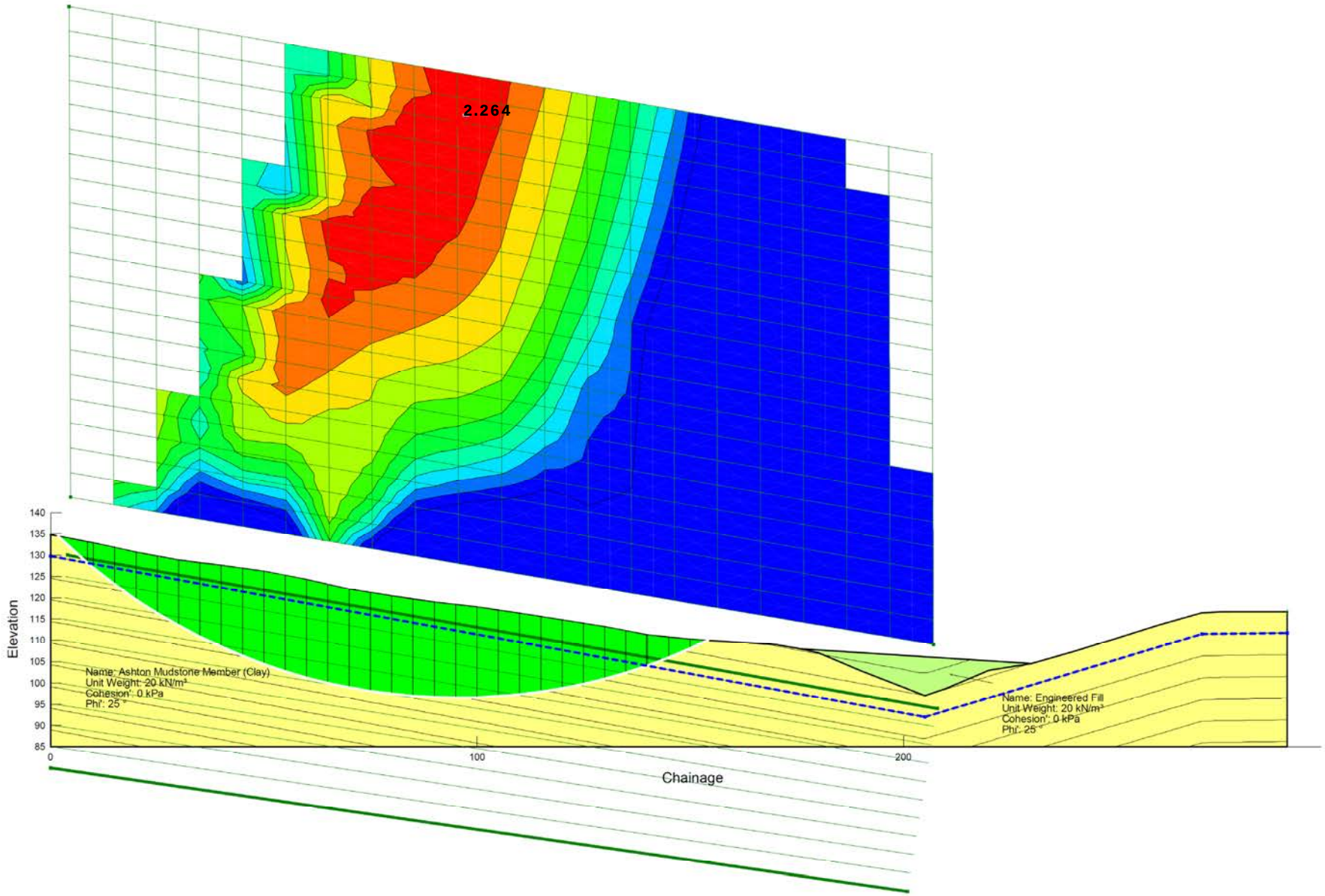
Scale	Date	Drg. No.	Rev.
1:1,500@A3	Jul'24	213189/PL/D/010	
	Drawn: KW / Chkd.: ML		

APPENDIX II

STABILITY ASSESSMENT OUTPUT PLOTS



Drawing No.	**Output Plot 1**
Drawing Name	**Basal Slope Sub-Grade 1:5**
Project Name	**Lower Hare Farm, Whitestone, Exeter**
Client Name	**AA Environmental Limited**
Project No.	**167-22-696**

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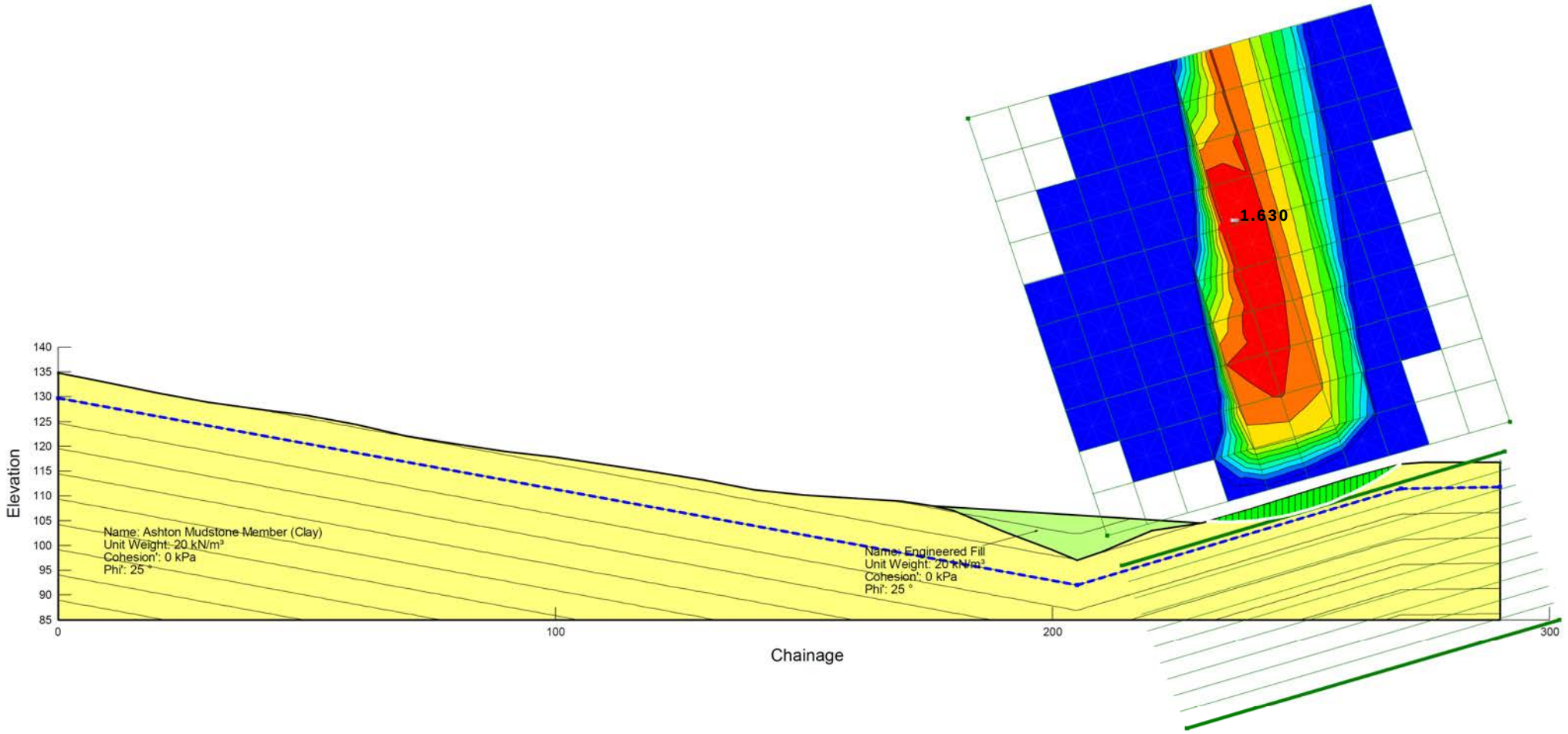

Drawing No.	**Output Plot 2**
Drawing Name	**Basal Slope Sub-Grade 1:3**
Project Name	**Lower Hare Farm, Whitestone, Exeter**
Client Name	**AA Environmental Limited**
Project No.	**167-22-696**

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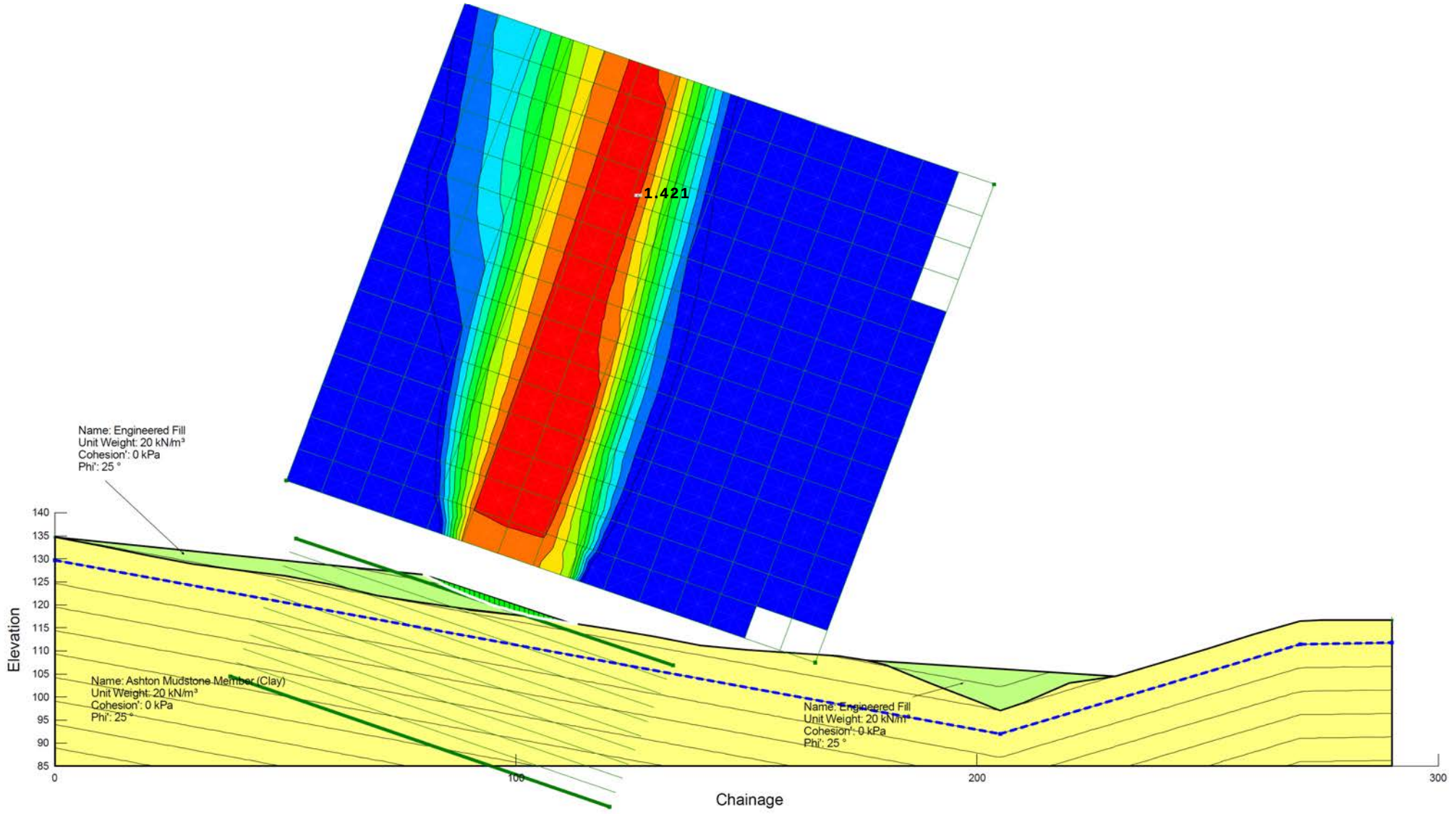

Drawing No.	**Output Plot 3**
Drawing Name	**Side Slope Sub-Grade (Engineered Fill)**
Project Name	**Lower Hare Farm, Whitestone, Exeter**
Client Name	**AA Environmental Limited**
Project No.	**167-22-696**

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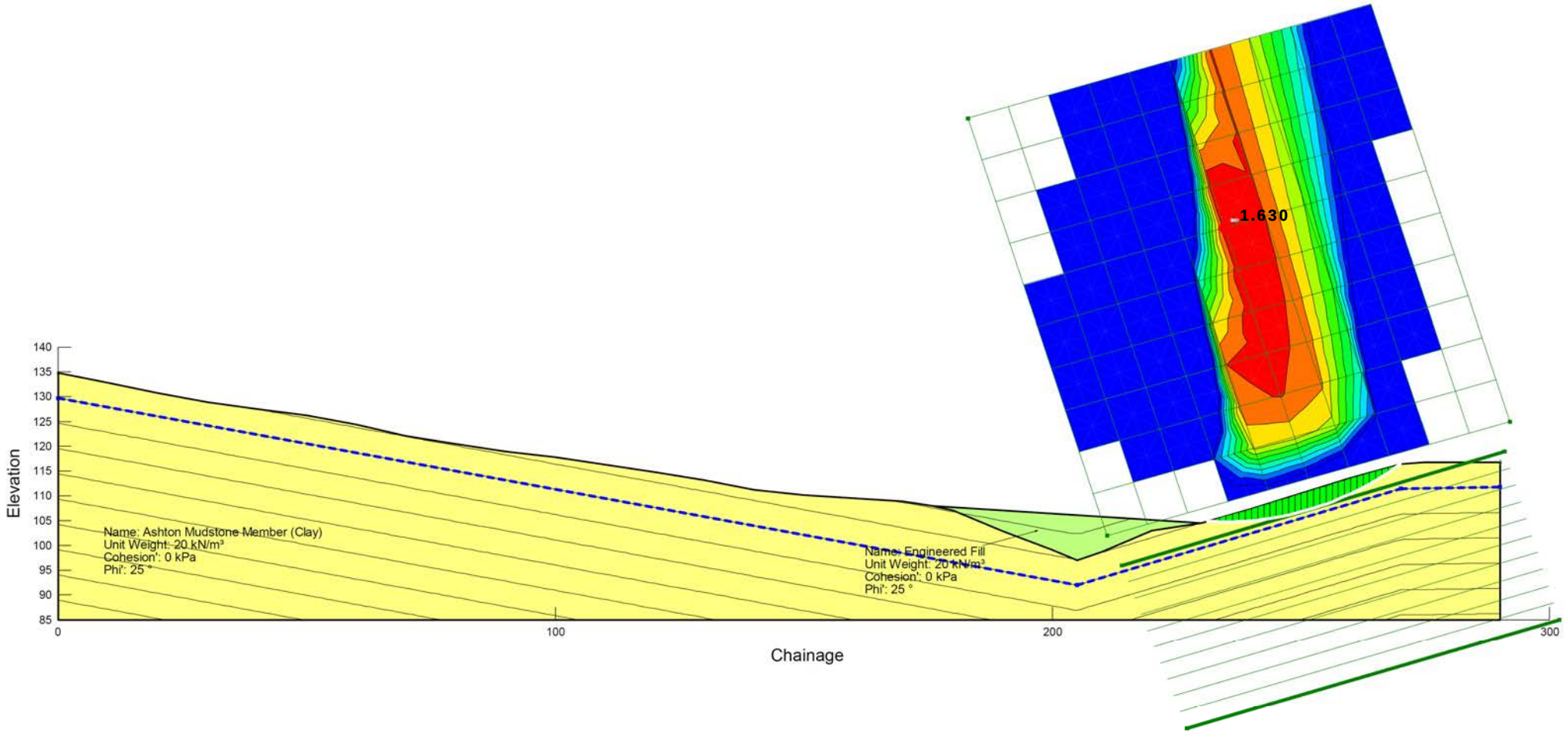

Drawing No.	**Output Plot 4**
Drawing Name	**Side Slope Sub-Grade (In-situ Natural)**
Project Name	**Lower Hare Farm, Whitestone, Exeter**
Client Name	**AA Environmental Limited**
Project No.	**167-22-696**

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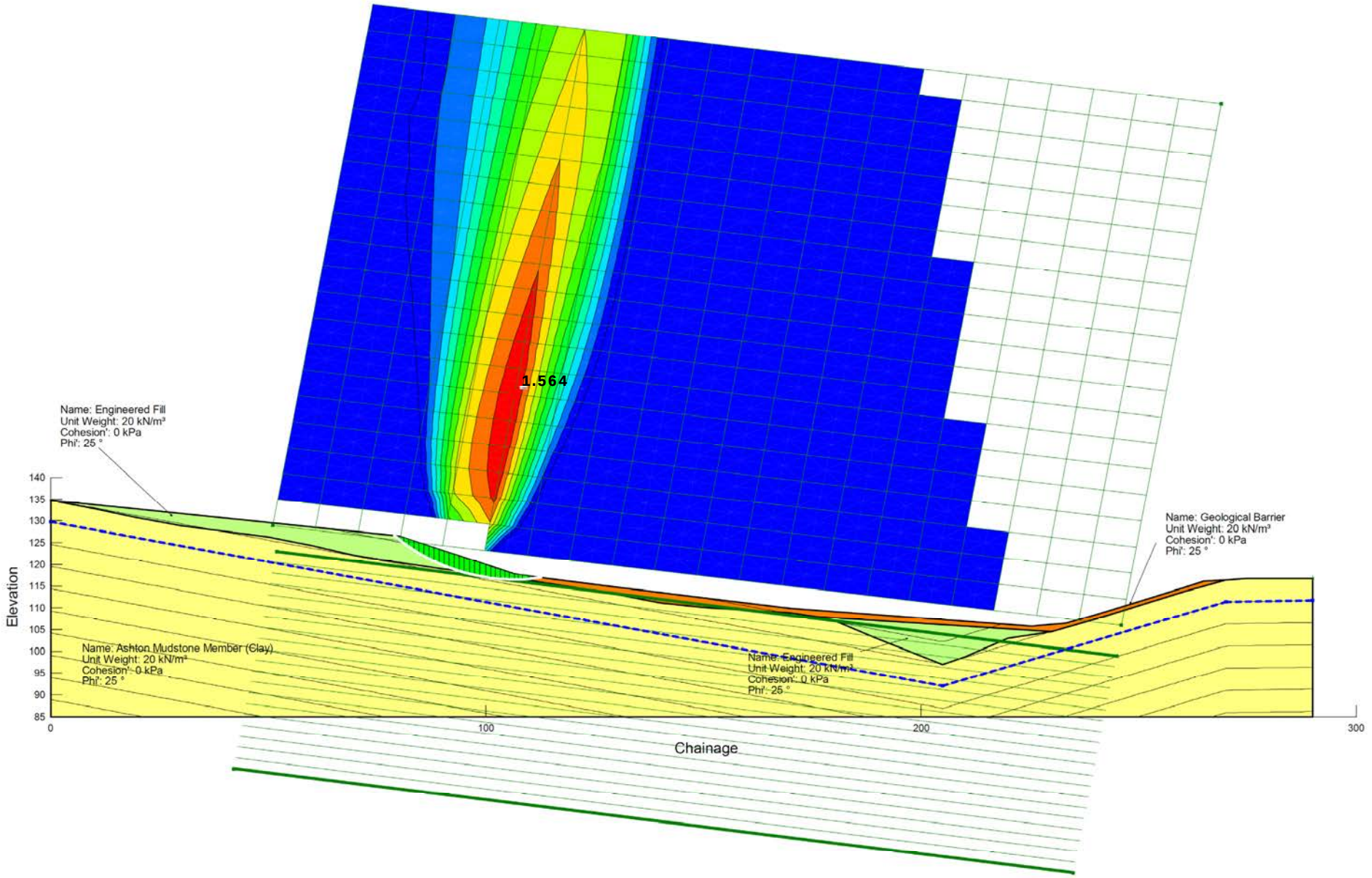

Drawing No.	**Output Plot 5**
Drawing Name	**Basal Liner**
Project Name	**Lower Hare Farm, Whitestone, Exeter**
Client Name	**AA Environmental Limited**
Project No.	**167-22-696**

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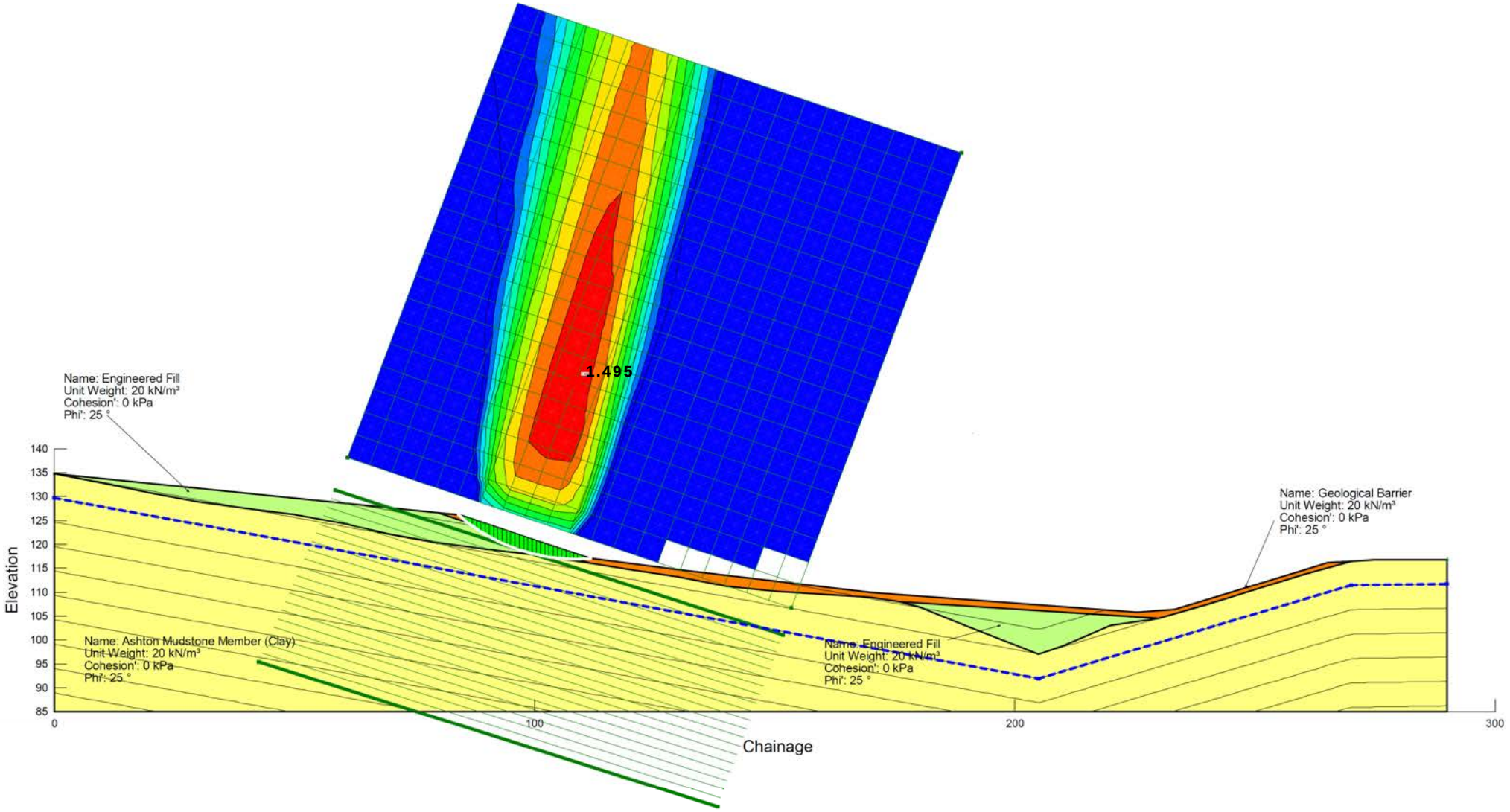

Drawing No.	**Output Plot 6**
Drawing Name	**Side Slope Liner (Engineered Fill)**
Project Name	**Lower Hare Farm, Whitestone, Exeter**
Client Name	**AA Environmental Limited**
Project No.	**167-22-696**

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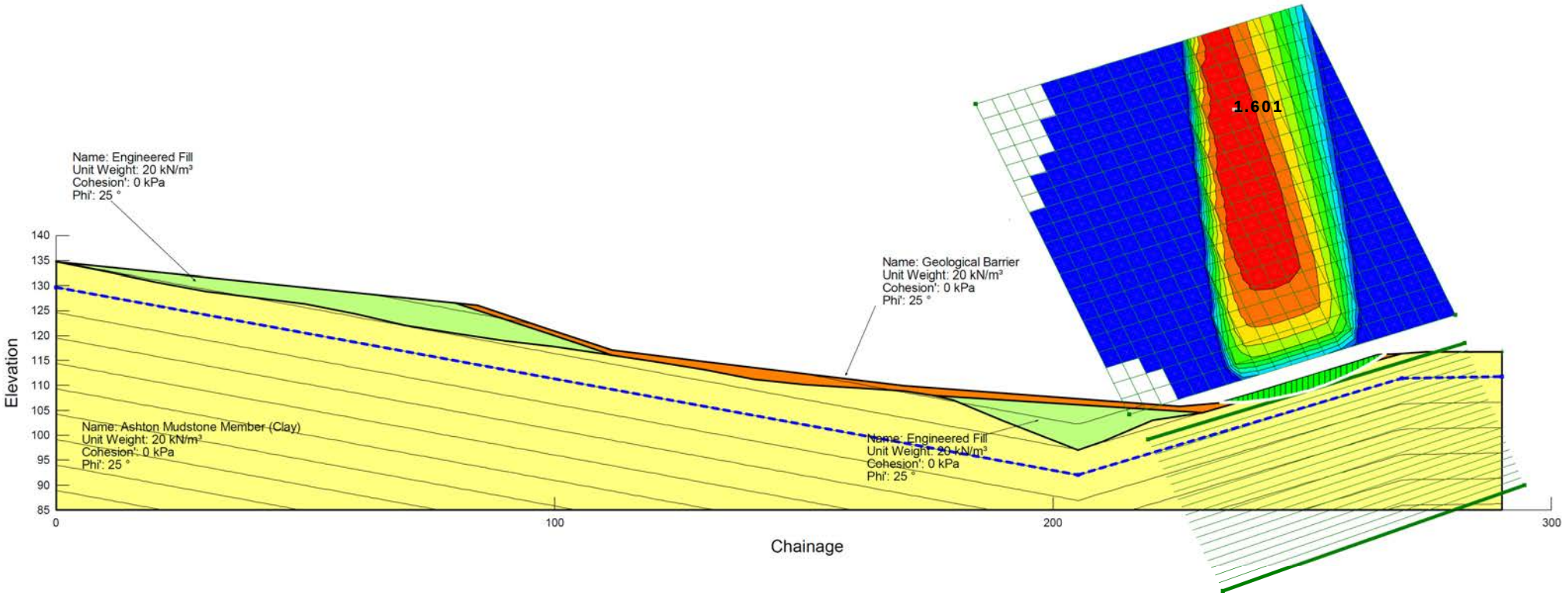

Drawing No.	**Output Plot 7**
Drawing Name	**Side Slope Liner (In-situ Natural)**
Project Name	**Lower Hare Farm, Whitestone, Exeter**
Client Name	**AA Environmental Limited**
Project No.	**167-22-696**

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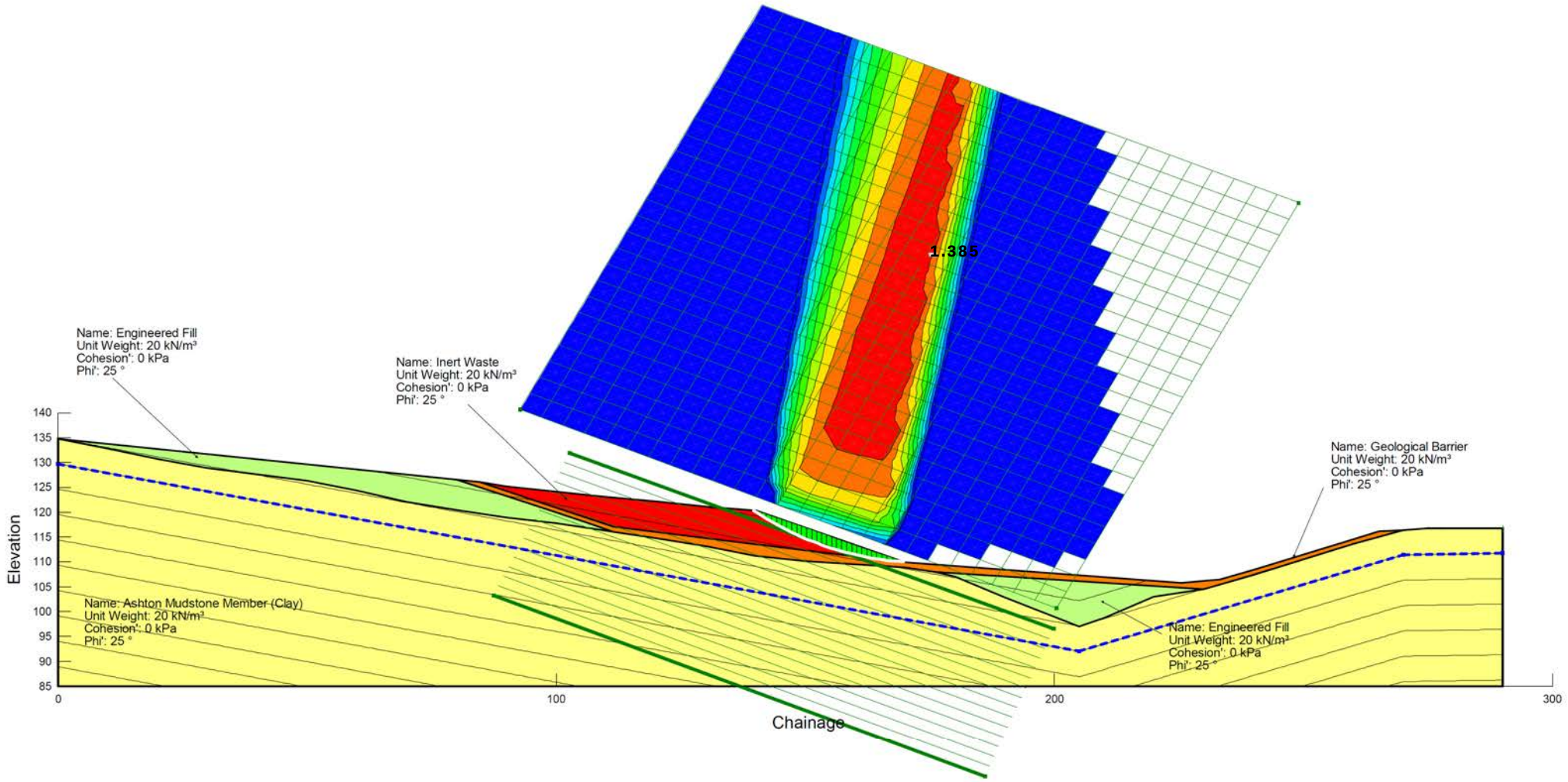

Drawing No.	**Output Plot 8**
Drawing Name	**Waste Filling (Typical North-South Section)**
Project Name	**Lower Hare Farm, Whitestone, Exeter**
Client Name	**AA Environmental Limited**
Project No.	**167-22-696**

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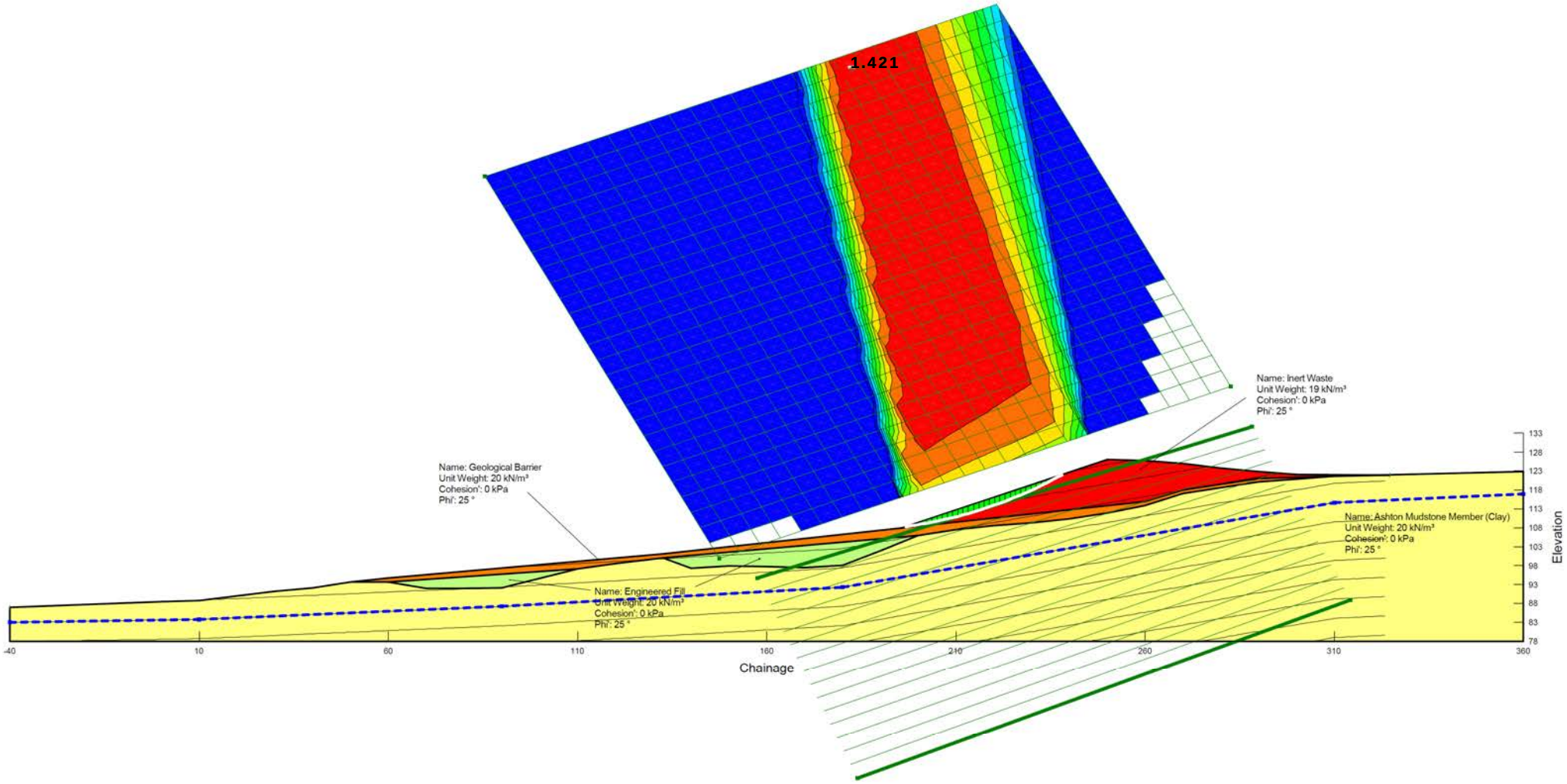

Drawing No.	**Output Plot 9**
Drawing Name	**Waste Filling (East-West Section)**
Project Name	**Lower Hare Farm, Whitestone, Exeter**
Client Name	**AA Environmental Limited**
Project No.	**167-22-696**

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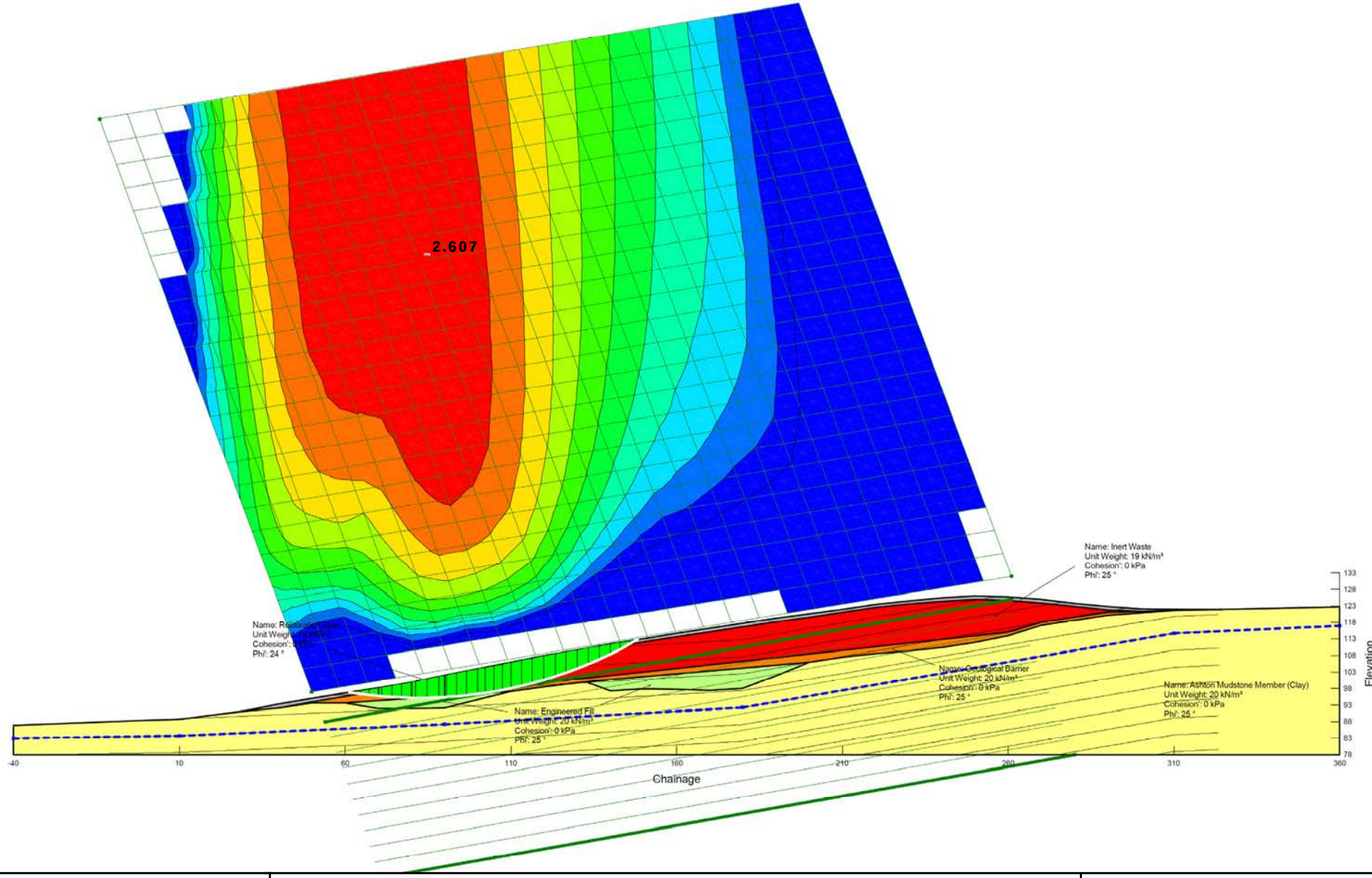

Drawing No.	**Output Plot 10**
Drawing Name	**Completed Landfill (East-West Section)**
Project Name	**Lower Hare Farm, Whitestone, Exeter**
Client Name	**AA Environmental Limited**
Project No.	**167-22-696**

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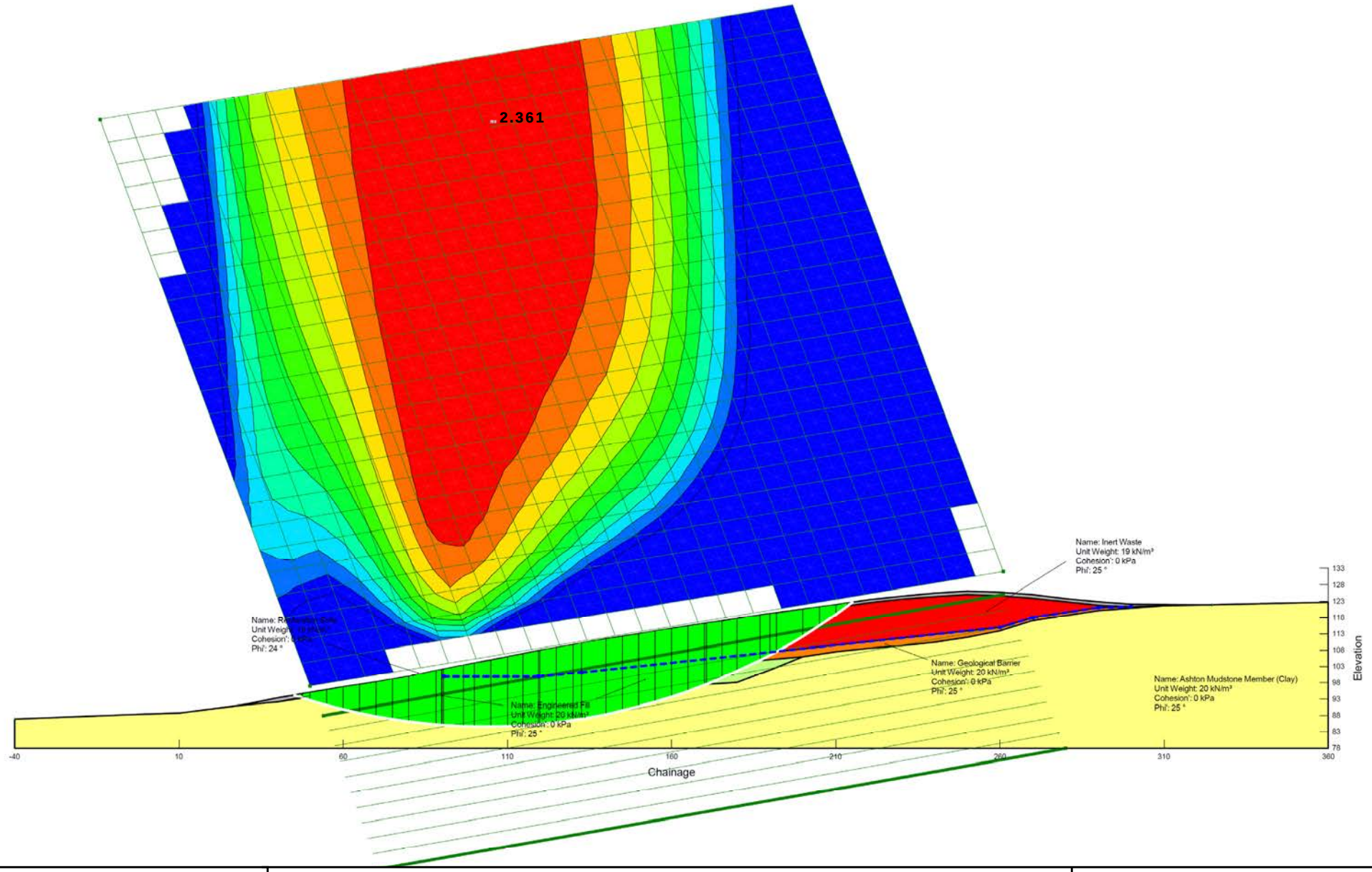

Drawing No.	**Output Plot 11**
Drawing Name	**Completed Landfill – Water in Waste Mass (East-West Section)**
Project Name	**Lower Hare Farm, Whitestone, Exeter**
Client Name	**AA Environmental Limited**
Project No.	**167-22-696**

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