EVIDENCE DOCUMENT: EGD/2.2

Proof of Evidence

Mark Barwood

On behalf of Egdon Resources U.K. Limited

Planning Application for the retention of the Wressle 1 Wellsite and access track for the Production of Hydrocarbons, together with an extension of the site by 0.12ha for the installation of additional security facilities; site reconfiguration to facilitate the installation of a new impermeable membrane, French drain and surface water interceptor; construction of a bund, tanker loader plinth and internal roadway system; installation of up to 2 additional groundwater monitoring boreholes and deepening of 3 existing groundwater monitoring boreholes; well operations; installation of production facilities and equipment; installation of gas engine and electrical grid connection; oil and gas production for a temporary period of 15 years; and restoration to arable land.

Wressle 1 Wellsite Lodge Farm, Clapp Gate, Appleby, Scunthorpe

Town and Country Planning Act 1990 (as amended)

October 2019

Proof of Evidence of:	Mark Barwood
On behalf of:	Egdon Resources U.K. Limited (Appellant Egdon)
Appeal Development:	Planning Application for the retention of the Wressle 1 Wellsite and access track for the Production of Hydrocarbons, together with an extension of the site by 0.12ha for the installation of additional security facilities; site reconfiguration to facilitate the installation of a new impermeable membrane, French drain and surface water interceptor; construction of a bund, tanker loader plinth and internal roadway system; installation of up to 2 additional groundwater monitoring boreholes and deepening of 3 existing groundwater monitoring boreholes; well operations; installation of production facilities and equipment; installation of gas engine and electrical grid connection; oil and gas production for a temporary period of 15 years; and restoration to arable land. Wressle 1 Wellsite Lodge Farm, Clapp Gate, Appleby, Scunthorpe.
Planning Inspectorate Ref:	APP/Y2003/W/19/3221694
Local Planning Authority Ref:	PA/2018/1316
Date of Inquiry:	5th to 8th and 12th to 13th November 2019 (6 days)
Location:	North Lincolnshire Council Scunthorpe
Inspector:	Phillip Ware
Internal Document Ref:	AWP-ER-W1-APP-JB-MAB-01
Date:	October 2019

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1. INTRODUCTION

1.1 My name is Mark Barwood, I am a civil and structural engineering consultant, with over 36 years' experience in the field. I am a Director of Alan Wood & Partners (AWP) a specialist firm of Civil and Structural Engineers with whom I have worked since August 2014. In November 2015 I was part of a management buyout of the business and am now an equity director alongside 6 of my colleagues. I am directly responsible for running the Lincoln Office of AWP.

1.2 I graduated with a Bachelor of Science in Civil and Structural Engineering studies in 1986, after following an Institution of Civil Engineers approved sandwich degree course at Nottingham (Trent) University. I achieved full chartered engineer status in 1991 and I am a corporate member of the Institution of Civil Engineers and a registered chartered engineer with the Engineering Council.

1.3 Alan Wood & Partners was founded as a firm of consulting Civil and Structural engineers in 1968. In summary AWP:-

- Provides professional consulting engineering and construction management services
- Has 100 technical staff and 6 UK offices
- Uses advanced design software packages
- Uses 3-D design, modelling and drawing packages
- Undertakes circa £800m of UK construction projects annually; and
- Provides multi-disciplinary services to all major UK construction sectors

1.4 AWP's professional engineering and construction management consultancy services include:

- Structural engineering
- Civil engineering
- Building consultancy
- Geo-environmental engineering; and
- Construction project management

AWP has over 50 years of experience covering the major UK construction sectors and applied to a diverse range of project types.

1.5 Prior to joining AWP I worked as a Technical Director for WSP Property and Buildings for 13 years, based initially in Hull and then in their Leeds Office. WSP is a world-leading management and technical consultancy for the property sector with over 48,000 employees. Whilst at WSP I rose to Technical Director within their building structures business, and was ultimately responsible for running the structures team in their Leeds Office, which numbered 20-40 people. I have delivered multimillion pound projects throughout the UK and internationally and was a global champion for WSP in the industrial sector.

1.6 Prior to joining WSP I worked for a variety of well-known businesses in the construction sector, both in professional consultancy and the contracting field as a construction Project Manager these included;

- Clugston Construction Ltd
- Taylor Woodrow Construction Ltd - Now part of Vinci; and
- Bowmer & Kirkland Ltd

1.7 Whilst working at both WSP and Alan Wood & Partners I have been directly responsible for delivering a number of land-based wind farm projects in numerous parts of the country, all of which require the design of delivery roads and crane lifting pads suitable for carrying heavy vehicles and accommodating large lifts. These include:-

- Hazlehead WF
- Armistead WF
- Hookmoor WF, and
- Moor House WF

1.8 In the context of the Appeal Development, my company was appointed by Egdon Resources UK Limited (the Appellant or Egdon) in March 2018 to provide Civil & Structural Engineering services for upgrading the existing well site at Wressle in conjunction with Mr Jonathan Foster of Zetland Group, who was responsible for strategic co-ordination of the well site design review and upgrade proposals.

1.9 My role within the appointment by the Appellant was to provide civil and structural design services to upgrade the well site in conjunction with other specialist consultants, including Zetland Group and Envireau Water Limited, who carried out a Hydrogeological Risk Assessment. This work culminated in the Civil and Structural Design Statement (CDA11), submitted in support of the Wressle 1 planning application, which was completed in June 2018.

1.10 I am, therefore, familiar with the Appeal Development, in terms of the civil and structural elements of the wellsite upgrade proposal. My professional declaration is provided at the end of this proof of evidence.

2. SCOPE & STRUCTURE OF EVIDENCE

2.1 My evidence relates to the Civil and Structural engineering design elements of the wellsite construction.

2.2 It will describe how the Civil and Structural Design was informed by a geotechnical investigation carried out at the Wressle 1 Wellsite by Opus International Consultants (UK) Limited in February 2018. The purpose of the geotechnical investigation, which was logged in accordance with BS EN ISO 14688, *Geotechnical investigation and testing – Identification and classification of soil,* was to confirm the ground conditions and geotechnical properties underlying the Wressle 1 Wellsite.

2.3 It will describe the existing site conditions of the Wressle 1 Wellsite

2.4 It will set out in detail the proposed site reconfiguration works including the installation of a new impermeable membrane, French drain and surface water interceptor and the construction of a bund, tanker loader plinth and internal roadway system. It describes the findings of the geotechnical investigation and how the civil and structural design has been established.

2.5 It will describe how the site reconfiguration works have been designed, drawing on my experience and that of my company, AWP, who were commissioned by the Appellant to design the reconfiguration works.

2.6 It will demonstrate that the site reconfiguration works have been designed appropriately and will be constructed in accordance with a Construction Quality Assurance (CQA) Plan.

2.7 Furthermore, it will consider and respond to the comments and representations made in the JBA planning review letter dated 16th October 2018 reference SJW|2018s1208-L-L001-4 which relate to my area of expertise.

2.8 In summary, the structure of my Proof of Evidence will be as follows:

- Description of the existing site conditions
- Description of the proposed site reconfiguration works
- Review of the comments made by JBA Consulting in their review letter of 16th October 2018 Ref: (SJW/2018s1208-L-L001-4)
- Conclusions
- Endorsement
- Supporting Appendices

3. WRESSLE 1 WELLSITE CIVIL & STRUCTURAL ENGINEERING

3.1 The purpose of this Section is to set out, in chronological order, wellsite construction works undertaken at the site to date. It also sets out the proposed reconfiguration work that has been designed, and how it will be constructed.

Existing Site Conditions

3.2 The Wressle 1 wellsite was constructed in April and May 2014. The design and subsequent construction, we understand, were managed on behalf of the Appellant by Mr Richard Elliott of R Elliott Associates, a highly experienced Chartered Structural and Civil Engineer. The design proposed in the initial planning application is set out in Figure 3.1 below.

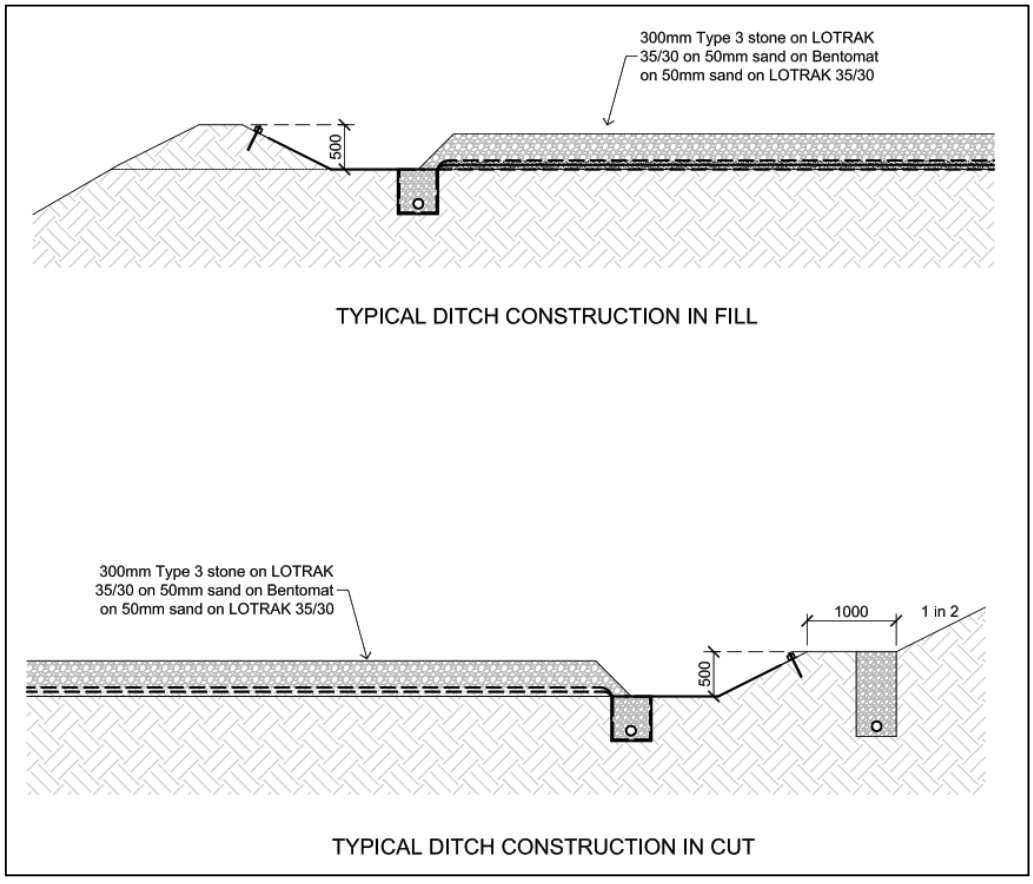


Figure 3.1: Site Construction Sections
(Extract from Drawing No. 3334 P 08. Planning Application MIN/2013/0281)

3.3 The Wressle 1 Wellsite is constructed upon clayey sand belonging to the Sutton Sand formation, which was cut, filled and compacted to create a level plateau. In order to access the subsoil, topsoil was first removed and deposited on the northern and western boundaries of the wellsite, where it has been stored for subsequent reuse during site restoration works.

3.4 As indicated in Figure 3.2 below, the wellsite is divided in to two (2) areas; an active area within which the drilling of the Wressle 1 well was to take place, and a non-active area within which site office, accommodation and parking were to be located. A perimeter 'v' type ditch profile was excavated around the perimeter of the active area of the wellsite. A larger excavation was made in the centre of the active area of the wellsite, in which a concrete drilling cellar was

constructed to house the Wressle 1 wellhead. A geosynthetic clay liner (GCL) was then laid directly on top of the Sutton Sand formation, across the active area of the wellsite and perimeter 'v' type ditch profile. Two (2) layers of protective geotextile were then laid above the GCL (active area) and Sutton Sand formation (non-active area), upon which a 300mm layer of aggregate cover was laid and compacted to form the working platform. The aggregate cover consists of blast furnace slag sourced from the Stanton Quarry at Scunthorpe steelworks.

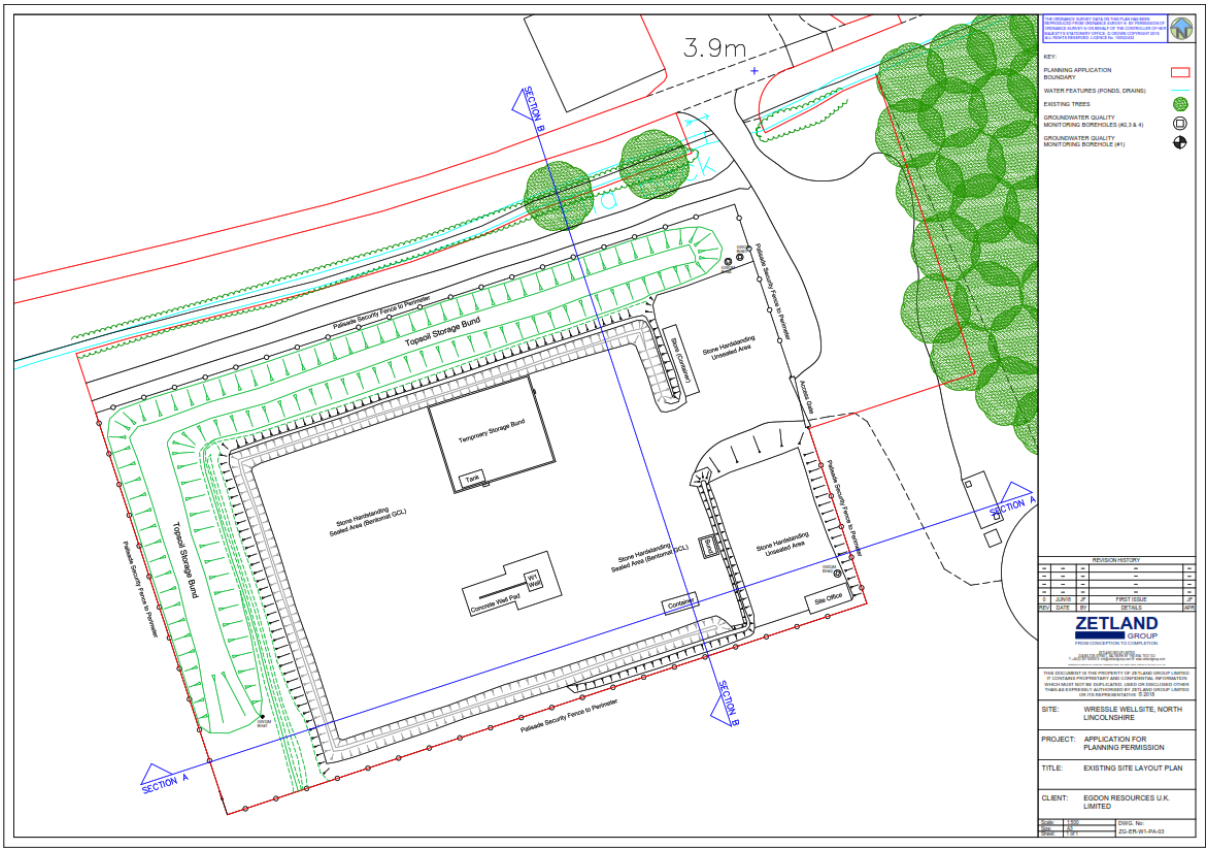


Figure 3.2: Existing Site Layout Plan
(Plan No. ZG-RE-W1-PA-03 of Planning Application MIN/2013/0281)

3.5 Used in conjunction with the perimeter 'v' type ditch profile, the GCL provides a low permeability hydraulic barrier, preventing fluid (surface water and potential contaminants) entering the subsoil. Geosynthetic Clay Liners (GCLs) are geotextile and bentonite composites (typically sodium bentonite sandwiched between two layers of geotextile) engineered for a variety of environmental containment applications. The geotextiles offer a long lasting resistance to physical or chemical break-down in harsh elements, while the bentonite's high swelling capacity and low permeability provide an effective hydraulic seal. We have included a typical photograph of the material in Figure 3.3 below.

Figure 3.3 Typical Photograph of Geo-synthetic clay liner (GCL)

3.6 Following completion of the exploratory drilling and flow testing works in 2014 and 2015, the wellsite has been retained on a care and maintenance basis, pending the outcome of a number of planning applications and appeals.

3.7 Following the granting of planning permission (Planning Ref: PA/2016/0808) in January 2017, the Appellant installed four (4) groundwater quality monitoring boreholes within the Wressle 1 wellsite in February 2017 which have since been subject to periodic monitoring, including establishing baseline groundwater conditions for the Wressle 1 Wellsite.

3.8 Subject to the granting of planning permission, it was the Appellant's intention to replace the GCL across the 'v' type ditch profile, pipe the containment ditch and cover with clean stone, thus protecting the GCL long term. However, as the Proposed Development was refused planning permission those works have not taken place. In the meantime, the exposed GCL across the perimeter 'v' type ditch profile has been subject to prolonged exposure to the sun, which has dried out the GCL, leading to cracking and slumping in some areas.

3.9 Due to the delays in obtaining planning permission, the Appellant undertook some remedial works and replaced some damaged areas of GCL across the 'v' type ditch profile in December 2018.

Proposed Site Reconfiguration Works

3.10 Following the decision by the Planning Inspectorate not to grant planning permission on appeal, the Appellant took the decision to redesign the wellsite, removing the need to resolve any remaining uncertainty over the suitability of the existing ground conditions, the condition of the GCL and the depth of aggregate cover required.

3.11 To inform the design of the reconfiguration works, the Appellant commissioned Opus to undertake a geotechnical investigation at the Wressle 1 Wellsite to provide a factual and

interpretive description of the existing ground conditions under the wellsite (ground investigation report). These investigations were undertaken on 23rd February 2018 and comprised six (6) windowless sample boreholes progressed to depths between 4m and 5.5m below ground level. The geology encountered was logged by an Opus field engineer, in accordance with BS EN ISO 14688. In-situ standard penetration tests (SPTs) were undertaken at selected depths within the windowless sample boreholes, progressed to a depth of penetration refusal (standard penetration resistance of 50 blows being insufficient to advance through the formation).

3.12 In addition to the six (6) windowless sample boreholes, six (6) Transport Research Laboratory (TRL) Dynamic Cone Penetrometer (DCP) tests were carried out, progressed to a depth of between 866mm and 950mm below ground level.

3.13 A topographic survey of the Wressle 1 wellsite was also commissioned in March 2018.

3.14 In parallel with the geotechnical evaluation works, the Appellant commissioned AWP to carry out a design review and upgrade details for the reconfiguration works. To assist in the design review and upgrade details, AWP was issued with the Opus ground investigation report and the topographic survey.

3.15 As part of the commission, AWP was tasked with reviewing the Opus ground investigation report and advising what works would be necessary in order to comply with CIRIA Guide C736 (CDH8) *Containment systems for the prevention of pollution* (CDH 8), taking into account concerns raised by JBA consulting when giving evidence at the first public inquiry, which the Appellant sought to address as part of the design review.

3.16 CIRIA C736 (CDH 8) is guidance developed to assist owners and operators of industrial and commercial facilities storing substances that may be hazardous to the environment. Funded by the Environment Agency and industry 'in-kind' contributions, the guidance is an update and revision of the original guidance, CIRIA R164 *Design of containment systems for the prevention of water pollution from industrial incidents*, published in 1997. It reflects changes in legislation, construction design and practices, together with lessons learned from recent incidents, including Buncefield, near misses and inspections. It includes new guidance covering actions to take on existing facilities, to ensure they continue to perform satisfactorily. It provides guidance on risk assessment and class of containment requirements, containment options, system capacity, existing facilities, containment bunds, containment tanks, transfer systems, sacrificial and temporary containment and repair and upgrades.

3.17 The Environment Agency considers the principle of CIRIA C736 (CDH 8) to be a Best Available Technique (BAT) for the design of containment systems for crude oil, as set out within its Onshore Oil & Gas Sector Guidance.

3.18 The design review considered the following five (5) areas of the Wressle 1 Wellsite, resulting in upgrade details (reconfiguration) being proposed:

1. Wellsite platform and perimeter containment ditches;
2. Crude oil storage bund;
3. Accessway and tanker loading area;
4. Extension to existing wellhead concrete platform; and
5. Wellsite platform drainage.

3.19 A summary of the reconfiguration works is provided below, with a more detailed description and supporting information contained within the Civil & Structural Engineering Design Statement (CDA11) prepared by AWP as part of the Planning Application.

Wellsite Platform and Perimeter Containment Ditches

3.20 The existing 300mm aggregate cover (blast furnace slag) will be removed from the active area of the wellsite and stockpiled in the non-active area of the wellsite for reuse, following screening. The two (2) layers of protective geotextile will then be removed, exposing the GCL.

3.21 Once the GCL is exposed, California Bearing Ratio (CBR) tests will be carried out, in accordance with a scheme for undertaking on-site load bearing testing across the site.

3.22 Whilst neither the Appellant nor its witnesses puts any reliance on the GCL in providing environmental containment, where the GCL has been penetrated in order to carry out the load bearing tests, it will be repaired prior to progressing the wellsite platform construction.

3.23 A SECUTEX® R301 protection geotextile (see figure 3.6) will be placed on top of the GCL and extended across the active area of the wellsite and perimeter containment ditch. A Carbofol® 2mm thick high-density polyethylene (HDPE) fully welded impermeable membrane(see figure 3.4), installed in accordance with a Construction Quality Assurance Plan (CQA), approved by the Environment Agency, will then be placed on top of the SECUTEX® R301 protection geotextile and extended across the active area of the wellsite and perimeter containment ditch. A SECUTEX® R801 protection geotextile (see figure 3.6) will then be placed on top of the Carbofol® 2mm HDPE impermeable membrane and extend across the active area of the wellsite and perimeter containment ditch. This sandwich of construction material is referred to within the Civil and Structural Design Statement drawings (Appendix 4 of CDA11) as a 'multi-layer remediation'.

3.24 Further to the specification of the NAUE Carbofol® HDPE geomembrane above, it provides a complete seal against even the most toxic substances. Routinely installed as a component of landfill base seals as well as caps Carbofol® protects groundwater from contamination. Even the strictest regulations and controls for the storage, filling, handling, manufacturing, treatment and use of contaminated liquids, such as the United Kingdoms Environmental Protection Act (EPA), are satisfied with the HDPE geomembrane Carbofol®. This is regulated by the Environment Agency with guidance provided in their document 'LFE5-Using geo-membranes in landfill engineering'. We have included this in Appendix 1 of this document.

3.25 Advantages of the geomembrane Carbofol®:

- Excellent chemical resistance due to selected raw materials
- Extreme high elongation (ability to stretch) during uni-axial and multi-axial deformation reducing the risk of stress cracking
- High stress cracking resistance
- Very high UV-resistance
- Direction independent shear stress transfer with structured surfaces
- Complete quality control from the resin to the final product
- High Melt Flow Index allows an excellent welding performance assisting jointing/sealing

- Smooth edges with removable plastic tape for a clean welding surface and overlap lines
- Durable product with more than 40 years of project experience
- ISO 9001 certified
- CE marked

We have included a typical photograph of the material in Figure 3.4 below.

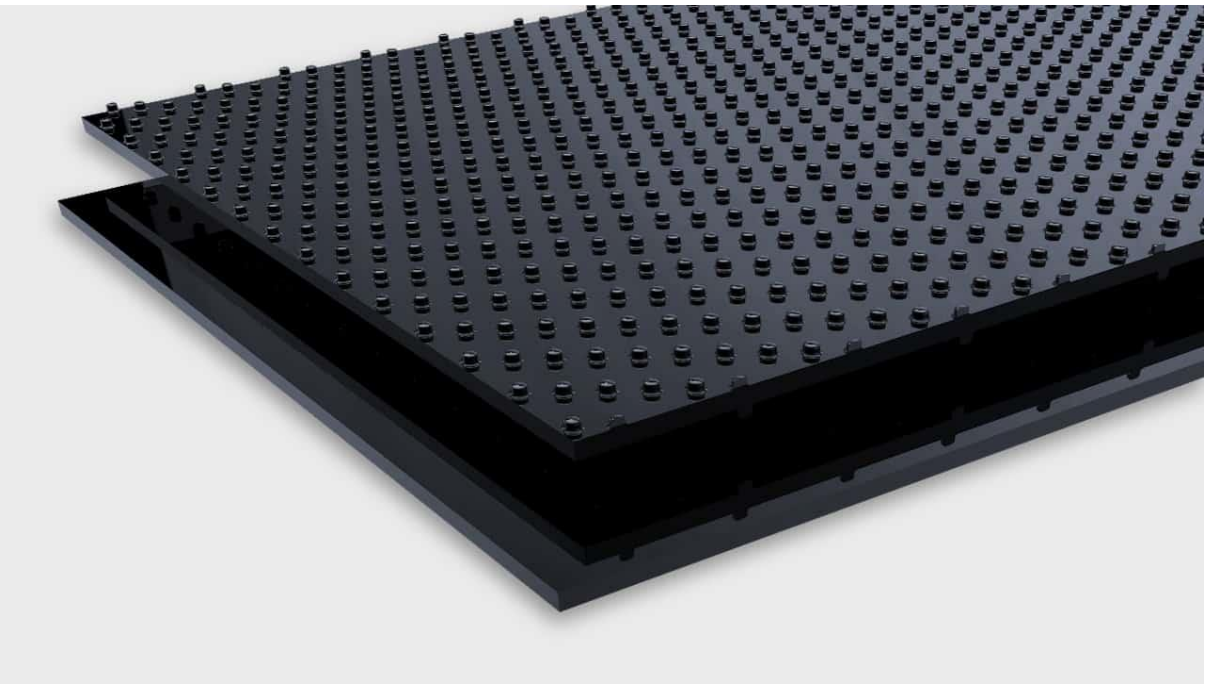


Figure 3.4 Typical Photograph of Carbofol HDPE Membrane

3.26 Secutex® geotextiles are used in many fields of civil engineering including hydraulic engineering, landfill engineering, road construction and tunnel construction. Secutex® with a high mass per unit area is used to protect geomembranes against mechanical damage. Needle-punched (mechanically bonded) non-wovens are robust geotextiles capable of withstanding harsh installation conditions and challenging construction loads. Their flexibility and elongation properties combine to provide high puncture resistance without sacrificing frictional properties. The use of protector geotextiles is regulated by the Environment Agency with guidance provided in their document 'LFE7-Using non-woven protector geotextiles in landfill engineering'. We have included this in Appendix 1 of this document.

3.27 The high elongation capacity (ability to stretch) of Secutex® nonwoven geotextiles ensures excellent resistance to damage. This characteristic of Secutex® products allows them to easily accommodate irregular or soft subgrades. Especially when covered with stone material, Secutex® non-woven geotextile fibres are reoriented around the stones, flexing and hence preventing damage to the non-woven structure and in turn the membrane beneath (see figure 3.5).

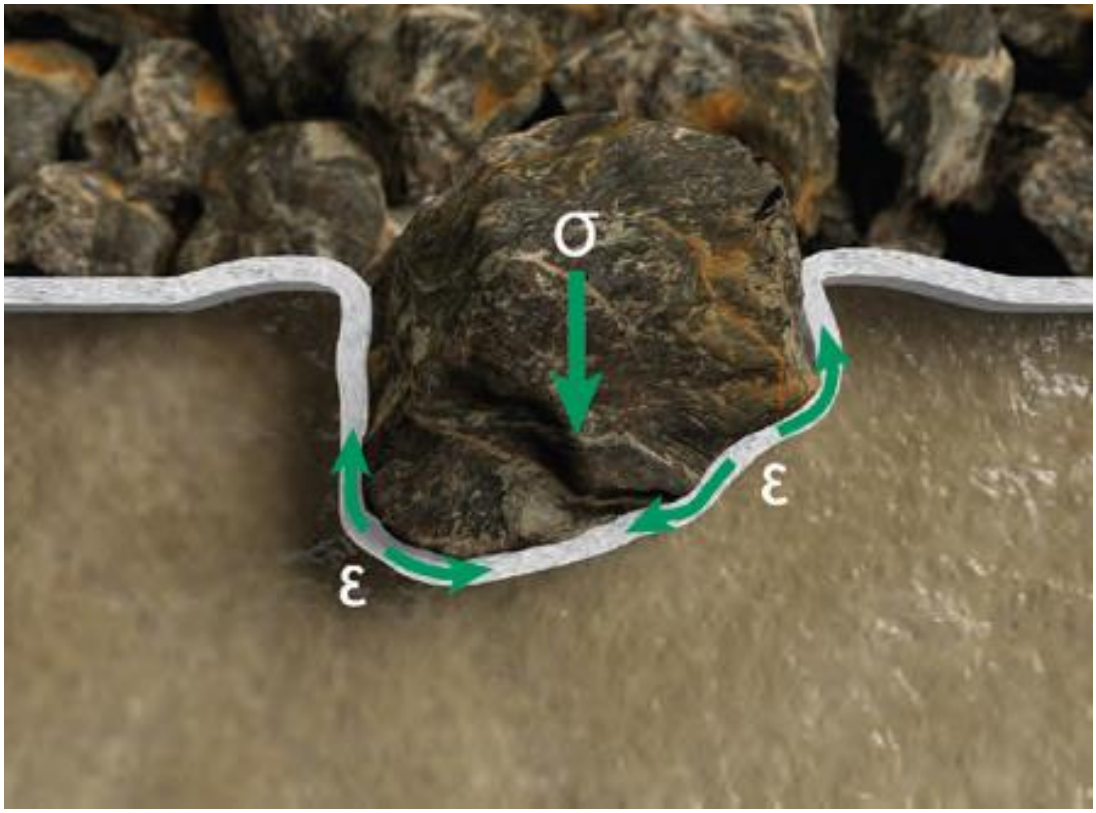


Figure 3.5 Site condition and stress/strain impact on Secutex® nonwoven

σ = Load on stone
ε = Strain

3.28 Advantages of the protective geotextile Secutex®:

- High elongation and therefore adjustable to soil deformations/flexible
- Very good interface shear resistance
- High puncture resistance
- Resistance to chemical and biological degradation
- Quick and cost-effective installation
- Robust against on-site conditions
- Highest quality control standards

We have included a typical photograph of the material in Figure 3.6 below.

Figure 3.6 Typical Photograph of Secutex Protective Geotextile

3.29 There are two (2) areas within the active area of the wellsite where the multi-layer remediation requires anchoring to a concrete structure, namely the existing Wressle 1 wellhead concrete platform and the proposed concrete entrance from the non-active area of the wellsite to the active area of the wellsite. All other proposed concrete structures within the active area of the wellsite will be constructed above the multi-layer remediation.

3.30 Where anchoring to a concrete structure is required, it will be anchored using a liquid-tight connection and sealing strip, as indicated in Figure 3.7.

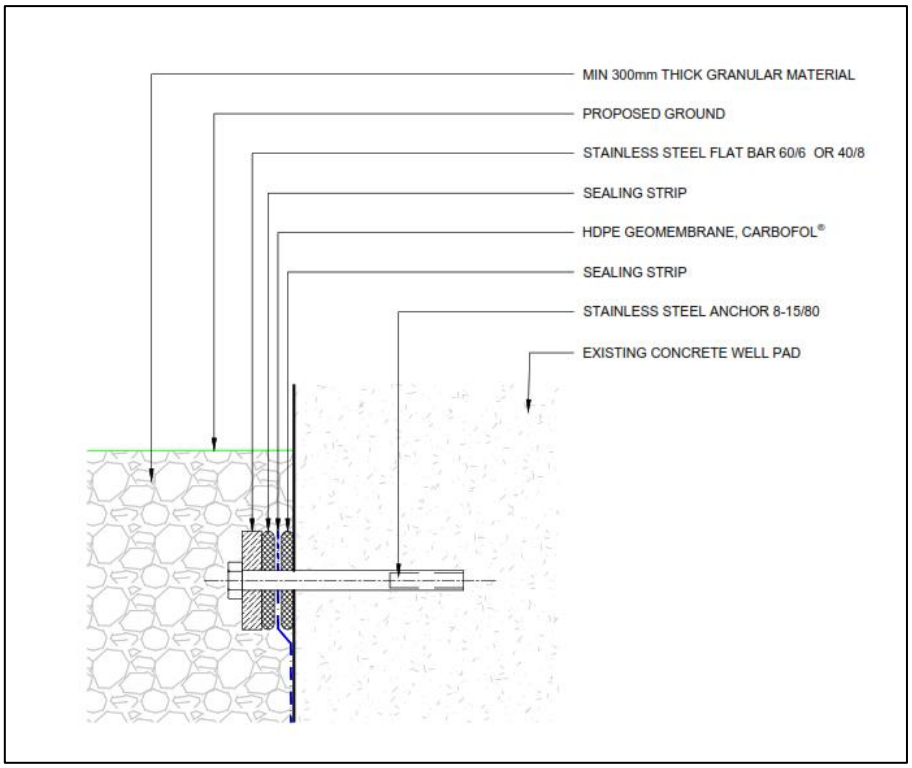


Figure 3.7: Anchoring Detail
(Drawing No. 40787-AWP-XX-XX-DR-C-2002 of Civil and Structural Design Statement)

3.31 Above the multi-layer remediation, an aggregate cover will be placed which will comprise the existing reclaimed granular material, screened and regraded. Areas subject to concrete construction, namely; the crude oil storage bund, the accessway and tanker loading area, and the extension to existing wellhead concrete platform, will have varying depths of aggregate cover, as indicated within the Civil and Structural Design Statement drawings (Appendix 4 of CDA11). Areas not subject to concrete construction will have 300mm aggregate cover. A typical example of the main platform build-up is provided as Figure 3.8.

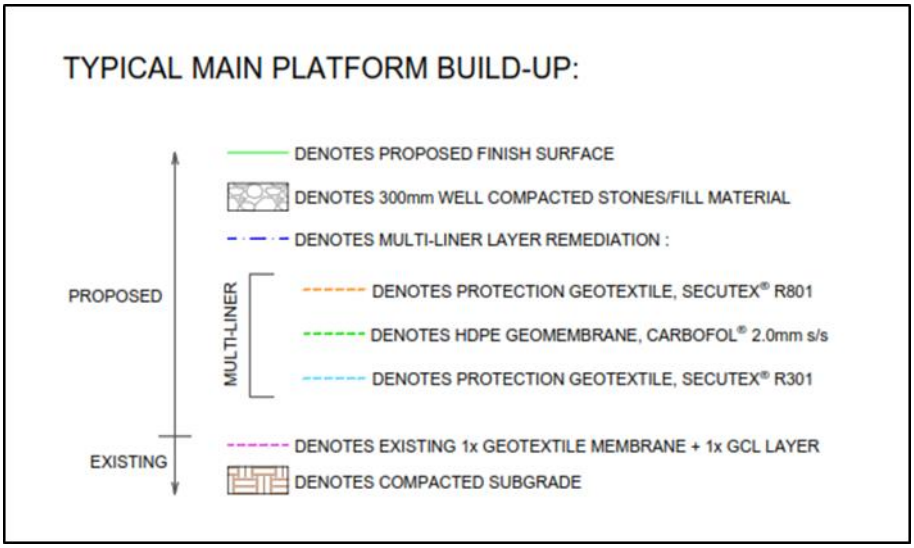


Figure 3.8: Typical Example of Main Platform Construction
(Drawing No. 40787-AWP-XX-XX-DR-C-2002 of Civil and Structural Design Statement)

3.32 The main platform within the active area of the wellsite, which is not subject to concrete construction, has been designed initially to accommodate a preliminary loading scenario of 160 KN on a 1.2m ø contact area. This is equivalent to 141.5 KN/m2 (kPa) loading intensity at the surface of the platform. This is based on our experience of designing crane pads for wind turbine installations where the cranes employed are significantly larger and we use an allowable bearing pressure at platform surface of 200KN/m².

3.33 The multi-layer remediation and representative aggregate cover has been subject to cylinder testing, in accordance with Environment Agency guidance *LFE 2 – Cylinder testing geomembranes and their protective materials* (BICS Laboratories Ltd UKAS Accredited Cylinder Test BD-N899/a-02 dater 29th May 2018), which confirmed that the proposed protection geotextile within the multi-layer remediation is suitable to protect the Carbofol® 2mm HDPE impermeable membrane at a pressure of 141 kPa.

3.34 The cylinder testing as noted above has been carried out in accordance with Environment Agency guidance *LFE 2 – Cylinder testing geomembranes and their protective materials*, which we have included in Appendix 1 of this document. It is a methodology for testing protector geotextiles for their performance in specific site conditions. This document describes a method for determining the effectiveness of a material in protecting a geomembrane against the long term mechanical effects of static point loads. The cylinder test method tests performance under the conditions likely to be encountered in a landfill site. This test methodology provides a consistent means of carrying out and reporting cylinder tests. The environment agency originally developed this method jointly between a working group of its regulatory officers and industry representatives, including test houses and geomembrane manufacturers. This update to the guidance has been developed again in association with an industry working group, namely BTTG Testing and Certification, Geofabrics Ltd and NAUE Geosynthetics Ltd. The methodology was derived originally from a technique developed at the University of Hanover. The test simulates many of the conditions faced by protector materials used in landfill sites. It applies primarily to non-woven geotextile protectors placed over high density polyethylene (HDPE) geomembranes, as these were the components in the original research.

3.35 Further to the above, JBA Consulting, within its review of the planning application on behalf of NLC, suggested that a condition be attached to the planning permission that *'No trafficking should be allowed outside the reinforced concrete area, except low ground pressure/light tracked vehicles, or in exceptional circumstances in response emergencies such as response to spills. If in such circumstances the liner is trafficked where it is not reinforced its condition should be checked afterwards.'*

3.36 It should be noted that the areas outside of the concrete roadway will be subject to infrequent vehicle movements and on this basis we are satisfied that the design is sufficient to allow trafficking of vehicles. We have carried out calculations in conjunction with NAUE that confirm the platform is suitable for general trafficking and these calculations are included in Appendix 2.

3.37 The calculations have been carried out using the loadings from a Tadano ATF 110G-5 Crane which we have been advised is the realistic worst case loading scenario for the site and are based on a maximum outrigger load of 68.4T and a maximum axle load of 16.2 T.

3.38 The underlying sub-grade conditions beneath the granular platform are extremely favourable in terms of load bearing characteristics. We have carried out calculations based on the following loading scenarios from the crane:

Load Type	**Pressure**	**Application Area**	**Calculated Minimum Thickness of Granular Platform Required**
68.4 T Outrigger Load	141.4 KN/m^2	2.2m x 2.2m	200mm
68.4 T Outrigger Load	200.0 KN/m^2	1.8m x 1.8m	200mm
16.2T Axle Load/80KN Tyre Load	404.0 KN/m^2	0.445m x 0.445m	300mm

On the basis of the above results I am satisfied that the proposed 300mm granular platform and the underlying sub-grade are adequate to support the required loads.

3.39 In addition to the above calculations carried out in conjunction with NAUE, we have separately carried out our own calculations using specialist geotechnical software called LimitStateGEO in accordance with Eurocode 7 using EC7DA1-2 – Eurocode for Geotechnical Design Approach 1 Combination 2.

3.40 Our analysis report has been generated using LimitState:GEO, a software application capable of directly identifying the critical collapse mechanism for a wide variety of geotechnical stability problems, including those involving slopes, retaining walls, footings etc.

3.41 The software utilizes the Discontinuity Layout Optimization (DLO) procedure to obtain a solution (Smith and Gilbert 2007). The main steps involved are: (i) distribution of nodes across the problem domain; (ii) connection of every node to every other node with potential discontinuities (e.g. slip-lines); (iii) application of rigorous optimization techniques to identify the critical subset of potential discontinuities, and hence also the critical failure mechanism and margin of safety. The accuracy of the DLO solution is controlled by the specified nodal density. Within the set of all possible discontinuities linking pairs of nodes, all potential translational failure mechanisms are considered, whether anticipated or not by the engineer. Failure mechanisms involving rotations along the edges of solid bodies in the problem can also be identified. Thus, in this case, the solution identified by the DLO procedure is guaranteed to be the most critical solution for the problem posed. This means that there is no need to prescribe any aspect of the collapse mechanism prior to an analysis, or to separately consider different failure modes. The critical mechanism and collapse load factor are determined according to the well-established upper bound theorem of plasticity. LimitState:GEO reports the solution to a problem both visually as a collapse mechanism and numerically in terms of an Adequacy Factor, which is defined as the factor by which specified loads must be increased, or material strengths decreased, in order for the system under consideration to reach a collapse state.

3.42 We have considered almost identical loading conditions as noted above under section 3.38 and the results are as below:

Scenario	Adequacy Load	Adequacy Strength	Acceptable
16.2T Axle Load/80KN Tyre Load = 404kN/m2	9.769	1.411	Y
Crane Outrigger			
68.4T Load on 2.20m x 2.20m spreader plate = 141.4kN/m2	16.83	2.018	Y
68.4T Load on 1.80m x 1.80m spreader plate = 211.1kN/m2	12.90	1.837	Y

The above results further confirm that the proposed 300mm granular platform and the underlying sub-grade are adequate to support the required loads we have included these calculations in Appendix 3

3.43 We can also confirm we have undertaken cylinder testing based on the following pressures used screened samples of the existing granular material:

- 200 KN/m²
- 405 KN/m²
- 500 KN/m²

The cylinder test certificates have been provided as Appendix 4 to this Proof of Evidence.

The results of the three (3) tests were that no indentations were observed on the Carbofol® 2mm HDPE membrane at 200KN/m² and 405KN/m² and only slight to moderate indentations at 500KN/m².

3.44 Given the above noted load intensity/pressures based on the worst case tyre pressure load of 404KN/m and the 405KN/m² cylinder test, no indentations were recorded I would conclude that this indicates that the multilayer remediation provides the necessary protection to the HDPE membrane.

3.45 Furthermore given that the cylinder tests indicate that the multi-layer remediation is capable of withstanding 500KN/m² of pressure the results confirm in my opinion, that the 300mm granular layer in conjunction with the protective geotextiles provides sufficient protection to the underlying HDPE membrane and its protective layers for normal trafficking.

3.46 In summary of the above, the 300mm granular platform is adequate to accommodate the applied loadings, and in conjunction with the protective geotextile layers provide the necessary protection to the HDPE membrane.

3.47 Finally, in support of the above summary, which as stated was carried out fully in conjunction with NAUE, AWP received a letter from NAUE confirming the following information on the 2?/09/19.

BBG, NAUE's sister consultancy company, carried out the preliminary design calculation demonstrating suitability for the sub soil in accordance with the Project Specification presented to NAUE by Alan Wood & Partners. Please find enclosed further calculations demonstrating the proof of sufficient soil bearing capacity for the reinforced system.

In reference to the revised Soil bearing calculations a series of Environment Agency Landfill Engineering guidelines cylinder tests on the Secutex R 801 were carried and are enclosed with this letter.

The results demonstrated "no measurable indentations" in the cylinder test using the proposed compacted aggregate fill on site with a 200 kPa and the design criteria pressure of 405 kpa. This shows that the protection geotextile offers the highest possible protection to the HDPE liner at this pressure. When evaluating the Secutex R 801 performance against the 2018 and subsequent 2019 cylinder test results, NAUE are satisfied that sufficient protection is being provided up to 500 kpa pressure based on the proposed design.

A copy of the above letter has been included in Appendix 5 of this document for completeness.

Crude Oil Storage Bund

3.48 Produced oil and produced formation water (if any) will be stored on site in five (5) storage tanks, each capable of holding 52m^3 of fluid. In accordance with Section 2 of CIRIA C736 (CDH 8). The storage of crude oil and produced formation water in tanks has been assessed and the requirement for secondary containment identified.

3.49 In accordance with Section 3 of CIRIA C736 (CDH 8), the containment system proposed is categorised as local containment and its capacity determined using Section 4 of CIRIA C736 (CDH 8), namely the *'110% and 25% rules'*, minimum secondary containment capacities derived from Section 3 (2)of the Control of Pollution (Oil Storage)(England) Regulations 2001, and an allowance for rain fall, which can reduce the net capacity of the bund. A copy of the relevant extract from the document Control of Pollution (Oil Storage) (England) Regulations 2001 is included in Appendix 5 of this Proof of Evidence. The calculation used to determine the required capacity of the bund is set out in Section 3.5 of the Civil and Structural Design Statement (CDA11)

3.50 The bund will be constructed using reinforced concrete, in accordance with Section 7 of CIRIA C736 (CDH 8). For clarity, the bund will be constructed above the multi-layer remediation, on a bed of 300mm aggregate cover, separated from the aggregate cover by a damp-proof membrane. Joints will be incorporated in to the construction of the bund to accommodate for movement, both from long-term shrinkage and thermal expansion and contraction. To prohibit the migration of fluid through the movement joint, external waterbars (below the joint) and sealing strips (within the joint) will be installed.

3.51 The internal base of the bund has been designed to accommodate the loading of the storage tanks, in accordance with the Concrete Society's TR34 (4th Edition) Classifications. It will have a nominal fall to the north, directing any fluids toward two (2) sumps, one located in the northeast corner of the bund and one located in the northwest corner of the bund.

Access way and Tanker Loading Bay

3.52 A reinforced concrete access way, incorporating a tanker loading bay, is proposed as part of the site reconfiguration works, the purpose of which is to provide additional protection to the HDPE impermeable membrane in areas which are expected to be subjected to more frequent HGV movements. It will also contain any mud or debris that could potentially be brought on to the active area of the wellsite and embed itself in the aggregate cover.

3.53 To inform the positioning of the access way, a swept path analysis was performed, as indicated within the Civil and Structural Design Statement drawings (Appendix 2 of CDA11), and will transition from the non-active area of the wellsite to the active area of the wellsite by way of a graded ramp, topping out immediately to the east of the perimeter containment ditch. It will provide sufficient fall to maintain containment within the active area of the wellsite, as indicated in Figure 3.9 below.

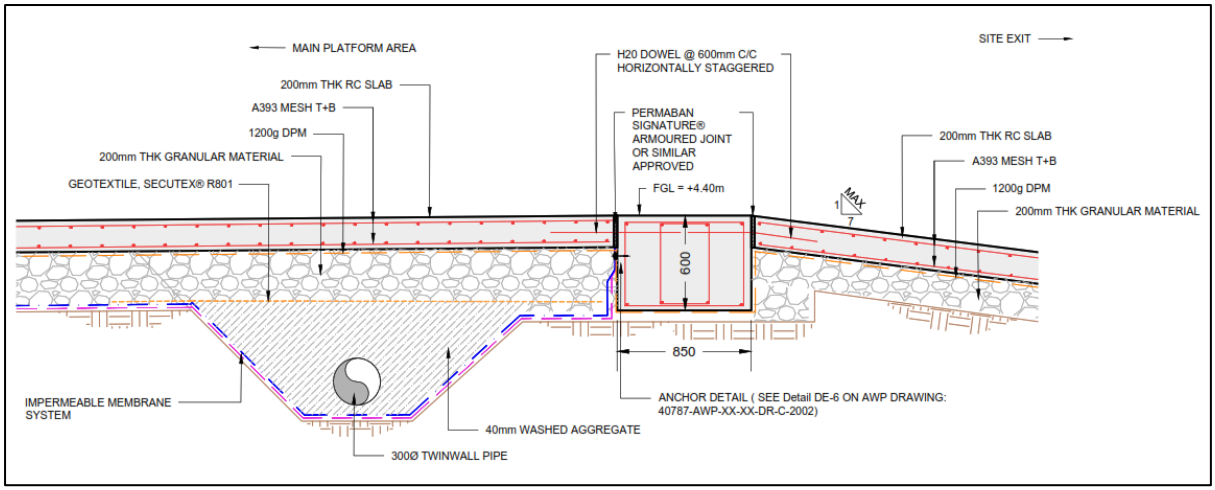


Figure 3.9: Access Ramp into Active Area of Wellsite
(Drawing No. 40787-AWP-XX-XX-DR-C-2003 of Civil and Structural Design Statement)

3.54 The access way will link with a tanker loading bay, located immediately to the east of the crude oil storage bund. In accordance with Section 2 of CIRIA C736 (CDH 8), the tanker loading bay has been assessed and the requirement for secondary containment identified.

3.55 In accordance with Section 3 of CIRIA C736 (CDH 8), the containment system proposed is categorised as a combined containment system which is designed to contain fluids and transfer them to a remote location, in this case the crude oil storage bund, which it does by way of a permanent pump and transfer system. Containment is provided by way of Trief Kerbs edging around the tanker loading bay, as indicated in Figure 3.10 below.

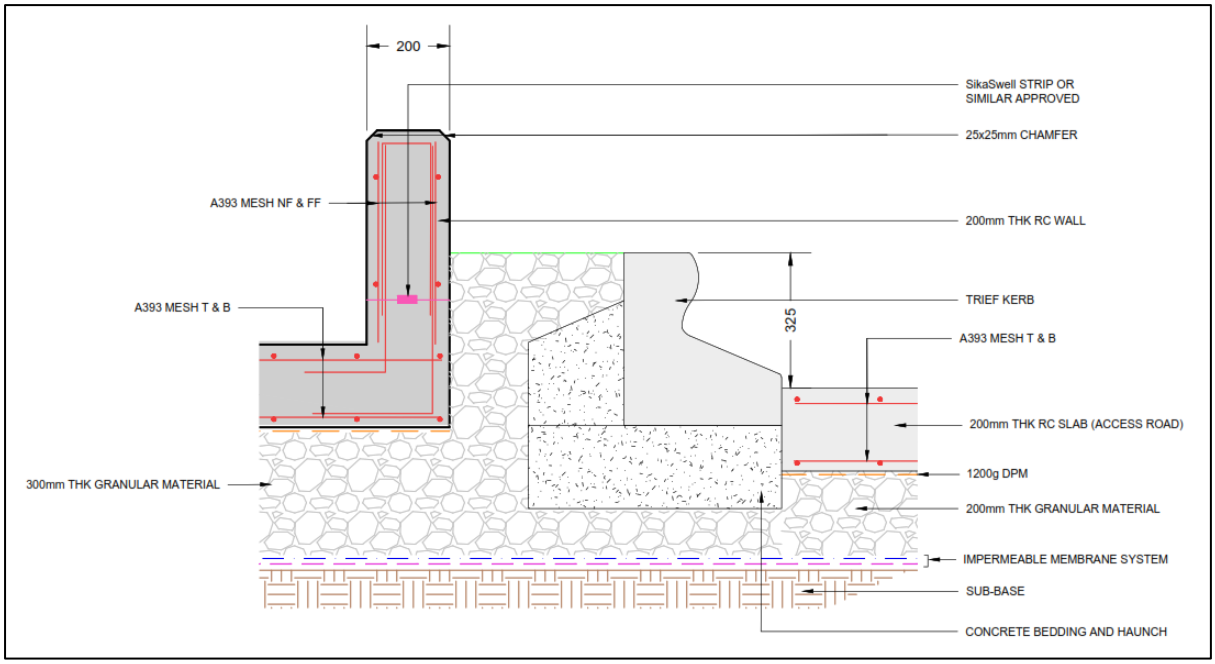


Figure 3.10: Tanker Loading Bay Trief Kerb Edging Detail
(Drawing No. 40787-AWP-XX-XX-DR-C-2001 of Civil and Structural Design Statement)

Extension to Existing Wellhead Concrete Platform

3.56 During the life of the Wressle 1 well, it may be necessary to carry out maintenance on the well, which requires the removal and temporary storage of production tubing and/or pumping rods from the well. In order to prevent contamination of the aggregate, the Appellant typically uses temporary bunding (as required). The purpose of extending the existing wellhead platform is to provide a level and even working area upon which temporary bunding can be installed (as required).

3.57 For clarity, the extension to the existing wellhead platform will be constructed above the multi-layer remediation, on a bed of 100mm aggregate cover, separated from the aggregate cover by a damp-proof membrane.

3.58 The multi-layer remediation will be anchored to the existing wellhead platform using a liquid tight connection, and sealing strip and the extension platform will encase the anchor proving a liquid tight connection, as indicated in Figure 3.11.

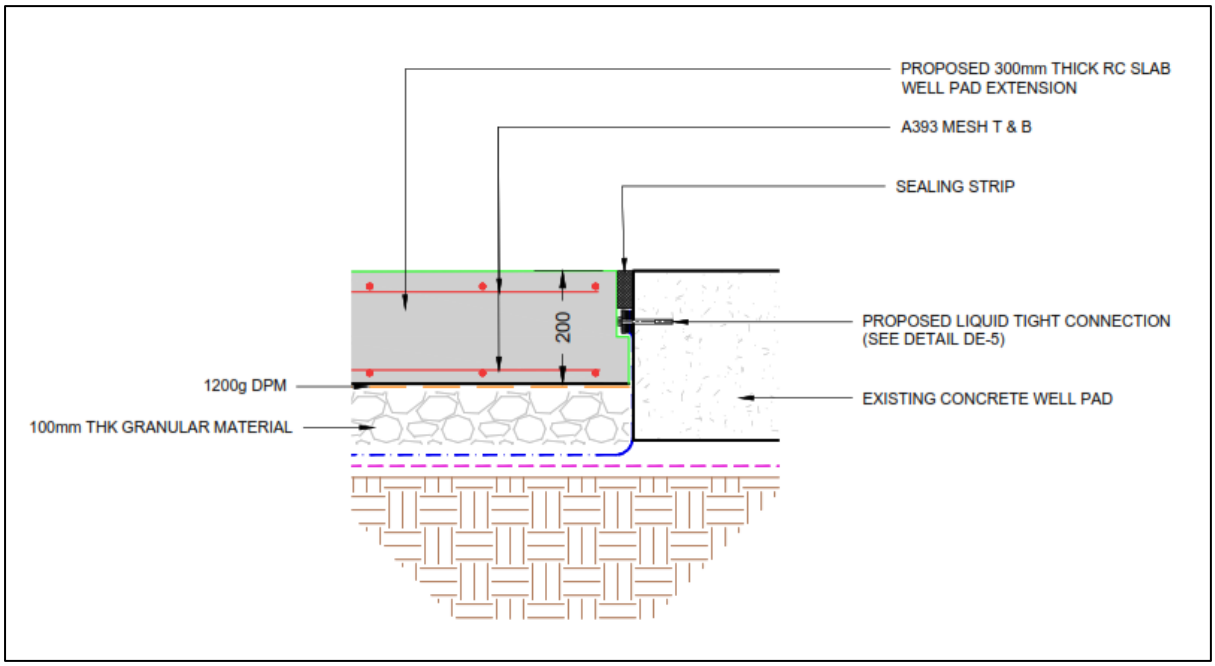


Figure 3.11: Multi-Layer Remediation Anchor to Existing Wellhead Platform
(Drawing No. 40787-AWP-XX-XX-DR-C-2002 of Civil and Structural Design Statement)

Wressle 1 Wellsite Platform Drainage

3.59 The proposed reconfiguration works provide for a fully contained active area within the wellsite with a permitted discharge of clean surface rainwater run-off at 5l/s.

3.60 Surface rain water falling within the active area of the wellsite, in areas not providing secondary containment (namely the Wressle 1 drilling cellar, the crude oil storage bund and tanker loading bay) will either percolate downward through the aggregate cover to the HDPE impermeable membrane or make its way by overland flow to the perimeter drainage containment system (French drains).

3.61 The drainage containment (French drain) will be formed by lining the existing perimeter ditches with the multi-layer remediation system, installing 300mm diameter perforated twin wall polyvinyl chloride drains (UPVC) and backfilling to finished level with a free draining 40mmø single sized washed gravel aggregate In this way the 'French drain' will create a continuous cut-off drain to the perimeter of the active area of the wellsite. A typical section is shown in Figure 3.12.

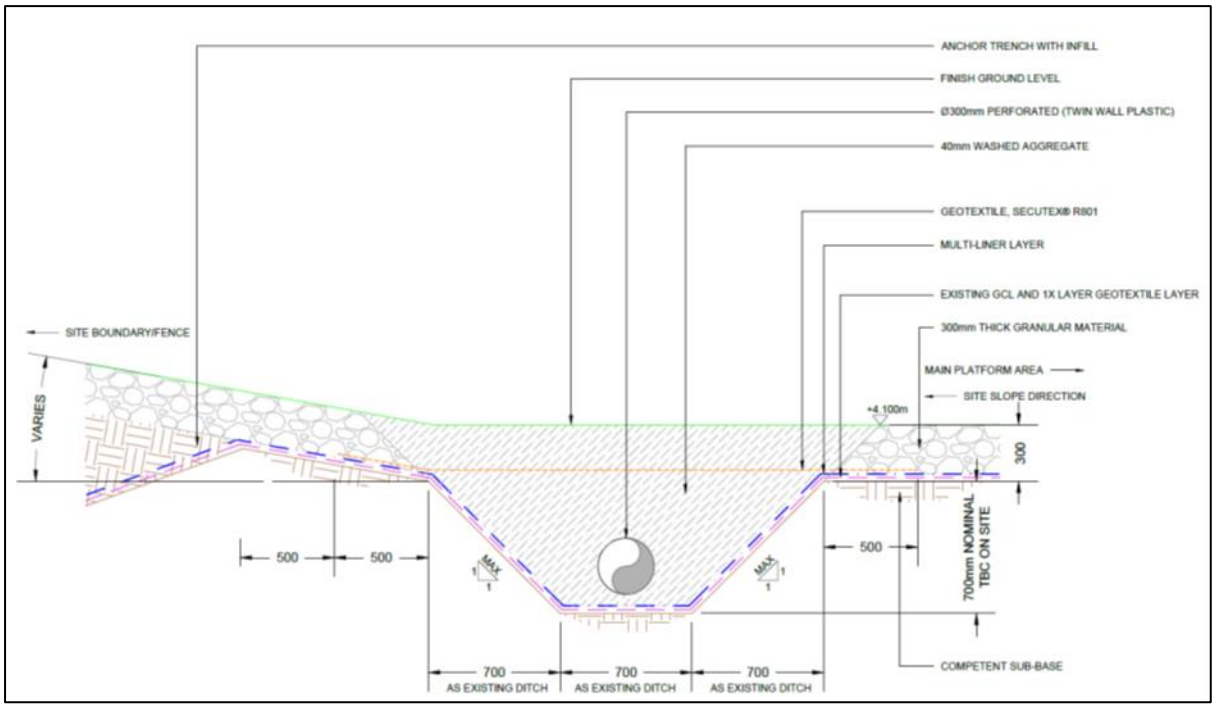


Figure 3.12 - Typical detail through perimeter drainage system (French Drain)
(Drawing No. 40787-AWP-XX-XX-SE-C-2300 of Civil and Structural Design Statement)

3.62 Access points for carrying out maintenance on the drain (rodding and/or jetting of the internal pipe) are proposed in all four (4) corners of the active area of the wellsite, immediately before the bend joints.

3.63 The flow of the drain within the perimeter containment ditch will be such that fluid is directed by constructed fall to the northeast corner of the active area of the wellsite, where an inspection chamber will be installed. An outlet pipe will be installed from the inspection chamber to a Kingspan NSFP006 Class 1 full retention interceptor. The outlet pipe, which will be fusion welded and sealed to the HDPE impermeable membrane to create a liquid tight connection, will incorporate a flow control device to restrict flow to 5l/s and an isolation valve positioned 'upstream' of the interceptor.

3.64 An outflow pipe from the interceptor to the discharge point, located at Ella Back, will be installed and backfilled. The outflow pipe will incorporate an isolation valve immediately downstream of the interceptor and an access manhole for subsequent sampling requirements.

3.65 At the end of the outflow pipe, where clean water is discharged to Ella Beck, a pre-cast concrete headwall will be installed. The purpose of the headwall is to prevent soil erosion, which might occur should clean water be discharged directly to the soil bank adjacent to Ella Beck.

3.66 The new drainage system will be constructed such that it discharges clean rainwater run-off via the interceptor to Ella Beck, at a maximum volume of 5l/s, as previously agreed and in accordance with the latest Flood Risk proposals. The performance of the containment system has been assessed against the 100-year event, including a 5% increase in rainfall rates to allow for climate change. Various scenarios have been tested, to ensure the system based on a

maximum out flow of 5l/s to Ella Beck can attenuate the appropriate volumes within the bunded platform area. Prior to discharge of clean rainwater run-off to Ella Beck, the discharge will be passed through a Kingspan NSFP006 Class 1, full retention interceptor which will be fully fitted with an oil alarm system including alarm beacon and audible alarm.

Summary of Wressle 1 Wellsite Construction

3.67 The Wressle 1 wellsite was constructed in April and May 2014, in preparation for drilling the Wressle 1 exploration well. It was designed and subsequently constructed to provide a level aggregate platform, incorporating a perimeter 'v' type ditch profile, overlaid with GCL and protective geotextiles, providing a low permeability hydraulic barrier, preventing fluid (surface water and potential contaminates) entering the subsoil.

3.68 Due to concerns raised by the Planning Inspector in his decision letter dated 4th January 2018 (Planning Application PA/2018/1315) regarding the absence of a ground conditions survey report prior to the initial site construction works, the absence of sufficient evidence on the adequacy of the GCL covering and uncertainty with regards to the near surface geology, specifically the presence of capping layers to the underlying aquifers,. The Appellant commissioned a ground investigation, carried out by OPUS in February 2018, specifically to confirm the above matters. The ground investigation confirmed the prevalent ground conditions which informed the Civil and Structural design, hence ensuring that the reconfiguration works to install an HDPE impermeable membrane, associated protective geotextiles (the multi-layer remediation), and granular layer above the GCL, were appropriately designed.

3.69 The design of the reconfiguration works has been informed by a ground investigation report and cylinder testing, in accordance with Environment Agency guidance *LFE 2*.

3.70 The design of the reconfiguration works will be fully installed in accordance with the guidelines contained in the Environment Agency document LFE4 - Earthworks in Landfill Engineering and specifically Chapter 6 - Construction Quality Assurance (CQA) please refer to Appendix 1 for a copy of this document. The largest difference from general civil engineering practice in the above document is that a more rigorous independent verification scheme known as Construction Quality Assurance (CQA) has to be used. This is required for aspects of construction for which failure could cause a significant increase in environmental risk. The lining system must be robust and will be constructed to the highest engineering standards to provide short, medium, and long term environmental protection.

3.71 As a minimum the CQA document will contain the following:

- Seam and weld testing of the liner (pull test using existing liner)
- Air testing of the liner welds, spark test over panel before covering (contractor & independent)
- Liner panel layout plan (showing joint locations, roll number, repairs and pipe penetrations etc.)
- Air testing of drainage (ditch to interceptor and discharge)
- Insitu plate bearing tests (on platform following pre/post installation)

- As-built topographical survey (upon completion)

3.72 The multilayer liner remediation and the 300mm granular cover to the well site platform have been designed fully in conjunction with the specialist membrane supplier NAUE. It takes into account the underlying ground conditions based on the latest OPUS geotechnical report and is designed to accommodate the realistic loading conditions the platform will be subject to. The design of the proposed wellsite reconfiguration works comply with British Standards, Codes of Practice or Eurocodes and relevant National annexes. The civil engineering structures have been designed and will be installed in accordance with the latest editions of all relevant British Standards and Codes of Practice and where these do not apply, by recognised good practice, as published by construction industry research establishments and organisations. In particular the following documents will apply:

- CIRIA Guide C736 (CDH 8)-Containment Systems for the Prevention of Pollution;
- TR 34 - Concrete Society Report-Edition 4 concrete Industrial Floor Slabs; and
- BS 8007 Design of concrete structures retaining aqueous liquids
- EN1997 - 1 Eurocode 7: Geotechnical design
- LFE4 - Earthworks in Landfill Engineering-Environment Agency

4. RESPONSE TO JBA COMMENTS IN APPLICATION REVIEW LETTER DATED 16/10/18

4.1 The Civil and Structural Design Statement (CDA11) was subject to review by JBA Consulting on behalf of NLC. JBA Consulting is an environmental engineering consultancy, who had represented NLC at the Public Inquiry for Appeal Ref: APP/Y2003/W/17/3173530 and Appeal Ref: APP/Y2003/W/17/3182879. In its review letter of 16th October 2018 Ref: (SJW/2018s1208-L-L001-4), there are a number of matters raised within the JBA report that we have addressed in this section of this Proof of Evidence.

4.2 JBA provided a table within the above noted letter summarising the points raised by the Planning Inspector at the November 2017 Enquiry (Appeal Decisions by Mr K L Williams BA, MA, MRTPI, 4th January). We have provided a point by point response to each of the matters raised where relevant to the Civil & structural Design elements in tabulated format in Appendix 6 of this document

4.3 JBA Consulting identified a number of aspects of the proposals regarding site engineering and mitigation in their report, which they felt prudent to capture in planning conditions to ensure that these aspects of the development are undertaken as planned, and if required the proposed working methods are clarified and approved. We have tabulated these items in the following schedule and annotated our response to each of these items. We have provided a point by point response to each of the matters raised in tabulated format in Appendix 6 of this document

4.4 JBA Consulting provided a more detailed assessment of the Civil and Structural design statement (CDA11) prepared by AWP as part of their Application review in section 2 of their Technical Appendix A. We have provided a point by point response to each of the matters raised in tabulated format in Appendix 6 of this document.

4.5 Finally, I have reviewed the JBA Consulting letter and I have identified the main substantive points where the inspector may find it helpful to have my response as part of my proof of evidence which are as follows:

- Existing Granular Layer-Contamination
- Design of Tertiary Containment-Use of average CBR Values
- Design of Tertiary Containment-Limiting the Trafficking of the Platform
- Design of Tertiary Containment-Free Draining Aggregate Layer/Cylinder Testing
- Design of Tertiary Containment-Method of Working/Liner Installation
- Interceptor
- Surface Containment on Site-Granular Cover-Angularity /Free Draining
- Surface Water Run-off-Volume Calculations

Site Investigation Report-Opus (March 2018), Existing Granular Layer-Contamination

4.6 In Section 2.1 of their Technical Appendix JBA Consulting made the following comment:

'A low level of contamination was found in the granular fill overlying the existing bentonite membrane. This was attributed to contamination brought on site within the granular stone layer. We would recommend that checks are made to confirm that the stone layer is not more widely contaminated if it is to be incorporated into the future site infrastructure and that any additional stone brought on site is from an uncontaminated source.'

4.7 The testing carried out by OPUS in the ground investigation has only identified minor contamination to be present in the aggregate layer but concluded this is not significant given the end use. Further testing will be carried out during the construction activities as part of the CQA process. We will ensure as part of the CQA process that any new material imported to site is from an uncontaminated source.

Design of Tertiary Containment-Use of Average CBR values

4.8 In Section 2.2 of their Technical Appendix A, JBA Consulting queried the use of average CBR values which were part of the Opus report and included in as part of the AWP Civil & Structural Design Statement (CDA 11) in Section 2.2 as follows:

'The use of average CBR values in Alan Woods (page 7) is potentially misleading as some of the actual CBR results (from cone tests) are much lower. Typical values of CBR for aggregate would be 25-30% on a reasonable sub-base. However, it is recommended that this should be demonstrated through additional plate testing of shallow soils on a grid basis before the new liner is installed.'

4.9 The critical CBR value in question is that of the Sutton Sand Formation which provides the underlying sub-grade to the working platform. The lowest recorded CBR in this material was 6.2. With respect to the CBR values presented within the Opus report, we have undertaken a statistical analysis of the CBR data set for underlying natural Sutton Sand Formation which resulted in a standard deviation of 14.35% with no outliers. From this we would conservatively adopt a CBR of 14% for design purposes if required. However, we would record generally that we have based the design of the platform on bearing calculations which were not carried out using the CBR values presented, but on the soil parameters determined from the empirical data obtained from the DCPs and windowless sampling boreholes. Our calculations are based on the N values and soil descriptions present in the Opus Report. However, as part of the CQA process during upgrading of the platform CBR tests will be taken on the underlying sub-grade once the existing stone layer has been removed and prior to replacing of the screened stone materials on a grid basis.

Design of Tertiary Containment-Limiting the Trafficking of the Platform

4.10 In Section 2.2 of their Technical Appendix A JBA Consulting has made the following comment:

'As only 300mm of aggregate is proposed for the site, no vehicle trafficking should be undertaken over the liner outside the concrete reinforced roadways'

My response to the above comment is identified earlier in this document and set out in paragraphs 3.35 to 3.47

Design of Tertiary Containment-Free Draining Aggregate Layer/Cylinder Testing

4.11 In Section 2.2 of their Technical Appendix A JBA Consulting has made the following comment:

'Further details should be provided regarding the proposed Scope of Works on site and how and where these will be undertaken and the order of works. The proposed screening of the aggregate layer to remove >125mm should also include removal of fines to prevent possible blockage of surface water drainage pathways. Following screening of the stone on site, we

recommend that the cylinder test is repeated using representative stone from site and repeated loading cycles.

4.12 It is not critical that the aggregate to the general platform is free draining, surface water from rain will either make its way via infiltration or by overland flow to the perimeter containment drainage system.

4.13 We have carried out cylinder testing using representative stone from site and the results of this are described in paragraphs 3.43 to 3.47 of this document. As part of the CQA process further repeat cylinder tests will also be carried out on the final screened aggregate. We have made enquiries with the certified testing specialist laboratory as to cyclical cylinder testing and this is not currently available or indeed a recognised test.

Design of Tertiary Containment-Method of Working/Liner Installation

4.14 In section 2.2 of their Technical Appendix A JBA Consulting has made the following comment:

'More detail regarding the 'careful removal' of the sub-base should be provided. This should be undertaken with only light weight plant (e.g. mini diggers, light weight tracked vehicles) or on temporary reinforced haul routes/runway plates. As the HDPE will be installed prior to and underlying the reinforced roadways on site, it is possible that temporary roadways may be required. The type of plant, protection measures, and where the sub-base is to be stored and screened should be confirmed within the CQA plan.'

4.15 We confirm that we will be complying fully with the specialist suppliers, NAUE, installation instructions for both the Secutex protective membranes and the Carbofol HDPE membrane to ensure no damage occurs to the liner during the construction process. We shall appoint a British Geomembrane Association (BGA) specialist sub-contract installer with the relevant Thermal welding institute (TWI) experience and qualifications. NAUE, the specialist supplier will form an integral member of the construction team. The works shall be quality assured by an independent 3rd party appropriately qualified consultant. This will include, but not limited to, 3rd party product and weld testing, a CQA plan for the construction and ultimately a CQA validation document for the works.

Interceptor

4.16 In Section 2.3 of their Technical Appendix A JBA Consulting has made the following comment:

'In particular the performance of the interceptor with regard to the full range of hydrocarbons/chemicals found in crude oil, formation water and produced water should be confirmed.

4.17 The interceptor that will be provided is a Kingspan Klargester NSFP006 Class 1 Full retention interceptor. Full retention separators are generally used in high risk spillage areas such as:

- Fuel distribution depots.
- Vehicle workshops.
- Scrap Yards

4.18 Kingspan Klargester interceptors are certified to EN 858-1 in the UK. The NSF number denotes the flow at which the separator operates. As part of this certification process the British

Standards Institute (BSI) has witnessed the performance tests of the required range of separators and having deemed the tests to be acceptable in terms of meeting the effluent requirements of EN858-1, has certified their performance.

4.19 Full retention interceptors treat the full flow that can be delivered from the connected drainage system and a Class 1 interceptor provides the highest degree of separation to achieve concentrations of less than 5mg/l under standard test conditions. This is the minimum requirement in drainage systems connected to a surface water outfall. In the case of the Appeal Development, the surface water outfall is Ella Beck.

4.20 In comparison to the above noted typical uses we would consider the Wressle 1 Wellsite to be of fairly low risk with regards to hydrocarbon contamination run-off particularly considering the other containment measures upstream that will be installed as part of the reconfiguration works.

4.21 The purpose of the interceptor is to separate and contain fuel, oil and other pollutants, which are lighter than water from the surface water as it passes through the interceptor. Following separation, the water passes through a filter before being discharged. The filter is connected to an alarm system, which activates when the filter is blocked or needs to be cleaned.

4.22 As noted above given the upstream levels of containment, I consider the risks of contamination to be minimal. Furthermore, the risk of contamination is further reduced by way of a Surface Water Management Plan (SWMP) which will form part of the CQA for the site.

4.23 The process of surface water discharge from the Wressle 1 Wellsite will be as follows and will be covered by the SWMP:

- Surface water will collect in the perimeter containment drainage system (French drain).
- This will be a closed system when specific site operations are in progress such as proppant squeeze, acidisation and sidetrack drilling controlled by means of an isolation valve prior to the interceptor.
- Following completion of the above operations a sample of water will be collected from the perimeter drain for laboratory analysis from the inspection chamber on the North East corner of the site.
- If the analysis results are below specified screening limits, then the water will be considered suitable for discharge and the isolation valve will be released.
- If the water does not meet the requirements for discharge, arrangements will be made for disposal by alternative methods, e.g. disposal by authorised haulage tanker to an Environment Agency licensed waste disposal facility/water treatment facility.
- During normal production operations the valve will be open to allow surface water to freely discharge via the interceptor to Ella Beck.

On the above basis I am satisfied that the Petrol interceptor specified is appropriate.

4.24 In Section 2.3 of their Technical Appendix A JBA Consulting has made the following comment:

Additional information should be provided about the ability of the interceptor to prevent ingress of water from Ella Beck in times of flood, including provision of a non-return valve.

An isolation valve has been provided please refer to AWP drawing 40787-AWP-XX-XX-PL-C-2100 -Proposed drainage layout. It is not specified as a non-return valve as the JBA query noted above but this could be accommodated within the final design of the drainage system.

Surface Containment on Site-Granular Cover-Angularity /Free Draining

4.25 In Section 2.7 of their Technical Appendix A JBA Consulting has made the following comment:

'It is stated (Planning Policy Statement page 14, Alan Wood page 11 para 3.3) that the granular cover on site will be regraded to remove aggregate larger than 125mm. No reference is made to the roundness of the aggregate. It is important that the aggregate is not too angular (not more angular than that used in the cylinder test) as this would invalidate the cylinder test results. It is noted that the photograph of the aggregate used in the cylinder test shows rounded aggregate with some considerable fines proportion.'

We will screen the stone material prior to re-laying on the site and this will be specified in the CQA Plan. We will screen out all materials above 50mm to create a 50mm down to dust material. Some angularity of the aggregate is in fact good thing as it aids aggregate interlock and helps provide a stiff working platform.

4.26 In Section 2.7 of their Technical Appendix A JBA Consulting has made the following comment:

'The aggregate layer on site is supposed to be freely draining (to the French drains) so it is important that there are not too many fines. However, the presence of the fines within the cylinder test sample may reduce the potential for puncturing the liner. It is important that the aggregate used in the cylinder test is representative of what is to be on site. It is also essential that the final cover is of appropriate size and roundness so as not to puncture the underlying protective membranes when loaded.'

It is not critical that the aggregate to the general platform is free draining, surface water from rain will either make its way via infiltration or by overland flow to the perimeter containment drainage system. The perimeter containment ditch system (French drain) will be backfilled with a free draining 40mm single size washed gravel aggregate which will act as a cut-off to any overland flow with any surface water thence percolating down to the 300mm ø perimeter perforated drainage system. For the purposes of our storm water analysis in terms of the water storage volumes we have conservatively ignored the potential storage volume within the general platform stone layer however, clearly in reality it will allow infiltration of rainwater through its surface.

4.27 In Section 2.7 of their Technical Appendix A JBA Consulting has made the following comment:

'If the existing aggregate on site is to be re-used to form the drainage layer above the membrane then its suitability should be confirmed through reference to appropriate guidance and also the liner manufacturer's specification. The material should also be checked to confirm that it is free from contamination.'

The testing carried out by Opus on the aggregate in their ground investigation has identified minor contamination to be present but concluded that it is not significant given the end use.

There was no contamination identified in the sub-strata, further testing will be carried out during the CQA process.

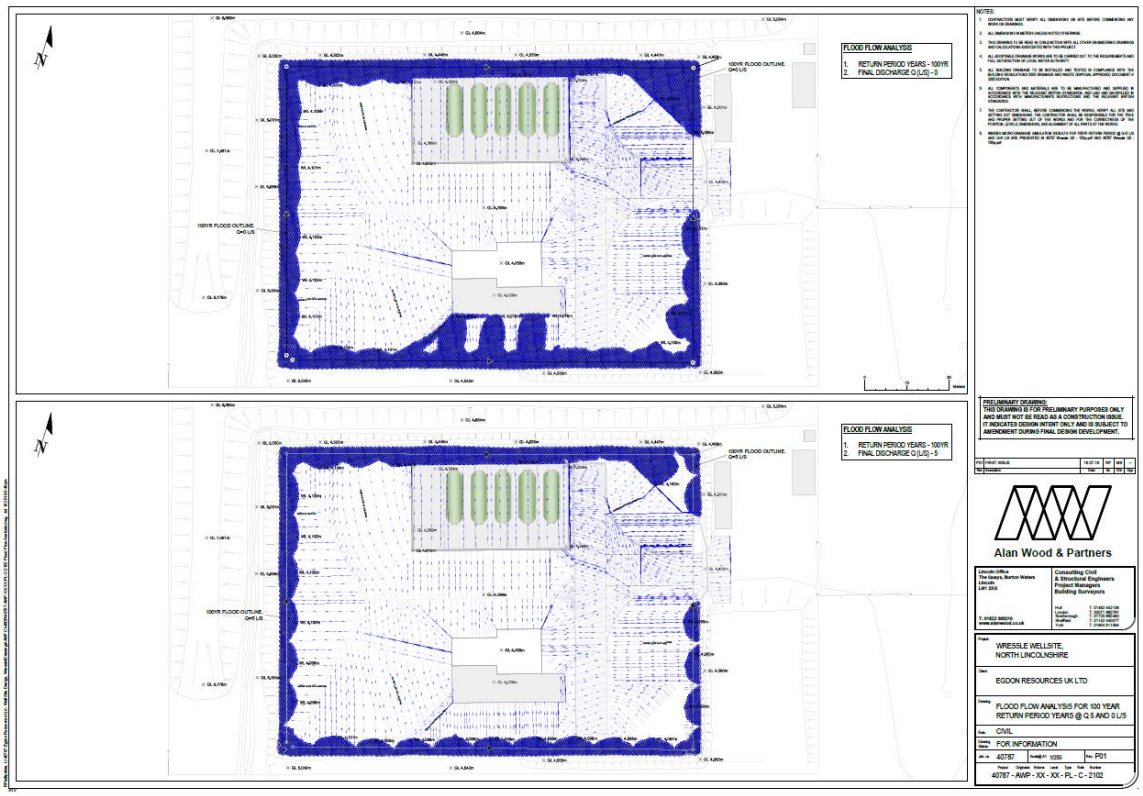
With regard to the liner manufacturer we have confirmed with the specialist NAUE that they are satisfied with the use of the 300mm protective stone layer above their HDPE liner.

Volume Calculations

4.28 In Section 2.9 of their Technical Appendix A JBA Consulting has made the following comment:

'Clarification could be provided that the storage volume calculations (for spillage and a 1 in 100 year flood retention on site) make allowance for the additional volumes of concrete (additional well apron and concrete road way areas).'

We can confirm that our storage calculations make due allowance for the new concrete structures to be installed at the site, please see below screen shots indicating flood modelling. We have included our supporting calculations and drawings in Appendix 7 of this document for your further information.



5. CONCLUSION

5.1 I have in the above sections outlined the Civil and Structural Design of the Wressle1 Wellsite platform which is covered in further detail in Civil and Structural Design Statement (CDA11)

5.2 I have set out how the Civil and Structural Design was informed by a geotechnical investigation carried out at the Wressle 1 Wellsite by Opus International Consultants (UK) Limited in February 2018. The geotechnical investigation confirmed the ground conditions and geotechnical properties underlying the Wressle 1 Wellsite.

5.3 The above noted geotechnical investigation fundamentally informed our design of the reconfiguration of the Wressle 1 Wellsite. The design parameters established by the geotechnical investigation ensures that the civil and structural design of the wellsite platform is suitable for its proposed use.

5.4 I have described the existing site conditions of the Wressle 1 Wellsite and the proposed reconfiguration works.

5.5 I have reviewed and responded to the comments and representations made in the JBA planning review letter dated 16th October 2018 reference SJW|2018s1208-L-L001-4 which relate to my area of expertise and are satisfied that we have addressed these appropriately

5.6 In summary, the upgraded well platform will provide robust protection to the existing environment during the Proposed Development activities. The design has been undertaken fully in accordance with the findings of the geotechnical report and in conjunction with the membrane specialist NAUE. Where appropriate, consultation with a specialist installer has also been undertaken to establish the practicalities of implementing the design. In conclusion the proposed design and reconfiguration work has addressed the following key points:-

- It is based on a detailed geotechnical investigation which has confirmed the nature of the underlying strata.
- It complies with all relevant guidance, standards and codes;
- It provides a new HDPE impermeable membrane and protective layers;
- Specific cylinder testing using the proposed stone thickness/type and membrane system has been undertaken to confirm its suitability.
- A new tanker access road and loading bay will be provided offering robust construction for heavily trafficked areas and removing the need for wheel washing.
- Bunds and site volumes have been confirmed to provide necessary storage volumes to meet all statutory requirements including 1:100 year storm including climate change allowance.
- Installation of a French Drain and full retention interceptor to manage clean surface water run-off into Ella Beck.
- A full CQA system will be employed to ensure the competency of the finished platform.

5.7 I consider the concerns raised as part of the previous planning submissions relevant to my area of expertise have now been addressed and summarised as part of this Proof of Evidence.

6. ENDORSEMENT

6.1 I confirm that the evidence I have prepared and provided for this appeal (Ref: APP/Y2003/W/19/3221694) within this Proof of Evidence, is true. I confirm that the opinions expressed are my true and professional opinions.

Mark Barwood
4th October 2019