SHELL BEMERTON

Remediation Implementation Plan

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This report dated 08 December 2022 has been prepared for Shell UK Oil Limited (the "Client") in accordance with the terms and conditions of appointment dated 01 October 2020 (the "Appointment") between the Client and **Arcadis (UK) Limited** ("Arcadis") for the purposes specified in the Appointment. For avoidance of doubt, no other person(s) may use or rely upon this report or its contents, and Arcadis accepts no responsibility for any such use or reliance thereon by any other third party.

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Abbreviations

BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
BGS	British Geological Survey
CoPC	Contaminants of Potential Concern
CPU	Continued Petroleum Use
CSM	Conceptual Site Model
DEFRA	Department for Environment, Food and Rural Affairs
DRO	Diesel Range Organics
DQRA	Detailed Quantitative Risk Assessment
ESA	Environmental Site Assessment
GAC	Generic Assessment Criteria
GrAC	Granular Activated Carbon
GSVM	Groundwater and Soil Vapour Monitoring Report
LEL	Lower Explosive Limit
LNAPL	Light Non-Aqueous Phase Liquid
mAOD	metres Above Ordnance Datum
MDL	Method Detection Limit
mbar	millibar
mbgl	metres Below Ground Level
MNA	Monitored Natural Attenuation
MTBE	Methyl Tert-Butyl Ether
PFS	Petrol Filling Station
PID	Photo Ionisation Detector
ppm	Parts per Millions
ppmV	Parts Per Million by Volume
PRO	Petroleum Range Organics
RC	Remediation Criteria
RIP	Remediation Implementation Plan
ROA	Remediation Options Appraisal
RoI	Radius of Influence
SIR	Site Investigation Report
SPZ	Source Protection Zone
SVE	Soil Vapour Extraction
TFP	Total Fluid Pumping
TPH	Total Petroleum Hydrocarbon
UST	Underground Storage Tanks
VOC	Volatile Organic Compounds

1 Introduction

Arcadis (UK) Limited (Arcadis) was commissioned by Shell UK Oil Products Limited ("Shell") to prepare a Remediation Implementation Plan (RIP) for Shell Bemerton, an operational Petrol Filling Station (PFS) located at 133 Wilton Road, Salisbury, Wiltshire SP2 7JB (hereafter 'the site'). A site location plan is presented on Figure 1 and the existing site layout and borehole location plan is presented on Figure 2 within Appendix A.

This RIP is designed to provide a detailed method for the implementation of the proposed remediation plan for the Site.

The work documented in this report was carried out with reference to current English legislation and regulatory guidance for the assessment of land contamination.

1.1 Background

The site has been a PFS since circa 1953, with seven operational double-skinned underground storage tanks (USTs) installed in 1991 located towards the centre of the site. In addition, there are four single-skinned historical USTs located north of the operational USTs which remain in-situ (understood to be decommissioned and filled with concrete slurry) and a potential fifth disused tank may be present to the east of the operational tanks. Based on the historical and current use of the site as PFS and the environmental investigations undertaken at the site, petroleum hydrocarbons have been identified as the primary contaminants of potential concern (CoPC) representing the potential source identified in soil and groundwater.

It is understood that the site will undergo a redevelopment with a proposed continued petroleum use (CPU). A proposed site layout plan is presented on Figure 3. Planning consent (application ref. 20/08577/FUL) was granted for the proposed redevelopment by Wiltshire Council on 07 January 2021 with Condition 7 pertinent to contaminated land:

> *'In the event that contamination is encountered at any time when carrying out the approved development, the Local Planning Authority must be advised of the steps that will be taken by an appropriate contractor; to deal with contamination and provide a written remedial statement to be followed be a written verification report that confirms what works that have been undertaken to render the development suitable for use.'*

The proposed redevelopment comprises redevelopment of the existing PFS including: demolition of the existing sales building, jet wash and forecourt, removal of the underground fuel tanks, erection of a new sales building, forecourt and canopy, provision of new underground tanks and associated pipe work, provision of an electric vehicle charging hub and associated plant, car parking and bin storage area, and associated works.

1.2 Objectives

The objective of the proposed remediation at the site is to manage the environmental risks and environmental liabilities associated with the historical use of the site as a petrol filling station. The primary purpose of the RIP is to present an outline of design, mobilisation, commissioning, operation, monitoring and validation requirements of the proposed remediation at the Site.

1.3 Limitations

Arcadis' liability pursuant to the terms of the appointment of Arcadis by Shell, is strictly limited to the work undertaken and the matters contained and specifically referred to in this report. A copy of Arcadis' study limitations is presented as Appendix B.

This report is only valid when used in its entirety. Any information included in the report should not be relied upon until considered in the context of the whole report and previous work.

1.4 Reliance

It is understood that this report has been prepared for the use of Shell. The contents of this report may not be used or relied upon by any person other than this party without the express written consent and authorisation of Arcadis.

1.5 Previous Reports by Arcadis

Previous environmental works undertaken by Arcadis are presented in the following reports:

- Groundwater and Soil Vapour Monitoring Report, Shell Bemerton, Arcadis, August 2021 (Report Reference: GB-10019043-20210805-MON-GME)
- Site Investigation Report, Shell Bemerton, Arcadis, December 2021 (Report Reference: GB-10019043-20211217-SA-SI 2021)
- Detailed Quantitative Risk Assessment, Shell Bemerton, Arcadis, December 2021, (Report Reference: GB-10019043-20211224-SA-BEMERTON DQRA)
- Remedial Options Appraisal, Shell Bemerton, Arcadis, March 2022 (Report Reference: GB-10019043-20220311-REM-ROA)
- Environmental Strategy Plan, Shell Bemerton, Arcadis, March 2022 (Report Reference: GB-10019043-20220315-REM-ESP)
- Remediation Pilot Trial Report, Shell Bemerton, Arcadis, April 2022 (Report Reference: GB-10019043-20220411-REM-PILOT)

Borehole logs from previous phases of site investigation carried out at the site are presented in Appendix C.

2 Site Characteristics

2.1 Site Description

The site is an active PFS located at National Grid coordinates 412950 (E), 130530 (N) at an approximate elevation of 57 metres Above Ordnance Datum (m AOD). Regionally the topography of the surrounding area generally slopes downwards in a southerly direction towards the River Nadder which lies approximately 250m southwest of the Site at its closest point.

The surrounding land use are as follows:

Direction	Surrounding Land Use
Land use to north	Wilton Road is situated adjacent to the northern site boundary, beyond which are dense vegetation and residential properties with gardens.
Land use to east	The eastern site boundary borders Gorringe Road, beyond which are residential properties with gardens.
Land use to south	Residential properties with gardens lie immediately adjacent to the southern site boundary. Commercial properties are located approximately 25m southeast and a railway line is 120m south of the site.
Land use to west	Cherry Orchard Lane borders the western site boundary, beyond which lies residential properties with gardens.

2.2 Geology

Geology	Unit	Maximum Depth	Aquifer Classification
Regional	Source: British Geological Survey (BGS) GeoIndex and Department for Environment, Food and Rural Affairs (DEFRA) Magic Maps [Accessed on 27/07/2022]		
Artificial Ground	BGS online mapping indicates records of Made Ground at the site and immediately around the site surrounding in east and west. BGS online mapping describes the Made Ground as an area where the pre-existing land surface is raised by artificial deposits. The presence of Made Ground in surrounding area is attributed to development of residential properties to the n east and west.	--	--
Superficial Deposits	BGS online mapping indicates that the site and the area immediately surrounding the site is underlain by Superficial Deposits of River Terrace Deposits – Sand, Silt and Clay.	--	Secondary A Aquifer
Bedrock	BGS online mapping indicates that the site and the area immediately surrounding the site is underlain by Bedrock Deposits of Newhaven Chalk Formation - Chalk	--	Principal Aquifer

Geology	Unit	Maximum Depth	Aquifer Classification
Local	Source: Shell Bemerton, Site Investigation Report (SIR), Arcadis, (Ref no: GB-10019043-20211217-SA-SI 2021), December 2021, logs presented in Appendix C		
Made Ground	Made Ground generally comprised bituminous surfacing overlying reddish brown to dark brown slightly clayey sandy gravel and gravelly clay.	To a proven depth of 3.48m bgl	Not applicable
Superficial Deposits	River Terrace Deposits comprising clayey gravelly sand, sandy gravelly clay, clayey sandy gravel and silty gravel of chalk and flint. Occasional cobbles of flint.	To a proven depth of 7.68m bgl	Secondary A Aquifer
Bedrock	White Chalk Subgroup (likely Newhaven/Seaford Chalk Formation) comprising structureless chalk generally recovered as creamish white to grey gravelly silt and silty gravel. Clasts are weak and of low to high density.	To a proven depth of 16m bgl	Principal Aquifer

2.3 Hydrogeology

Hydrogeology	Details	Source
Aquifer Designations	**Superficial Aquifer** – River Terrace Deposits encountered beneath the site are designated as Secondary A Aquifer. **Bedrock Aquifer** – White Chalk Subgroup (likely Newhaven/Seaford Chalk Formation) encountered beneath the site are designated as Principal Aquifer	DEFRA Magic Maps (Accessed on 27/07/2022)
Groundwater Elevation	Site Investigation Report (SIR) (December 2021) indicated depth to groundwater ranging from 8.464m to 10.395m bgl. Groundwater elevations ranged from 47.008m to 47.115m AOD. Previous groundwater monitoring event (April 2021) indicated depth to groundwater ranging from 9.85m bgl to 10.38m bgl. Associated groundwater elevation ranged from 47.084m AOD to 47.164m AOD.	SIR, Arcadis, (Ref no: GB-10019043-20211217-SA-SI 2021), December 2021 and Groundwater and Soil Vapour Monitoring (GSVM) Report, (Ref no: GB-10019043-20210805-MON-GME), August 2021
Groundwater Flow Direction	The SIR (December 2021) indicated a groundwater flow direction beneath the site towards the southwest. A previous groundwater monitoring event (April 2021) indicated the groundwater flow direction in south-easterly direction which was in line with the previous monitoring completed in March and August 2020.	
Groundwater Vulnerability	The Envirocheck report (2019) indicated summary classification: Secondary Superficial Aquifer – Medium Vulnerability. Flow mechanism: Well-connected fracture	Phase 1 Environmental Site Assessment (ESA), AECOM (Ref no: GB-10019043-

Hydrogeology	Details	Source
Flooding Risk	The Envirocheck report (2019) indicated the northern section of site lies within an area which has limited potential for groundwater flooding to occur. The southern area of the site has a potential for groundwater flooding of the property situated below ground level.	190902-SA-P1.docm), September 2019
Groundwater Source Protection Zone (SPZ)	The site is located within a Source Protection Zone (SPZ), Zone I (Inner Protection Zone).	Phase 1 ESA, AECOM (Ref no: GB-10019043-190902-SA-P1.docm), September 2019
Licenced Potable Groundwater Abstraction within 2km	The Envirocheck (2019 states three records of potable water supply relating to Wessex Water Services Ltd (13/43/022/G/079) were identified approximately 403m, 406m and 574m northeast of the site.	
Licenced Non-Potable Abstraction within 2km	As per Envirocheck report (2019) four records on non-potable abstraction were identified within 1km with the nearest abstraction point located 718m south of the site associated with Flowplant Group Ltd (13/43/022/G/119) and used for machinery and electronics – general use.	
Private Groundwater Abstraction	As stated with the AECOM Phase 1 ESA report (September 2019), Wiltshire Council holds no record of any private groundwater abstractions within 1km of site.	

2.4 Summary of Contaminant Distribution

The summary of contamination distribution mentioned in this report is based on the previous Detailed Quantitative Risk Assessment (DQRA) undertaken by Arcadis in December 2021.

2.4.1 Soil

The greatest hydrocarbon impact in soil was observed within the Made Ground and top of the River Terrace Deposits. The highest sum total petroleum hydrocarbon (TPH) (C_5-C_{35}) concentration of 5,144mg/kg was measured at a depth of 4.5m bgl in borehole MW106, located to the southeast of the historical tank farm and terminated at a depth of 15m bgl. The detections comprised both Petroleum Range Organics (PRO) and Diesel Range Organics (DRO) fractions, with the majority of the TPH concentration in the PRO band. The second highest concentration of sum TPH was measured in borehole PW202 at a concentration of 486mg/kg at 5m bgl, located hydraulically downgradient (southeast) of the historical tank farm, with PW202 terminated at 10m bgl. Other elevated concentrations of sum TPH (C_5-C_{35}) were from borehole MW105, which had a concentration of 182mg/kg at 1m bgl, with borehole MW105 terminating at a depth of 15m bgl). Borehole MW105 is located on the northern Site boundary adjacent to the historical tank farm and upgradient of MW106. Another elevated TPH concentration was measured at 178mg/kg at 6.5m bgl in MW106. Sum TPH concentrations in other unsaturated soil samples (<8.5m bgl) across the site were typically in the ones to tens of mg/kg. The remaining elevated concentrations of sum TPH (C_5-C_{35}) were found to be associated with the smear zone or saturated zone within the Chalk and are an order to two orders of magnitude lower than concentrations measured in MW106 and comprised predominantly PRO.

Concentrations of benzene, toluene, ethylbenzene and xylenes (BTEX) generally mirrored that of sum TPH with the highest concentrations measured in MW106 at 4.5m bgl and PW202 at 5m bgl. Benzene was measured at concentrations in soil above the laboratory MDL in 4no. of 29no. samples analysed, ranging from 0.014mg/kg to 0.24mg/kg.

Review of the borehole logs indicated that Photo Ionisation Detector (PID) readings were elevated in PW201 in the Made Ground between 2m to 2.2m bgl and ranged from 262ppm to 763ppm. PW202 had elevated PID readings between 3.5m to 6m bgl, ranging from 26ppm to 519ppm within granular River Terrace Deposits. A PID reading of 125ppm was measured in the weathered (structureless) Chalk in MW105 at 11.2m bgl. The highest PID readings were measured in MW106 ranging from 2,987ppm at 3m bgl (Made Ground) to 112ppm at 15m bgl, where the borehole terminated in weathered Chalk. It should be noted that groundwater was measured at 8.57m bgl within MW106 and PID measurements below this are associated with the saturated zone.

Based on the results of the previous intrusive investigations, the risk assessment defined a modelled source area which covers the historical tank farm, the majority of the operational tank farm and off-set fill points.

2.4.2 Groundwater

Sum TPH (C_5-C_{35}) concentrations were measured above the laboratory Method Detection Limit (MDL) in 11no. of 15no. groundwater samples analysed in 2021 (Arcadis, 2021a & 2021b). The detections comprised predominantly PRO for most locations, with some light end DRO fractions. Review of the fractions present indicated that several were above the limit of solubility, which could be suggestive of LNAPL (light non-aqueous phase liquid) being present in the subsurface, albeit no measurable thickness of LNAPL was recorded.

Concentrations of sum TPH (C_5-C_{35}) in the tens of thousands of µg/l were noted in monitoring wells MW106, located downgradient of the historic tank farm. Sum TPH (C_5-C_{35}) across the remainder of the site was significantly lower (typically in the thousands and hundreds of µg/l or lower). During the most recent round of monitoring (October 2021), the second highest concentration of 3,758µg/l was measured in MW202 located in the southeast of the site. In April 2021, the second highest concentration was measured in MW105 of 5,403µg/l located in the north of the Site.

Measured concentrations of BTEX typically mirrored that of sum TPH, with the bulk of the total BTEX concentrations made of toluene, ethylbenzene and xylenes. The highest concentrations were found in MW106, correlating with the location of the highest measured soil source concentrations. The earliest groundwater data available is from March 2020. Since this time, site conditions are considered to have remained largely unchanged and trend analysis has therefore not been undertaken. The maximum measured concentration of Methyl Tert-Butyl Ether (MTBE) (5.7 µg/l) recorded in October 2021 is below the Generic Assessment Criteria (GAC) for human health and water resource receptors.

The groundwater source area covers the majority of the eastern half of the site, defined based on measured CoPC concentrations during the two most recent monitoring visits in April and October 2021.

2.5 Conceptual Site Model

The Conceptual Site Model (CSM) summarised in this report is based on the DQRA report (Arcadis, December 2021). The following source-pathway-receptor linkages were considered to be potentially active, based on the findings of the risk assessment:

- Migration of CoPC (aromatics >C8-C10, aromatics >C10-C12, benzene, toluene and naphthalene) in groundwater within the Principal Aquifer beneath the Site to a hypothetical environmental compliance point of 50m, 100m and 250m.

The findings of the risk assessment indicated that a significant risk to water resources from a potential residual soil source is unlikely to be present based on the measured concentrations of CoPC in soils sampled to date. However, remedial technologies to reduce CoPC concentrations in unsaturated soils were included in the Remedial Options Appraisal (Arcadis, March 2022), because higher soil concentrations are expected to be present immediately beneath the tank farms remaining at the site. Therefore, remediation of impacts associated with unsaturated soils encountered during the site redevelopment works is considered likely to be required.

The CSM summarised on Figure 4 is based on a Continued Petroleum Use (CPU). The proposed preliminary treatment zones are shown on Figure 5.

2.6 Pilot Test Results

A pilot test was performed to assess potentially viable remediation technologies including groundwater pumping (Total Fluid Pumping (TFP)) and Soil Vapour Extraction (SVE). A summary of the test results is provided below and the Pilot Test Report (Arcadis, 2022c) provides a detailed account of the test methodology and results.

2.6.1 Total Fluid Pumping tests

Groundwater pumping tests involved extraction of groundwater to create a known drawdown within the pumped well and measuring the drawdown of the groundwater table at distances away from the pumped well. By measuring the water levels in the surrounding observation monitoring wells, the shape of the cone of depression was determined and relevant aquifer properties were evaluated. Two (2) forms of pumping test (step test and constant discharge test) were utilised for the study. MW106 was chosen as the pilot trial pumping well due to its location within an area associated with identified groundwater impacts while MW101, MW102, MW105, MW202, MW204 and MW205 were chosen as response well.

A series of step tests were carried out on MW106 for determining the head losses, effect of variable pumping rates and for ascertaining the appropriate abstraction rate for constant discharge pumping test. The drawdown and flowrate data gathered during the step tests were used to estimate the head loss and well efficiency for pumping wells tested using the Jacob (1947) method. The actual results of the constant discharge test were found to be 4.37m^3/day and based on this the contaminant removal rate was ascertained. Data collected during the constant discharge test were used to determine aquifer properties namely Transmissivity (*T*) and Hydraulic Conductivity (*K*) by using Cooper Jacob's and Theis's recovery method.

Results:

The results from the Total Fluids Pumping tests indicate that the use of a 2" pneumatic submersible pump within the 2" internal diameter MW106 is capable of abstracting groundwater at a sustained rate of 4.37m^3/day, thereby generating a drawdown of 0.119m within the pumping well and a Radius of Influence (ROI) of 9m around the pumping well. Further data analysis showed the aquifer conductivity to be 1.78m/day through the upper saturated chalk formation, with a potential to increase to 27.90m/day potentially due to the presence of a localised 0.5m thick gravel band located at 11m bgl in the MW106 pumping area. Overall, the pumping data suggest that Total Fluids Pumping techniques are suitable at addressing the saturated environmental impacts identified beneath the site. Contaminant removal rates were estimated at between 16 and 26g/day of sum TPH contaminants from pumping well MW106 during the test period.

2.6.2 Soil Vapour Extraction Tests

The SVE tests involved application of a vacuum on a series of extraction wells in order to generate the air movement within the unsaturated zone. The applied vacuum enhances contaminants partitioning into the vapour phase, while the generated air flow promotes the subsequent removal from the subsurface. To enable meaningful data collection soil vapour extraction wells (PW201, PW202 and PW203) were installed and screened in an unsaturated unit, while the observation wells (MW105 and MW106) were installed with screens in the same unit and at a range of distances and direction from the extraction well.

For ascertaining the influence of applied vacuum beneath the pilot trial area, test was carried out at three increased vacuums from s minimum of 5mbar to a maximum of 115mbar (Low, Medium and High conditions based on the performance capacity of the vacuum blower) on each of the extraction wells. Effective ROI was determined for appropriate SVE well spacing to ensure adequate coverage of the full-scale treatment area. Pore volume exchange rates were determined at an achievable target extraction rate which was ascertained during test undertaken on site. Additionally, the volatile organic compounds (VOC) contaminant removal was assessed at multiple points during the pilot trial and the removal rates were calculated from the gasoline concentrations in the extracted vapour prior to treatment using Granular Activated Carbon (GrAC), as well as the airflow processed by the extraction system.

Results:

The results from the SVE tests indicate that a maximum applied vacuum ranging from 73mbar to 115mbar was sufficient to generate a well extraction airflow from 20m^3/h to 50m^3/h depending on the location of the extraction well. The effective ROI for the SVE wells was determined to be 3m for an extraction well head applied vacuum of around 100mbar and would be sufficient to generate a daily pore volume exchange of at least 10, within the range recommended for SVE application. Further data analysis highlighted a wide response in contaminant removal rates depending on the location of the extraction wells and proximity of identified impacts, ranging from 107.0g/day for PW201 and 78.2g/day for PW203, to a maximum of 13,411.8g/day for PW202, thereby confirming the suitability of SVE techniques at recovery of unsaturated volatile hydrocarbon impacts identified beneath the site.

3 Considerations

3.1 Engineering Considerations

Due to the active nature of the site the installation of the remediation system will, where possible, utilise existing pilot test wells, which were installed during previous site investigation work (September 2021). However additional new extraction wells and ducting will also have to be installed as part of the works. An indicative proposed remediation plan is presented on Figure 6.

The installation of the remediation system at the time of the redevelopment activities at the Site will enable the system infrastructure to be incorporated into the design of the site and subsurface utilities. Arcadis have consulted with the Principal Contractor to build in time for system installation within the redevelopment programme.

The remediation technologies selected are considered to be appropriate for the identified impacts and geology identified beneath the Site given the site-specific constraints.

3.2 Stakeholder Considerations

Client

Arcadis understands the remediation technologies implemented on-site should be designed to reduce the environmental liabilities as quickly as possible, with minimum disruption to the operational use of the Site while it is cost effective.

Regulators

Remediation must be acceptable to regulators. The proposed remediation strategies must be implemented in accordance with applicable legislation and not cause detriment to the environment.

Neighbouring Resident/Property Owners

The closest neighbouring residential properties are located immediately to the south, 7m east, 10m west and 12m north of the Site. Therefore, consideration should be given to the control of noise, disturbance, dust and prevention of vapour migration that may be arise from the application of the proposed remediation system at the Site.

3.3 Timescale and Financial Considerations

The remediation technologies to be applied at the Site have been selected to provide the most rapid approach whilst maintaining a reasonable cost. The remediation well layout and SVE / TFP systems will need to be designed to provide sufficient coverage and capacity to significantly reduce the contaminant mass in the saturated zone, with contingency to enable optimisation of recovery depending on the groundwater response to pumping.

4 Remediation Objectives and Criteria

4.1 Remediation Objective

The objective of the proposed remediation is to manage the potential environmental liabilities for the site considering the ongoing use as a PFS and to manage the potential risks to the identified receptors. This objective will be achieved by controlling or breaking the active source-pathway-receptor linkages identified in the CSM in Section 2.5.

Arcadis considered the following objectives to be appropriate for the risk management works at the site:

- Achieve 'betterment' in groundwater quality through reduction of the overall contaminant mass in soil beneath the Site;
- Reduce concentrations of CoPC in groundwater to mitigate the potential liabilities associated with CoPC concentrations within the Principal Aquifer beneath the Site;
- Remedial works will be undertaken to the extent practicable and in line with the sustainable remedial objectives as set out in Sustainable Remediation Forum (SuRF) UK (CL:AIRE, 2010); and,
- Remedial works will be designed and implemented to achieve regulatory sign off including discharge of Town Planning conditions related to encountered impacts and remediation of impacts.

4.2 Remediation Criteria

It is proposed to continue the remediation works until one of the following criteria has been attained:

- Measured concentrations of CoPC in groundwater on-site are reduced to below the site specific assessment criteria (SSAC) based on a 50m compliance point;
- The data trends indicate that the improvement of on-site conditions due to continued remediation cannot be justified using a cost/benefit and sustainability assessment approach;
- A revision of the controlled waters risk assessment, justified by changes in the plume geometry or the conceptual understanding of the site, indicates that the reduced mass of CoPC does not present a risk to the identified receptors;
- Further data is available demonstrating that applicable source-pathway-receptor linkages have been severed.

The SSAC based on a 50m compliance point have been derived in the DQRA completed in December 2021 (Arcadis, 2021c). Due to the uncertainties inherent in characterising the environment, risk assessment is necessarily conservative. As a result, some SSAC may be extremely stringent, and may, therefore, be beyond the capability of some remediation technologies. For this reason, the duration of the risk management programme will be subject to review and cost-benefit analysis. Such review and analysis may include the use of lines of evidence such as trends in CoPC mass recovery rates and consideration of observed bulk attenuation rates based on collected monitoring data through the remediation programme.

5 Remediation Design

The Remediation Options Appraisal (ROA) evaluated appropriate technologies to mitigate the identified environmental liabilities associated with the site. The remediation technology was defined through review of a range of the following literature sources including:

- Land Contamination Risk Management (LCRM) (Environment Agency, 2021);
- Remedial Treatment for Contaminated Land, Volumes I-XII (SP164) (Construction Industry Research and Information Association (CIRIA), 2005);
- United States Environmental Protection Agency (US EPA) Contaminated Site Clean-up Information (CLU-IN) database (www.clu-in.org)

Based on the findings of the ROA and remediation pilot testing, TFP and SVE were identified as the most appropriate remediation technologies for achieving the remediation criteria. A subsequent phase of Monitored Natural Attenuation (MNA) was proposed once the active remediation systems approached asymptotic conditions.

5.1 Remediation Technology

Arcadis propose to implement the remediation technologies as detailed below in order to manage the identified environmental risks associated with the site.

5.1.1 Total Fluid Pumping and Soil Vapour Extraction

The remediation technology utilises the TFP system to extract both groundwater and LNAPL (if present), and a separate SVE system to apply vacuum to the subsurface and extract contaminated soil vapours. The extracted contaminated groundwater and vapours are then treated above ground.

The remediation technology increases the mass removal of the volatile and semi-volatile contamination, by creating a depression in the groundwater table around the extraction points and facilitating volatilisation from previously saturated soils via increased air movements. Mass removal of aerobically biodegradable contaminants will also be enhanced by the increase of subsurface oxygen levels. In addition, the extraction of the groundwater through the TFP will create a hydraulic barrier reducing the potential off-site migration of dissolved phase contamination.

5.1.2 Pilot Testing

The TFP and SVE pilot testing were conducted by Arcadis in February 2022 in order to assess the response of the aquifer to soil vapour and groundwater extraction technologies and provide information to aid design of a full-scale remediation system.

In general, the results of the SVE pilot test indicated that SVE can be successfully applied for the removal of the contaminant mass within the unsaturated zone beneath the Site. In addition, the results of the pilot testing indicated that groundwater pumping could feasibly be implemented at the Site to remove contaminant mass from beneath the Site while creating hydraulic containment to minimise the potential for off-site migration of contamination.

5.2 Technical Specification

5.2.1 Remediation Technology Application

The proposed remediation system at the site comprises the following components:

- Extraction wells
- Total fluid pumping and soil vapour extraction systems
- Water treatment unit

- Vapour phase treatment unit
- Subsurface pipework within utility ducts

5.2.2 Remediation Infrastructure

Basic site infrastructure will comprise a remediation system with associated machinery enclosed in a secure steel shipping container located within a fenced compound. Pipework to the remediation wells will be contained within the subsurface utility ducts.

The remediation infrastructure comprises a number of components as detailed in section 5.2.1. The outline design specification of each component is presented below:

1. Extraction Wells

The outline layout of the extraction well system is presented on Figure 6. The details of each well construction are presented below:

Well Reference	Purpose	Depth to Base of Well (m bgl)	Screening Section (m bgl)	Well Diameter (mm)
PW201 – PW203	SVE Extraction Well	10.00	4.00 to 10.00	100mm
MW202	TFP Extraction Well	16.00	8.00 to 16.00	100mm
MW204	TFP Extraction Well	16.00	7.50 to 16.00	100mm
MW205	TFP Extraction Well	16.00	4.00 to	100mm
MW101	TFP Extraction Well	15.00	8.00 to 15.00	50mm
MW102	TFP Extraction Well	15.00	8.00 to 15.00	50mm
MW105	TFP Extraction Well	15.00	8.00 to 15.00	50mm
MW106	TFP Extraction Well	15.00	8.00 to 15.00	50mm
SVE1-SVE6 (to be installed)	SVE Extraction Well	10.00	4.00 to 10.00	100mm
SVE/TFP1-SVE/TFP8 (to be installed)	SVE/TFP Extraction Well	16.00	8.00 to 16.00	100mm
TFP1-3 (to be installed)	TFP Extraction Well	16.00	8.00 to 16.00	100mm

The well locations and screen depths may be adjusted during the well installation phase, based on contamination encountered during drilling of the excavation wells.

The extraction well network and main pipework manifold will be connected to the SVE/TFP system via 25mm and 50mm reinforced hoses installed within subsurface ducting.

2. Total Fluid Pumping

The primary components of the TFP system will include:

- Air compressor
- Pressure regulators
- Pressure gauges
- Moisture traps
- Top loaded pneumatic pumps
- Oil-water separator
- Transfer pump
- Control and level switches
- Monitoring gauges
- Valves and associated fittings and pipes
- Pipework manifold
- Water meter

Initially 5no. pumps will be installed in selected remediation wells and the flow rate(s) adjusted to abstract groundwater and NAPL (if present) from beneath the site and to create hydraulic containment to minimise the potential for off-site migration of dissolved phase impacts. The total groundwater extraction flow rate will be maintained below 20 m^3/day.

The proposed remediation infrastructure will allow the alteration of pump locations, extraction rates and the connection of additional pumps to the remediation system during operation if necessary.

3. Soil Vapour Extraction System

The primary components of the SVE system are as follows:

- Side channel blower
- Moisture separator
- Particulate air filter
- Flow meter
- Pressure gauge
- Vapour treatment system
- Safety shutdown switches
- Lower explosive limit (LEL) safety system
- Pipework manifold
- Valves and associated fittings and pipes

Based on the findings recorded during pilot testing, it is anticipated that the extraction flow rate for each well will be approximately 30 m^3/h, at a vacuum of 100 mbar. The proposed SVE system involves at least 9no. wells therefore considering 10x pore volume exchange per location per day, the anticipated maximum total extraction air flow rate would be approximately 180 m^3/ hr. During the operation of the remediation system, the SVE well configuration will be modified as necessary based on the system operating parameters to maximise the contamination removal from beneath the Site.

4. Vapour Treatment System

Extracted soil vapour will be treated, prior to discharge to the atmosphere, in order to prevent atmospheric pollution and nuisance odours, by GrAC absorbent media. Activated carbon treatment is considered the most appropriate method for the SVE off-gas treatment based on the vapour concentrations encountered during the pilot trial. Vapour concentrations are considered unlikely to be high or sustained for long enough to make other technologies cost-effective, e.g., catalytic oxidation.

Contaminated vapours are drawn from the surrounding soil beneath the site by applying suction on the remediation wells using a vacuum blower. A moisture separator is positioned in line to collect any moisture drawn with the vapours, and to ensure that no damage is transferred to the blower components, for example corrosion or mineralization. A vacuum relief valve is mounted on top of the moisture separator, and it is designed to operate should excessive vacuum be created within the moisture separator. In addition, a fresh air dilution valve is located before the separator and can be adjusted manually to reduce the applied vacuum and reduce the extracted vapour concentrations. The vapours are then drawn through an in-line filter which protects the blower and the system from dust and other airborne particles and contaminants. After passing through the vacuum blower, the extracted vapours are treated by flowing through two GrAC-filled vessels prior to discharge to the atmosphere, in order to prevent atmospheric pollution and nuisance odours. The clean air is then released to atmosphere via a flame arrestor.

5. Groundwater Treatment and Discharge System

An oil-water separator will be used to separate the LNAPL (if present) recovered with groundwater. The LNAPL will be separated based on the principle of immiscibility and the differences between the specific gravity of LNAPL and groundwater.

Separated LNAPL will be stored in an integral product storage tank housed within the remediation container for off-site disposal in accordance with applicable waste management legislation under duty of care documentation.

Potentially contaminated groundwater, separated by the oil-water separator will be treated using absorbent media such as GrAC. This will be sufficient to remove the contaminants from the extracted groundwater to ensure compliance with the discharge consent conditions prior to discharge to foul sewer. The effluent is proposed to be discharged to foul sewer via a meter to monitor the discharge quantities.

6. Subsurface Ducting and Inspection Chamber

Subsurface ducting will be installed within trenches during the proposed redevelopment works. As the site will continue to operate as an active petrol filling station all the inspection chambers will be rated appropriately for the anticipated vehicle loads.

Pipework associated with the remediation system will be installed below ground in the ducting. The ducting routes and inspection chamber locations are shown on Figure 6.

5.2.3 Utility Requirements

The implementation of the proposed remediation scheme requires the service of the utilities to the site. The required utilities are discussed briefly below:

Power:

Operation of the remediation equipment at the Site will require a suitable three-phase 415 Volt, 100 Amp power supply to be available.

Electricity consumption will be dependent on final equipment specification and operating loads (dependant on Site specific conditions).

Sewer:

Abstracted groundwater, once treated, will be discharged to foul sewer under a trade effluent discharge consent.

6 Remediation Methodology

6.1 Project Team

It is considered that the overall project team should comprise the following components:

Client	Delivery Team (Arcadis)	Peer Review (Arcadis)
Shell	Project Director Project Manager Field Consultant Appointed Sub-contractors	Technical Health and Safety (H & S) Officer Purchasing Officer

6.2 Remediation Phasing and Zoning

It is envisaged that the proposed remediation strategy will take place within the distinct phases as follows:

- Regulatory liaison and licensing;
- Pipework and above-ground remediation system component installation;
- Commissioning and operation of the remediation system component installation;
- Validation monitoring and reporting; and,
- Decommissioning

6.3 Remediation Implementation

6.3.1 Scope of Works

The proposed remediation strategy for the site comprises the following tasks:

- Task 1: Regulatory and stakeholder interface;
- Task 2: Installation of remediation equipment;
- Task 3: System commissioning;
- Task 4: System operation, monitoring and maintenance;
- Task 5; Post-remediation groundwater monitoring; and
- Task 6: Remediation closure and reporting.

6.3.2 Documentation

Prior to mobilisation and commencing the remediation works the following documentation, notifications, permits and approvals shall be obtained and in place:

- Health & Safety File
- Method Statements & Risk Assessments
- Deployment of Environmental Permit
- Environmental Management Plan

6.4 Programme

Details regarding the programme are presented in the following sections:

6.4.1 Task 1: Regulatory and Stakeholder Interface

Prior to commissioning of the remediation system, this report should be forwarded to the Local Authority Contaminated Land Team for comment. In addition, it is expected that remediation work at Shell Bemerton will need to be carried out under an Environmental Permit. Therefore, prior to implementing the proposed remediation, a Deployment Form will be submitted to the EA Permitting Service to seek their agreement for the proposed remediation work to be undertaken after deployment of Arcadis's Environmental Permit.

It is considered that a groundwater abstraction license will not be required to operate the proposed remediation system at the Site as abstraction will be less than 20 m^3/ day. In the event that an abstraction license is deemed necessary to optimise the remediation system performance, an application will be made to the EA.

As the Site will undergo remediation, a discharge consent will be required to enable discharge of treated effluent to foul sewer during the works. The consent should be obtained from the local sewerage undertaker on Shell's behalf. The need to carry out effluent treatment should be discussed with the sewerage undertaker and the remediation equipment design amended as necessary in order to achieve any consented conditions.

It is anticipated that this initial interface period may take up to three months and hence Task 2 can be conducted within this period to reduce the overall duration of the remediation programme.

6.4.2 Task 2: Installation of Remediation Equipment

A remediation system container will be installed at the site. This task will comprise the following elements:

- Delivery of the remediation container to the site;
- Delivery of treatment units (GAC vessels) to the site and connection;
- Connection of the pipework associated with remediation system to the system container;
- Connection of discharge line to foul sewer; and
- Connection of remediation system to an electrical supply.

Pipework will be installed within ducting and inspection chambers installed as part of the site redevelopment and system installation.

6.4.3 Task 3: System Commissioning

A groundwater monitoring event following the remediation well installation will be undertaken to provide an indication of baseline conditions prior to commissioning of the remediation system.

The remediation system will be tested for safe and correct operational conditions. During commissioning the system will operated, optimised and monitored, at which time baseline system operating data will be collected. Commissioning tasks include:

- Measurement of depth to LNAPL, if present and depth to water
- Power connection;
- Initial system adjustments;
- Critical Safety Devices (CSDs) checks;
- Initial meter readings;
- Groundwater extraction rates;
- Air flow extraction rates;
- Measurement of applied and included vacuum;
- Measurement of air VOC concentration pre- and post-treatment plant;
- Nuisance monitoring as required by the Environmental Permit likely to including background noise and VOC monitoring; and,
- Collection of discharge water sample.

The system operation and maintenance (O&M) manual will be issued following system commissioning. The O&M Manual should include information on the following aspects:

- System overview;
- Process and instrument drawings;
- Hazard and operation study (HazOp) and Critical Safety Devices (CSDs) check list;
- Operation and maintenance instructions; and,
- Monitoring schedules and data logs.

6.4.4 Task 4: System Operation, Monitoring and Maintenance

It is anticipated that the proposed remediation system will be operated at the site for an initial period of 12 months. During the period of in-situ remediation, the system will be operated automatically, and the site will be visited on a monthly basis to conduct system monitoring and maintenance tasks.

The operating, monitoring and maintenance schedule is designed to meet three key requirements for operation of the remediation system.

1. To provide data for the tracking of system performance and progress towards the remediation objectives, and allow necessary adjustments to be made to optimise the system;

2. To ensure reliable operation of the remediation system to minimise downtime, and ensure clean-up goals are achieved as swiftly as possible; and,

3. To meet regulatory requirements for the waste discharge streams.

The system monitoring and maintenance tasks will comprise visual inspection and system operation optimisation as well as collection of the following data:

- Depth to groundwater and LNAPL, if present in the monitoring and extraction well network across the site;
- Power consumption;
- Extraction air flow rates;
- Applied vacuum within the system;
- Groundwater extraction rates;
- Air VOC concentration pre and post treatment plant;
- Meter readings;
- Water discharge sample;
- System maintenance activities; and,
- Nuisance monitoring including measurement of VOC concentrations at the site boundary and noise levels.

In addition to the collection of above-mentioned system operation data, groundwater samples will be collected using low-flow methods from up to 15no. monitoring wells at the site on quarterly basis.

The monitoring program, provisional monitoring well selection and analysis schedule for collected samples is presented as Appendix E.

A remediation update report will be issued quarterly documenting the works undertaken presenting the results obtained, providing an estimation of contaminant removal and providing recommendations for application of remediation process.

6.4.5 Task 5: Post-Remediation Groundwater Monitoring

It is proposed that the remediation system will be switched off after the results of the system and groundwater monitoring visits indicate that the remediation criteria have been consistently met at the site. This point will be defined on consideration of the following:

- Measurement of LNAPL thickness;
- Comparison of measured groundwater concentrations of the defined CoPC against the SSAC;
  - Inspection of contaminant removal rates to determine if near-asymptotic conditions have been achieved (*i.e*. where the beneficial contaminant mass removal *via* continued operation of remediation system is no longer justified on cost or sustainability grounds); and
- Interpretation of long-term groundwater concentration trends.

Following deactivation of the remediation system, the Site will continue to be monitored for a minimum period of three months to determine whether Site conditions remain stable. Monitoring will include inspection of monitoring wells for the presence of groundwater and LNAPL, if present, and collection of groundwater samples, using low flow methodology from the monitoring well network across the Site for laboratory analysis.

The provisional monitoring well selection and analysis schedule for collected samples is presented as Appendix E.

The monitoring at the Site will be carried out by a competent, experienced Arcadis environmental consultant. The results of the monitoring visits including the laboratory analyses will be inspected, and action will be taken accordingly, if necessary, by an Arcadis senior consultant to adjust the remediation system operation.

6.4.6 Task 6: Remediation Closure

Reporting

Following completion of the post-remediation groundwater monitoring tasks, a Remediation Verification report will be issued to the Local Authority documenting the works undertaken and presenting the results obtained. Once regulatory approval has been obtained the remediation infrastructure will be decommissioned.

Completion Works

The remediation system will be decommissioned, and the remediation equipment, electricity and system control units will be removed from the Site. Remediation and monitoring wells at the Site will be decommissioned in accordance with EA guidance.

6.5 Health and Safety Requirements

Risk assessments will be undertaken for each of the phases of work and, where applicable, method statements will be developed.

6.5.1 Safety and Security

In order to prevent unauthorised access to the remediation systems and minimise the effects of potential vandalism, critical above-ground components of the systems will be housed within the secure locked shipping container. In addition, the remediation system will be located within a secure fenced compound.

An automatic shutdown will be fitted to activate in the event of high vapour levels accumulating within the vapour extraction system. High levels of liquid accumulating in the oil-water separator will also result in automatic shutdown.

6.6 Pollution Prevention and Control

The identified potential waste streams and controls to prevent pollution are summarised below.

6.6.1 Solid Waste

Solid waste generated during the works will comprise spent GrAC media.

Solid waste generated by the remediation programme during remediation works will be disposed of in accordance with the applicable Waste Management and Environmental Permitting Regulations, under Duty of Care documentation.

6.6.2 Liquid Waste

Contaminated groundwater will be treated using absorbent media. This will be sufficient to remove contaminants from the extracted groundwater to ensure compliance with discharge consent conditions, prior to discharge to foul sewer under discharge consent.

Should LNAPL be collected during the operation of the proposed remediation works, LNAPL will be disposed of in accordance with the applicable Waste Management and Environmental Permitting Regulations, under Duty-of-Care documentation.

6.6.3 Gaseous Waste

Extracted soil vapour will be passed through an absorbent media to reduce contaminant concentrations and odour prior to discharge to the atmosphere. The air discharged will be monitored during the monthly Site visits and absorbent media renewed as required.

6.6.4 Dusts, Fibres, Particulates and Aerosols

It is considered that the proposed remediation system at the Site will not generate dust, fibres, particulates and aerosols during operation.

6.6.5 Noise Level

The background noise level will be measured during the system commissioning and the trigger level for the noise will be set as agreed in the conditions of the Environmental Permit application. Should the operation of the remediation system exceed the agreed trigger level, operation of the remediation system will cease and necessary action will be taken to reduce the noise level as appropriate.

7 Regulatory Requirements

7.1 Regulatory Interface

The proposed remediation work at the Site will be carried out under the Environmental Permitting regime. Therefore, the details of the proposed remediation work together with a deployment form will be sent to the EA.

7.2 Abstraction Licences and Discharge Consents

An abstraction licence is required where abstraction rates are above 20 m^3/day. The initial groundwater abstraction rate at the Site by the proposed remediation system is not anticipated to be above 20 m^3/day. Therefore, an abstraction license should not be required to commission the proposed remediation system. If continuous operation of remediation system at the Site indicates that abstraction of groundwater more than 20 m^3/day is necessary to optimise remediation performance, an abstraction license from the EA will be required prior to the alteration.

A discharge consent will be required to discharge treated effluent to foul sewer during the remediation works. The consent will be obtained from the local sewerage undertaker on behalf of Shell. The need to carry out effluent treatment will be discussed with the sewerage undertaker and the remediation equipment design amended as necessary in order to achieve any consented conditions.

7.3 Waste Management Licensing

The need for an Environmental Permit for the proposed remediation has been assessed.

Where the volume of treated media is less than 1,000 m^3, an Environmental Permit is not normally required, as detailed in the EA Licensing/ Permitting Position Statements, Licensing/ Permitting Position 1.1 – Trials and small scale remediation schemes:

"Where a small scale remediation scheme or a trial is to be undertaken to determine whether or not a particular remediation technique is suitable to ensure the remediation of contaminated materials, then provided that:

(1) for any site the total quantity of contaminated material, substances or products treated as part of the trial remediation project does not exceed 1,000 m^3; and,

(2) the name, contact address (home or business), and contact telephone numbers of any landowner, developer or contractor involved in the remediation project, details of the technique and dates on site, are supplied to the Environment Agency area office at least five working days before that project begins, then the Environment Agency will not expect a waste management licence to be obtained to cover these works."

Based on the current understanding of the Site condition, the total treatment volume has been estimated as follows to assess the requirement to perform remediation under an Environmental Permit:

Area of Site requiring treatment*:	1,200 m^2
Treatment zone thickness**:	7.0 m
Total volume requiring treatment:	8,400 m^3

* Based on the conceptualised extent of impacts to soil and groundwater quality in the sub-surface as presented on Figure 5.

** Treatment thickness was considered from the rest groundwater levels at the Site (considered as 8.0 m – 15.0 m bgl) allowing for a smear zone.

In addition, to the area of the proposed remediation, consideration is given to the volume of groundwater that will be extracted and treated by the proposed TFP system. Therefore, Arcadis anticipate that an Environmental Permit will be required for the proposed remediation work. Arcadis will submit a Deployment Form to the EA Permitting Service to enable the remediation to be conducted under Arcadis' Environmental Permit.

8 References

Arcadis (2021a), Groundwater and Soil Vapour Monitoring Report, Shell Bemerton, Arcadis, August 2021 (Report Reference: GB-10019043-20210805-MON-GME)

Arcadis (2021b), Site Investigation Report, Shell Bemerton, Arcadis, December 2021 (Report Reference: GB-10019043-20211217-SA-SI 2021)

Arcadis (2021c), Detailed Quantitative Risk Assessment, Shell Bemerton, Arcadis, December 2021, (Report Reference: GB-10019043-20211224-SA-BEMERTON DQRA)

Arcadis (2022a), Remedial Options Appraisal, Shell Bemerton, Arcadis, March 2022 (Report Reference: GB-10019043-20220311-REM-ROA)

Arcadis (2022b), Environmental Strategy Plan, Shell Bemerton, Arcadis, March 2022 (Report Reference: GB-10019043-20220315-REM-ESP)

Arcadis (2022c), Remediation Pilot Trial Report, Shell Bemerton, Arcadis, April 2022 (Report Reference: GB-10019043-20220411-REM-PILOT)

Sustainable Remediation Forum UK (SuRF) (2010), A Framework for Assessing the Sustainability of Soil and Groundwater Remediation, Contaminated Land: Applications in Real Environments (CL:AIRE), London, ISBN 978-905046-19-5, March 2010

Appendix A

Report Figures

Figure 1 – Site Location Plan

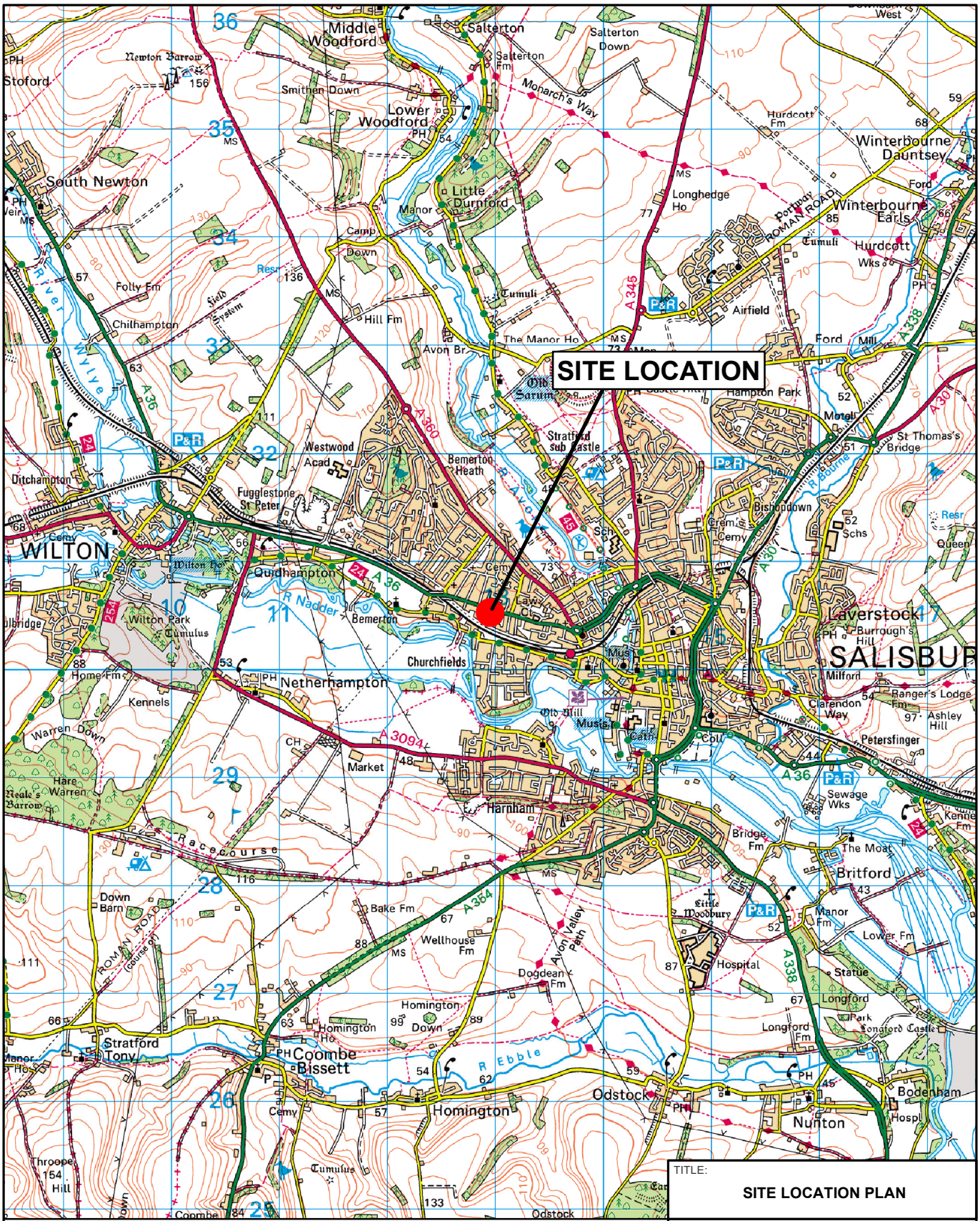
Figure 2 – Existing Site Layout and Borehole Location Plan

Figure 3 – Proposed Site Layout

Figure 4 – Conceptual Site Model Cross Section

Figure 5 – Preliminary Treatment Zones

Figure 6 – Proposed Remediation Plan



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LEGEND

SITE LOCATION

NOTES

SYMBOLS FOR BOREHOLES, TRIAL PITS AND OTHER SPECIFIC FEATURES ARE REPRESENTATIONS OF LOCATION ONLY AND UNLESS OTHERWISE SPECIFIED, DO NOT REPRESENT THE TRUE SIZE OF THE FEATURE.

0 0.2 0.4 0.8 1.2 1.6 2 Kilometres

N

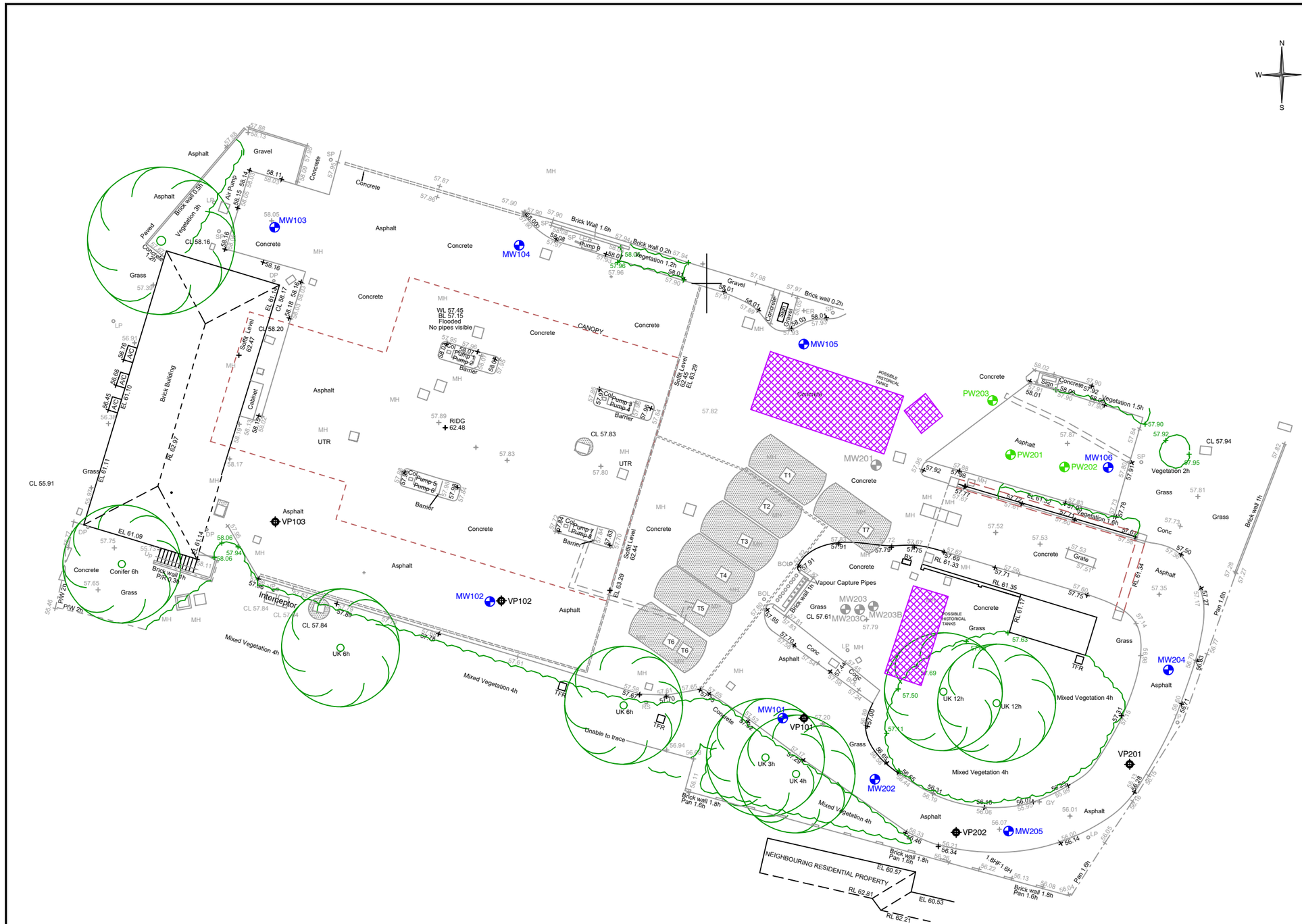
TITLE: **SITE LOCATION PLAN**

SITE : **SHELL BEMERTON**

CLIENT : **SHELL UK OIL PRODUCTS LTD**

PROJECT :	10044284	FIGURE 1	
DATE :	10/12/20	DRAWN BY :	BNB
DRG No. :	10044284-AUK-SHBM-XX-DR-ZZ-29-P1		
SCALE :	1 : 50,000	PRINT :	A4

ARCADIS Design & Consultancy for natural and built assets



KEY

- MONITORING WELL LOCATION
- VAPOUR WELL LOCATION
- BOREHOLE REFUSALS
- SVE PILOT WELL
- APPROXIMATE LOCATION OF HISTORICAL UNDERGROUND TANKS BASED ON 1996 SITE LAYOUT DRAWING
- CURRENT UNDERGROUND STORAGE TANKS (ASSUMED LAYOUT)

NOTES

1. TOPOGRAPHICAL SURVEY BASED ON GEOTECHNICAL ENGINEERING DRAWING REF 35641-0 DATED 01.11.2019

REV	DATE	COMMENT	CAD

TITLE: MONITORING WELL LOCATION PLAN

SITE: SHELL BEMERTON

CLIENT: SHELL UK OIL PRODUCTS LIMITED

PROJECT: 10044284 | FIGURE 2

DATE: 18/11/21 | DRAWN: MS | REV: 01

DRG.No.:10044284-AUK-SHBM-XX-DR-ZZ-0034-01 | PRINT: A3

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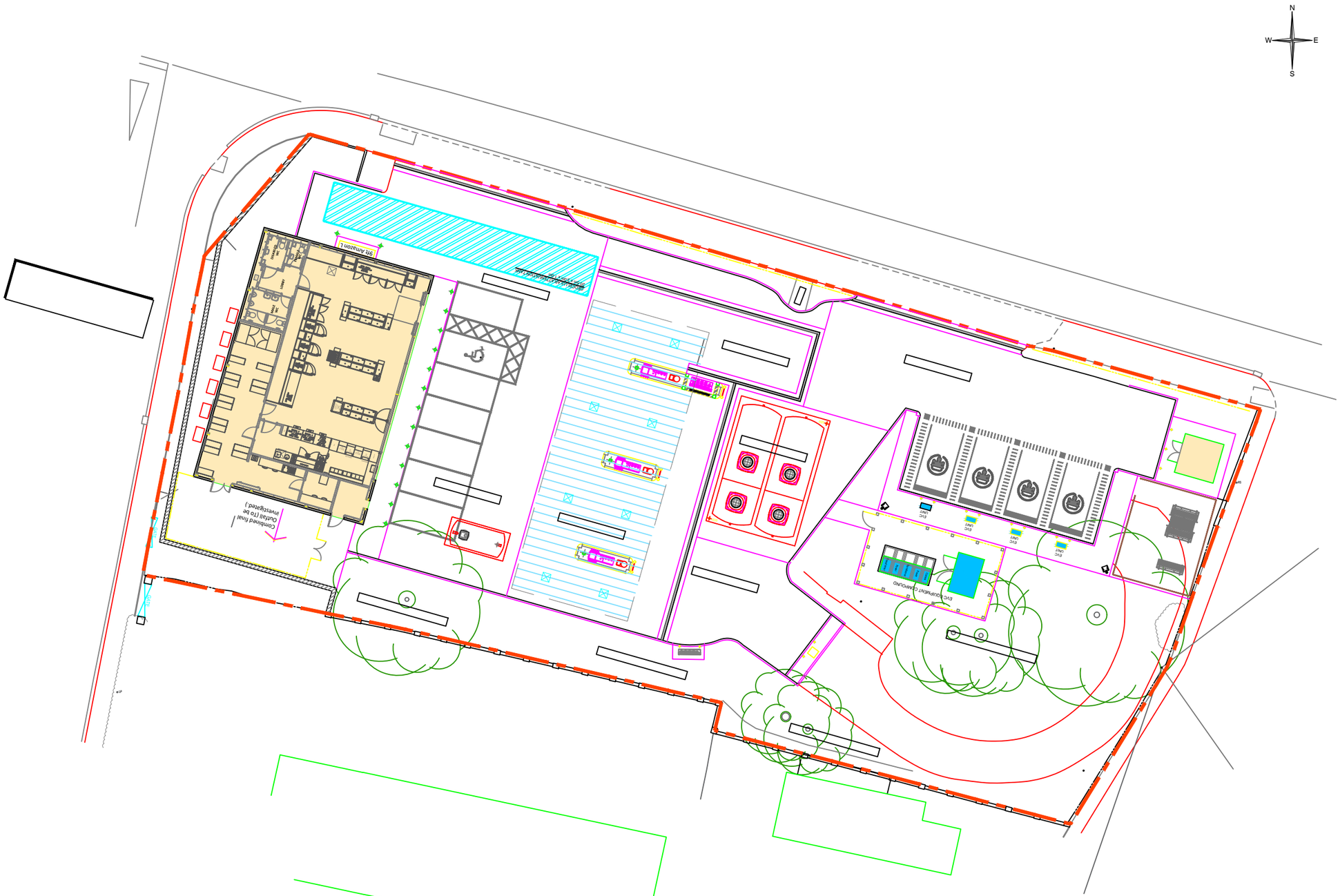

KEY

NOTES

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REV	DATE	COMMENT	CAD

TITLE:
PROPOSED SITE LAYOUT PLAN

SITE:
SHELL BEMERTON

CLIENT:
SHELL UK OIL PRODUCTS LIMITED

PROJECT: 10044284 | FIGURE 3

DATE: 01/03/22 | DRAWN: BNB | REV: -

DRG.No.: 10044284-AUK-SHBM-XX-DR-ZZ-311-P1 | PRINT: A3

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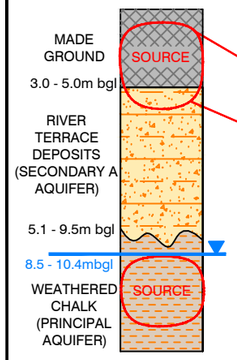
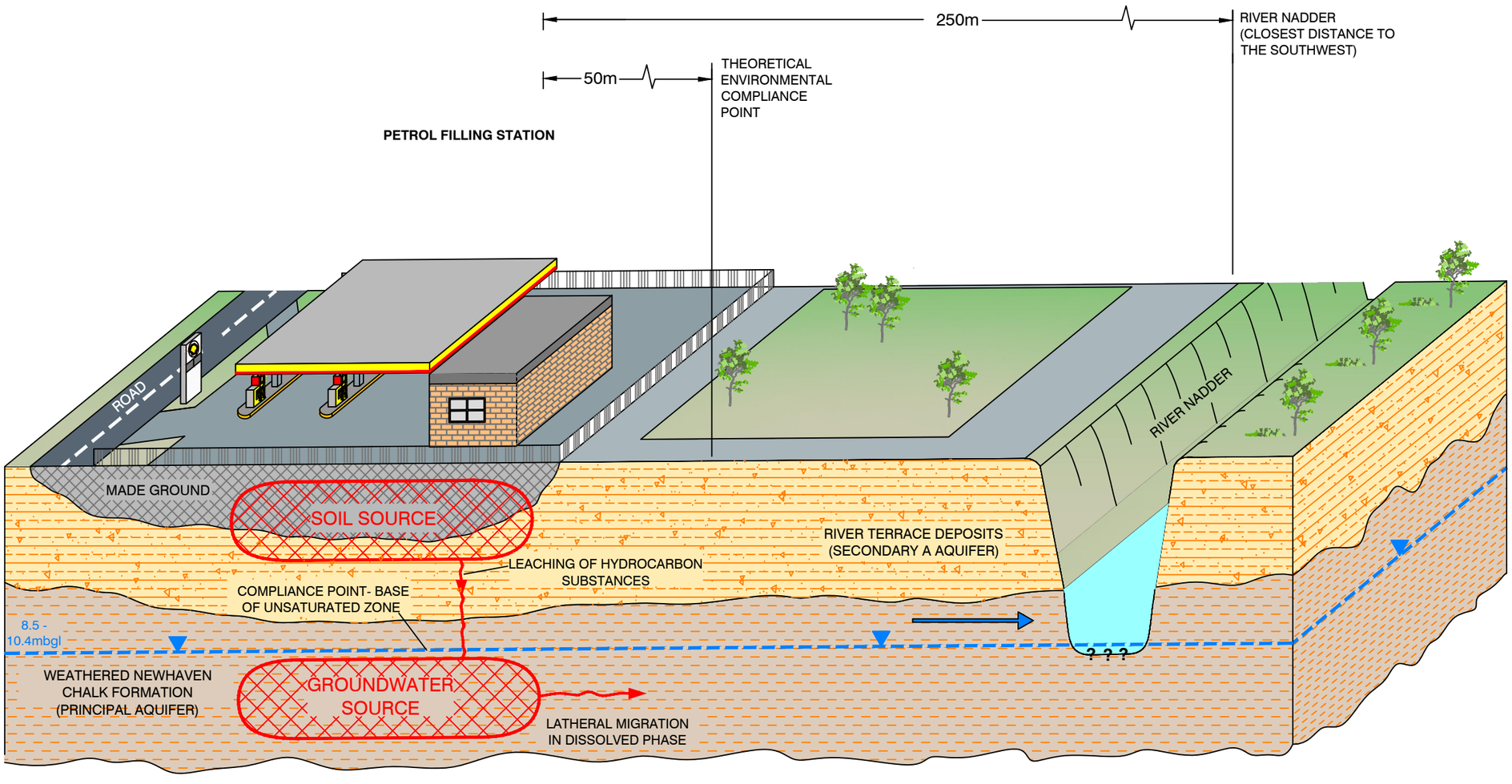
SITE-SPECIFIC GROUND CONDITIONS



CONCEPTUAL ZONE	CONCEPTUAL ZONE THICKNESS (m)	PHYSICAL CHARACTERISTICS	JUSTIFICATION
SOURCE ZONE	4.5 - 6.0	CLAY SAND AND GRAVEL	REPRESENTATIVE OF DEPOSITS WITHIN WHICH THE MAJORITY OF IMPACTS ARE LOCATED.
UNSATURATED ZONE	2.0 - 4.0	SLIGHTLY CLAYEY SANDY GRAVEL	REPRESENTATIVE OF MADE GROUND IMMEDIATELY ABOVE SOURCE ZONE.
SATURATED ZONE	50	WEATHERED CHALK	REPRESENTATIVE OF GEOLOGY WITHIN WHICH OFF-SITE MIGRATION OF GROUNDWATER IS LIKELY TO OCCUR



KEY

GROUNDWATER LEVEL

GROUNDWATER FLOW DIRECTION

NOTES

INDICATIVE ONLY - NOT TO SCALE

REV	DATE	COMMENT	CAD

TITLE: CONCEPTUAL SITE MODEL CROSS-SECTION

SITE: SHELL BEMERTON

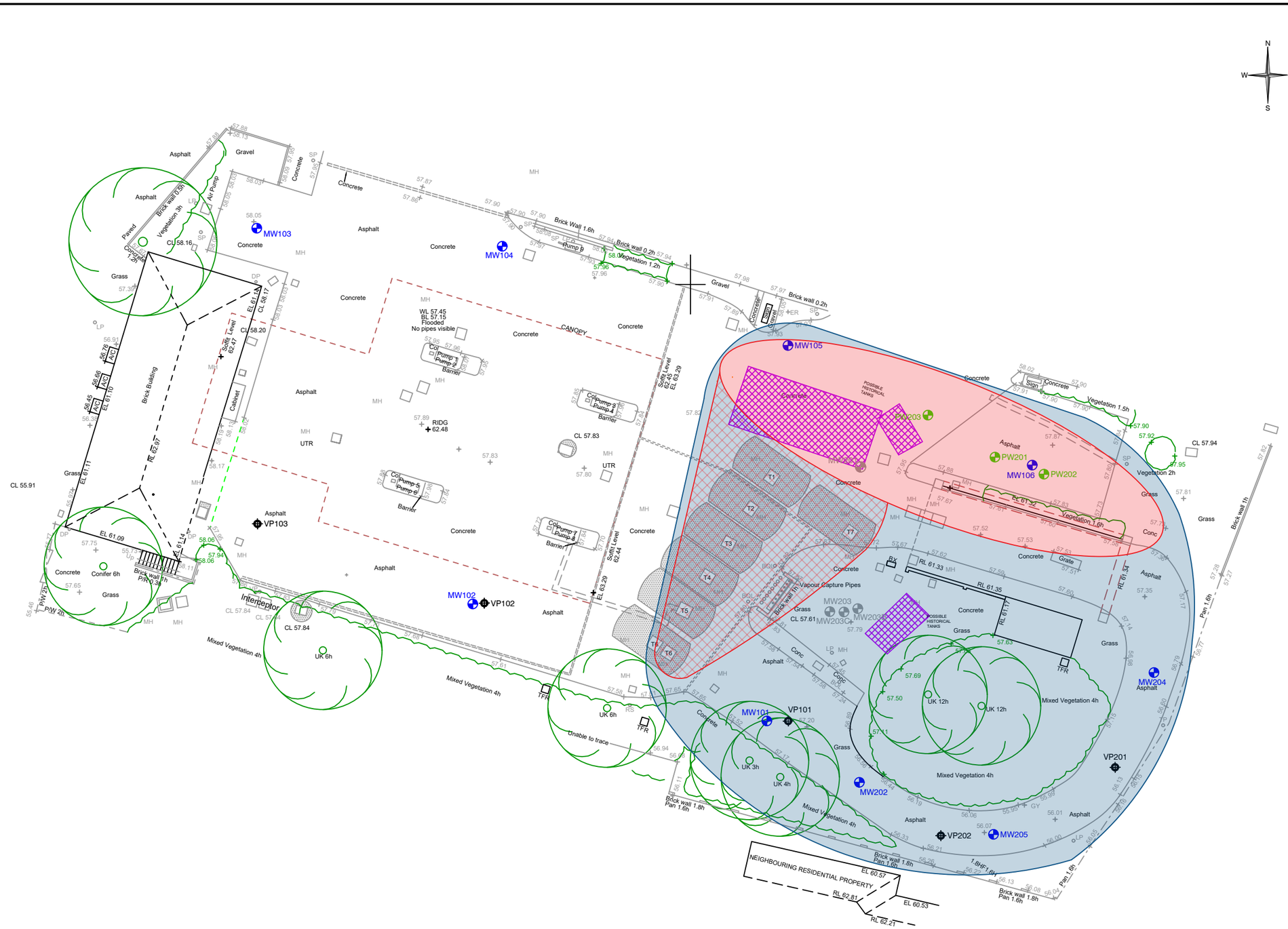
CLIENT: SHELL UK OIL PRODUCTS LIMITED

PROJECT: 10044284 | FIGURE 4

DATE: 01/03/22 | DRAWN: BNB | REV: -

DRG.No.10044284-AUK-SHBM-XX-DR-ZZ-310-P1 | PRINT: A3

ARCADIS



KEY

- MONITORING WELL LOCATION
- VAPOUR WELL LOCATION
- BOREHOLE REFUSALS
- SVE PILOT WELL
- APPROXIMATE LOCATION OF HISTORICAL UNDERGROUND TANKS BASED ON 2019 GPR SURVEY
- CURRENT UNDERGROUND STORAGE TANKS (ASSUMED LAYOUT)
- PRELIMINARY SVE TREATMENT ZONE
- POTENTIAL EXTENSION TO PRELIMINARY SVE TREATMENT ZONE
- TOTAL FLUIDS PUMPING TREATMENT ZONE

NOTES

1. TOPOGRAPHICAL SURVEY BASED ON GEOTECHNICAL ENGINEERING DRAWING REF 35641-0 DATED 01.11.2019

REV	DATE	COMMENT	CAD

TITLE: PRELIMINARY TREATMENT ZONES

SITE: SHELL BEMERTON

CLIENT: SHELL UK OIL PRODUCTS LIMITED

PROJECT: 10044284 | FIGURE 5

DATE: 17/02/22 | DRAWN: JR | REV: 01

DRG.No.:10044284-AUK-SHBM-XX-DR-ZZ-0037-01 | PRINT: A3

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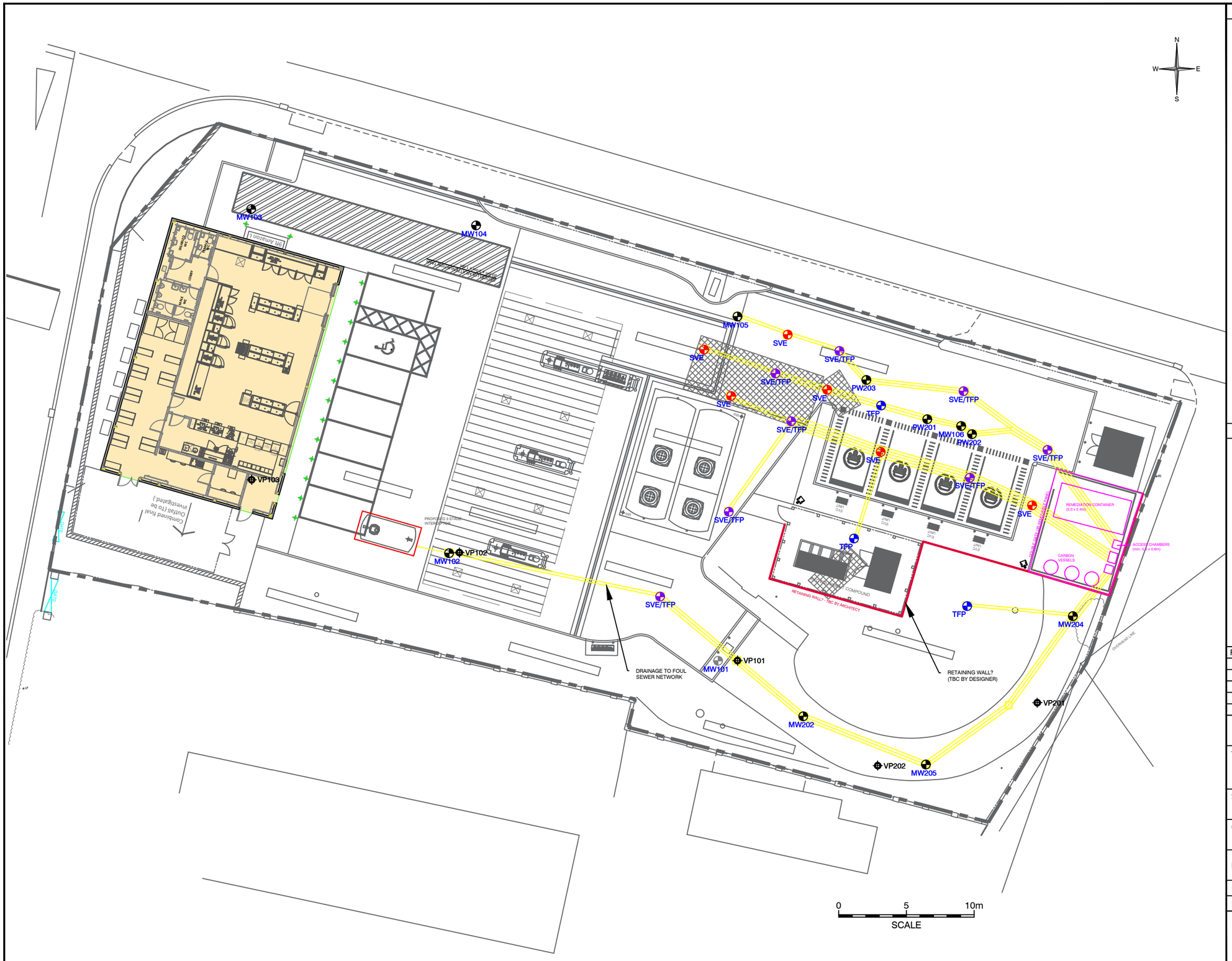

KEY

- SVE EXTRACTION WELL
- TFP EXTRACTION WELL
- COMBINED SVE TFP EXTRACTION WELL
- VAPOUR MONITORING POINT
- WELL TO BE DECOMISSIONED
- EXISTING MONITORING WELL (TO BE RETAINED)
- APPROXIMATE LOCATION OF HISTORICAL UNDERGROUND TANKS BASED ON 1996 SITE LAYOUT DRAWING
- CURRENT UNDERGROUND STORAGE TANKS (ASSUMED LAYOUT)
- REMEDIATION DUCTING (INDICATIVE LAYOUT)

NOTES

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NOT FOR CONSTRUCTION

REV	DATE	COMMENT	CAD
P2	06JUL22	MINOR UPDATE	JR

TITLE: PRELIMINARY REMEDIATION SYSTEM LAYOUT

SITE: SHELL BEMERTON

CLIENT: SHELL UK OIL PRODUCTS LTD

PROJECT: 10044284 | FIGURE 6

DATE: 17/02/22 | DRAWN: JR | REV: P2

DRG.No.: 10044284-AUK-SHBM-XX-DR-ZZ-0038- | PRINT: A3

ARCADIS

NOTE: ALL ENTITIES SHOWN ON THIS DRAWING ARE TO BE REGARDED AS APPROXIMATE AND ARE INDICATIVE ONLY. NO MEASUREMENTS TAKEN FROM THIS DRAWING SHOULD BE USED FOR THE LOCATION OF INTRUSIVE INVESTIGATION WORKS ON SITE. SYMBOLS FOR BOREHOLES, TRIAL PITS AND OTHER SPECIFIC FEATURES ARE REPRESENTATIONS OF LOCATION ONLY AND UNLESS OTHERWISE SPECIFIED, DO NOT REPRESENT THE TRUE SIZE OF THE FEATURE. - CONTACT ARCADIS UK IN CASE OF ANY QUERY

Appendix B

Study Limitations

IMPORTANT. This section should be read before reliance is placed on any of the information, opinions, advice, recommendations or conclusions contained in this report.

1. This report has been prepared by Arcadis (UK) Limited ('Arcadis') with all reasonable skill, care and diligence within the terms of the Appointment and with the resources and manpower agreed with Shell UK Oil Products (the 'Client'). Arcadis does not accept responsibility for any matters outside the agreed scope.
2. This report has been prepared for the sole benefit of the Client unless agreed otherwise in writing.
3. Unless stated otherwise, no consultations with authorities or funders or other interested third parties have been carried out. Arcadis are unable to give categorical assurance that the findings will be accepted by these third parties as such bodies may have unpublished, more stringent objectives. Further work may be required by these parties.
4. All work carried out in preparing this report has used, and is based on, Arcadis' professional knowledge and understanding of current relevant legislation. Changes in legislation or regulatory guidance may cause the opinion or advice contained in this report to become inappropriate or incorrect. In giving opinions and advice, pending changes in legislation, of which Arcadis is aware, have been considered. Following delivery of the report, Arcadis have no obligation to advise the Client or any other party of such changes or their repercussions.
5. This report is only valid when used in its entirety. Any information or advice included in the report should not be relied upon until considered in the context of the whole report.
6. Whilst this report and the opinions made are correct to the best of Arcadis' belief, Arcadis cannot guarantee the accuracy or completeness of any information provided by third parties.
7. This report has been prepared based on the information reasonably available during the project programme. All information relevant to the scope may not have been received.
8. This report refers, within the limitations stated, to the condition of the site at the time of the inspections. No warranty is given as to the possibility of changes in the condition of the site since the time of the investigation.
9. The content of this report represents the professional opinion of experienced environmental consultants. Arcadis does not provide specialist legal or other professional advice. The advice of other professionals may be required.
10. Where intrusive investigation techniques have been employed they have been designed to provide a reasonable level of assurance on the conditions. Given the discrete nature of sampling, no investigation technique is capable of identifying all conditions present in all areas. In some cases the investigation is further limited by site operations, underground obstructions and above ground structures. Unless otherwise stated, areas beyond the boundary of the site have not been investigated.
11. If below ground intrusive investigations have been conducted as part of the scope, service tracing for safe location of exploratory holes has been carried out. The location of underground services shown on any drawing in this report has been determined by visual observations and electromagnetic techniques. No guarantee can be given that all services have been identified. Additional services, structures or other below ground obstructions, not indicated on the drawing, may be present on-site.
12. Unless otherwise stated the report provides no comment on the nature of building materials, operational integrity of the facility or on any regulatory compliance issues.
13. Unless otherwise stated, samples from the site (soil, groundwater, building fabric or other samples) have NOT been analysed or assessed for waste classification purposes.

Appendix C

Borehole Logs

Client: Shell

Project: Bemerton, Salisbury.

Contract No: 60608753

AECOM

Record of Rotary Borehole

MW101

Coring Details					Samples & Tests				Water Level	Strata				
TCR%	SCR%	RQD%	Fracture Index	Core Run (m)	Depth	Type/ No.	Test Results	PID (ppm)		Reduced Level m(AOD)	Legend	Depth (Thick-ness)	DESCRIPTION	Instru-ment Backfill
										56.79		0.14	MADE GROUND: Black bituminous TARMAC hardstanding.	
													MADE GROUND: Medium dense brown-black and white clayey silty very gravelly SAND. Gravel is angular to subrounded to coarse flint and chalk.	
					1.00	E				56		(1.36)		
										55.43		1.50		
										55.13		(0.30)	MADE GROUND: Medium dense brown clayey silty SAND. Gravel is angular to subrounded to coarse flint and chalk.	
												1.80		
										55			MADE GROUND: Brown black gravelly clayey fine to coarse SAND. Gravel is angular to subrounded fine to coarse brick, flint and chalk.	
					2.50	PID		2.1				(1.20)		
					3.00	PID		1.9		53.93 54		3.00		
													Medium dense brown gravelly slightly silty fine to coarse SAND. Gravel is angular to subrounded fine to medium flint.	
										53		(1.50)		
										52.43		4.50		
										52			Loose GRAVELS of flint with occasional cobbles of flint. 50% Recovery	
												(1.50)		
										50.93 51		6.00		
													No Recovery	
										50		(1.50)		
					7.50	PID		2.9		49.43		7.50		
										49			Poor recovery of loose SAND, silt and occasional Gravel	
												(0.70)		
									8.51	48.73		8.20		
													Structureless CHALK composed of light grey cream gravelly SILT.	
												(0.80)		
										47.93 48		9.00		
													No Recovery	
												(1.00)		
										46.93 47		10.00		

GENERAL REMARKS

Vacuum excavation to 1.5m bgl. Monitoring well completed at the surface with a traffic rated cover set in concrete

Exploratory hole logs should be read in conjunction with corresponding Key Sheets.

Boring Progress and Water Observations

Date	Time	Hole Depth	Standing Level	Strike	Rise	Time (mins)	Sealed
26/02/20		8.51		8.51			

Rotary Flush

From	To	Type	Return (%)

Logged by: RC	Equipment: Comacchio GEO 305	Coordinates: (OS NGR) Easting: 130521.74m Northing: 412955.16m	Ground Level: (OS) 56.93m AOD	Date: Start: 25/02/2020 End: 26/02/2020
Checked by: EE	Contractor: ADP Group Ltd			
Status: Final				Sheet 1 of 2

AGS

• 2018 AECOM File: \\UKXXX\Projects\60608753\Shell\Bemerton\40_TECHNICAL\40_FIELD_AND_LABORATORY_DATA\LOGS\BH-MW\GPJ Printed: 06/03/2020 08:13

Client: Shell

Project: Bemerton, Salisbury.

Contract No: 60608753

AECOM

Record of Rotary Borehole

MW101

Coring Details					Samples & Tests				Water Level	Strata				
TCR%	SCR%	RQD%	Fracture Index	Core Run (m)	Depth	Type/ No.	Test Results	PID (ppm)		Reduced Level m(AOD)	Legend	Depth (Thick-ness)	DESCRIPTION	Instru-ment Backfill
					10.00	PID		22.9					Poor recovery of loose SAND, silt and occasional Gravel (Flint)	
					11.00	E				46		(1.50)		
										45.43		11.50		
												(0.50)	No Recovery	
					12.00	PID		21.8		44.93 45		12.00		
													Structureless CHALK composed of light greyish cream gravelly SILT. Gravel is very weak low density white subangular to rounded fine to medium flint.	
										44		(1.50)		
					13.50	PID		2.9		43.43		13.50		
													Structureless CHALK composed of gravelly SILT. Gravel is weak low density white subangular to rounded fine to medium	
										43		(1.50)		
										41.93 42		15.00		
													End of Borehole at 15.00m	

GENERAL REMARKS

Vacuum excavation to 1.5m bgl. Monitoring well completed at the surface with a traffic rated cover set in concrete

Boring Progress and Water Observations							
Date	Time	Hole Depth	Standing Level	Strike	Rise	Time (mins)	Sealed

Rotary Flush			
From	To	Type	Return (%)

Logged by:	Equipment:	Coordinates: (OS NGR)	Ground Level: (OS)	Date:	
RC	Comacchio GEO 305	Easting: 130521.74m	56.93m AOD	Start: 25/02/2020	AGS
Checked by: EE	Contractor: ADP Group Ltd	Northing: 412955.16m		End: 26/02/2020	Sheet 2 of 2
Status: Final					

• 2018-ECOM-AGS-V4.0.1.GDT • C:\USERS\RICHARD.CLARKE\APPDATA\LOCAL\TEMP\ACCESS\2015\SHELL\60608753\GEOTECHNICAL\40_FIELD_AND_LABORATORY_DATA\LOGS\BH LOGS.GPJ Printed:06/03/2020 08:13

Client: Shell

Project: Bemerton, Salisbury.

Contract No: 60608753

AECOM

Record of Rotary Borehole

MW102

Coring Details					Samples & Tests				Water Level	Strata				
TCR%	SCR%	RQD%	Fracture Index	Core Run (m)	Depth	Type/ No.	Test Results	PID (ppm)		Reduced Level m(AOD)	Legend	Depth (Thick-ness)	DESCRIPTION	Instru-ment Backfill
										57			MADE GROUND: Black Bituminous TARMAC hardstanding.	
												(0.85)		
										56.30		0.85		
					1.00	E				56			MADE GROUND: Medium dense brown clayey silty SAND. Gravel is angular to subrounded to coarse flint and chalk.	
												(1.55)		
										55				
										54.75		2.40		
					2.50	PID		1.0					MADE GROUND: Very soft grey mottled black gravelly CLAY. Gravel is angular to subrounded fine to medium flint and chalk.	
												(0.60)		
					3.00	PID		1.2		54.15		3.00		
										54			Soft to firm brown very silty sand CLAY with fine to medium gravel size flints.	
					4.00	PID		1.3		53				
												(3.00)		
										52				
										51.15		6.00		
					6.00	PID		1.6		51			Loose GRAVELS of flint with occasional cobbles of flint. 40% Recovery	
												(1.50)		
										50				
										49.65		7.50		
					8.00	PID		0.1					Firm creamy, brown slightly sandy CLAY with occasional gravels of flint	
									8.63	49		(1.50)		
										48.15		9.00		
										48			Structureless CHALK composed of gravelly SILT. Gravel is weak, low density with sub angular to rounded fine to medium. UPPER CHALK	
												(6.00)		

GENERAL REMARKS

Vacuum excavation to 1.5m bgl. Monitoring well completed at the surface with a traffic rated cover set in concrete

Exploratory hole logs should be read in conjunction with corresponding Key Sheets.

Boring Progress and Water Observations

Date	Time	Hole Depth	Standing Level	Strike	Rise	Time (mins)	Sealed
25/02/20		8.63		8.63			

Rotary Flush

From	To	Type	Return (%)

Logged by: RC	Equipment: Comacchio GEO 305	Coordinates: (OS NGR) Easting: 130528.41m Northing: 412935.29m	Ground Level: (OS) 57.15m AOD	Date: Start: 24/02/2020 End: 25/02/2020
Checked by: EE	Contractor: ADP Group Ltd			
Status: Final				Sheet 1 of 2

AGS

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Client: Shell

Project: Bemerton, Salisbury.

Contract No: 60608753

AECOM

Record of Rotary Borehole

MW102

Coring Details					Samples & Tests				Water Level	Strata				
TCR%	SCR%	RQD%	Fracture Index	Core Run (m)	Depth	Type/ No.	Test Results	PID (ppm)		Reduced Level m(AOD)	Legend	Depth (Thick-ness)	DESCRIPTION	Instru-ment Backfill
					10.00	PID		1.2		47			Structureless CHALK composed of gravelly SILT. Gravel is weak, low density with sub angular to rounded fine to medium. UPPER CHALK *Stratum text copied from layer at 48.151mAOD from previous sheet.*	
					10.50	PID		11.1						
					11.00	E PID		12.3		46				
					12.00	PID		1.2		45				
												(6.00)		
					13.00	PID		1.3		44				
					14.00	PID		0.9		43				
										42.15		15.00		
													End of Borehole at 15.00m	

GENERAL REMARKS

Vacuum excavation to 1.5m bgl. Monitoring well completed at the surface with a traffic rated cover set in concrete

Boring Progress and Water Observations

Date	Time	Hole Depth	Standing Level	Strike	Rise	Time (mins)	Sealed

Rotary Flush

From	To	Type	Return (%)

Logged by:	Equipment:	Coordinates: (OS NGR)	Ground Level: (OS)	Date:	
RC	Comacchio GEO 305	Easting: 130528.41m	57.15m AOD	Start: 24/02/2020	AGS
Checked by: EE	Contractor: ADP Group Ltd	Northing: 412935.29m		End: 25/02/2020	Sheet 2 of 2
Status: Final					

• 2018/ECOWARE/3/001/DATA/PROJECTS_GEOS2015/SHELL/60608753/GEOS/FIELD/AD/LADORATORY_DATA/LOGS/BH-LOGS/ Printed:08/03/2020 08:08:16

Client: Shell

Project: Bemerton, Salisbury.

Contract No: 60608753

AECOM

Record of Rotary Borehole

MW103

Coring Details					Samples & Tests				Water Level	Strata				
TCR%	SCR%	RQD%	Fracture Index	Core Run (m)	Depth	Type/ No.	Test Results	PID (ppm)		Reduced Level m(AOD)	Legend	Depth (Thick-ness)	DESCRIPTION	Instru-ment Backfill
										57.36		0.18	Concrete reinforced with rebar	
													MADE GROUND: Medium dense brown clayey silty SAND. Gravel is angular to subrounded to coarse flint and chalk.	
					1.00	E				57		(1.32)		
										56.04		1.50		
										56			MADE GROUND: Very soft grey mottled black gravelly CLAY. Gravel is angular to subrounded fine to medium flint and chalk.	
					2.50	PID		1.2				(1.50)		
										55				
										54.54		3.00		
													Very soft brown CLAY	
					3.50	PID		0.1		54				
												(2.00)		
										53				
										52.54		5.00		
													Soft to firm brown very silty sand CLAY with fine to medium gravel size flints.	
					5.50	PID		3.1		52		(1.00)		
										51.54		6.00		
													No Recovery	
					6.50	PID		1.3		51		(1.00)		
										50.54		7.00		
													Structureless CHALK composed of very silty subangular to subrounded GRAVEL with angular fine to coarse flint. Clasts are weak low density white with brown spots and black specs.	
										50		(1.00)		
										49.54		8.00		
													Structureless Chalk of light grey gravelly silt.	
									8.54	49		(1.00)		
					9.00	PID		2.0		48.54		9.00		
													Cream becoming white structureless CHALK composed of gravelly SILT. Gravel is weak low density white sub angular to rounded fine to medium. UPPER CHALK	
										48		(6.00)		

GENERAL REMARKS

Vacuum excavation to 1.5m bgl. Monitoring well completed at the surface with a traffic rated cover set in concrete

Exploratory hole logs should be read in conjunction with corresponding Key Sheets.

Boring Progress and Water Observations

Date	Time	Hole Depth	Standing Level	Strike	Rise	Time (mins)	Sealed
21/02/20		8.54		8.54			

Rotary Flush

From	To	Type	Return (%)

Logged by:	Equipment:	Coordinates: (OS NGR)	Ground Level: (OS)	Date:	
RC	Comacchio GEO 305	Easting: 130553.80m	57.54m AOD	Start: 20/02/2020	AGS
Checked by: EE	Contractor:	Northing: 412920.69m		End: 21/02/2020	Sheet 1 of 2
Status: Final	ADP Group Ltd				

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Client: Shell

Project: Bemerton, Salisbury.

Contract No: 60608753

AECOM

Record of Rotary Borehole

MW103

Coring Details					Samples & Tests				Water Level	Strata				
TCR%	SCR%	RQD%	Fracture Index	Core Run (m)	Depth	Type/ No.	Test Results	PID (ppm)		Reduced Level m(AOD)	Legend	Depth (Thick-ness)	DESCRIPTION	Instru-ment Backfill
					10.00	PID		1.0					Cream becoming white structureless CHALK composed of gravelly SILT. Gravel is weak low density white sub angular to rounded fine to medium. UPPER CHALK *Stratum text copied from layer at 48.541mAOD from previous sheet.*	
										47				
					11.00	E								
										46				
					12.50	PID		1.9		45		(6.00)		
					13.00	PID		1.6						
										44				
					14.50	PID		1.2		43				
										42.54		15.00		
													End of Borehole at 15.00m	

GENERAL REMARKS

Vacuum excavation to 1.5m bgl. Monitoring well completed at the surface with a traffic rated cover set in concrete

Boring Progress and Water Observations

Date	Time	Hole Depth	Standing Level	Strike	Rise	Time (mins)	Sealed

Rotary Flush

From	To	Type	Return (%)

Logged by:	Equipment:	Coordinates: (OS NGR)	Ground Level: (OS)	Date:	
RC	Comacchio GEO 305	Easting: 130553.80m	57.54m AOD	Start: 20/02/2020	AGS
Checked by: EE	Contractor: ADP Group Ltd	Northing: 412920.69m		End: 21/02/2020	Sheet 2 of 2
Status: Final					

• 2018 AECOM File: \\UKGLD1FP01\DATA\PROJECTS\GEOS2015\SHELL\60608753\GEOTECH\LOGS\BEMERTON\60608753_BEMERTON.GPJ Printed:06/03/2020 08:03:18

Client: Shell

Project: Bemerton, Salisbury.

Contract No: 60608753

AECOM

Record of Rotary Borehole

MW104

Coring Details					Samples & Tests				Water Level	Strata				
TCR%	SCR%	RQD%	Fracture Index	Core Run (m)	Depth	Type/ No.	Test Results	PID (ppm)		Reduced Level m(AOD)	Legend	Depth (Thick-ness)	DESCRIPTION	Instru-ment Backfill
										57.21		0.22	Reinforced concrete MADE GROUND	
										57		(1.28)	MADE GROUND: Medium dense brown clayey silty SAND. Gravel is angular to subrounded to coarse flint and chalk.	
					1.00	E								
					1.50	PID		2.2		55.93 56		1.50		
													MADE GROUND: Medium dense brown clayey silty SAND. Gravel is angular to subrounded to coarse flint	
										55				
					3.00	PID		3.8				(3.50)		
										54				
										53				
					4.50	PID		2.1						
										52.43		5.00		
										52		(0.50)	Loose brown GRAVELS of flint with occasional cobbles of flint	
										51.93		5.50		
										51.43		(0.50)	Soft to firm brown very silty sand CLAY with fine to medium gravel size flints.	
												6.00		
										51			Loose brown GRAVELS of flint with occasional cobbles of flint. Poor Recovery	
					6.50	PID		1.0						
										50		(3.00)		
										49				
									8.84					
										48.43		9.00		
										48		(6.00)	Cream becoming white structureless CHALK composed of gravelly SILT. Gravel is weak low density white sub angular to rounded fine to medium. UPPER CHALK	

GENERAL REMARKS

Vacuum excavation to 1.5m bgl. Monitoring well completed at the surface with a traffic rated cover set in concrete

Exploratory hole logs should be read in conjunction with corresponding Key Sheets.

Boring Progress and Water Observations

Date	Time	Hole Depth	Standing Level	Strike	Rise	Time (mins)	Sealed
19/02/20		8.84		8.84			

Rotary Flush

From	To	Type	Return (%)

Logged by: RC	Equipment: Comacchio GEO 305	Coordinates: (OS NGR) Easting: 130552.59m Northing: 412937.28m	Ground Level: (OS) 57.43m AOD	Date: Start: 18/02/2020 End: 19/02/2020
Checked by: EE	Contractor: ADP Group Ltd			
Status: Final				Sheet 1 of 2

AGS

File \\UKCDP3V001\DATA\PROJECTS\GEOS2015\SHELL\60608753\GEOS\BEMERTON\40_TECHNICAL\40_FIELD_AND_LABORATORY_DATA\LOGS\BH-MW\GPJ Printed 08/03/2020 08:32

Client: Shell

Project: Bemerton, Salisbury.

Contract No: 60608753

AECOM

Record of Rotary Borehole

MW104

Coring Details					Samples & Tests				Water Level	Strata				
TCR%	SCR%	RQD%	Fracture Index	Core Run (m)	Depth	Type/ No.	Test Results	PID (ppm)		Reduced Level m(AOD)	Legend	Depth (Thick-ness)	DESCRIPTION	Instru-ment Backfill
					10.50	PID		2.6		47			Cream becoming white structureless CHALK composed of gravelly SILT. Gravel is weak low density white sub angular to rounded fine to medium. UPPER CHALK *Stratum text copied from layer at 48.434mAOD from previous sheet.*	
					11.00	E								
										46				
					12.00	PID		2.1						
										45		(6.00)		
										44				
										43				
										42.43		15.00		
													End of Borehole at 15.00m	

GENERAL REMARKS

Vacuum excavation to 1.5m bgl. Monitoring well completed at the surface with a traffic rated cover set in concrete

Boring Progress and Water Observations

Date	Time	Hole Depth	Standing Level	Strike	Rise	Time (mins)	Sealed

Rotary Flush

From	To	Type	Return (%)

Logged by:	Equipment:	Coordinates: (OS NGR)	Ground Level: (OS)	Date:	
RC	Comacchio GEO 305	Easting: 130552.59m	57.43m AOD	Start: 18/02/2020	AGS
Checked by: EE	Contractor: ADP Group Ltd	Northing: 412937.28m		End: 19/02/2020	Sheet 2 of 2
Status: Final					

• 2018/ECOM/AGS/4.0.1/UK/PROJECTS_GEOS2015/SHELL/60608753/GEOS/BEMERTON/40_TECHNICAL/40_FIELD/AD_LADORATORY_DATA/LOGS/BH-MW2.GPJ Printed:08/09/2020 08:08:20

Client: Shell

Project: Bemerton, Salisbury.

Contract No: 60608753

AECOM

Record of Rotary Borehole

MW105

Coring Details					Samples & Tests				Water Level	Strata				
TCR%	SCR%	RQD%	Fracture Index	Core Run (m)	Depth	Type/ No.	Test Results	PID (ppm)		Reduced Level m(AOD)	Legend	Depth (Thick-ness)	DESCRIPTION	Instru-ment Backfill
										57.19		0.22	Reinforced concrete MADE GROUND	
										57		(1.28)	MADE GROUND: Medium dense brown clayey silty SAND. Gravel is angular to subrounded to coarse flint and chalk.	
					1.00	E				55.91	56	1.50		
										55		(3.50)	MADE GROUND: Medium dense brown clayey silty SAND. Gravel is angular to subrounded to coarse flint	
					2.50	PID		3.2		54				
					3.50	PID		3.7		53				
					4.50	PID		3.2		52.41		5.00		
										51.91	52	(0.50) 5.50	Loose brown GRAVELS of flint with occasional cobbles of flint	
					6.00	PID		2.8		50.91	51	(1.00) 6.50	Soft to firm grey, brown very silty sand CLAY with fine to medium gravel size flints.	
										49.91	50	(1.00) 7.50	No Recovery	
									8.56	49		(1.50)	Loose brown GRAVELS of flint with occasional cobbles of flint. Poor Recovery	
										48.41		9.00		
										48		(2.80)	Cream becoming white structureless CHALK composed of gravelly SILT. Gravel is weak low density white sub angular to rounded fine to medium. UPPER CHALK	

GENERAL REMARKS

Vacuum excavation to 1.5m bgl. Monitoring well completed at the surface with a traffic rated cover set in concrete

Exploratory hole logs should be read in conjunction with corresponding Key Sheets.

Boring Progress and Water Observations

Date	Time	Hole Depth	Standing Level	Strike	Rise	Time (mins)	Sealed
18/02/20		8.56		8.56			

Rotary Flush

From	To	Type	Return (%)

Logged by: RC	Equipment: Comacchio GEO 305	Coordinates: (OS NGR) Easting: 130545.88m Northing: 412956.59m	Ground Level: (OS) 57.41m AOD	Date: Start: 17/02/2020 End: 18/02/2020
Checked by: EE	Contractor: ADP Group Ltd			
Status: Final				Sheet 1 of 2

AGS

File:\\AUKSLOUFS001\DATA\PROJECTS\GEOS\2015\SHELL\60608753\GEOS\FIELD\AD\LOCATION\DATA\LOGS\BH\MW105.GPJ Printed:08/03/2020 08:38:22

Client: Shell

Project: Bemerton, Salisbury.

Contract No: 60608753

AECOM

Record of Rotary Borehole

MW105

Coring Details					Samples & Tests				Water Level	Strata				
TCR%	SCR%	RQD%	Fracture Index	Core Run (m)	Depth	Type/ No.	Test Results	PID (ppm)		Reduced Level m(AOD)	Legend	Depth (Thick-ness)	DESCRIPTION	Instru-ment Backfill
										47			Cream becoming white structureless CHALK composed of gravelly SILT. Gravel is weak low density white sub angular to rounded fine to medium. UPPER CHALK *Stratum text copied from layer at 48.414mAOD from previous sheet.*	
					11.00	E						(2.80)		
					11.20	PID		125.3		46				
										45.61		11.80		
										45.41		12.00	Structureless Chalk of light grey gravelly silt.	
													Loose grey GRAVELS of Silt with occasional cobbles of flint	
					12.50	PID		11.6		45		(0.80)		
										44.61		12.80		
													Structureless CHALK composed of gravelly SILT. Gravel is weak, low density with sub angular to rounded fine to medium. UPPER CHALK	
					13.50	PID		13.7		44				
												(2.20)		
										43				
										42.41		15.00		
													End of Borehole at 15.00m	

GENERAL REMARKS

Vacuum excavation to 1.5m bgl. Monitoring well completed at the surface with a traffic rated cover set in concrete

Boring Progress and Water Observations

Date	Time	Hole Depth	Standing Level	Strike	Rise	Time (mins)	Sealed

Rotary Flush

From	To	Type	Return (%)

Logged by:	Equipment:	Coordinates: (OS NGR)	Ground Level: (OS)	Date:	
RC	Comacchio GEO 305	Easting: 130545.88m	57.41m AOD	Start: 17/02/2020	AGS
Checked by: EE	Contractor: ADP Group Ltd	Northing: 412956.59m		End: 18/02/2020	Sheet 2 of 2
Status: Final					

2018/ECOM/AGS/4.0/UKAS File:\\UKAD1-FS01\DATA\PROJECTS\GEO\2015\SHELL\60608753\GEO\BEMERTON\40_TECHNICAL\40_FIELD_AND_LABORATORY_DATA\LOGS\FIELD LOGS.GPJ Printed:08/03/2020 03:08:22

Client: Shell

Project: Bemerton, Salisbury.

Contract No: 60608753

AECOM

Record of Rotary Borehole

MW106

Coring Details					Samples & Tests				Water Level	Strata				
TCR%	SCR%	RQD%	Fracture Index	Core Run (m)	Depth	Type/ No.	Test Results	PID (ppm)		Reduced Level m(AOD)	Legend	Depth (Thick-ness)	DESCRIPTION	Instru-ment Backfill
										57.07		0.25	Reinforced Concrete MADE GROUND	
										57			MADE GROUND: Medium dense brown clayey silty SAND. Gravel is angular to subrounded to coarse flint	
					1.00	E						(1.25)		
					1.50	PID		30.0		56 55.82		1.50		
													MADE GROUND: Medium dense brown clayey silty SAND. Gravel is angular to subrounded to coarse flint	
										55				
					3.00	PID		2987.0				(3.00)		
										54				
										53				
					4.50	PID		1027.0		52.82		4.50		
												(0.50)	Soft to firm grey, brown very silty sand CLAY with fine to medium gravel size flints.	
					5.00	PID		252.0		52.32		5.00		
										52			Loose brown GRAVELS of flint with occasional cobbles of flint	
												(1.50)		
										51 50.82		6.50		
													Loose grey GRAVELS of Silt with occasional cobbles of flint	
					7.00	PID		865.0		50		(1.50)		
										49.32		8.00		
									8.57				No Recovery	
										49				
												(1.50)		
					9.00	PID		1140.0		48 47.82		9.50		
													Structureless Chalk of light grey gravelly silt. 30% Recovery	
												(1.50)		

GENERAL REMARKS

Vacuum excavation to 1.5m bgl. Monitoring well completed at the surface with a traffic rated cover set in concrete

Exploratory hole logs should be read in conjunction with corresponding Key Sheets.

Boring Progress and Water Observations

Date	Time	Hole Depth	Standing Level	Strike	Rise	Time (mins)	Sealed
27/02/20		8.57		8.57			

Rotary Flush

From	To	Type	Return (%)

Logged by: RC	Equipment: Comacchio GEO 305	Coordinates: (OS NGR) Easting: 130538.34m Northing: 412973.70m	Ground Level: (OS) 57.32m AOD	Date: Start: 26/02/2020 End: 27/02/2020
Checked by: EE	Contractor: ADP Group Ltd			
Status: Final				Sheet 1 of 2

AGS

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Client: Shell

Project: Bemerton, Salisbury.

Contract No: 60608753

AECOM

Record of Rotary Borehole

MW106

Coring Details					Samples & Tests				Water Level	Strata				
TCR%	SCR%	RQD%	Fracture Index	Core Run (m)	Depth	Type/ No.	Test Results	PID (ppm)		Reduced Level m(AOD)	Legend	Depth (Thick-ness)	DESCRIPTION	Instru-ment Backfill
										47		(1.50)	Structureless Chalk of light grey gravelly silt. 30% Recovery *Stratum text copied from layer at 47.819mAOD from previous sheet.*	
					11.00	E				46.32		11.00		
					11.50	PID		672.0		46 45.82		(0.50) 11.50	Loose grey GRAVELS of Silt with occasional cobbles of flint	
										45			Structureless CHALK composed of gravelly SILT. Gravel is weak, low density with sub angular to rounded fine to medium. UPPER CHALK	
					13.50	PID		252.0		44		(3.50)		
										43				
					15.00	PID		112.0		42.32		15.00		
													End of Borehole at 15.00m	

GENERAL REMARKS

Vacuum excavation to 1.5m bgl. Monitoring well completed at the surface with a traffic rated cover set in concrete

Boring Progress and Water Observations							
Date	Time	Hole Depth	Standing Level	Strike	Rise	Time (mins)	Sealed

Rotary Flush			
From	To	Type	Return (%)

Logged by:	Equipment:	Coordinates: (OS NGR)	Ground Level: (OS)	Date:	
RC	Comacchio GEO 305	Easting: 130538.34m	57.32m AOD	Start: 26/02/2020	AGS
Checked by: EE	Contractor: ADP Group Ltd	Northing: 412973.70m		End: 27/02/2020	Sheet 2 of 2
Status: Final					

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Client: Shell

Project: Bemerton, Salisbury.

Contract No: 60608753

AECOM

Record of Rotary Borehole

VP101

Coring Details					Samples & Tests				Water Level	Strata				
TCR%	SCR%	RQD%	Fracture Index	Core Run (m)	Depth	Type/ No.	Test Results	PID (ppm)		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	Instru-ment Backfill
												0.13	Tarmac	
												(0.72)	MADE GROUND: Medium desne brown black white clayey silty gravelly sand.	
												0.85		
					1.00	PID		1.8				(0.30)	MADE GROUND: Large cobbles and gravels of red brick with brown gravelly sand. Gravel is angular.	
												1.15		
					1.50	PID		2.4				(0.85)	MADE GROUND: Medium dense brown clayey silty sand. Gravel is angular subrounded. Sand is fine to coarse.	
												2.00		
													End of Borehole at 2.00m	

GENERAL REMARKS

Vacuum excavation to 1.5m bgl. Monitoring well completed at the surface with a traffic rated cover set in concrete

Exploratory hole logs should be read in conjunction with corresponding Key Sheets.

Boring Progress and Water Observations

Date	Time	Hole Depth	Standing Level	Strike	Rise	Time (mins)	Sealed

Rotary Flush

From	To	Type	Return (%)

Logged by: JL 7/4/20	Equipment: Vacuum excavation	Coordinates: Not surveyed	Ground Level: Not surveyed	Date: Start: 10/02/2020
Checked by: EE	Contractor: ADP Group Ltd	Not surveyed		End: 10/02/2020
Status: Final				Sheet 1 of 1

AGS

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Client: Shell

Project: Bemerton, Salisbury.

Contract No: 60608753

AECOM

Record of Rotary Borehole

VP102

Coring Details					Samples & Tests				Water Level	Strata				
TCR%	SCR%	RQD%	Fracture Index	Core Run (m)	Depth	Type/ No.	Test Results	PID (ppm)		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	Instru-ment Backfill
												0.10	Tarmac	
					0.50	PID		2.8				(0.70)	MADE GROUND: Brown/black medium dense silty very gravelly sand. Gravel is subrounded - angular of reworked flint and chalk.	
												0.80		
					1.00	PID		4.1				(1.00)	MADE GROUND: Brown/black very gravelly clayey fine to coarse sand. Gravel is coarse of red brick and flint.	
												1.80		
													End of Borehole at 1.80m	

GENERAL REMARKS

Vacuum excavation to 1.5m bgl. Monitoring well completed at the surface with a traffic rated cover set in concrete

Exploratory hole logs should be read in conjunction with corresponding Key Sheets.

Boring Progress and Water Observations

Date	Time	Hole Depth	Standing Level	Strike	Rise	Time (mins)	Sealed

Rotary Flush

From	To	Type	Return (%)

Logged by:	Equipment:	Coordinates:	Ground Level:	Date:
JL 7/4/20	Vacuum excavation	Not surveyed	Not surveyed	Start: 13/02/2020
Checked by: EE	Contractor: ADP Group Ltd	Not surveyed		End: 13/02/2020
Status: Final				Sheet 1 of 1

AGS

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Client: Shell

Project: Bemerton, Salisbury.

Contract No: 60608753

AECOM

Record of Rotary Borehole

VP103

Coring Details					Samples & Tests				Water Level	Strata				
TCR%	SCR%	RQD%	Fracture Index	Core Run (m)	Depth	Type/ No.	Test Results	PID (ppm)		Reduced Level	Legend	Depth (Thickness)	DESCRIPTION	Instrument Backfill
												0.12	Tarmac	
					1.00	PID		8.2				(1.38) 1.50	MADE GROUND: Brown medium dense clayey gravelly sand. Gravel is angular to subrounded. Occasional red brick.	
												(0.90) 2.40	MADE GROUND: Medium brown dense clayey silty sand. Gravel is angular to subrounded coarse flint and chalk.	
													End of Borehole at 2.40m	

GENERAL REMARKS

Vacuum excavation to 1.5m bgl. Monitoring well completed at the surface with a traffic rated cover set in concrete

Exploratory hole logs should be read in conjunction with corresponding Key Sheets.

Boring Progress and Water Observations

Date	Time	Hole Depth	Standing Level	Strike	Rise	Time (mins)	Sealed

Rotary Flush

From	To	Type	Return (%)

Logged by: JL 7/4/20	Equipment: Vacuum excavation	Coordinates: Not surveyed	Ground Level: Not surveyed	Date: Start: 13/02/2020	AGS
Checked by: EE	Contractor: ADP Group Ltd	Not surveyed		End: 13/02/2020	Sheet 1 of 1
Status: Final					

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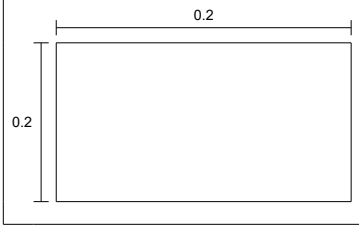
ARCADIS Inspection Pit Log

MW201

Project	Project No.	Ground Level (mAOD)	Start Date	Scale
Shell Bemerton	**10044284**		**23/09/2021**	**1:10**
Client	Easting (OS mE)	Northing (OS mN)	End Date	
Shell UK Oil Products Limited	**412961.53**	**130537.66**	**23/09/2021**	**Sheet 1 of 1**

SAMPLES		TESTS			Water Strikes	STRATA		Depth (Thickness)	Level	Install/ Backfill
Depth	Type/ No.	Depth	Type/ No.	Results		Description	Legend			
						Grey reinforced concrete.		(0.28)		
						Grey concrete.		0.28 0.30		

PLAN DETAILS



Long Axis Orientation:

Shoring / Support: N/A

Stability: Stable

Groundwater (description):

Remarks

Refusal on concrete at 0.30m bgl

Termination Depth: 0.30m

AGS

Unless otherwise stated:
Depth (m), Diameter (mm), Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
Concrete Corer and Vacuum Excavation	**ADP Group**	**Rudo Mafikeni**	**Lauren Hunt**

ARCADIS Rotary Borehole Log

MW202

Project	Project No.	Ground Level (mAOD)	Start Date	Scale
Shell Bemerton	**10044284**		**29/09/2021**	**1:50**
Client	**Easting (OS mE)**	**Northing (OS mN)**	**End Date**	
Shell UK Oil Products Limited	**412961.42**	**130516.36**	**30/09/2021**	**Sheet 1 of 2**

Samples	TCR SCR RQD	If/FI	Tests: Results	Tests: Water Depth	Progress: Date & Time	Progress: Casing & Water (m)	Strata: Description	Strata: Legend	Depth (Thickness)	Level	Install/ Backfill
							Black tarmacadam (Layer 1).		0.05		
							Black tarmacadam (Layer 2).		0.10		
							Black tarmacadam (Layer 3).		(0.48)		
							MADE GROUND: Reddish brown slightly clayey sandy GRAVEL. Gravel is fine to coarse subangular of shale, brick, flint with occasional cobbles.		0.59		
							MADE GROUND: Dark brown slightly gravelly clayey SAND with occasional cobbles of brink and flint. Sand is fine to coarse. Gravel is fine to coarse subangular to subrounded of brick and flint.		(1.17)		
(ES1) 1.50 - 1.70			PID 1.50m: 2.8ppm								
			PID 2.00m: 2.4ppm				Brown slightly gravelly clayey SAND with occasional rootlets. Sand is fine to coarse. Gravel is fine to coarse subangular to subrounded of flint. [River Terrace Deposits]		1.76 (0.29) 2.05		
			PID 2.50m: 2.2ppm				Light orangish brown slightly gravelly sandy CLAY with occasional roots and rootlets. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of chalk and flint. [River Terrace Deposits]				
			PID 3.00m: 1.7ppm						(2.18)		
			PID 3.50m: 3ppm								
			PID 4.00m: 3.1ppm				Brown clayey slightly sandy GRAVEL band.				
			PID 4.50m: 3ppm				Light creamish brown to light brown mottled cream slightly sandy clayey GRAVEL. Gravel is subangular to subrounded fine to coarse of chalk and flint. [River Terrace Deposits]		4.23		
			PID 5.00m: 2.2ppm						(1.41)		
			PID 5.50m: 2.3ppm								
(ES2) 5.70 - 6.00									5.64		
			PID 6.00m: 2.3ppm				Light brown mottled cream and reddish brown sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of chalk and flint. [River Terrace Deposits]		(0.60)		
			PID 6.50m: 2.4ppm				Structureless CHALK composed of brownish cream orange stained silty GRAVEL. Gravel is weak medium density cream with orange staining subangular fine to coarse. (Grade Dc). [White Chalk Subgroup]		6.24 (0.78)		
			PID 7.00m: 1.8ppm				Structureless CHALK composed of cream orange stained slightly sandy gravelly SILT. Clasts are weak medium density cream fine to coarse subangular. (Grade Dm). [White Chalk Subgroup]		7.02		
(ES3) 7.50 - 8.00			PID 7.50m: 2.4ppm								
			PID 8.00m: 1.7ppm						(1.98)		
			PID 8.50m: 1.6ppm				Structureless CHALK composed of cream mottled brownish grey slightly sandy silty GRAVEL with occasional subangular fine to medium flint. Gravel is weak medium density cream subangular fine to coarse of chalk. (Grade Dc). [White Chalk Subgroup]				
			PID 9.00m: 2ppm				Structureless CHALK composed of brownish orange mottled orangish cream slight sandy gravelly SILT with occasional cobbles of chalk. Gravel is weak medium density cream subangular fine to coarse. (Grade Dm). [White Chalk Subgroup]		9.00 (0.80)		
			PID 9.50m: 1.7ppm				Structureless CHALK composed of cream mottled orangish cream slightly sandy gravelly SILT with occasional cobbles of chalk. Gravel is weak medium density cream subangular fine to coarse. (Grade Dm). [White Chalk Subgroup]		9.80 9.90		
			PID 10.00m: 1.5ppm								

DRILLING TECHNIQUE

From	To	Type
0.00	1.50	Inspection Pit
1.50	16.00	Rotary Core

FLUSH DETAILS

From	To	Rtn%	Flush Type

WATER OBSERVATIONS

Date/Time	Strike At	Time Elapsed	Rise To	Casing	Sealed
30/09/2021 00:00	9.34		-		

HOLE/CASING DIAMETER

Hole Dia.	Depth	Casing Dia.	Depth

WATER ADDED

From	To	Volume (ltr)
1.50	16.00	

Remarks

Terminated at target depth. Hydrocarbon odour recorded at 10.50 - 14.39m bgl.

Termination Depth: 16.00m

AGS

Unless otherwise stated:
Depth (m), Diameter (mm), Time (hhmm), Thickness (m), Level (mOD).

Equipment Used: **GEO 305 Comacchio, Concrete Corer and Vacuum Excavation**

Contractor: **ADP Group**

Logged By: **Rudo Mafikeni**

Checked By: **Lauren Hunt**

ARCADIS Rotary Borehole Log

MW202

Project	Project No.	Ground Level (mAOD)	Start Date	Scale
Shell Bemerton	**10044284**		**29/09/2021**	**1:50**
Client	Easting (OS mE)	Northing (OS mN)	End Date	
Shell UK Oil Products Limited	**412961.42**	**130516.36**	**30/09/2021**	**Sheet 2 of 2**

Samples	TCR SCR RQD	If/FI	Tests: Results	Tests: Water Depth	Progress: Date & Time	Progress: Casing & Water (m)	Strata: Description	Strata: Legend	Depth (Thickness)	Level	Install/ Backfill
			PID 10.50m: 2ppm				Structureless CHALK composed of cream mottled orangish cream slightly sandy gravelly SILT with occasional cobbles of chalk. Gravel is weak medium density cream subangular fine to coarse. (Grade Dm). [White Chalk Subgroup]		(0.60) 10.50		
			PID 11.00m: 25.2ppm				Structureless CHALK composed of light grey to greyish cream slightly gravelly SILT with hydrocarbon odour. Gravel is weak medium to high density cream subangular fine to coarse. (Grade Dm). [White Chalk Subgroup]				
			PID 11.50m: 27.4ppm								
			PID 12.00m: 15.3ppm				No recovery				
			PID 12.50m: 27.7ppm						(3.89)		
			PID 13.00m: 12.5ppm								
			PID 13.50m: 5.5ppm								
			PID 14.00m: 4.4ppm								
			PID 14.50m: 2.7ppm				Structureless CHALK composed of cream slightly gravelly SILT. Gravel is weak medium to high density cream with orange staining fine to coarse subangular. (Grade Dm). [White Chalk Subgroup]		14.39 (0.61)		
			PID 15.00m: 7.1ppm				Structureless CHALK composed of cream slightly gravelly SILT. Gravel is weak low density cream subangular fine to coarse. (Grade Dm). [White Chalk Subgroup]		15.00		
			PID 15.50m: 2.4ppm						(1.00)		
			PID 16.00m: 2.5ppm						16.00		

DRILLING TECHNIQUE

From	To	Type
0.00	1.50	Inspection Pit
1.50	16.00	Rotary Core

FLUSH DETAILS

From	To	Rtn%	Flush Type

WATER OBSERVATIONS

Date/Time	Strike At	Time Elapsed	Rise To	Casing	Sealed
30/09/2021 00:00	9.34		-		

HOLE/CASING DIAMETER

Hole Dia.	Depth	Casing Dia.	Depth

WATER ADDED

From	To	Volume (ltr)
1.50	16.00	

Remarks

Terminated at target depth. Hydrocarbon odour recorded at 10.50 - 14.39m bgl.

Termination Depth: 16.00m

AGS

Unless otherwise stated:
Depth (m), Diameter (mm), Time (hhmm), Thickness (m), Level (mOD).

Equipment Used: **GEO 305 Comacchio, Concrete Corer and Vacuum Excavation**

Contractor: **ADP Group**

Logged By: **Rudo Mafikeni**

Checked By: **Lauren Hunt**

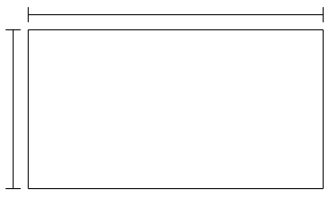
ARCADIS Inspection Pit Log

MW203 A

Project	Project No.	Ground Level (mAOD)	Start Date	Scale
Shell Bemerton	**10044284**		**15/09/2021**	**1:10**
Client	Easting (OS mE)	Northing (OS mN)	End Date	
Shell UK Oil Products Limited	**412960.38**	**130527.87**	**15/09/2021**	**Sheet 1 of 1**

SAMPLES		TESTS			Water Strikes	STRATA		Depth (Thickness)	Level	Install/ Backfill
Depth	Type/ No.	Depth	Type/ No.	Results		Description	Legend			
						MADE GROUND: Brown sandy slightly clayey GRAVEL. Gravel is fine to medium of mixed lithologies including flint.		(0.24)		
								0.24		

PLAN DETAILS



Long Axis Orientation:

Shoring / Support:

Stability:

Groundwater (description):

Remarks

Refusal on concrete at 0.24m bgl

Termination Depth: 0.24m

AGS

Unless otherwise stated:
Depth (m), Diameter (mm), Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
Concrete Corer and Vacuum Excavation	**ADP Group**	**Rudo Mafikeni**	**Lauren Hunt**

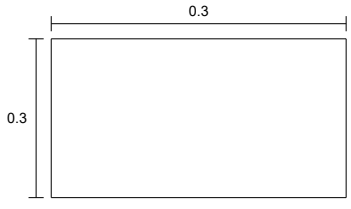
ARCADIS Inspection Pit Log

MW203 B

Project	Project No.	Ground Level (mAOD)	Start Date	Scale
Shell Bemerton	**10044284**		**15/09/2021**	**1:10**
Client	Easting (OS mE)	Northing (OS mN)	End Date	
Shell UK Oil Products Limited	**412961.32**	**130528.09**	**15/09/2021**	**Sheet 1 of 1**

SAMPLES		TESTS			Water Strikes	STRATA		Depth (Thickness)	Level	Install/ Backfill
Depth	Type/ No.	Depth	Type/ No.	Results		Description	Legend			
						MADE GROUND: Brown sandy slightly clayey GRAVEL. Gravel is fine to medium of flint and concrete.		(0.51) 0.51		

PLAN DETAILS



Long Axis Orientation:

Shoring / Support: N/A

Stability: Stable

Groundwater (description):

Remarks

Refusal on concrete blocks at 0.51m bgl

Termination Depth: 0.51m

AGS

Unless otherwise stated:
Depth (m), Diameter (mm), Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
Concrete Corer and Vacuum Excavation	**ADP Group**	**Rudo Mafikeni**	**Lauren Hunt**

ARCADIS Inspection Pit Log

MW203 C

Project	Project No.	Ground Level (mAOD)	Start Date	Scale
Shell Bemerton	**10044284**		**15/09/2021**	**1:10**
Client	Easting (OS mE)	Northing (OS mN)	End Date	
Shell UK Oil Products Limited	**412959.43**	**130527.89**	**24/09/2021**	**Sheet 1 of 1**

SAMPLES		TESTS			Water Strikes	STRATA		Depth (Thickness)	Level	Install/ Backfill
Depth	Type/ No.	Depth	Type/ No.	Results		Description	Legend			
						MADE GROUND: Brown sandy slightly clayey GRAVEL. Gravel is fine to coarse of flint and brick.		(1.00)		
						Brick cobbles				
						Concrete hardstanding		1.00 (0.24) 1.24		

PLAN DETAILS

Long Axis Orientation:

Shoring / Support:

Stability:

Groundwater (description):

Remarks

Refusal on concrete slab at 1.24m bgl

Termination Depth: 1.24m

AGS

Unless otherwise stated:
Depth (m), Diameter (mm), Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
Concrete Corer and Vacuum Excavation	**ADP Group**	**Rudo Mafikeni**	**Lauren Hunt**

ARCADIS Rotary Borehole Log

MW204

Project	Project No.	Ground Level (mAOD)	Start Date	Scale
Shell Bemerton	**10044284**		**20/09/2021**	**1:50**
Client	**Easting (OS mE)**	**Northing (OS mN)**	**End Date**	
Shell UK Oil Products Limited	**412981.33**	**130523.78**	**21/09/2021**	**Sheet 1 of 2**

Samples	TCR SCR RQD	If/FI	Tests: Results	Tests: Water Depth	Progress: Date & Time	Progress: Casing & Water (m)	Strata: Description	Strata: Legend	Depth (Thickness)	Level	Install/ Backfill
							Black tarmacadam (Layer 1).		0.03 (0.12) 0.15		
							Dark grey bituminous hardstanding (Layer 2).				
			PID 0.50m: 2.5ppm				MADE GROUND: Reddish brown to brown slightly clayey GRAVEL with occasional cobbles of flint. Gravel is subangular fine to coarse of flint.		(0.95)		
			PID 1.00m: 2.3ppm								
							MADE GROUND: Grey angular cobbles of concrete.		1.10 (0.11) 1.21		
			PID 1.50m: 2.1ppm				MADE GROUND: Light brown slightly clayey GRAVEL with occasional cobbles of flint. Gravel is fine to coarse of flint and chalk.		(0.75)		
			PID 2.00m: 18.9ppm				MADE GROUND: White mottled light brown silty GRAVEL. with frequent rootlets. Gravel is subrounded fine to coarse of chalk.		1.96 (0.29) 2.25		
							MADE GROUND: Dark reddish brown slightly gravelly clay. Gravel is subangular fine to medium of flint and brick.		2.30 (0.29)		
(ES1) 2.50			PID 2.50m: 44.3ppm				MADE GROUND: Dark brown slightly gravelly clayey SAND. Sand is fine to coarse. Gravel is subangular fine to medium of chalk, flint, brick and slag.		2.59		
			PID 3.00m: 23.9ppm				Reddish brown to brown slightly gravelly sandy CLAY. Sand is fine to medium. Gravel is subangular to subrounded fine to coarse of flint and chalk. [River Terrace Deposits]		(1.22)		
			PID 3.50m: 27.5ppm								
(ES2) 4.00 - 4.50			PID 4.00m: 44.4ppm				Brown mottled reddish brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is fine to medium subrounded of flint. [River Terrace Deposits]		3.81 (0.69)		
			PID 4.50m: 43.5ppm						4.50 (0.11)		
			PID 4.70m: 16.8ppm				Reddish brown slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium of chalk and flint. [River Terrace Deposits]		4.61 (0.49)		
			PID 5.10m: 18.4ppm				Brownish grey to reddish brown gravelly CLAY with frequent angular cobbles of flint. Gravel is subangular to subrounded fine to coarse of chalk and flint. [River Terrace Deposits]		5.10 (0.22) 5.32		
			PID 5.50m: 17.7ppm				Reddish brown mottled white slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of flint and chalk. [River Terrace Deposits]		(0.16) 5.48 (0.83)		
			PID 6.00m: 19ppm				Greyish brown to reddish brown gravelly CLAY with frequent cobbles of flint. Gravel is subangular to subrounded fine to coarse of chalk and flint. [River Terrace Deposits]				
			PID 6.35m: 15.9ppm						6.31 (0.14) 6.45		
			PID 6.50m: 17.6ppm				Greyish brown clayey GRAVEL. Gravel is subangular fine to coarse of flint and chalk. [River Terrace Deposits]				
			PID 7.00m: 13.2ppm				Reddish brown slightly sandy slightly gravelly CLAY. Gravel is subrounded fine to coarse of chalk and flint. [River Terrace Deposits]		(1.05)		
			PID 7.50m: 17.9ppm				Greyish brown mottled white silty GRAVEL with occasional cobbles of flint. Gravel is subangular fine to coarse of chalk of flint. [River Terrace Deposits]		7.50 (0.18) 7.68		
			PID 8.00m: 58.5ppm				Brownish grey slightly silty GRAVEL. Gravel is subangular medium of flint. (Drilling Induced). [River Terrace Deposits]				
			PID 8.50m: 74.2ppm				Structureless CHALK composed of brownish cream mottled brown silty GRAVEL with frequent subangular medium to coarse gravel of flint. Clasts are greyish cream weak medium to high density subangular to subrounded fine to coarse of chalk. (Grade Dc). [White Chalk Subgroup]		(1.32)		
			PID 9.00m: 36.4ppm						9.00		
			PID 9.50m: 16.7ppm				Structureless CHALK composed of greyish cream with orange staining silty GRAVEL. Clasts are greyish cream white weak high density subangular medium to coarse chalk. (Grade Dc). [White Chalk Subgroup]		(1.31)		
			PID 10.00m: 13.5ppm								

DRILLING TECHNIQUE

From	To	Type
0.00	1.50	Inspection Pit
1.50	16.00	Rotary Core

FLUSH DETAILS

From	To	Rtn%	Flush Type

WATER OBSERVATIONS

Date/Time	Strike At	Time Elapsed	Rise To	Casing	Sealed

HOLE/CASING DIAMETER

Hole Dia.	Depth	Casing Dia.	Depth
		225	3.00
		150	15.00

WATER ADDED

From	To	Volume (ltr)
1.50	16.00	

Remarks

Termination Depth: 16.00m

AGS

Unless otherwise stated:
Depth (m), Diameter (mm), Time (hhmm), Thickness (m), Level (mOD).

Equipment Used: **GEO 305 Comacchio, Concrete Corer and Vacuum Excavation**

Contractor: **ADP Group**

Logged By: **Rudo Mafikeni**

Checked By: **Lauren Hunt**

ARCADIS Rotary Borehole Log

MW204

Project	Project No.	Ground Level (mAOD)	Start Date	Scale
Shell Bemerton	**10044284**		**20/09/2021**	**1:50**
Client	Easting (OS mE)	Northing (OS mN)	End Date	
Shell UK Oil Products Limited	**412981.33**	**130523.78**	**21/09/2021**	**Sheet 2 of 2**

Samples	TCR SCR RQD	If/FI	Tests: Results	Tests: Water Depth	Progress: Date & Time	Progress: Casing & Water (m)	Strata: Description	Strata: Legend	Depth (Thickness)	Level	Install/ Backfill
			PID 10.50m: 6.8ppm				Structureless CHALK composed of greyish cream with orange staining silty GRAVEL. Clasts are greyish cream white weak high density subangular medium to coarse chalk. (Grade Dc). [White Chalk Subgroup]		10.31		
			PID 11.00m: 15.3ppm				Structureless CHALK composed of greyish white mottled light grey (staining) gravelly SILT. Gravel is subangular fine to coarse weak medium density greyish cream. (Grade Dm). [White Chalk Subgroup]		(1.87)		
			PID 11.50m: 13.8ppm								
			PID 12.00m: 14.4ppm						12.18		
			PID 12.50m: 3.6ppm				Structureless CHALK composed of greyish cream with localised orangish brown staining slightly gravelly SILT with occasional cobbles of chalk. Gravel is weak medium density greyish cream fine to coarse of chalk. (Grade Dm). [White Chalk Subgroup]				
			PID 13.00m: 4.5ppm						(1.51)		
			PID 13.50m: 3.9ppm								
			PID 14.00m: 2ppm				Structureless CHALK composed of greyish cream with localised orangish brown staining slightly gravelly SILT. Gravel is weak medium density greyish cream medium to coarse. (Grade Dm). [White Chalk Subgroup]		13.69		
			PID 14.50m: 2ppm								
			PID 15.00m: 2.2ppm						(2.31)		
			PID 15.50m: 2.4ppm								
			PID 16.00m: 2.6ppm						16.00		

DRILLING TECHNIQUE			FLUSH DETAILS				WATER OBSERVATIONS						HOLE/CASING DIAMETER				WATER ADDED		
From	To	Type	From	To	Rtn%	Flush Type	Date/Time	Strike At	Time Elapsed	Rise To	Casing	Sealed	Hole Dia.	Depth	Casing Dia.	Depth	From	To	Volume (ltr)
0.00 1.50	1.50 16.00	Inspection Pit Rotary Core													225 150	3.00 15.00	1.50	16.00	

Remarks

Termination Depth: 16.00m

AGS

Unless otherwise stated:
Depth (m), Diameter (mm), Time (hhmm), Thickness (m), Level (mOD).

Equipment Used: **GEO 305 Comacchio, Concrete Corer and Vacuum Excavation**

Contractor: **ADP Group**

Logged By: **Rudo Mafikeni**

Checked By: **Lauren Hunt**