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Remediation Strategy

Point of Ayr (PoA), Talacre, Holywell

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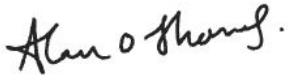
0743746

Peter Taylor-Bray
Managing Consultant

Sonia Devons
Managing Consultant

Russell Cullen
Partner in Charge



Alan Thomas
Technical Director

Environmental Resources Management Limited
33 St Mary Axe
Exchequer Court
London, England
EC3A 8AA
United Kingdom
T +44 20 3206 5200

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Acronyms and ABBREVIATIONS

Acronyms	Description
°C	degrees Celsius
µg/L	micrograms per litre
µS/cm	microSiemens per centimetre
AA	Annual Average
aOD	above Ordnance Datum
bgl	below ground level
Client	ENI UK Limited
9Cl-PF3ONS	9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid
cm	Centimetre
CW	Controlled Waters
CWRA	Controlled Waters Risk Assessment
DF	Dilution Factor
ADONA	4,8-Dioxa-3H-perfluorononanoic acid
DQRA	Detailed Quantitative Risk Assessment
DWS	Drinking Water Standard
EA	Environment Agency
Element	Element Materials Technology Laboratory
EQS	Environmental Quality Standards
ERM	Environmental Resources Management Limited
EU	European Union
GAC	Generic Assessment Criteria
GQRA	Generic Quantitative Risk Assessment
HFPO-DA	Hexafluoropropylene oxide dimer acid
HI	Hazard Index
L	Litre
m	metre
MAC	Maximum Allowable Concentrations
ug/l	micrograms per litre
ug/kg	micrograms per kilogram
mg/kg	milligrams per kilogram

Acronyms	Description
mg/L	milligrams per litre
mm	millimetre
MRL	Method Reporting Limit
mV	Millivolts
NEtFOSA	N-ethyl perfluorooctanesulfonamide
NEtFOSAA	N-ethyl perfluorooctanesulfonamidoacetic acid
NMeFOSA	N-methyl perfluorooctanesulfonamide
NMeFOSAA	N-methyl perfluorooctanesulfonamidoacetic acid
NRW	Natural Resources Wales
PFBS	Perfluorobutanesulfonic acid
PFBA	Perfluorobutanoic acid
PFDS	Perfluorodecanesulfonic acid
PFDA	Perfluorodecanoic acid
PFDoS	Perfluorododecanesulfonic acid
PFDoDA	Perfluorododecanoic acid
8:2FTS	1H,1H, 2H, 2H-Perfluorodecane sulfonic acid
PFHpS	Perfluoroheptanesulfonic acid
PFHpA	Perfluoroheptanoic acid
4:2FTS	1H,1H, 2H, 2H-Perfluorohexane sulfonic acid
PFHxS	Perfluorohexanesulfonic acid
PFHxA	Perfluorohexanoic acid
PFHxDA	Perfluoro-n-hexadecanoic acid
PFODA	Perfluoro-n-octadecanoic acid
PFNS	Perfluorononanesulfonic acid
PFNA	Perfluorononanoic acid
PFOSA	Perfluorooctanesulfonamide
6:2FTS	1H,1H, 2H, 2H-Perfluorooctane sulfonic acid
PFOA	Perfluorooctanoic acid
PFPeA	Perfluoropentanoic acid
PFPeS	Perfluoropentansulfonic acid
PFTeDA	Perfluorotetradecanoic acid
PFTrDA	Perfluorotridecanoic acid

Acronyms	Description
PFUnDA	Perfluoroundecanoic acid
OWS	Oily water System
PoA	Point of Ayr
POP	Persistent Organic Pollutant
ppm	Parts per million
Site	Point of Ayr Gas Terminal, adjacent former colliery area and associated contractor's car park located in Talacre, Flintshire, CH8 9RD, United Kingdom
SSC	Subsurface Service Clearance
SWS	Surface Water System
TCPA	Town and Country Planning Act
UK	United Kingdom
wt%	% by weight

EXECUTIVE SUMMARY

ENI UK Limited (hereafter referred to as 'the Client' or 'Eni') operates the Point of Ayr Gas Terminal (hereafter referred to as 'the site' or 'PoA') in Talacre, Flintshire, CH8 9RD, United Kingdom to process natural gas imported from the off-shore Douglas Platform and then exported via pipeline to Connah's Quay Power Station.

To support its Carbon Capture and Storage (CCS) Project, Eni is planning to convert the existing PoA terminal to facilitate CO2 injection to the offshore assets. Consequently, demolition and redevelopment of PoA is required using a phased approach.

This report presents the results of a remedial options appraisal (ROA) and remedial strategy development that is based on fulfilling the requirement for remediation identified in the DQRA. Eni's intention is to implement a voluntary but comprehensive and robust remedial strategy for the site to enable development to proceed, to reduce potential risks to human health and controlled waters during demolition construction activities and in the long term and as a consequence discharge all planning requirements.

In terms of remediation, while the intention is to reuse soils to the extent possible in historical source, it is clear areas some off-site disposal of soils will be required. Classifying the soil as nonhazardous waste and disposal to landfill is the most appropriate remedial solution.

In conjunction with the soil removal, groundwater abstraction is required, as temporary works to support the development of the site. Any groundwater or surface water assessed as contaminated with PFAS during the construction works will require onsite treatment (using the existing but upgraded treatment system) prior to discharge to Talacre Brook.

The surface water drainage system is currently capturing groundwater and discharging directly into Talacre Brook. No treatment of this discharge is currently envisaged beyond betterment as a result of removal of soil sources.

Once the ground works are complete, the DQRA will be revisited, and it is believed that further groundwater remediation will not be required. As part of the future validation and verification monitoring plan contingency measures will be included for groundwater and surface water.

1. INTRODUCTION

1.1 CONTEXT

ENI UK Limited (hereafter referred to as 'the Client' or 'Eni') operates the Point of Ayr Gas Terminal (hereafter referred to as 'the site' or 'PoA') in Talacre, Flintshire, CH8 9RD, United Kingdom to process natural gas imported from the off-shore Douglas Platform and then exported via pipeline to Connah's Quay Power Station. A Site location map is provided as Figure 1 (Appendix A) and the current site layout is provided as Figure 2 (Appendix A).

To support its Carbon Capture and Storage (CCS) Project, Eni is planning to convert the existing PoA terminal to facilitate CO2 injection to the offshore assets. Consequently, demolition and redevelopment of PoA is required using a phased approach and the future layout of the proposed development is provided in Figure 3 (Appendix A).

As part of the redevelopment process Eni commissioned Environmental Resources Management Limited (hereafter referred to as 'ERM') to undertake a Phase 2 site investigation in March 2024. The most significant result of this investigation[1] was the identification of groundwater impact from a range of Per- and polyfluoroalkyl substances (PFAS) that were subsequently linked to the storage and testing of aqueous fire-fighting foams (AFFF) over the lifetime of the facility.

The Phase 2 site investigation in March 2024 undertook laboratory analysis of soil and groundwater samples for a suite of analytes that were selected based on the nature of historical and current potential sources of contamination at the Site. It concluded that, *with the exception of PFAS, based on the findings of the GQRA, the potential risk to Human Health and Controlled Waters from identified soil and groundwater contamination at the Site is considered to be "low".*

To understand the implications of the identified PFAS contamination in the context of the proposed redevelopment (both at the demolition, construction phase and in the long term) Eni retained ERM to undertake a further phase of investigation works and detailed quantitative risk assessment (DQRA) and this has been reported separately[2].

This report presents the results of a remedial options appraisal (ROA) and remedial strategy development that is based on fulfilling the requirement for remediation identified in the DQRA. Eni's intention is to implement a voluntary but comprehensive and robust remedial strategy for the site to enable development to proceed, to reduce potential risks to human health and controlled waters during demolition construction activities and in the long term and as a consequence discharge all planning requirements.

The ROA is based on ERM's current understanding of the scope and nature of the redevelopment project and is structured to provide: a summary of the remedial requirement and proposed remedial criteria; an outline of the likely scope of works based on ERM's current understanding of

[1] ERM, 2024, Point of Ayr (PoA) Environmental Site Assessment, April 2024, 0712595
[2] ERM, 2025, Point of Ayr (PoA) Detailed Quantitative Risk Assessment (DQRA) Report, February 2025, 0743746

the redevelopment project; and remedial technology identification and evaluation based on current UK Land Contamination Risk Management (LCRM) guidance[1].

1.2 SUMMARY OF REQUIREMENT FOR REMEDIATION & PROPOSED REMEDIATION CRITERIA

- The requirements for remediation the site meets the requirements of Eni and the regulatory authorities in terms of discharge of planning conditions specifically for planning condition 12 "Land affected by contamination" sub section c - an options appraisal and remediation strategy giving full details of the remediation measures required and how they are to be undertaken. The specific considerations are as follows:
- The site poses no significant risk based on the Regulatory requirements of the UK – "Statutory Risk" this includes
  - The requirement to ensure protection of human health during the demolition and construction phases and for the future commercial / industrial land use;
  - Protection of the wider environment in particular the protection of controlled waters and the environment (surface water and groundwater) surrounding and adjacent to the site, during demolition, construction and in the long term.

1.3 PROPOSED INTEGRATED REMEDIATION CRITERIA

Proposed integrated treatment criteria were developed on completion of the DQRA and are presented in Table 1-1, and discussed further below.

TABLE 1-1 PROPOSED INTEGRATED REMEDIATION CRITERIA

Medium	Remedial Standard	Rationale
Soils (protective of human health and controlled waters)	600 ug/kg (PFOA, PFNA, PFHxS and PFOS)	The Commercial Soils C4SL value of 600 ug/kg for perfluorooctanoic acid (PFOA), Perfluorononanoic acid (PFNA), perfluorohexane sulfonic acid (PFHxS) and perfluorooctane sulfonic acid (PFOS) is proposed being protective of human health and controlled waters
Groundwater (in situ, not extracted)	No standard proposed	Based on results of Level 4 assessment - considering dilution in Dee Estuary then risk is low so no standard is proposed (recognising that soil source will be removed)
Groundwater and Surface water extracted to be discharged to surface water	0.10ug/l PFOS	using PFOS as an indicator for PFAS (noting that reduction of all other PFAS will take place as well). The number being developed from a consensus of technology suppliers, reputable contractors and consultant evaluation as providing a balance of protection of ecological receptors, public health and what is practically and economically feasible

[1] https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm/lcrm-stage-2-options-appraisal

1.3.1 SOILS

For the purposes of developing integrated remediation criteria as the starting point, then based on the review DQRA the Commercial Soils C4SL value of 600 ug/kg (sum of perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorohexane sulfonic acid (PFHxS), and perfluorooctane sulfonic acid (PFOS)) is adopted as the primary standard. This also being protective of controlled waters given the Level 3 risk assessment generated soils-based criteria with a broad range of results for PFOS between 3 ug/kg (a source 100m from the receptor) and 82,600 ug/kg (200m from the receptor). Based on a review of the source locations, and assuming a natural prevailing groundwater flow direction to the east, then ~100m is considered a conservative distance for most significant sources, and the calculated acceptable soil concentration is 629 ug/kg. Therefore, the 600ug/kg proposed for human health will also be protective of controlled waters. This approach satisfies the statutory requirement for protection of human health, and is considered to be a conservative balance for the protection of controlled waters, given the circumstances of the site.

No other soils impact is considered significant to date however a watching brief (together with appropriate analytical analysis) will be maintained during the works. Any unexpected contamination will be addressed either as part of the existing planned remediation or will be segregated and treated or disposed of separately.

1.3.2 GROUNDWATER

Given that the Level 4 risk assessment indicated no risk to the Dee Estuary, then no specific criteria are proposed for groundwater other than general betterment through the proposed programme of works. Given the proposed extent of PFOS and other PFAS soil source mass to be removed, this betterment will likely be significant. In respect of the potential for future cross-boundary migration of groundwater, the potential for active treatment is therefore considered limited. Therefore, a contingency remedial strategy, based on passive pathway intervention, is included in this options appraisal, which would provide long-term sustainable betterment, should it be required. No specific remedial criteria are proposed for this element but significant reduction in mass discharge would be anticipated.

1.3.3 SURFACE WATER DISCHARGE

Treatment of any waters produced as part of the redevelopment works will be undertaken to the extent reasonably practical with betterment of any discharge. The proposed PFOS concentration in the discharge is 0.10ug/l. This is a remedial target for surface water discharges (noting that reduction of all other PFAS will take place as well) during the construction and development period, and was developed from a consensus of technology suppliers, reputable contractors and consultant evaluation as providing a balance of protection of ecological receptors, public health and what is practically and economically feasible. No long term treatment of the ongoing surface water discharge is proposed at present however this will be monitored and the requirement evaluated post development. It is anticipated that concentrations in the surface water discharge will reduce as the site is developed.

1.4 PROPOSED SCOPE OF WORKS

The proposed scope of works that forms the basis for the remedial strategy will be fully integrated with the demolition and construction phase of the project and consists of the following key elements:

- Segregation and disposal of areas of concrete that are impacted with residual PFAS focusing on bases of foam monitors and methanol sump area.
- Excavation of two PFOS hotspots exceeding the remedial criteria that lie within and beyond redevelopment boundary to a maximum depth indicated by the water table (approximately 1.2m) together with the excavation of the primary source area in the south east corner of the site with disposal and or treatment of soils off site.
- Minimal disturbance and where possible reuse of soils in construction areas containing low levels of PFAS.
- The treatment of all extracted groundwater from dewatering and surface water discharges prior to release to the environment until construction is completed.

The spatial location of each of the proposed elements (and their anticipated boundaries) is summarised in Figure 1.4-1, below. The anticipated volumes of materials requiring treatment in each area and the rationale for the selection are summarised in Table 1-2.

FIGURE 1.4-1INDICATIVE LOCATIONS OF PROPOSED SCOPE OF WORKS (PRACTICAL REMEDIATION AREAS) (NOTE: EXACT LOCATIONS TO BE CONFIRMED)

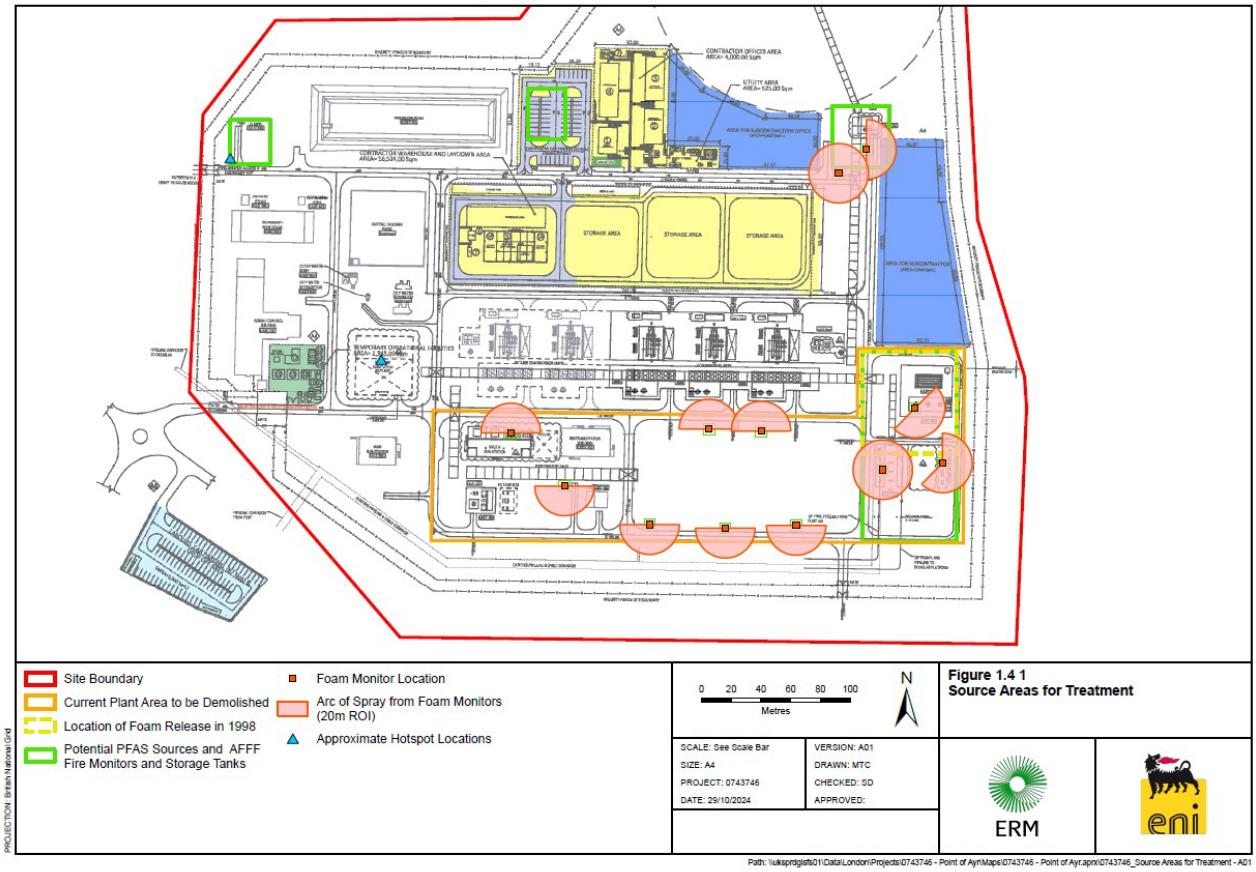

TABLE 1-2 ANTICIPATED VOLUMES OF SOIL TO BE DISPOSED BY AREA

Area	Area of impact, approx. (m^2)	Anticipated depth requiring treatment (m)	Volume of area requiring treatment (m^3)	Rationale of treatment requirement	PFOS concentrations in soils by area		
					Depth of sample (m bgl)	Mean (ug/kg)	Max (ug/kg)
Development area: Metering Unit Location of historic foam release (1998) in which ~2,000-3,000 litres of foam was released to ground. Also includes spray area of Fire Monitor 3.	3,559	Requiring treatment: 0.0-1.5	Requiring treatment: 5,338	Location where a high volume of foam was released to ground. High concentrations of PFAS precursors in TOP assay results. Likelihood of penetration beyond 1.0m is considered high.	0.0-0.5m:	78.5	139.4
					0.5-1.0m:	49.6	92.1
Development area: Inlet Unit Area immediately adjacent (south) of historic foam release. Contains multiple Fire Monitors (FM4, FM5 and methanol sump fire monitor), and methanol sump area.	3,616	Requiring treatment: 0.0-1.0	Requiring treatment: 5,424	Location immediately adjacent to major foam release. High concentration in groundwaters surrounding this area suggest primary source area	0.0-0.5m:	82.7	216.8
Fire Monitor 2 (approximately 50% segment from spray outlet) 	628	1.5	942	High concentrations of PFAS in shallow soils within spray arc. Shallow soil PFOS concentration is above the proposed criteria (600 ug/kg).	0.0-0.5m:	1,096.3	1,096.3
					0.5-1.0m:	63.1	63.1
Fire Monitor 6 (approximately 50% segment from spray outlet)	628	1.5	942	High concentrations of PFAS in shallow soils within spray arc.	0.0-0.5m:	1,537.9	1,537.9

Area	Area of impact, approx. (m^2)	Anticipated depth requiring treatment (m)	Volume of area requiring treatment (m^3)	Rationale of treatment requirement	PFOS concentrations in soils by area		
					Depth of sample (m bgl)	Mean (ug/kg)	Max (ug/kg)
				Shallow soil PFOS concentration is above the proposed criteria (600 ug/kg).			
Total volume of source areas requiring treatment:			12,646	Total volume of source areas requiring treatment:			

The spray radius of a fire monitor has been assumed as 20m as a worse-case scenario (i.e. potential radius of impact from a fire monitor).

The anticipated depth for treatment is currently based on a sampling programme which ceased at 1.0m bgl. Addition sampling beyond 1.0m bgl is required to confirm the concentrations of PFAS at depth (>1.0m but above the groundwater, observed between 1.5 and 2.0m bgl), volume of PFAS leaching to groundwater, and a required treatment depth for each area. Currently an estimate on required treatment depth has been made for each area based on PFOS concentrations reported (within each area), as well as the measured groundwater level.

The site will also be redeveloped in additional areas outside of the above identified source areas. This will include excavations for demolition as well as new foundations (subject to piling assessments etc.). The treatment requirements in these development areas will be further assessed following initial engagement with the regulator but the intention is to maximise the reuse of soils on site where possible through testing comparison of excavated soils with the developed criteria and validation of soils prior to reuse.

1.4.1 -SITE PREPARATION WORKS

1.4.1.1 CONCRETE REMOVAL

As part of preparation works for the site development additional areas of concrete slab may be removed from the site surface and crushed potential to be used as an aggregate either on or off site reuse.

This will be undertaken in a manner to avoid the potential for cross contamination since some concrete is known to be impacted with PFAS. Areas known to be impacted should be removed initially and temporarily stored on plastic sheeting before being removed off site.

Areas of concrete free from contamination can then be safely broken out, crushed and graded into an engineered fill to support redevelopment of the site.

1.4.1.2 BOREHOLE DECOMMISSIONING

In parallel with the construction and remedial works (and prior to slab removal), where boreholes lie within the source area, the existing groundwater monitoring well network will be progressively decommissioned in accordance with Environment Agency guidelines[1]. This will reduce the likelihood of monitoring wells and their backfill materials presenting groundwater migration pathways for potential contaminants during site redevelopment. The borehole network proposed for long term monitoring will be stated in the long-term monitoring plan developed to satisfy TCPA condition No.14 “Long Term Monitoring Plan Contamination”.

[1] Environment Agency, 2012, Good practice for decommissioning redundant boreholes and wells

2. REMEDIAL TECHNOLOGY EVALUATION

ERM has completed a ROA in accordance with current UK LCRM guidance[1]. The key steps in this ROA are as follows:

- The identification and preliminary screening of feasible remediation options.
- The detailed evaluation of retained options including:
  - A technical assessment; and
  - Preliminary evaluation of sustainability.
- The identification of the preferred remedial options and integration with the overall site redevelopment strategy.

2.1.1 IDENTIFICATION AND SCREENING OF FEASIBLE REMEDIATION OPTIONS

Based on the Conceptual Site Model and the remediation objectives previously detailed, a wide range of potential technologies have been considered and screened on a qualitative basis. These include in-situ and ex-situ technologies for source reduction as well as a variety of technologies that may be used for the construction of a barrier for pathway interception and surface water treatment. Proven technologies for the treatment of PFAS are limited and the list of candidate technologies was developed based on ERM experience, confidential discussions with specialist remediation contractors, and a literature review. The screening process was undertaken in two phases:

- In the first phase (Table 2-1) the list of candidate technologies was evaluated with respect to the key elements of the conceptual site model to ensure that from a fundamental technical basis the technology is compatible with the requirements for the site; and
- In the second phase (Table 2-2) the technologies were then screened against high-level technical screening criteria that are fundamental to technology selection within the context of the constraints of the project and focussed on:
  - **Technical applicability** (is the technology applicable to the contaminants of concern and the matrix?);
  - **Likely performance** (does the technology have the ability to meet remediation criteria?);
  - **Robustness** (has the technology been commercially demonstrated and is it available?); and
  - **Practicality in context of site-specific requirements** (will the technology be practically applicable to the site circumstances, redevelopment plans and timescale available?).

[1] https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm/lcrm-stage-2-options-appraisal

TABLE 2-1 HIGH-LEVEL SCREENING OF REMEDIAL TECHNOLOGIES - BASED ON CONCEPTUAL SITE MODEL

Technology	CSM				
	Treatment of Water from construction dewatering	Groundwater Boundary Control	Soils & Soil Arisings from Construction		Technology Retained ?
			High Concn.	Low Concn.	
Surface Water / Groundwater Treatment					
Hydraulic Containment - Groundwater Extraction & Above Ground Treatment					✓
Granular Activated Carbon (GAC)					✓
Powdered activated carbon (PACT) / fludisied bed					✓
Surface Activation Foam Fractionation (SAFF)					✓
Flocculant based sysems					✓
Ion exchange resins					✓
Membrane Separation (RO/NF)					✓
Other systems					✓
Physical containment - Barrier wall					✓
Permeable Reactive Barrier or Reactive Zone					✓
Funnel & Gate					✓
Air Sparging / Biosparging & SVE					x
Injectable Carbon (enhance attenuation capacity) -					✓
Carbon enhanced barriers (RemBind)					✓
Natural Attenuation					✓
SoilsTreatment					
Excavation & off site disposal - landfill					✓
Excavation & off site disposal - incineration					✓
Excavation & on site treatment					✓
Soil Washing					✓
Ex Situ Stabilisation					✓
On site Containment/ Capping					✓
Thermal desorption					✓
In situ soil mixing (Stabilisation)					✓
Soil Vapour Extraction (SVE)					x
Dual Phase Vacuum Extraction DPVE					x
Air Sparging & SVE					x
In Situ Chemical Oxidation					x
In Situ Chemical Reduction					x
In Situ Biological Treatment					x
Phytoremediation					x
In situ Thermal Treatment					x
Surfactant & Co solvent Flushing					x
Natural Source Zone Depletion					x
Applicable					
Potentially Applicable					
Not Applicable					

TABLE 2-2 HIGH LEVEL SCREENING OF REMEDIAL TECHNOLOGIES - BASED ON TECHNICAL APPLICABILITY

Technology	Technical Applicability	Likelihood of meeting remediation criteria	Commercially Demonstrated & Available	Practically Applicable	Technology Retained ?	Approximate Cost (£ per ton unless stated)
Surface Water / Groundwater Treatment						
Hydraulic Containment - Groundwater Extraction & Above Ground T	✓		✓	✓	only in context of dewatering	
Granular Activated Carbon (GAC)	✓	✓	✓	✓	✓	
Powdered activated carbon (PACT) / fludisied bed	✓	✓	✓	✓	✓	
Surface Activation Foam Fractionation (SAFF)	✓	✓	✓	?	✓	
Flocculant based sysems	?	?	✓	?		
Ion exchange resins	✓	✓	✓	?	✓	
Membrane Separation (RO/NF)	✓	✓	?	?		
Other systems	?	?	✓	?		
Physical containment - Barrier wall	✓	?	✓	?	✓	
Permeable Reactive Barrier or Reactive Zone	✓	?	✓	✓	✓	
Funnel & Gate	✓	?	?	?	?	
Air Sparging / Biosparging & SVE						
Injectable Carbon (enhance attenuation capacity)	✓	?	✓	?	✓	
Carbon enhanced barriers (RemBind)	✓	?	✓	?	✓	
Natural Attenuation	?	?	?	?		
SoilsTreatment						
Excavation & off site disposal - landfill	✓	✓	?	✓	✓	~106 - 120
Excavation & off site disposal - incineration	✓	✓	✓	✓	✓	
Excavation & on site treatment	✓	✓	✓	?	✓	
Soil Washing	✓	?	?			
Ex Situ Stabilisation	✓	✓	✓	?	✓	~59-126
On site Containment/ Capping	✓	✓	✓	?	✓	
Thermal desorption	✓	?	?	?		
In situ soil mixing (Stabilisation)	✓	?	?	?		
Applicable						
Potentially Applicable						
Not Applicable						

The preliminary screening of candidate technologies (Table 2-1) is relatively straightforward as PFAS are only treatable using a relatively limited number of technologies. A number of traditional in situ technologies (with the exception of boundary control) have not therefore been considered further.

Based on the preliminary screening, three source reduction technologies are considered applicable to the site, all based around excavation of the main contaminant sources and reflecting that source remediation needs to be integrated into the overall decommissioning, demolition and construction plan for the redevelopment:

- Excavation and off-site treatment/disposal;
- Excavation and off -site treatment and incineration; and
- Excavation and on-site treatment using stabilisation.

These three technologies have been selected to be taken forward for detailed assessment. In addition, on site containment /capping that can be integrated as part of the redevelopment is also retained.

Excavations during redevelopment works will require dewatering and any groundwater collected during dewatering or draining into the excavations will also require treatment. A suite of technologies is considered applicable to treatment of these waters including

- Sorption systems including:

  - Granular activated carbon.
  - Powdered activated carbon.
- Separation technologies – that also require treatment of disposal of the concentrate:
  - Ion exchange resins.
  - Surface activation foam fractionation.
- A combination of the above.

These have been retained for further assessment at this stage.

2.2 DETAILED EVALUATION OF OPTIONS

This initial evaluation of options has been undertaken in (confidential) consultation with specialist contractors and considers the relative technical and site-specific advantages / disadvantages of each of the candidate technologies, an assessment of their likely integration within the context of the development project, an economic assessment and a preliminary assessment of overall sustainability. Further iteration will be undertaken when exact details of the redevelopment works, scope, timing and constraints are known from the contractor.

For the purposes of the preliminary detailed technical assessment then following on from the results of the preliminary screening the following options appraisal evaluation criteria were considered:

- Ability to meet the proposed remedial criteria and minimise long-term liabilities;
- Ability to meet the commercial requirements from a practical perspective within the context of the construction project;
- Ability to obtain necessary regulatory requirements in terms of licensing / permissions; and
- Ability to avoid unacceptable environmental impacts, health and safety issues.

2.2.1 TECHNICAL ASSESSMENT – SOIL TECHNOLOGIES

A summary of the evaluation is provided in Table 2-3 below according to each of the key criteria.

TABLE 2-3 SUMMARY OF TECHNICAL ASSESSMENT OF REMEDIAL TECHNOLOGIES FOR SOIL TREATMENT

Candidate Technology	Technical Feasibility – Ability to meet remedial criteria	Practicality	Commercial Requirements /Timescale	Unacceptable Environmental/Health and Safety Issues?
Excavation & Disposal to Landfill	Excavation is common to all options and is a proven technology for localised removal of contamination, and widely available. Observed concentrations are within those acceptable for landfill if capacity is available. Off-site treatment and landfill capacity for PFAS impacted soils is understood available but require clarification. Highest concentrations of PFOS are in near surface soils so considerable mass reduction likely.	It is understood that some excavation is a requirement for the redevelopment, and excavation of other source areas is practical and can be phased to follow demolition and integrated with construction. Predelineation of soils to the extent possible should be used to segregate soils, minimise handling and stockpiling of soils on site and avoid cross contamination. Will require planning to maximize efficiency as on-site storage, and processing of soils may be limited.	*Likely to be in the region of <20 weeks for site work.* *Given off site lorry movements then may require planning permission.* Can be integrated with redevelopment – will require import of clean soils.	PFAS will not be destroyed during landfilling so Eni may want to consider potential long-term issues associated with disposal and select an appropriate waste management facility. Additional and numerous heavy plant / haulage vehicle movements both on- and off-site, but no unusual or technology specific considerations. Will require an active programme of dust / leachate and access management.
Excavation & Disposal to Incineration	Incineration is feasible for PFAS. High temperatures (>1000C) and residence times (>2 seconds) are understood to be required to achieve full defluorination. Incineration is most suitable for small volumes of high concentration wastes. Post treatment residues will be landfilled.	As above. It is understood that UK facilities can only accept soils in bulk bags not loose lorry loads. The addition of a soil bagging step, as well as any screening to remove stones, may also add to operational complexity.	*As above* Incineration is most suited to high concentration low volumes of soils to date concentrations of total PFAS are still in the low mg/kg and may not merit treatment with incineration unless there is no alternative.	As Above The lines of evidence to verify effective treatment and support regulatory acceptance likely include demonstration of suitable incineration conditions and facility permits, materials (waste) tracking and transfer documentation as well as certificates of destruction.

Candidate Technology	Technical Feasibility – Ability to meet remedial criteria	Practicality	Commercial Requirements /Timescale	Unacceptable Environmental/Health and Safety Issues?
				This can also include confirmation of suitable ash management / landfilling arrangements. Supporting evidence regarding stack emissions and PFAS analysis within ash and other by-products may also be valuable but may not always be possible or appropriate where mixed wastes are incinerated.
On site soil Mixing and Stabilisation	Stabilisation involves chemical fixation, and often physical solidification, of soil by mechanically mixing the soil with binders and other additives to reduce leachability and/or bioavailability of PFAS, and obtain the required geotechnical characteristics. The approach is also referred to as immobilisation. PFAS are not destroyed but remain stabilised within soils to manage the potential risk of PFAS leaching to underlying groundwater. Approaches typically employ activated carbon (AC) based reagents, biochar and/or modified organoclays to provide hydrophobic sorption mechanisms. Certain reagents also include charged sorption sites and/or	A key aspect of effective application is achieving thorough mixing of soils with reagents which can be achieved either in-situ, via specialised rotary mixing equipment, or ex-situ using pugmills, excavators or specialised excavator mixing buckets. There is insufficient available footprint at the site to undertake these operations. Application is very site specific with the nature of the geology and depth of impacts often determining the mixing approach and any pre-treatment requirement (e.g., physical screening). There is limited ability to integrate the requirements for onsite stabilisation within the development plans given	Overall, stabilisation is increasingly being seen as a pragmatic and cost-effective option compared with many other soil remediation technologies for PFAS Will require a mobile plant license and experienced contractor to ensure process is correctly undertaken to maximise efficiency. Upfront laboratory trials must be factored into the construction programme and requires additional validation onsite to show its been mixed properly.	Same as for excavation, though excavations may remain open while stabilisation works are proceeding so increased requirement for water/ odour and access management. In addition, depending on what the bench trials show is the best stabilising mix, additional binders may need to be present onsite which have to be managed from a H&S perspective whilst mixing etc.

Candidate Technology	Technical Feasibility – Ability to meet remedial criteria	Practicality	Commercial Requirements /Timescale	Unacceptable Environmental/Health and Safety Issues?
	inorganic minerals to provide electrostatic interactions. On site stabilisation has been demonstrated to reduce leachable concentrations of PFAs significantly in other projects (>99%) Will require some short-term testing to evaluate loading rates.	timings and an overall surplus of materials. Site specific, laboratory bench scale trials are typically recommended to assess PFAS leaching reduction, geotechnical performance, durability as well as determine cost effective reagent dosages and optimum water content. Practical application and mixing will be limited if soils are too wet and this maybe a constraint depending on time of year works are undertaken. Will require construction of treatment area. With a lined base and leachate collection. Likely to be limited space available for this on site. Treated soils can be sampled and validated and returned to the site relatively quickly. However, stabilisation would be very difficult to integrate with the works and is considered not practicable.		

Based on the above, excavation and off-site treatment or disposal are the two most favorable options for soils associated with each of the historical source area. Neither are considered optimal from the point of view of overall sustainability however disposal to landfill is the most economic and is considered to have lower carbon emissions than the incineration alternative. Further details on the final preferred option will be provided when there is sufficient clarity on acceptable volumes and concentrations from the waste disposal companies contacted as part of this assessment. Initial indications do suggest that the soils are likely to be classified as non-hazardous rather than hazardous based purely on the PFAS concentrations, therefore local landfills are likely to accept such soils.

On site stabilisation has been discounted at this stage given the limited ability to integrate this with site works, and the overall surplus of materials.

2.2.2 TECHNICAL ASSESSMENT – WATER TREATMENT TECHNOLOGIES

Table 2-4 summarises the overall technical assessment of water treatment technologies.

TABLE 2-4 SUMMARY OF TECHNICAL ASSESSMENT OF REMEDIAL TECHNOLOGIES FOR WATER TREATMENT

Candidate Technology	Technical Feasibility – Ability to meet remedial criteria	Practicality	Commercial Requirements /Timescale	Unacceptable Environmental/Health and Safety Issues?
GAC/PACT	Granular Activated Carbon and Powdered Activated Carbon (GAC and PACT) are widely used for the removal of PFAS from contaminated groundwater. While effective for the removal of long-chain PFAS, relatively early breakthrough has been observed for short-chain PFAAs. However, this method can be designed to meet low detection limits / discharge criteria. GAC/PACT use rates depend on the characteristics of the GAC/PACT, PFAS properties, and background water matrix constituents. In addition, operation and maintenance costs depend on the unit cost of the sorbent, and disposal or reactivation costs. Pretreatment steps may be necessary to optimize the performance of GAC, including coagulation, precipitation, filtration, pH adjustment, or oxidant removal. GAC/PACT usage for PFAS is particularly sensitive to the total organic matter content of groundwater. Additional sampling and testing will be required to develop detailed design specification.	Mobilising and installing activated carbon vessels on site can be undertaken relatively quickly in the short-term to provide initial surface water and groundwater treatment from existing operations and redevelopment works. The vessels will require suitable space on site and easy access for carbon change out. Based on current understanding of groundwater chemistry there should not be a requirement for overly complicated pre- or post-treatment.	Proven track record and commercially available. Temporary and permanent GAC systems can be rapidly deployed and require minimal operator attention, if intensive pretreatment is not needed.	Main issues are associated with the lifetime of the carbon, the regeneration and or waste disposal of the carbon, and the overall carbon footprint of the works.

Candidate Technology	Technical Feasibility – Ability to meet remedial criteria	Practicality	Commercial Requirements /Timescale	Unacceptable Environmental/Health and Safety Issues?
Ion Exchange (IX) Resins	Although used less extensively than GAC, IX can be an effective alternative to GAC for PFAS remediation. When remediating relatively dilute PFAS plumes, single-use IX resins are often considered. Once the treatment criterion is reached, the spent single-use resin is replaced with fresh resin, and the spent resin is either incinerated or landfilled. IX may be cost-competitive with GAC for PFAA removal, both for shorter-chain PFAAs and longer-chain PFAAs, such as PFOA and PFOS Selective IX has been demonstrated to reduce concentrations for a broad suite of PFAS at the bench and field scale for influent concentrations as high as 100s of parts per billion (ppb) total PFAS to below analytical detection limits in effluent. Resin usage rates will be determined by, PFAS characteristics, background water matrix constituents, IX resin properties, and IX resin bed design and operating conditions. In addition, co-contaminants (including organic and inorganic compounds) may significantly reduce the removal capacity of IX for PFAS, although this depends on the selectivity of the IX resin.	As above.	As above Despite the growing adoption of modeling, pilot testing is still recommended when evaluating breakthroughs for multiple PFAS or when the impact of TOC or other contaminants such as iron and manganese must be known to determine pretreatment requirements.	Main issues are associated with the lifetime of the resin, the regeneration and or waste disposal of the resin and the overall carbon footprint of the works.

Candidate Technology	Technical Feasibility – Ability to meet remedial criteria	Practicality	Commercial Requirements /Timescale	Unacceptable Environmental/Health and Safety Issues?
	As with GAC further study and testing would be required to develop an economic design.			
Membrane filtration	Membrane filtration systems include both nanofiltration (NF) and reverse osmosis (RO) membranes. High-pressure membrane systems are commonly used for various industrial and municipal drinking water applications, including separation of solutes, reclamation of impaired water resources (e.g., wastewater, seawater, brackish water), and as a barrier for inorganic and organic contaminants. NF and RO have shown to be effective in the removal of PFAS and can meet the discharge criteria but have only been applied at full scale in a limited number of cases.	Compared to other PFAS removal processes, high-pressure membrane systems are generally more complicated requiring effective pretreatment, requiring significantly more energy to operate, and are generally more capitally expensive. However, compared to adsorbent systems, high-pressure membranes serve as a continuous barrier to PFAS (at pre-determined rejection or separation levels) without issues of breakthrough. Because high-pressure membranes are a separation process, PFAS and other constituents are concentrated into a retentate or concentrate stream requiring further treatment and/or disposal. High-pressure membrane systems are also prone to operational upsets caused by fouling (adsorption of components to membrane	Will require significant evaluation prior to adoption. Likely to be very capital intensive.	As noted main the production and disposal of a concentrate (20% of initial volume) will be a significant issue and additional cost. Overall high energy use and significant carbon footprint likely relative to other technologies.

Candidate Technology	Technical Feasibility – Ability to meet remedial criteria	Practicality	Commercial Requirements /Timescale	Unacceptable Environmental/Health and Safety Issues?
		polymer) and scaling (precipitation of minerals on the membrane surface). Effective pretreatment is needed for membrane systems generally consisting of pre-filtration (usually down to at least 1 um), pH adjustment (between 6 and 6.5), and addition of antiscalants to reduce scaling. However, additional pretreatment may be necessary, including removal of iron, manganese, calcium, and magnesium as well as reduction of organic matter prior to filtration.		
SAFF	Surface Activation Foam Fractionation (SAFF)is a separation process designed to remove PFAS from groundwater and concentrate the PFAS in a small volume for offsite disposal. Foam fractionation is a physical separation process that traditionally uses air and turbulence to generate bubbles rising through a water column to strip amphiphilic substances such as PFAS from the bulk liquid. Foam fractionation technology has been used for decades in the commercial-scale aquarium business to clean water by separating and removing proteinaceous waste and has	Will require construction and installation of a dedicated treatment compound. Batch process so integration with current surface water management system will require careful integration.	Likely to be considerable lead in team in terms of design, manufacture and mobilisation to site – To be confirmed. May not be appropriate to be consider in context of redevelopment works but should be considered for longer term operation.	No significant operational concerns main issues are the disposal of the PFAs concentrate which will require incineration and the overall carbon footprint of the works.

Candidate Technology	Technical Feasibility – Ability to meet remedial criteria	Practicality	Commercial Requirements /Timescale	Unacceptable Environmental/Health and Safety Issues?
	been advanced to multistage configurations for PFAS separation and concentration. The concentrated foamate are then removed for further treatment or disposal. This process has been implemented for ex situ water treatment. The extent to and rate at which PFAS are removed depends on individual PFAS physical chemical properties, background water quality properties, and operational considerations. SAFF is highly effective at removing PFOS and PFOA and longer chain PFAS and has been shown to remove >99% of PFOS and other PFAS in full scale installations.			

On the basis of discussion with technology providers to date then for water treatment during the construction phase GAC appears to be the most favorable technology, being both readily available, easily and quickly installed at the site, and having the flexibility to be monitored and optimised relative to the other alternatives. The final form and configuration of treatment unit and its anticipated performance will be clarified prior to installation and operation.

3. OUTLINE REMEDIAL STRATEGY

3.1 INTEGRATED REMEDIAL OBJECTIVES

Following consultation with Eni, and to fulfill the needs of discharging the TCPA conditions in relation to land contamination the following broad remediation objectives have been agreed for the site:

- The final state of the site shall be suitable for on-going commercial use / redevelopment and not be capable of being determined as contaminated land under the statutory regime.
- The remediation would focus on addressing historical source zones that include the majority of observed contaminant mass, and thereby future groundwater impact as far as is reasonably practicable and sustainable.
- All works are to be completed to Eni's Global Health and Safety standards.
- The remediation scheme shall take into account the potential and actual constraints present at the site and the proposed development time frame and be fully integrated within the overall redevelopment framework to the extent possible.

This section assumes that long term treatment of the surface water discharge will not be required.

3.2 OVERALL APPROACH

Based on the findings of the remedial options appraisal and discussions with contractors, an outline remedial strategy has been developed for the site reflecting the above objectives that is described in the following sections. This outline plan will be further developed into a detailed working document following discussions with the Natural Resources Wales and Flint County Council.

In terms of remediation options to treat the soils on site are not conducive with the development of the site and incineration is not practicable given the volumes of soils (~13,000m3). Therefore disposal to landfill is the most appropriate remedial solution. It is likely that the soils would be classed as nonhazardous waste and therefore transport costs could be limited since local facilities could be employed.

In conjunction with the soil removal, dewatering is required as temporary works to support the development of the site (best estimate of 5.7m^3/hour over a period of 12 months), to be undertaken in line with **T-LS-022.** Any extracted groundwater assessed to be contaminated with PFAS will be treated using GAC prior to discharge to Talacre Brook given the uncertainties associated with volumes and final concentrations of PFAS the treatment system will be sized to allow for a reasonable worst case and a contingency based on the pump test results and should monitoring indicate insufficient treatment then additional refinements to the system will be made to improve performance.

The surface water drainage system is currently capturing some groundwater and discharging directly into Talacre Brook. Given that the development of the site will result in removal of primary sources of soil and groundwater that contains PFAS, it is believed that the quality of the discharge

will improve and therefore an approach of betterment is proposed. The discharge will therefore be monitored for a declining trend rather than being directly treated.

Once the ground works are complete, the DQRA will be revisited and it is believed that further remediation will not be required. However, post-construction sampling will be undertaken, and if it is found that long-term remediation is required it will be considered in the development of the Long Term Monitoring Plan

3.3 REGULATORY & PERMITTING

The proposed works will be undertaken on a voluntary basis as part of the planned redevelopment of the site and to fulfill the requirements of the TCPA conditions specifically for planning Condition 12(c), an options appraisal and remediation strategy giving full details of the remediation measures required and how they are to be undertaken with respect to land contamination. Table 3-1 presents the relevant TCPA conditions. Over and above this, all works will be completed in full accordance with all necessary regulatory requirements this will include:

- No development within the Demolition or Construction phases in a specific parcel of land known to be / suspected of contamination, shall take place until the following components of a scheme to deal with the risks associated with contamination at the site, has been submitted to and approved in writing by the Local Planning Authority.
- If, during development, contamination not previously identified is found to be present at the site then no further development (unless otherwise agreed in writing with the Local Planning Authority) shall be carried out until a remediation strategy detailing how this unsuspected contamination shall be dealt with has been submitted to and approved in writing by the Local Planning Authority.
- A Construction Phase Plan for Construction (Design & Management) (CDM) compliance & Remediation Method Statement for approval by Regulatory Authorities.
- A Mobile Treatment Licence (MTL) deployment from Eni's appointed contractor to address groundwater treatment during construction that will be prepared and submitted to NRW in advance of the works.
- It is anticipated that all discharges of extracted groundwater and collected surface water will be made to the existing Eni effluent treatment system and will comply with the existing effluent discharge permit as well as being treated to reduce PFAS concentrations.
- A materials management plan (MMP) will also be prepared in advance of the works to support the re-use of soils on site, where appropriate.
- All materials requiring off-site disposal will be disposed of in an appropriately-licensed and Eni-approved facility.
- Prior to the Operational phase a verification report demonstrating completion of works set out in the approved remediation strategy and the effectiveness of the remediation shall be submitted to and approved in writing by the Local Planning Authority.
- Prior to the Operational phase, a long-term monitoring plan of pollutant linkages, maintenance, and arrangements for contingency action, as identified in the verification plan shall be submitted and approved in writing by the Local Planning Authority.

TABLE 3-1 RELEVANT TCPA CONDITIONS

PLANC ref	Heading	Condition
PoAPP.11	Construction Environment Management Plan (CEMP)	No development within the Demolition or Construction phases shall commence until a construction environment management plan (CEMP) addressing that phase of the development has been submitted to and approved in writing by the Local Planning Authority. The CEMP shall refer to the submitted Register of Environmental Actions and Commitments (REAC document reference T.5.3) and the Outline Construction Management Plan (OCMP document reference T.5.1) and include, where relevant to that phase: - any site-specific method statements required; - corrective action and contingency plan procedures; management plans namely: • Demolition Management Plan; • Dust Management Plan; • Flood Action Plan; • Groundwater Management and Monitoring Plan; • Intertidal INNS Management Plan • Lighting Management Plan • Materials Management Plan; • Noise and Vibration Management Plan; • Sediment Management Plan; • Odour Management Plan • Soil Management Plan; • Stakeholder Communications Plan; • Surface Water Management and Monitoring Plan; • Terrestrial INNS Management Plan and • Worker Travel Plan. The CEMP shall include all ecological and landscaping recommendations set out in the submitted Environmental Statement relating to the Construction or Demolition phase being undertaken, providing a detailed programme of work and detailed specifications. It shall include: (a) risk assessment of potentially damaging activities; (b) a programme and methodology for any pre-demolition/pre-construction surveys required for protected species; (c) full details of ecological and landscape mitigation measures during demolition and construction phases, including method statements and conservation plans as required for protected and priority species, and for habitat protection; (d) summary information (including annotated plans and schedules) should be provided to give an overview of requirements as well as detailed timetables and method statements and specifications to be adhered to; (e) details of landscape and ecological compliance monitoring. The approved CEMP shall be adhered to and implemented throughout the construction period strictly in accordance with the approved details, unless otherwise agreed in writing by the Local Planning Authority.
PoAPP.13	**Operation and Maintenance Environment Management Plan (OMEMP)**	Prior to commencement of the Operational phase an Operation and Maintenance Environment Management Plan (OMEMP) shall be submitted to and approved in writing by the Local Planning Authority. The OMEMP shall refer to the submitted Register of Environmental Actions and Commitments (REAC). The approved OMEMP shall be adhered to and implemented throughout the construction period strictly in accordance with the approved details, unless otherwise agreed in writing by the Local Planning Authority.
PoAPP.15	**Land Affected by Contamination**	No development within the Demolition or Construction phases in a specific parcel of land known to be / suspected of

PLANC ref	Heading	Condition
		contamination, shall take place until the following components of a scheme to deal with the risks associated with contamination at the site, has been submitted to and approved in writing by the Local Planning Authority addressing that phase of development: a) a preliminary risk assessment which has identified: all previous uses potential contaminants associated with those uses a conceptual model of the site indicating sources, pathways, and receptors potentially unacceptable risks arising from contamination at the site b) site investigation scheme, based on (a) to provide information for a detailed assessment of the risk to all receptors that may be affected, including those off site. c) The results of the site investigation and the detailed risk assessment referred to in (b) and, based on these, an options appraisal and remediation strategy giving full details of the remediation measures required and how they are to be undertaken. d) A verification plan providing details of the data that will be collected in order to demonstrate that the works set out in the remediation strategy in (c) are complete and identifying any requirements for longer-term monitoring of pollutant linkages, maintenance, and arrangements for contingency action. The remediation strategy and its relevant components shall be carried out in accordance with the approved details.
PoAPP.16	**Contamination Verification Report**	Prior to the Operational phase a verification report demonstrating completion of works set out in the approved remediation strategy and the effectiveness of the remediation shall be submitted to and approved in writing by the Local Planning Authority. The report shall include results of sampling and monitoring carried out in accordance with the approved verification plan to demonstrate that the site remediation criteria have been met.
PoAPP.17	**Long-term Monitoring Plan (Contamination)**	Prior to the Operational phase a long-term monitoring plan of pollutant linkages, maintenance, and arrangements for contingency action, as identified in the verification plan shall be submitted and approved in writing by the Local Planning Authority. The long-term monitoring plan should include: (a) Details of the methods and triggers for action to be undertaken. (b) Timescales for the long-term monitoring and curtailment mechanisms e.g., a scheme of monitoring for 3 years unless the monitoring reports indicate that subsequent monitoring is or is not required. (c) Timescales for submission of monitoring reports to the LPA e.g., annually; (d) Details of any necessary contingency and remedial actions and timescales for actions. (e) Details confirming that the contingency and remedial actions have been carried out The monitoring plan shall be carried out in accordance with the approved details, within the agreed timescales.
PoAPP.18	**Unsuspected Contamination**	If, during development, contamination not previously identified is found to be present at the site then no further development (unless otherwise agreed in writing with the Local Planning Authority) shall be carried out until a remediation strategy detailing how this unsuspected contamination shall be dealt with has been submitted to and approved in writing by the Local Planning Authority. The remediation strategy shall be carried out as approved.
PoAPP.19	**Surface Water Drainage**	No infiltration of surface water drainage into the ground at the Site is permitted other than with the express written consent of the Local Planning Authority, which may be given for those parts of the site where

PLANC ref	Heading	Condition
		it has been demonstrated that there is no resultant unacceptable risk to controlled waters. The development shall be carried out in accordance with the approved details.
PoAPP.21	**Piling and foundations**	No development within the Construction phase shall commence until details of piling or any other foundation designs using penetrative methods sufficient to demonstrate that there is no unacceptable risk to groundwater have been submitted to and approved in writing by the Local Planning Authority. The piling/foundation designs shall be implemented in accordance with the approved details.
PoAPP.28	**Decommissioning Environmental Management Plan (DEMP)**	A detailed scheme for the decommissioning of the site shall be submitted to the Local Planning Authority for written approval no later than six months prior to the planned Decommissioning and Restoration phase. The Decommissioning Environmental Management Plan (DEMP) submitted) must include: (a) details of any below ground apparatus to be left in situ (b) method statements for the decommissioning and dismantlement of above ground infrastructure; (c) full details of measures to prevent harm to protected and priority species and habitats to include details of habitat protection and soil management; (d) traffic management plan for the decommissioning works; and (e) waste management plan for the decommissioning works. Decommissioning of the authorised development must be implemented in accordance with the approved DEMP.

3.4 SCOPE OF WORKS & PHASING

An outline scope of works is summarised in the following table.

TABLE 3-2 – SUMMARY OF PROPOSED SCOPE OF WORKS

Task	Description	Key elements
Task 1	Pre-commencement works	Discussions with regulatory authorities and agreement of scope of works. Obtain all necessary regulatory licenses & permissions. Finalise detailed design and develop detailed remediation implementation plan. Complete work to acquired additional data.
Task 2	Mobilisation and set up	Mobilise / set up site welfare & equipment for remediation works including water treatment plant. Establish environmental monitoring and controls for health & safety and compliance with MTL.
Task 3	Phased excavation of source areas	**All earthworks will be undertaken in line with TCPA REAC item T-LS-005.** In parallel with on-going demolition works (and phased to follow on from these works): • Scraping back of uncontaminated topsoil and retention onsite in line with a Soils Management Plan or Construction Code of Practice for the Sustainable Use of Soils on Construction Sites • In line **with T-LS-021**, it is proposed to select a site level that achieves a balance of cut and fill and so avoids import or export of materials to and from the site. Materials excavated for the trenching work will be stockpiled adjacent to the

Task	Description	Key elements
		works and reused during backfilling of the trenches. Any topsoil or organic surface material will be stockpiled separately for re-use on completion of the works and revegetated as necessary. These methods reduce loss of site won material. • Controlled breakout of uncontaminated concrete where required and temporary storage for crushing and re-use. • Controlled excavation and loading of soils onto waiting trucks for offsite disposal to a designated landfill. • All trucks to be appropriately sheeted and run through a wheel wash before entering a public highway. • If soils are to be temporarily stored on site, the soils must be placed on an impermeable membrane and covered to reduce the potential for contaminated runoff. • In line **with T-WR-007** where necessary, temporary stockpiles will be covered when not in use. • Transport and off-site disposal of soils deemed to be unsuitable for use onsite. • All loads to have appropriate certification such as a waste consignment notes that are collated, stored and periodically audited. • Undertake validation sampling of the soils being removed from site, the base and sides of the excavations and periodic testing of the groundwater. • Import of soils or aggregates to replace soils removed from site. Testing to be in line with the MMP. • Treatment of waters arising from demolition and construction activities using a system of active carbon filters to remove sediments and contamination above proposed thresholds. • Periodic testing of the groundwater, prior to discharge, at a testing rate agreed with NRW, in line with T-LS-016.
Task 4	Final verification, demobilisation and reporting	On completion of all works a final verification report will be produced together with all the contractor's completion reports and health and safety file for CDM.

3.5 TIMESCALE

The detailed time scale for the project is still under finalization. At present it is envisaged that removal of the impacted soils associated with the identified hotspots would occur in the period 30-Jul-2025 to 26-Sept-2025. Well dewatering associated with the construction phase is likely from Jan-26 up to mid 2027. These timings will be finalized and a detailed timeline provided at that time.

3.6 ENVIRONMENTAL MONITORING

As indicated above and prior to commencement of works then Eni and its appointed contractor will develop a detailed environmental monitoring programme as part of the MTL application and in agreement with the requirements of LCRM guidance. The scope of environmental monitoring works is anticipated to include (but may not be limited to) the following:

- Groundwater and surface water.
- Air emissions (including odour and dusts).
- Noise and vibration.

The environmental monitoring plan will provide an overall description and programme for the works to address all requirements of the MTL.

3.7 VERIFICATION AND VALIDATION

A verification and validation plan will be developed as part of the detailed remedial implementation plan. This will set out the nature and frequency of proposed verification and validation works and include a future contingency plan. This will be based on a 'lines of evidence' approach using a combination of field screening methods and collection of samples for laboratory analysis for validation against the proposed remedial criteria and which include:

- The nature and frequency of sampling to determine the extent of any excavations on site.
- The nature and frequency of sampling as part of operational monitoring (for both soils and groundwater).
- The nature and frequency of sampling for any treated or imported materials.
- Final validation sampling.

A summary of proposed measures is provided below.

3.7.1 SOIL

Soil samples will be collected from the hot spot areas prior to the excavation works to define the lateral quality of soils in excavations. This will confirm that contaminant concentrations are above or below the defined target concentrations, and can be excavated where this can be practically and safely achieved.

Samples will be collected at 10m lateral intervals within identified source zones. A more intense sampling regime may be undertaken within an excavation area if it is considered that ground conditions observed warrant such actions.

Sampling of materials in the base of the excavation will be undertaken to document conditions post excavation.

Samples taken will be tested for chemical components dependent upon the contamination previously determined to be present, and this will include:

- PFAS.
- TOP assay.

Should unexpected conditions be encountered, additional analysis may be undertaken and any additional actions required will be addressed (if needed) through negotiation with the Regulatory Authorities.

Following the results of verification testing, excavations will be backfilled with the soil that was taken from that excavation or other site-won materials. Currently importation of material is deemed unnecessary.

A full audit record of where imported backfill material has been obtained, the results of validation, and where it is placed as backfill will also be provided as part of this activity in line with the MMP that will be verified by a qualified person (QP).

Where possible, any sources of imported fill material (should it be necessary to import material) will be placed directly into the excavations to minimise the need for stockpiling. Prior to importing to the Site, testing of this material will be undertaken in line with relevant UK guidance. Where no off-Site testing can be undertaken, ERM will request that materials are stockpiled on-site until they are confirmed as suitable fill material.

Where no guidance exists, all backfill materials (imported and site-won) are to be sampled and sent for laboratory chemical testing, a UKAS/MCERTS accredited laboratory, at the following frequency:

- All soils considered un-contaminated (typically brick or hardcore materials), and treated soils post-treatment, will be sampled at a frequency of one test per 100m^3.
- Stockpiles of potentially contaminated material will be tested for classification purposes at a rate of at least one sample per 250m^3.
- Materials to be removed off-site will be sampled and characterised for proper disposal at a minimum frequency of one sample per 250m^3;.

Imported material, unless already certified, will be tested for an appropriate suite of analysis dependent on historical use but as a minimum for the following parameters:

- PFAS;
- VOC;
- OPPs & Organochloride pesticides (OCPs);
- Polycyclic aromatic hydrocarbons (PAHs) (including Benzo(a)pyrene, Anthracene, Fluoranthene, sum of Indeno(1,2,3-cd)Pyrene and Benzo(g,h,i)Perylene, and Naphthalene);
- Speciated Total Petroleum Hydrocarbons (TPH) Criteria Working Group;
- Metals (including Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Zinc and Vanadium);
- Asbestos; and
- Cyanide.

3.7.2 SURFACE WATER AND GROUNDWATER

Prior to the commencement of the remediation works, it is proposed that a round of baseline monitoring will be undertaken using selected surface water locations and groundwater monitoring wells across the Site. Additional data (up to 3 additional rounds) will also be collected from the current surface water holding pond and discharge point. Data from the monitoring of the surface water will act as the pre-works baseline to which subsequent monitoring can be compared and assessed.

During the active remediation works it is proposed that surface water level monitoring will be undertaken on a weekly frequency, utilising up to 4 locations. Water levels in up to 10

groundwater monitoring locations around the periphery of the site will also be measured monthly. Similarly, following completion of the remediation, monitoring will continue monthly until three months after completion of the aforementioned active works.

In each monitoring round (baseline, during remediation, and post works monitoring), groundwater samples will be analysed by Element analytical laboratory for:

- PFAS;
- TOP;
- pH;
- Total Organic Carbon (TOC); and
- Chloride.

Blind duplicate (full suite) samples will also be submitted for laboratory analysis for quality assurance / quality control (QA/QC) purposes. Field monitoring will also be undertaken to monitor for pH, dissolved oxygen, redox potential, temperature and conductivity.

3.8 REPORTING

A final verification report will be produced that will detail:

- Confirmation that remediation objectives have been met;
- Details of who completed the work;
- Details and justification for any changes from the original remediation strategy;
- All laboratory data;
- Summary data plots and tables relating to clean-up criteria;
- Plans showing excavation location, sampling points, treatment areas and details of any differences from the original remediation strategy;
- Description of the nature and quantity of material encountered, treated and re-used;
- The results of all monitoring and verification testing undertaken during the works;
- If required, waste transfer documentation to demonstrate all unsuitable materials have been removed from the Site to a suitable waste management facility;
- Copies of all regulatory agency correspondence, notifications and permits;
- A photographic log;
- Manifests, transfer notes and disposal records; and
- Summary of any problems encountered during the works.

4. SUMMARY AND RECOMMENDATIONS

As part of the redevelopment process for the PoA facility and following an additional phase of site investigation and DQRA, Eni commissioned ERM to undertake a ROA and preliminary remedial strategy development of the identified groundwater impact from a range of PFAS that were linked to the storage and testing of AFFF over the lifetime of the gas processing operations.

In terms of remediation, while the intention is to reuse soils to the extent possible in historical source, it is clear areas some off-site disposal of soils will be required, and these areas of excavation align with some areas that are subject to redevelopment. Options to treat the soils on site are not conducive with the development of the site, and incineration is not practicable given the volumes of soils. Therefore, disposal to landfill is the most appropriate remedial solution. Based on discussions to date, soils would be classed as nonhazardous waste, and therefore transport costs could be limited, since local facilities could be employed.

In conjunction with the soil removal, groundwater abstraction is required, as temporary works to support the development of the site. Any groundwater or surface water assessed as contaminated with PFAS during the construction works will require onsite treatment (using the existing but upgraded treatment system) prior to discharge to Talacre Brook. The system will be sized to allow contingency in volumes/concentrations of PFAS, and will be refined as needed, based on monitoring results to meet the objective of treatment.

The surface water drainage system is currently capturing groundwater and discharging directly into Talacre Brook. No treatment of this discharge is currently envisaged beyond betterment as a result of removal of soil sources.

Once the ground works are complete, the DQRA will be revisited, and it is believed that further groundwater remediation will not be required. As part of the future validation and verification monitoring plan contingency measures will be included for groundwater and surface water.

ERM recommends that during redevelopment activities across the Site, appropriate mitigation measures including suitable PPE and risk assessment are employed to minimise the potential short-term risks of workers coming into contact with soils and shallow groundwater, in the event that excavations works are undertaken on-site.

In terms of the proposed construction phase, ERM recommends that all working plans and detailed designs are reviewed to incorporate the findings of this DQRA, and that methodologies and procedures are adapted to consider the presence of PFAS. All soil and water arisings should be appropriately tested, and either treated or disposed.

ERM further recommends a watching brief is implemented during ground works. This will identify unforeseen ground conditions or localised contamination hotspots that were not encountered by this investigation. This is a standard approach for earthworks projects on brownfield sites. The risk to site workers from inhalation and ingestion of windblown dust from the colliery site is within acceptable probability limits for all scenarios. During long dry periods in summer months, it would be prudent to adopt a Dust Management Plan to mitigate any increase in risk, which is standard practice for all construction sites.

APPENDIX A FIGURES

0 0.5 1 1.5 2 2.5
Kilometres

N

Figure 1
Site Location Plan

SIZE: A4	VERSION: A01
SCALE: 1:100,000	DRAWN: MTC
PROJECT: 0743746	CHECKED: SD
DATE: 29/10/2024	APPROVED:

SOURCE: GB Topographic: Contains OS data © Crown Copyright and database right 2023
Contains data from OS Zoomstack

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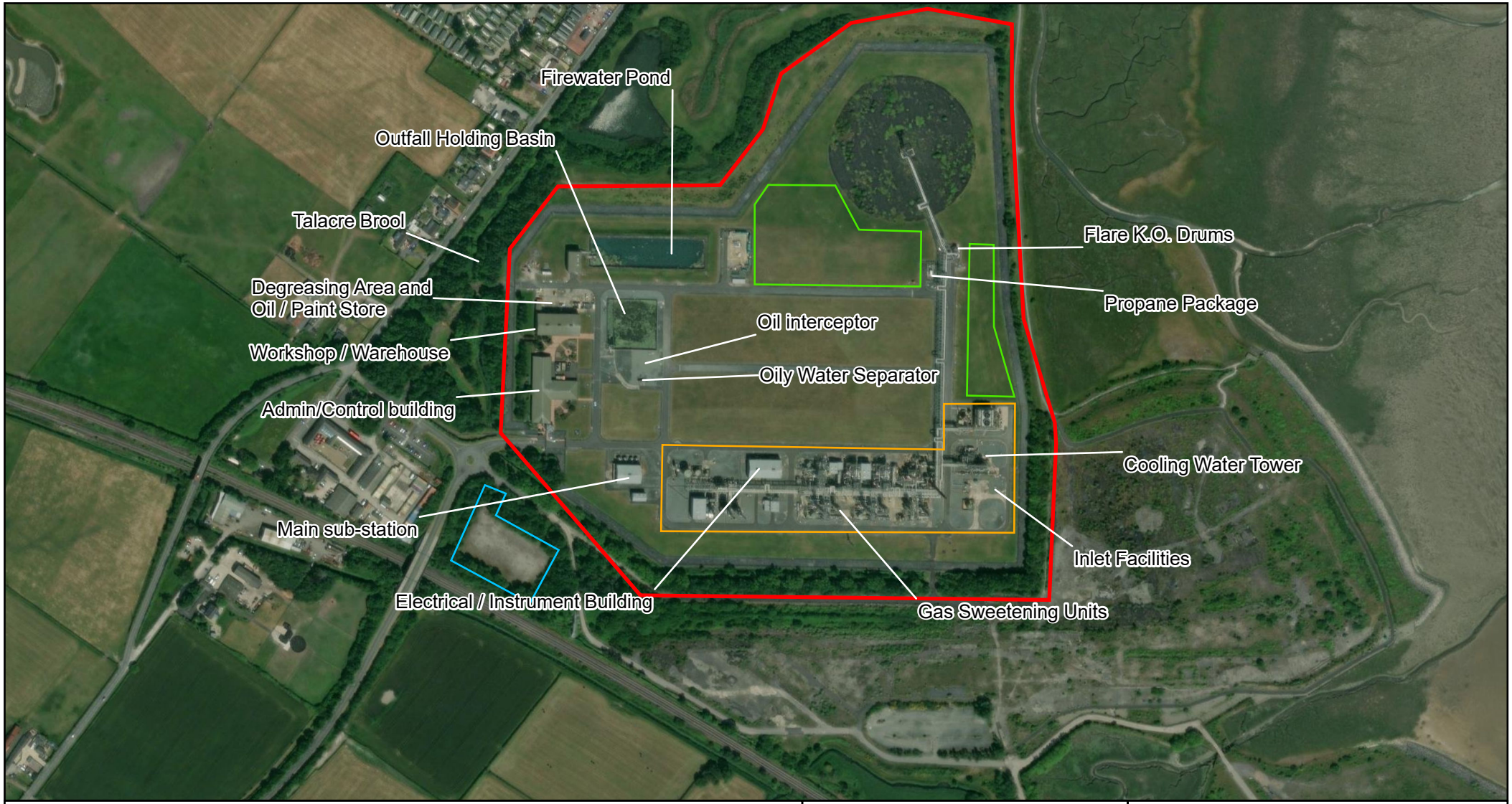
Path: \\uksprdgisfs01\Data\London\Projects\0743746 - Point of Ayr\Maps\0743746 - Point of Ayr.aprx\0743746_SiteLocation - A01



Approximate Site Boundary

Current Plant Area to be Demolished

Approximate Proposed Contractor's Compound

Approximate Proposed Contractor's Compound - Alternate Location

Proposed Contractor's Car Park

0 20 40 60 80 100

Metres

N

Figure 2
Site Layout

SCALE: See Scale Bar	VERSION: A01
SIZE: A4	DRAWN: MTC
PROJECT: 0743746	CHECKED: SD
DATE: 29/10/2024	APPROVED:

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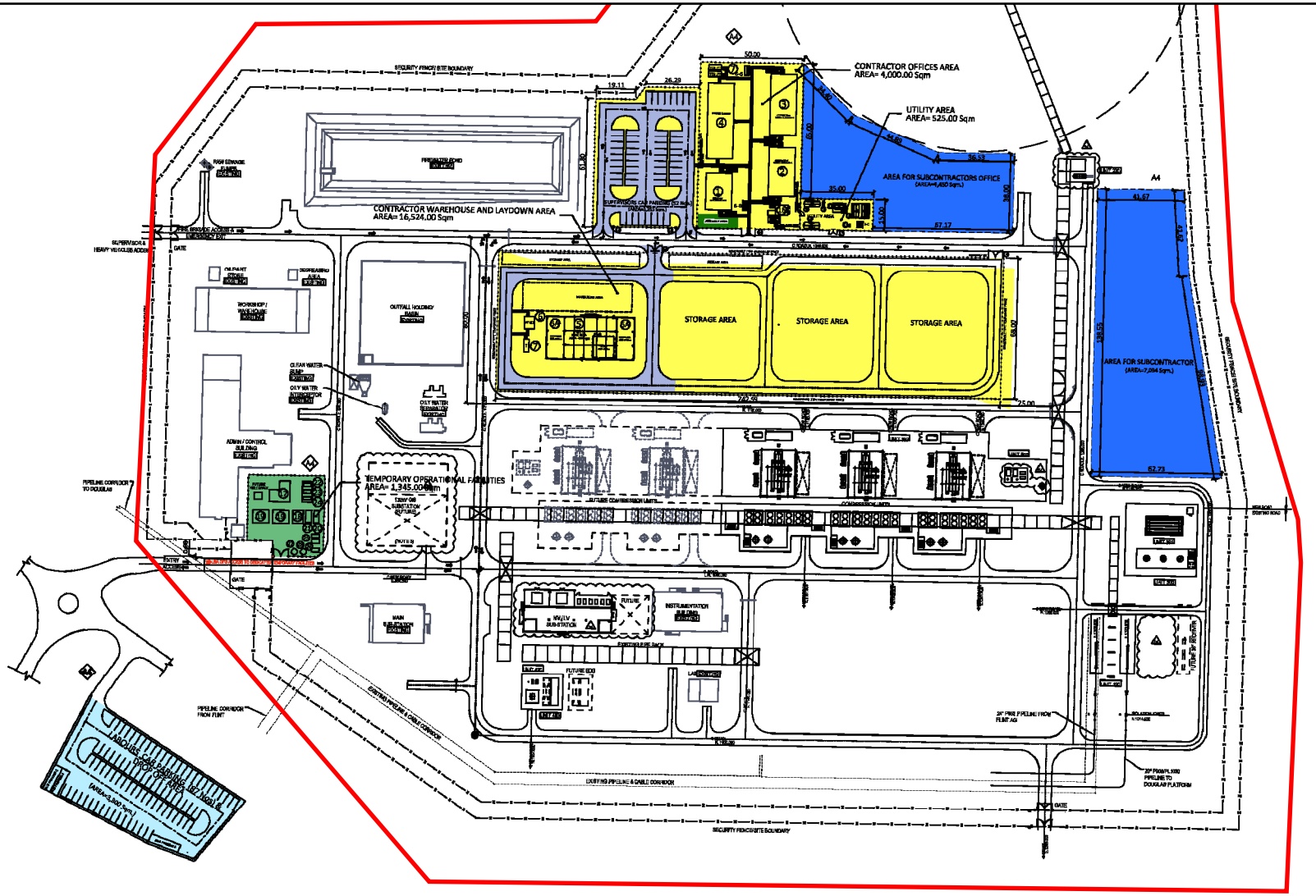
PROJECTION: British National Grid

Maxar, Microsoft

Path: \\uksprdgisfs01\Data\London\Projects\0743746 - Point of Ayr\Maps\0743746 - Point of Ayr.aprx\0743746_Site Layout - A01



Approximate Site Boundary

0 20 40 60 80 100

Metres

N

Figure 3
Future Site Layout

SCALE: See Scale Bar	VERSION: A01
SIZE: A4	DRAWN: MTC
PROJECT: 0743746	CHECKED: SD
DATE: 29/10/2024	APPROVED:

ERM

eni

PROJECTION: British National Grid

Path: \\uksprdgisfs01\Data\London\Projects\0743746 - Point of Ayr\Maps\0743746 - Point of Ayr.aprx\0743746_Future Site Layout - A01

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ERM's London Office
33 St Mary Axe
Exchequer Court
London EC3A 8AA
United Kingdom

T: +44 (0)20 3206 5200

www.erm.com