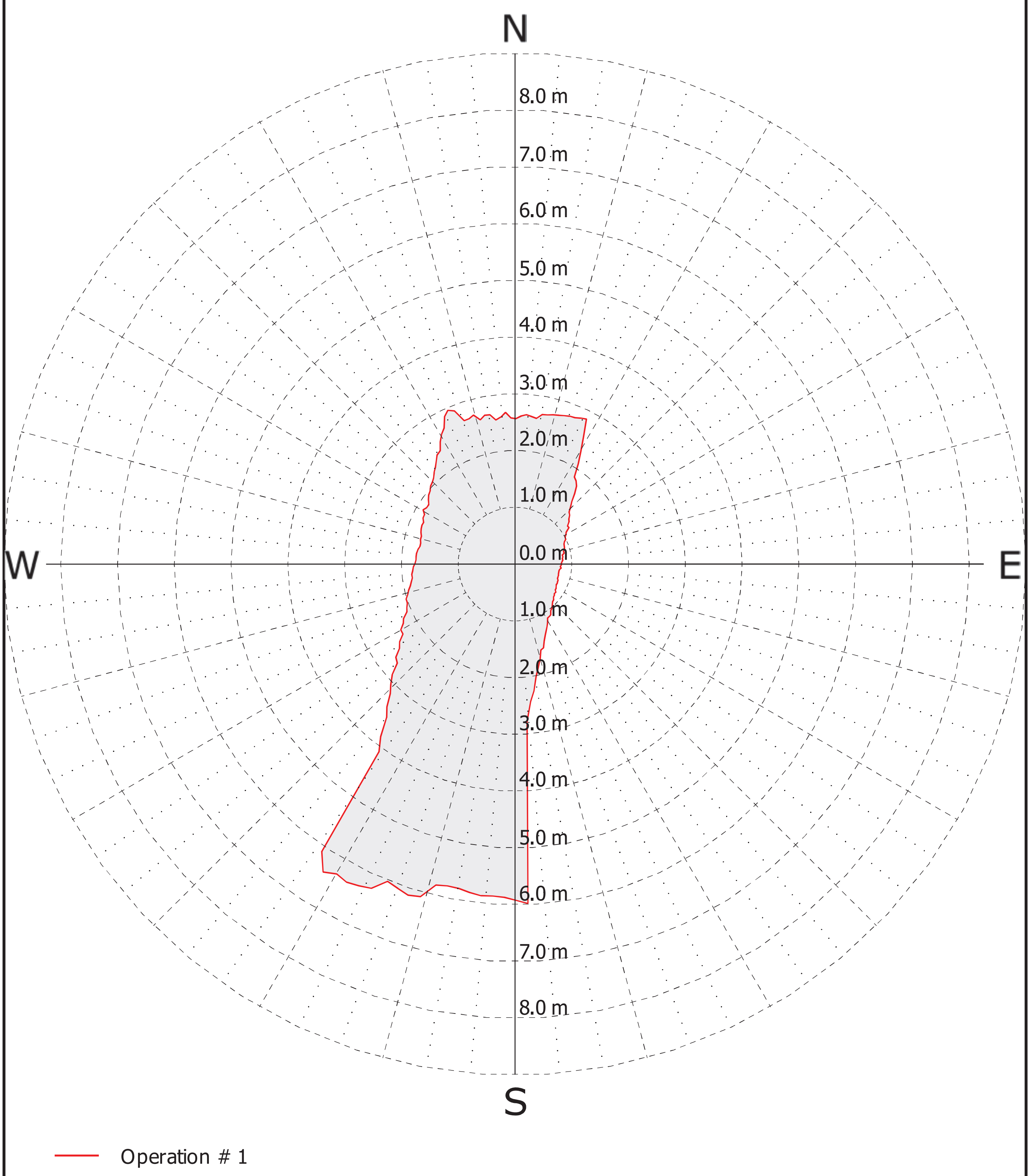
	CUSTOMER :STRUCTURAL SOILS DATE :10/01/2018	CAVITY :WELL1 OPERATION # :1	

Horizontal section
2.4 m

SCALE 1/100

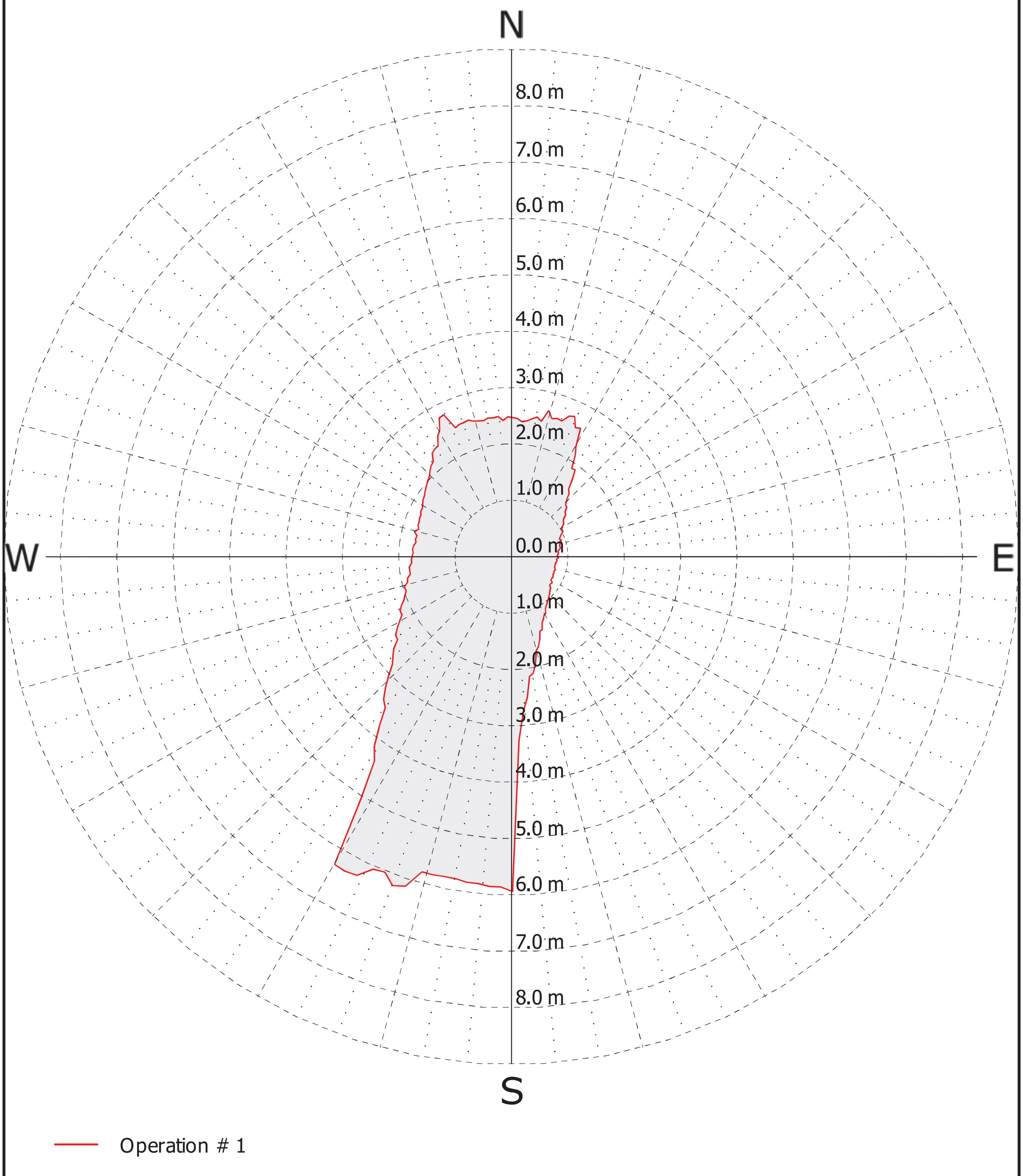


Maximum radius	: 6.39 m
Orientation maxi. radius	: 212 °
Surface	: 22.75 m²
Maximum distance	: 9.20 m

	CUSTOMER :STRUCTURAL SOILS DATE :10/01/2018	CAVITY :WELL1 OPERATION # :1	

Horizontal section
2.5 m

SCALE 1/100

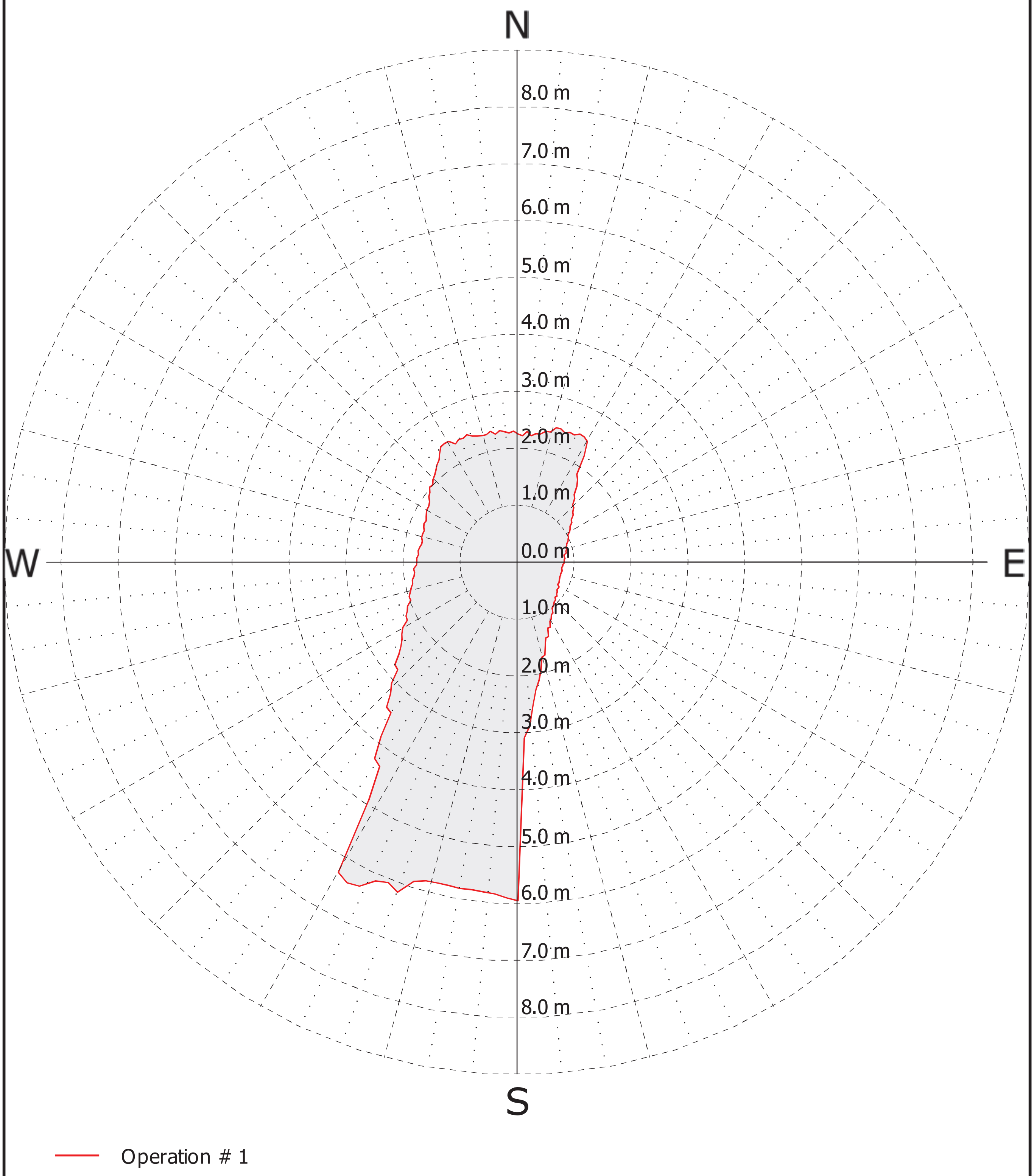


Maximum radius	:	6.31 m
Orientation maxi. radius	:	208 °
Surface	:	21.26 m²
Maximum distance	:	9.00 m

CUSTOMER :STRUCTURAL SOILS DATE :10/01/2018	CAVITY :WELL1 OPERATION # :1	

Horizontal section
2.6 m

SCALE 1/100

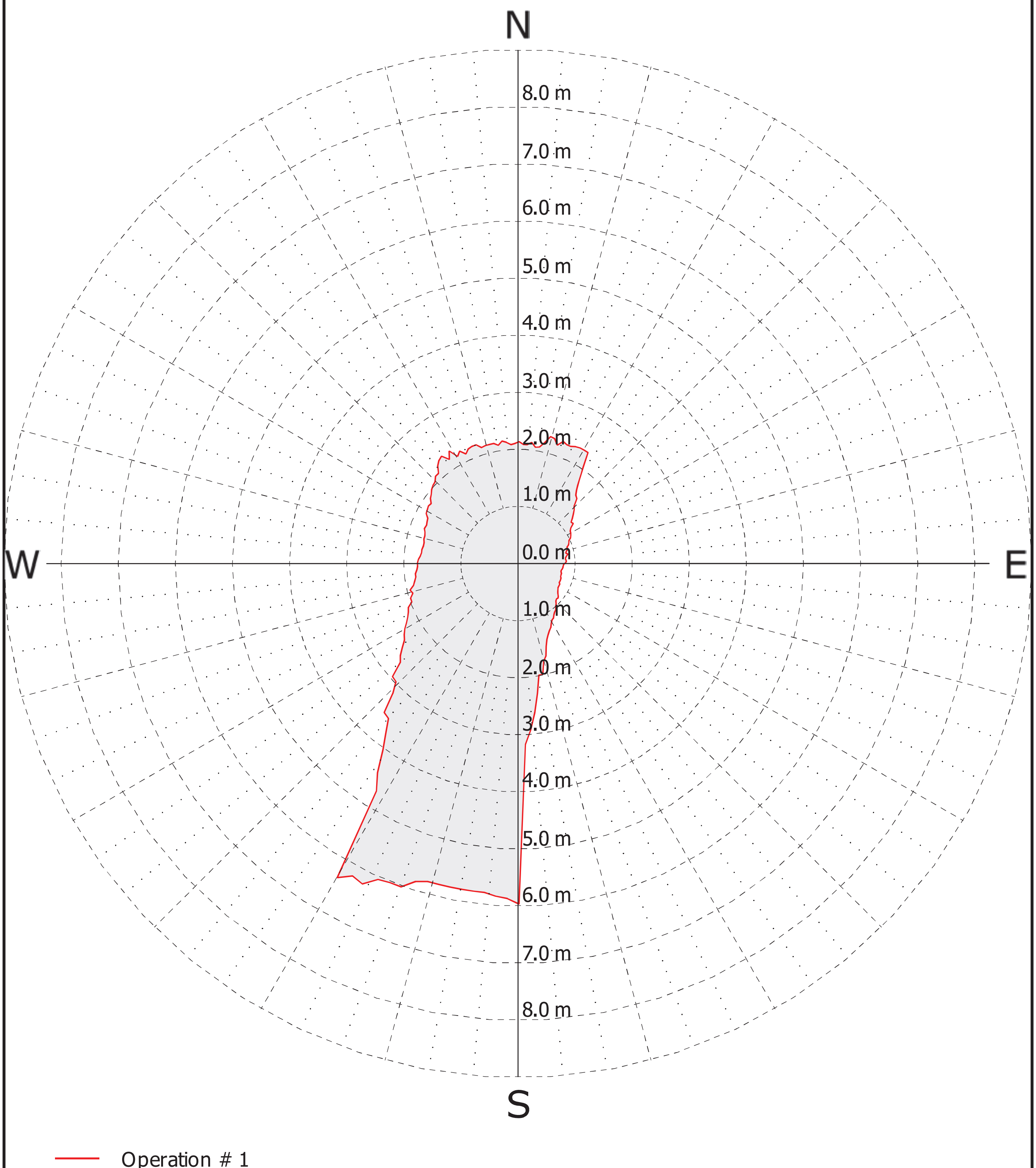


Maximum radius	: 6.37 m
Orientation maxi. radius	: 208 °
Surface	: 20.79 m²
Maximum distance	: 8.85 m

	CUSTOMER :STRUCTURAL SOILS DATE :10/01/2018	CAVITY :WELL1 OPERATION # :1	

Horizontal section
2.7 m

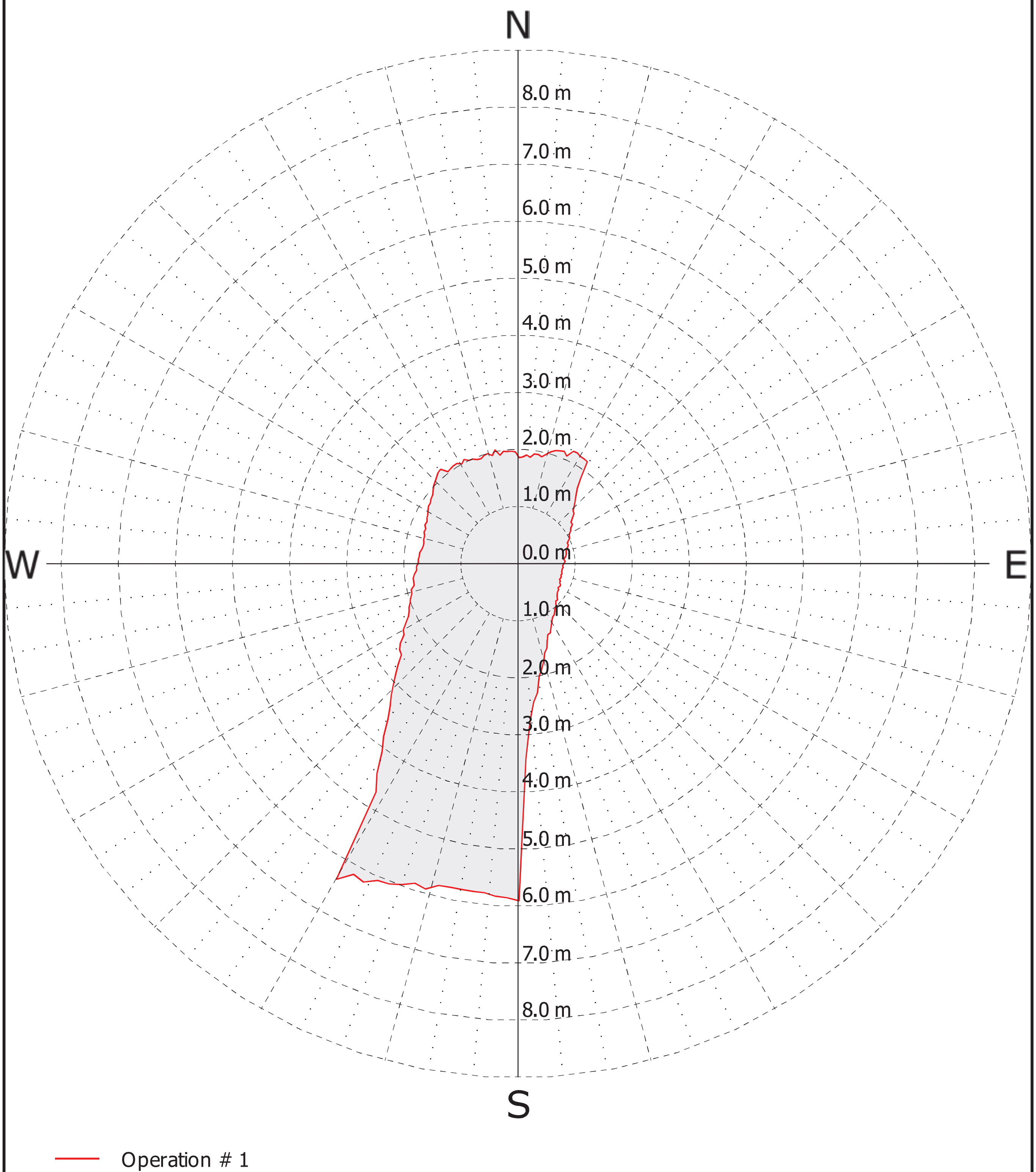
SCALE 1/100



Maximum radius	:	6.35 m
Orientation maxi. radius	:	210 °
Surface	:	20.12 m²
Maximum distance	:	8.62 m

	CUSTOMER :STRUCTURAL SOILS DATE :10/01/2018	CAVITY :WELL1 OPERATION # :1	
	Horizontal section **2.8 m**		

SCALE 1/100

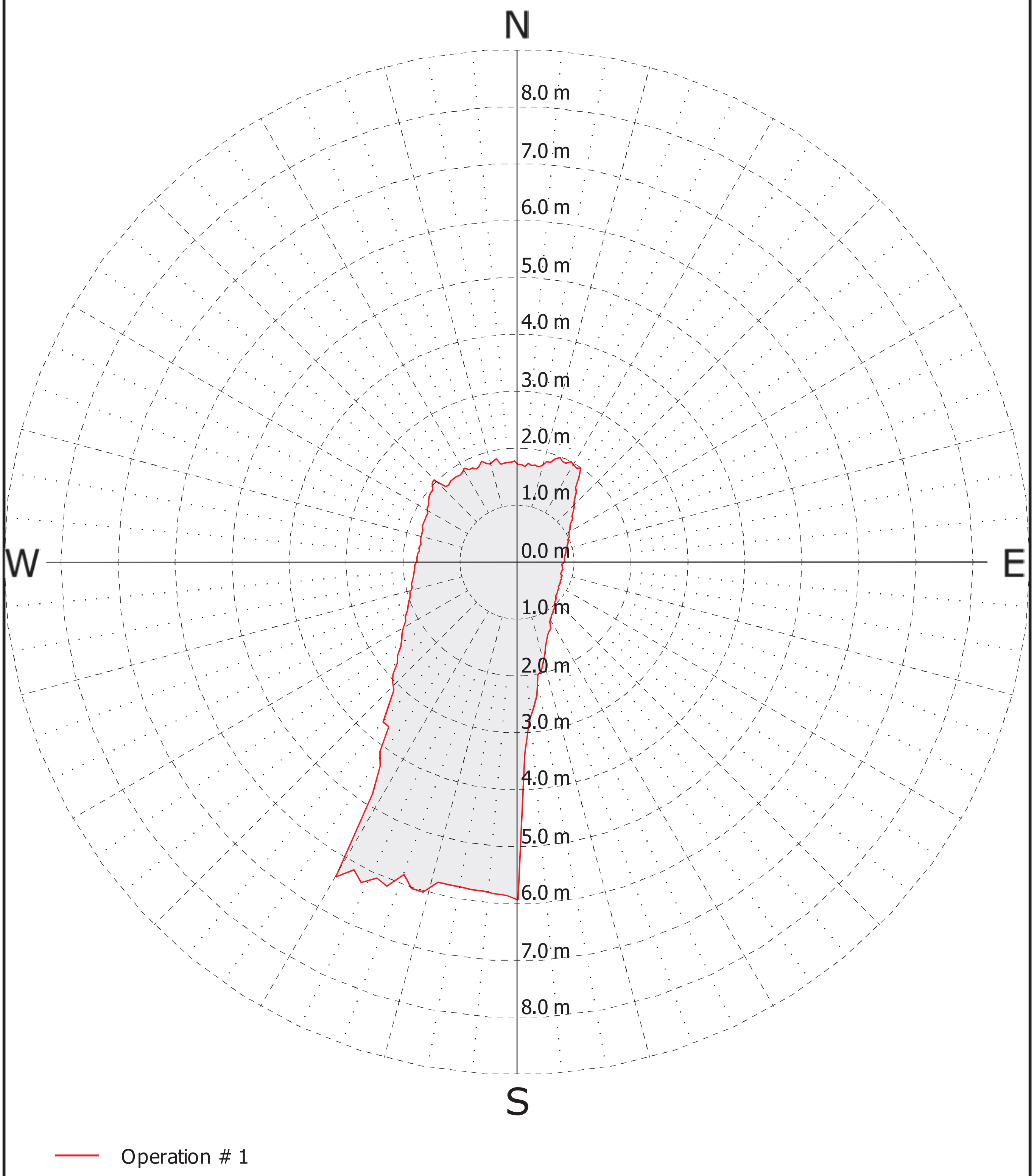


Maximum radius	:	6.38 m
Orientation maxi. radius	:	210 °
Surface	:	19.68 m²
Maximum distance	:	8.55 m

CUSTOMER :STRUCTURAL SOILS DATE :10/01/2018	CAVITY :WELL1 OPERATION # :1	

Horizontal section
2.9 m

SCALE 1/100

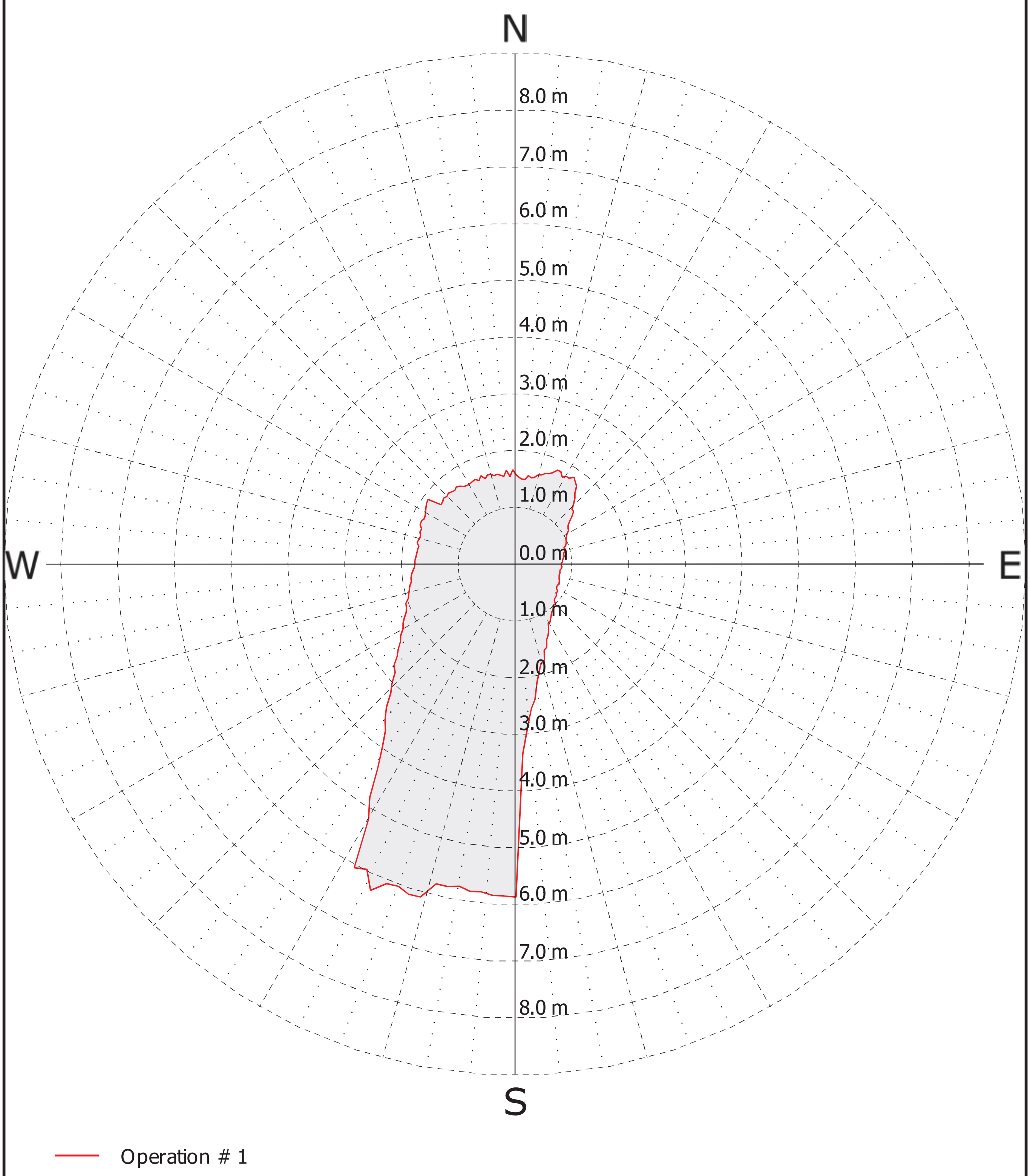


Maximum radius	:	6.38 m
Orientation maxi. radius	:	210 °
Surface	:	19.29 m²
Maximum distance	:	8.35 m

CUSTOMER :STRUCTURAL SOILS DATE :10/01/2018	CAVITY :WELL1 OPERATION # :1	

Horizontal section
3.0 m

SCALE 1/100

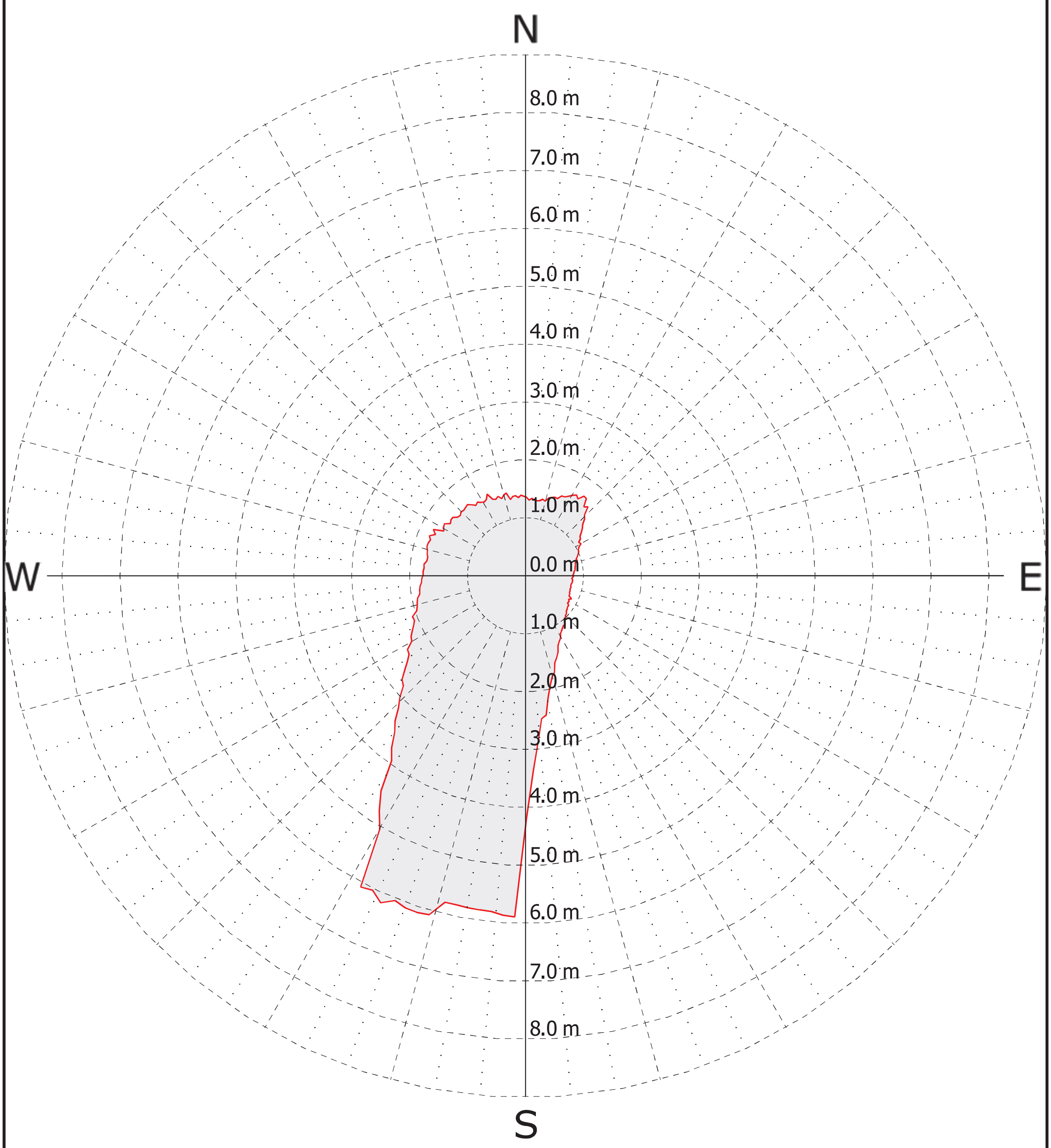


Maximum radius	: 6.29 m
Orientation maxi. radius	: 204 °
Surface	: 18.66 m²
Maximum distance	: 8.08 m

	CUSTOMER :STRUCTURAL SOILS DATE :10/01/2018	CAVITY :WELL1 OPERATION # :1	geoterra FLODIM Challenging the limits

Horizontal section
3.1 m

SCALE 1/100

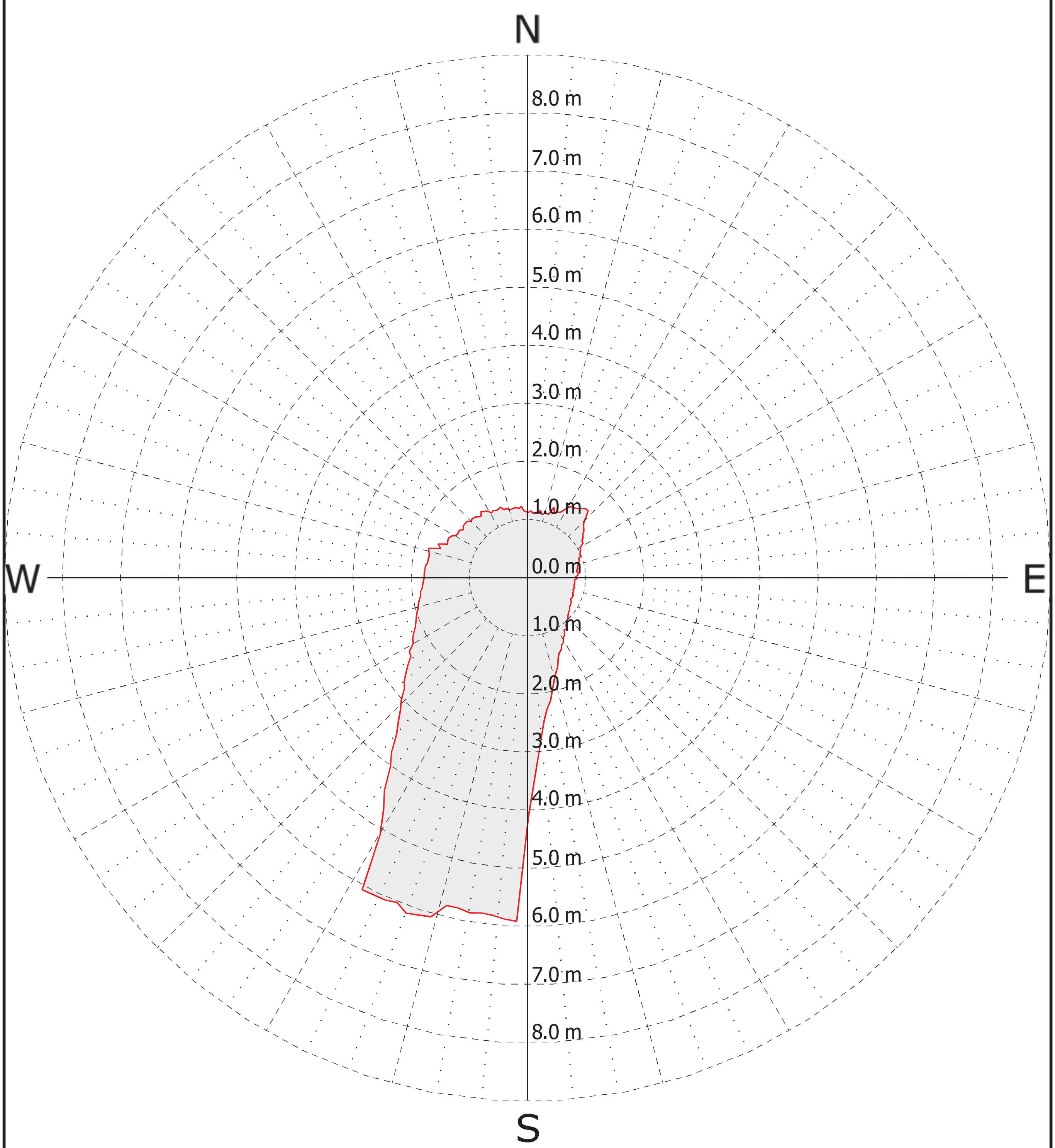


Operation # 1

Maximum radius	:	6.17 m
Orientation maxi. radius	:	204 °
Surface	:	17.83 m²
Maximum distance	:	7.82 m

CUSTOMER :STRUCTURAL SOILS DATE :10/01/2018	CAVITY :WELL1 OPERATION # :1	
	Horizontal section **3.2 m**	

SCALE 1/100

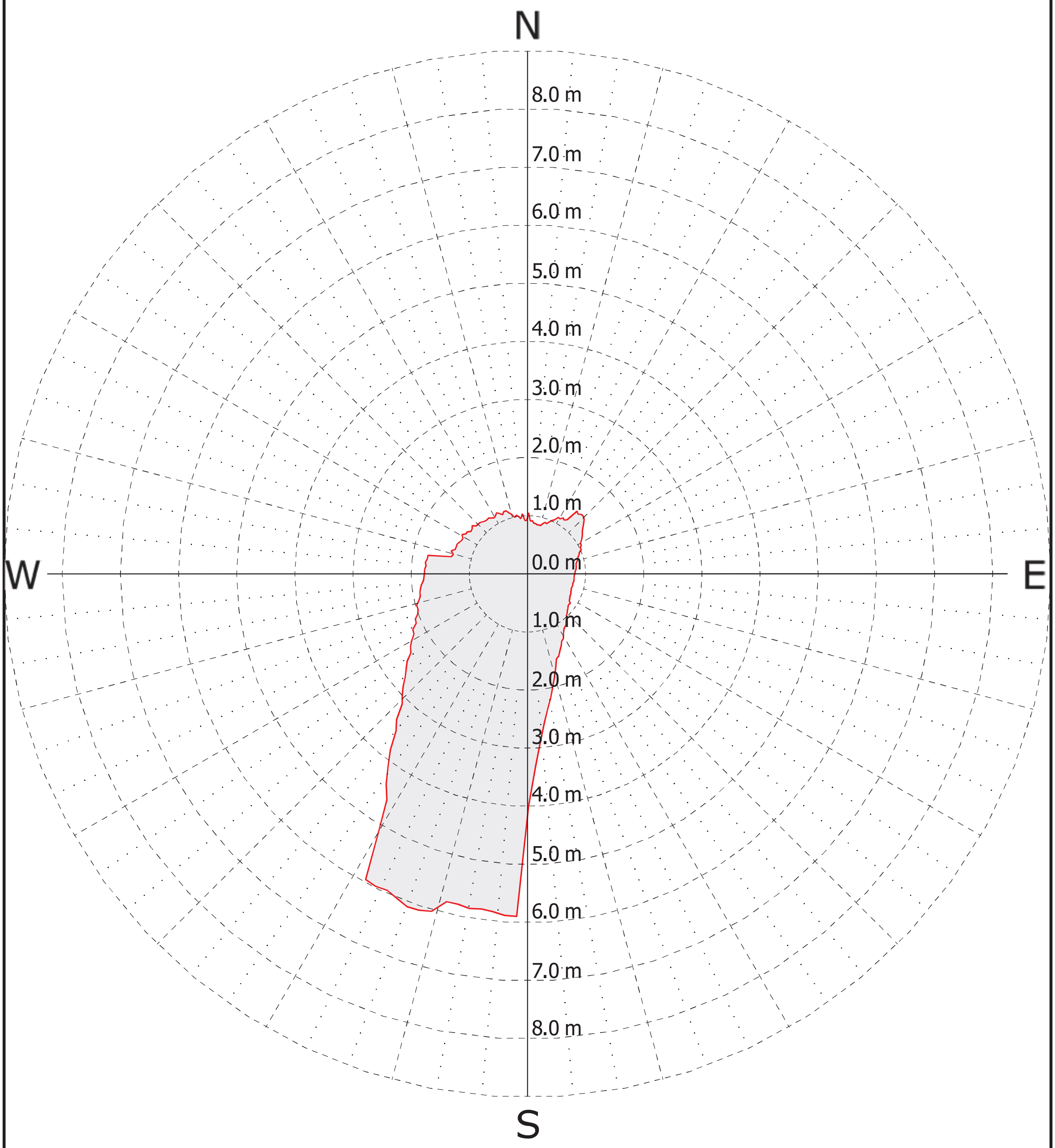


Operation # 1

Maximum radius	:	6.14 m
Orientation maxi. radius	:	200 °
Surface	:	17.27 m²
Maximum distance	:	7.59 m

STRUCTURAL SOILS LTD	CUSTOMER :STRUCTURAL SOILS DATE :10/01/2018	CAVITY :WELL1 OPERATION # :1	geoterra FLODIM Challenging the limits
	Horizontal section **3.3 m**		

SCALE 1/100

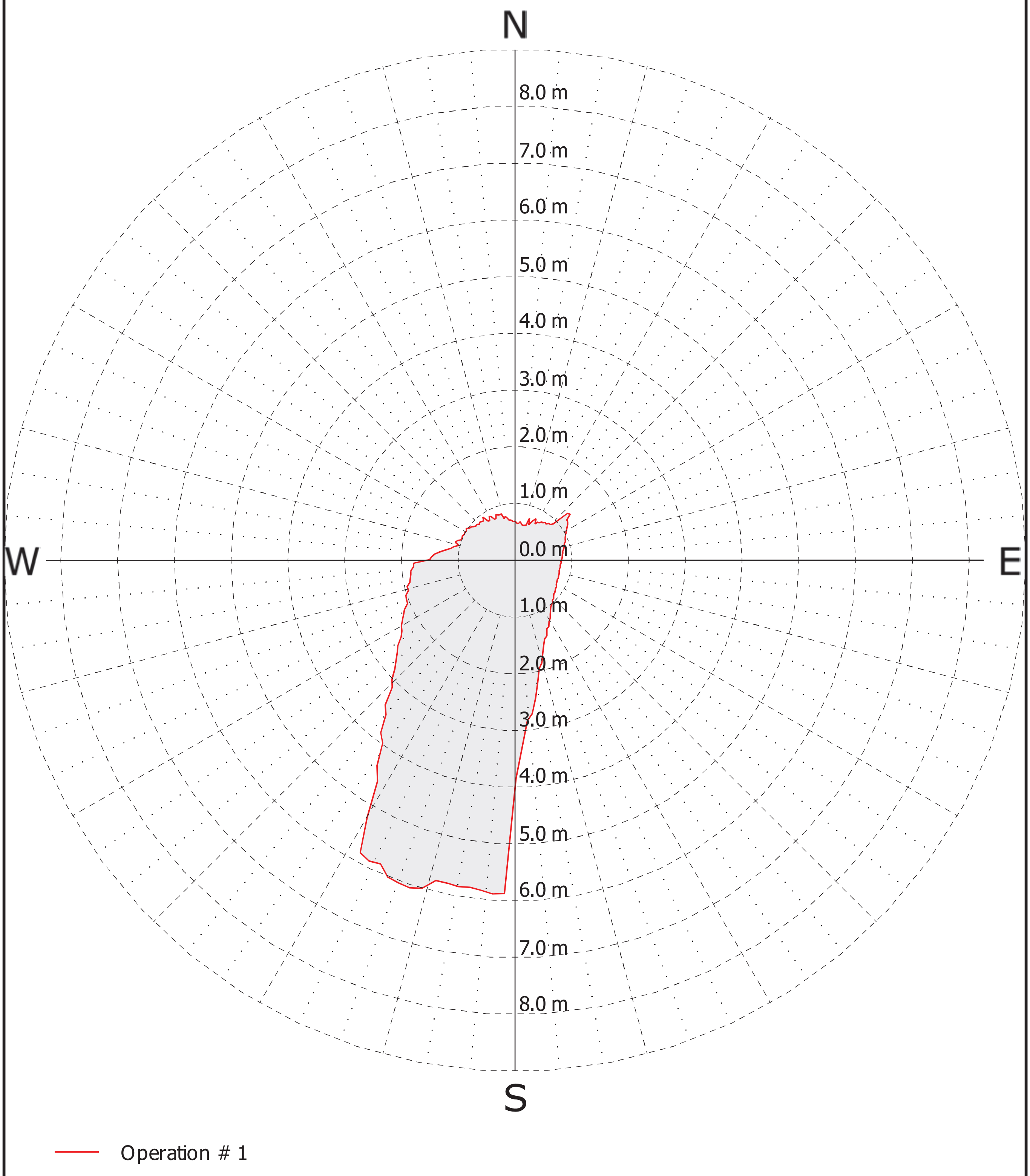


Maximum radius	:	6.09 m
Orientation maxi. radius	:	200 °
Surface	:	16.58 m²
Maximum distance	:	7.38 m

	CUSTOMER :STRUCTURAL SOILS DATE :10/01/2018	CAVITY :WELL1 OPERATION # :1	

Horizontal section
3.4 m

SCALE 1/100

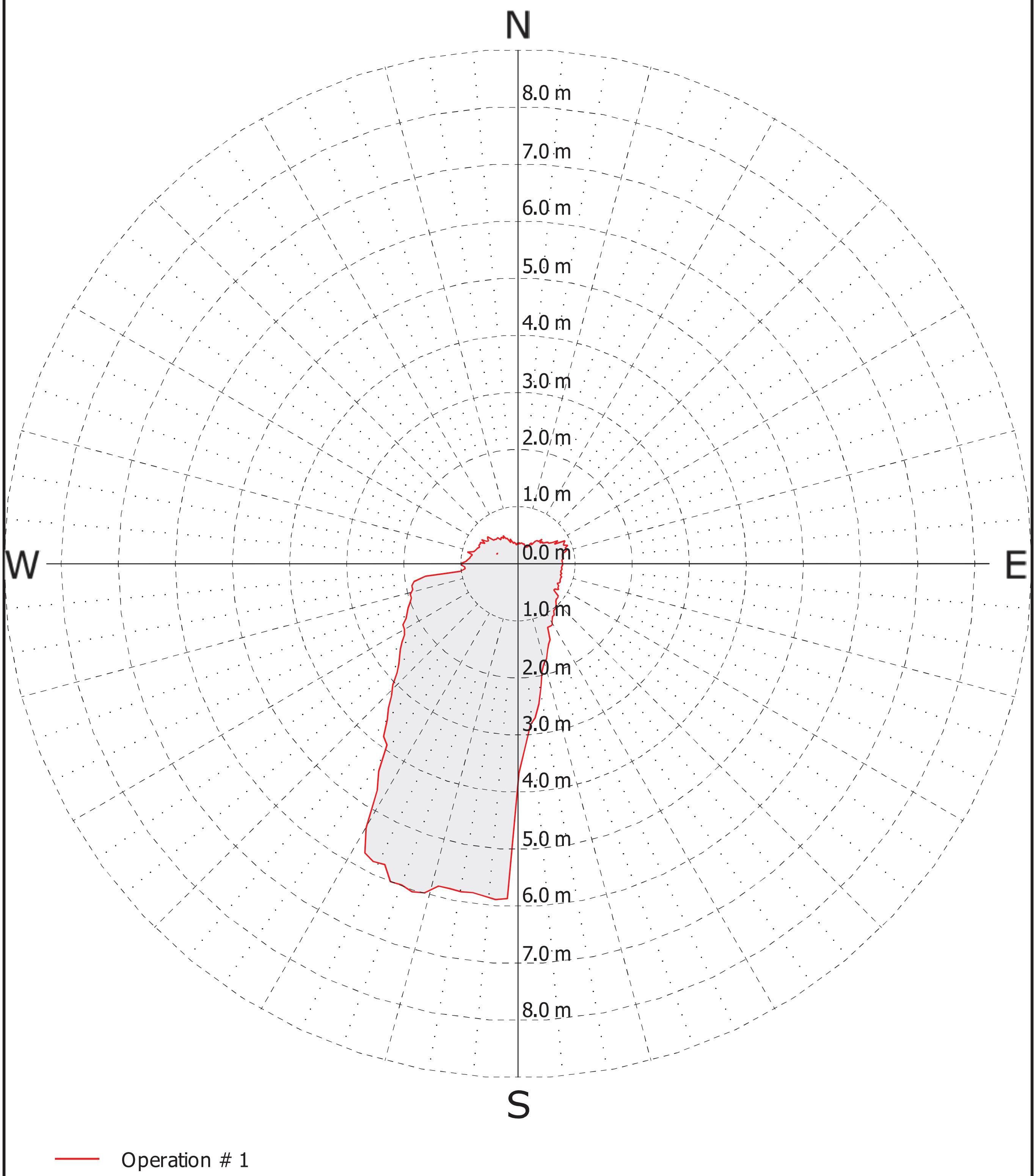


Maximum radius	:	6.06 m
Orientation maxi. radius	:	198 °
Surface	:	15.71 m²
Maximum distance	:	7.14 m

	CUSTOMER :STRUCTURAL SOILS DATE :10/01/2018	CAVITY :WELL1 OPERATION # :1	

Horizontal section
3.5 m

SCALE 1/100

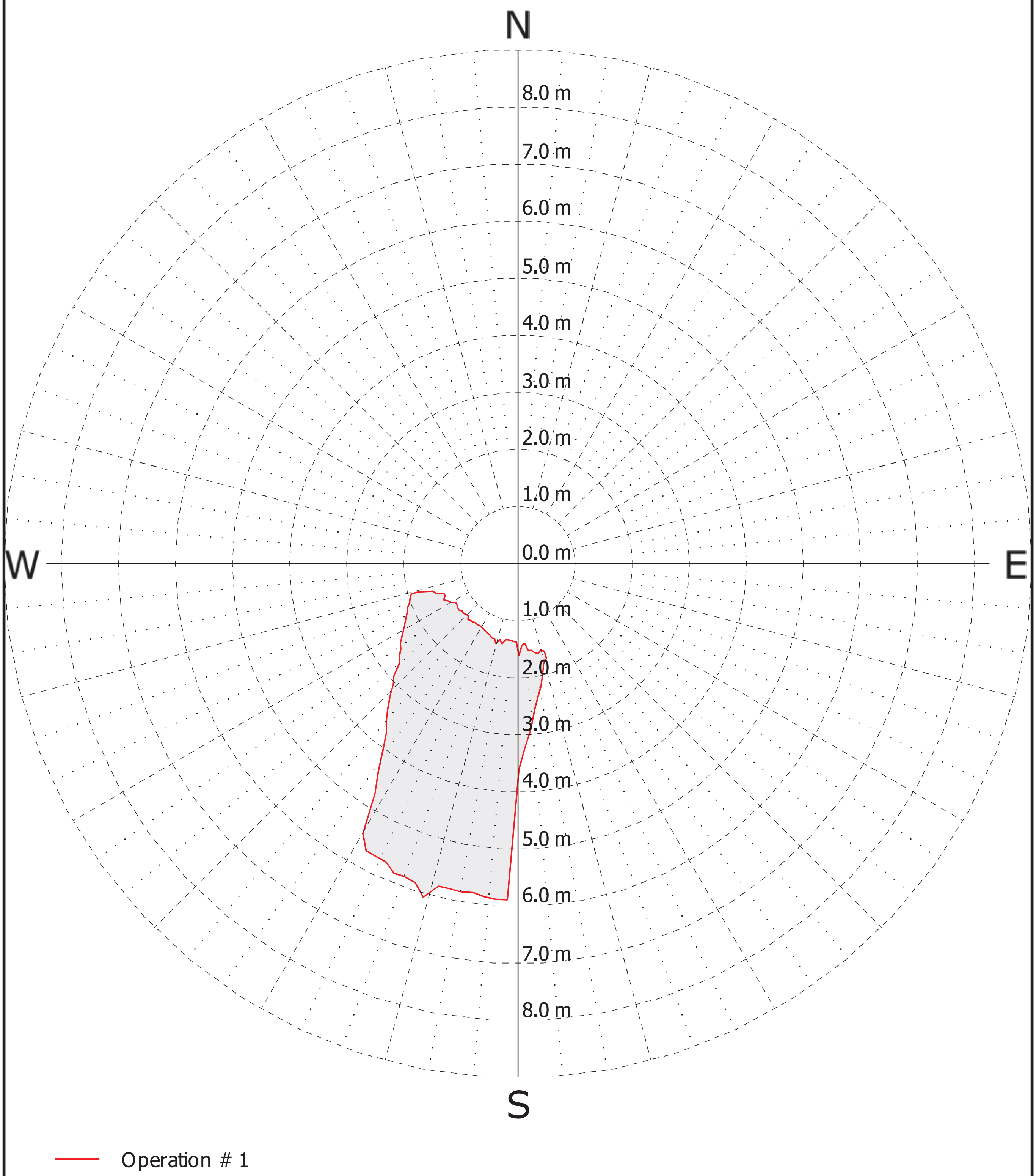


Maximum radius	:	6.03 m
Orientation maxi. radius	:	198 °
Surface	:	14.72 m²
Maximum distance	:	6.68 m

CUSTOMER :STRUCTURAL SOILS DATE :10/01/2018	CAVITY :WELL1 OPERATION # :1	

Horizontal section
3.6 m

SCALE 1/100

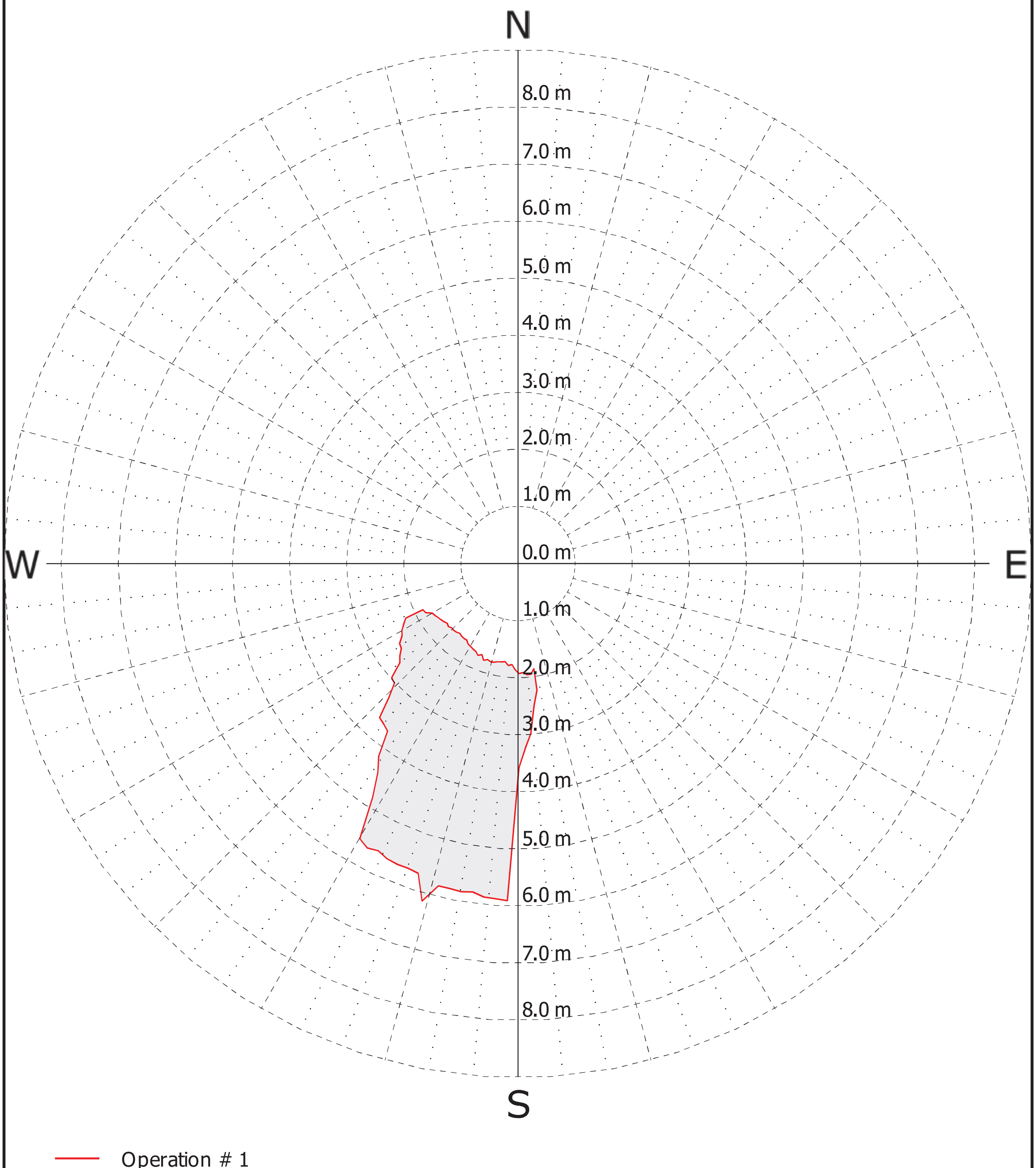


Maximum radius	: 6.07 m
Orientation maxi. radius	: 196 °
Surface	: 11.57 m²
Maximum distance	: 5.60 m

	CUSTOMER :STRUCTURAL SOILS DATE :10/01/2018	CAVITY :WELL1 OPERATION # :1	

Horizontal section
3.7 m

SCALE 1/100

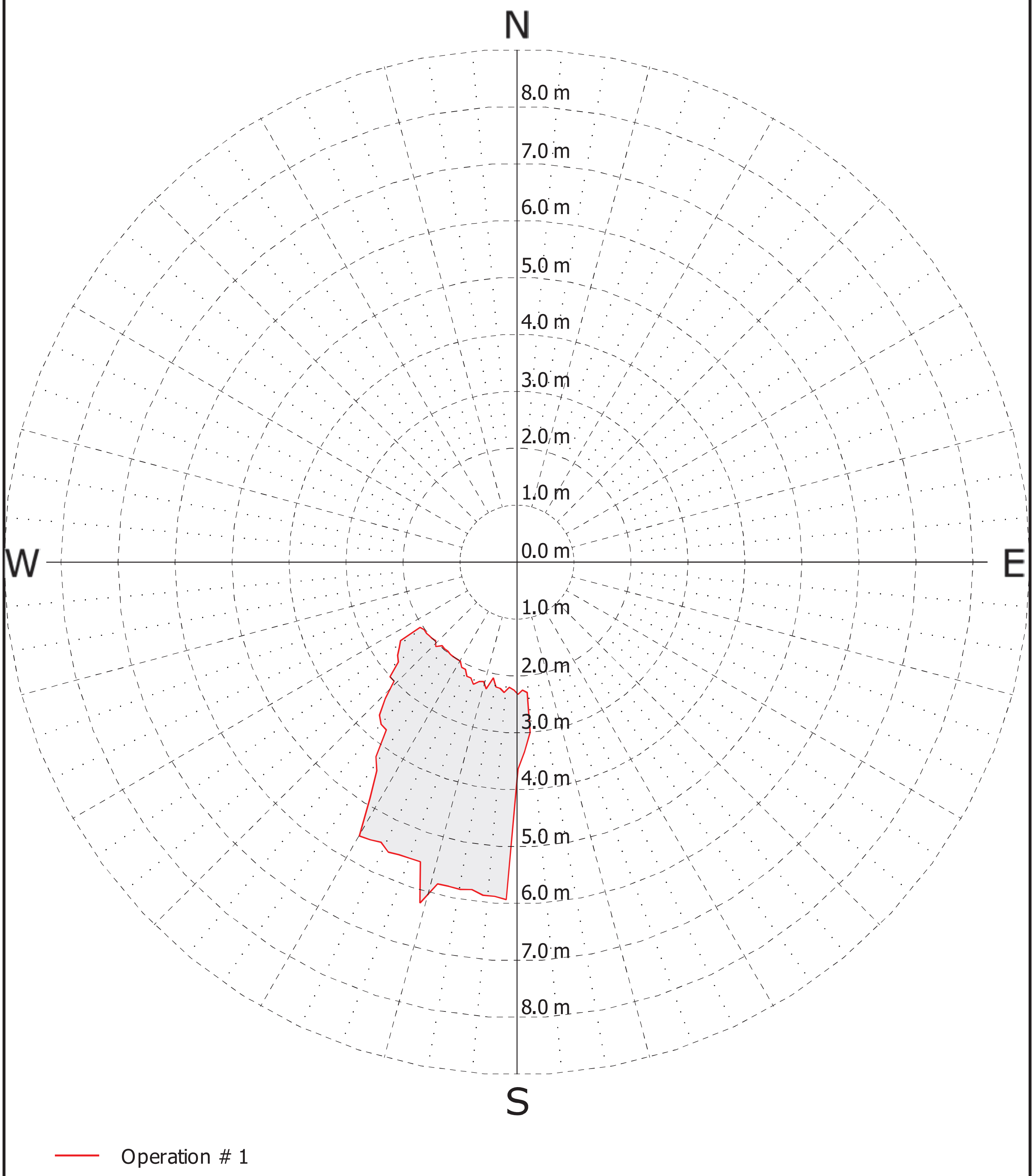


Maximum radius	:	6.14 m
Orientation maxi. radius	:	196 °
Surface	:	10.51 m²
Maximum distance	:	5.29 m

STRUCTURAL SOILS LTD	CUSTOMER :STRUCTURAL SOILS DATE :10/01/2018	CAVITY :WELL1 OPERATION # :1	geoterra FLODIM Challenging the limits

Horizontal section
3.8 m

SCALE 1/100

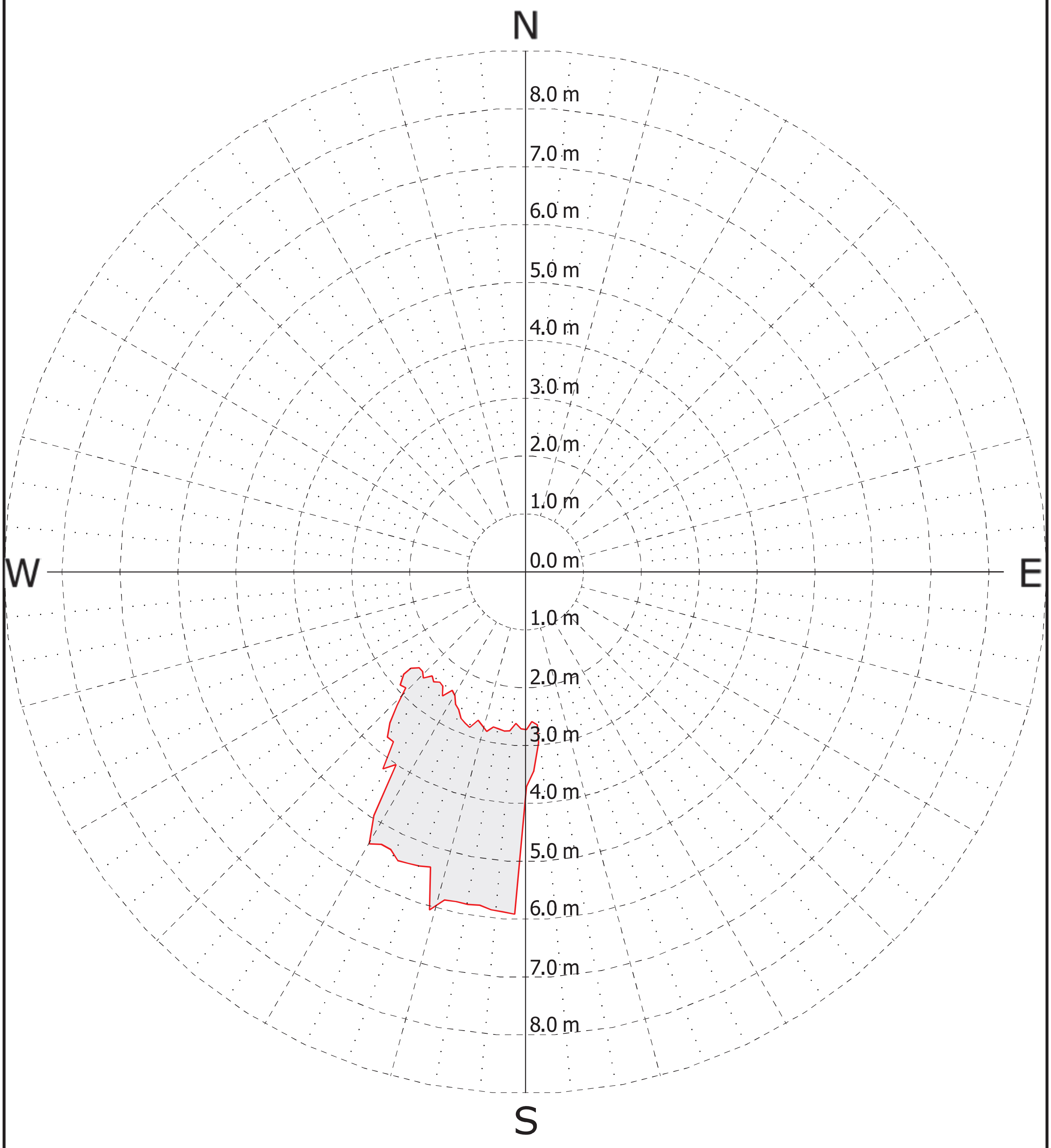


Maximum radius	:	6.22 m
Orientation maxi. radius	:	196 °
Surface	:	9.37 m²
Maximum distance	:	5.00 m

	CUSTOMER :STRUCTURAL SOILS DATE :10/01/2018	CAVITY :WELL1 OPERATION # :1	geoterra FLODIM Challenging the limits

Horizontal section
3.9 m

SCALE 1/100

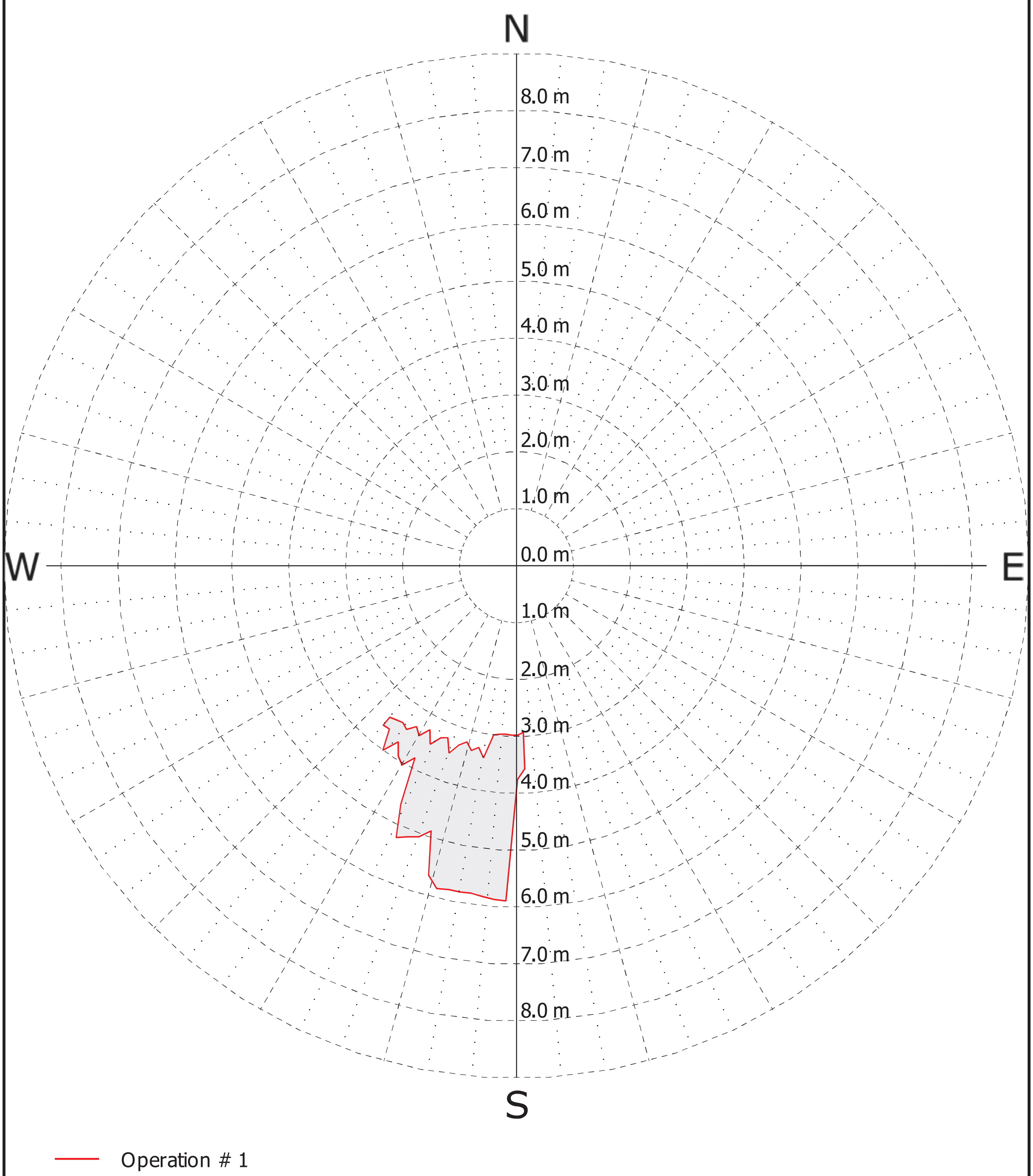


Operation # 1

Maximum radius	:	6.06 m
Orientation maxi. radius	:	196 °
Surface	:	7.80 m²
Maximum distance	:	4.59 m

STRUCTURAL SOILS LTD	CUSTOMER :STRUCTURAL SOILS DATE :10/01/2018	CAVITY :WELL1 OPERATION # :1	geoterra FLODIM Challenging the limits
	Horizontal section **4.0 m**		

SCALE 1/100



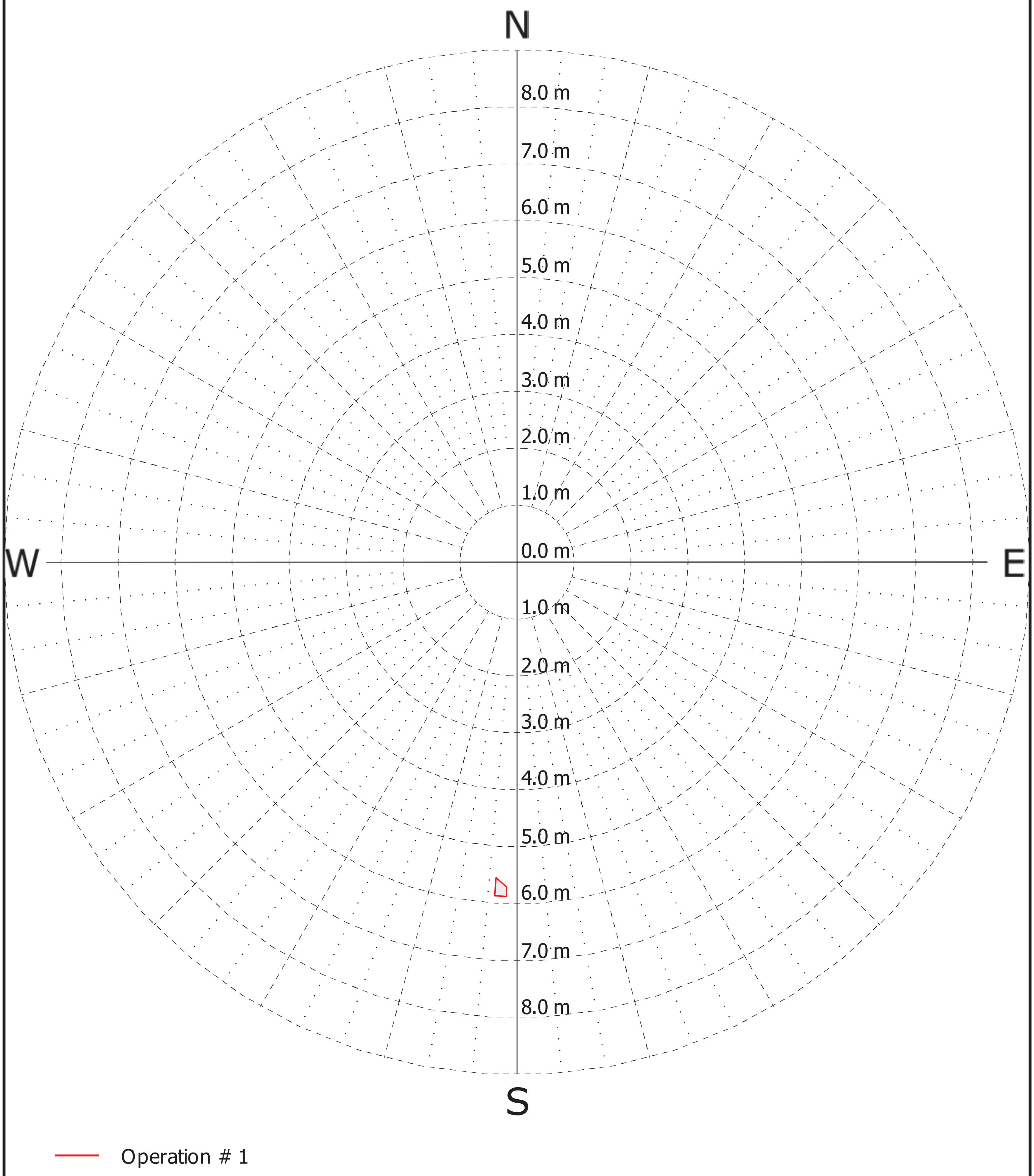
Maximum radius	:	5.89 m
Orientation maxi. radius	:	182 °
Surface	:	4.96 m²
Maximum distance	:	3.80 m

STRUCTURAL SOILS LTD	CUSTOMER :STRUCTURAL SOILS DATE :10/01/2018	CAVITY :WELL1 OPERATION # :1	geoterra FLODIM Challenging the limits

Horizontal section

4.1 m

SCALE 1/100

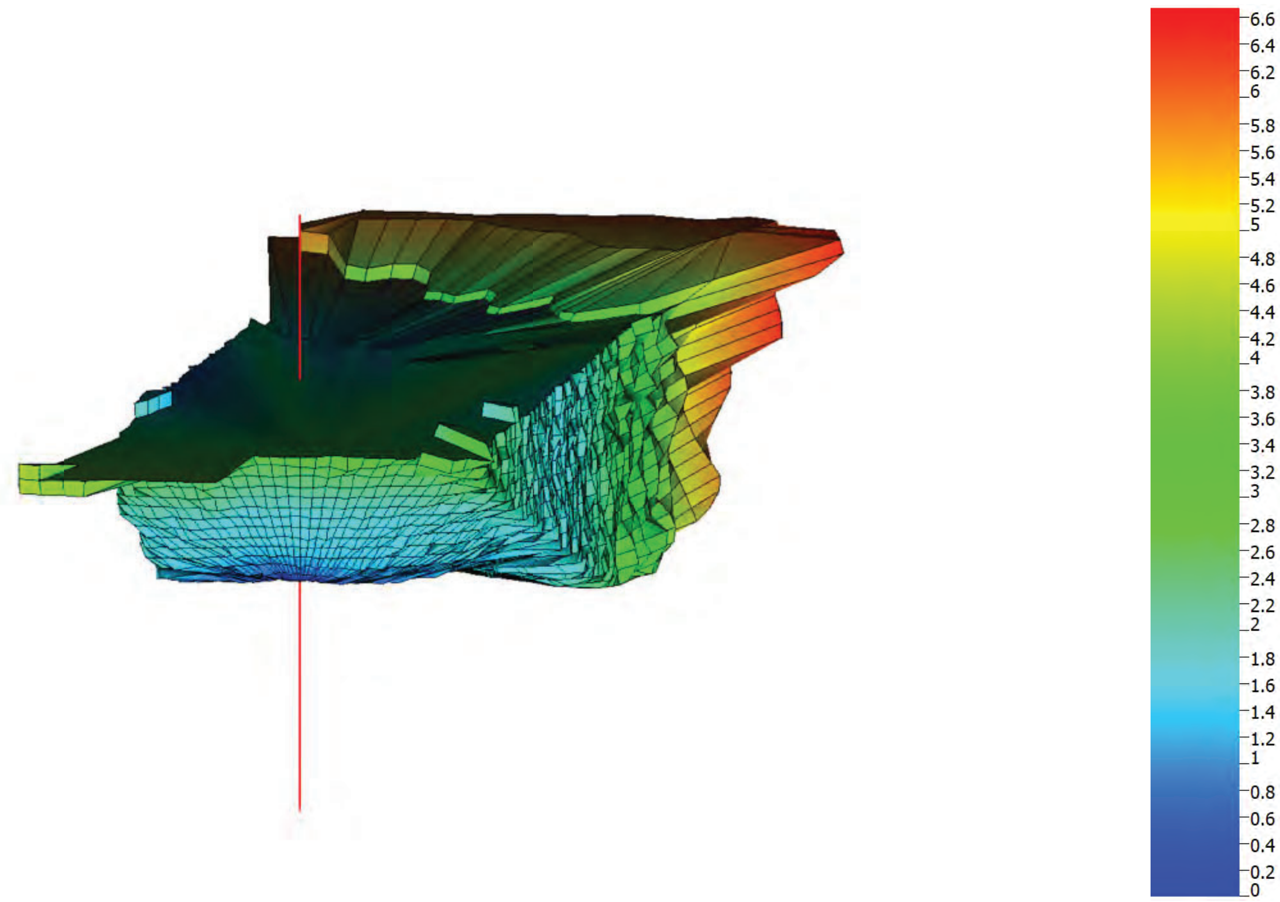


Maximum radius	:	5.87 m
Orientation maxi. radius	:	182 °
Surface	:	0.05 m²
Maximum distance	:	0.38 m

CUSTOMER	: STRUCTURAL SOILS	CAVITY	: WELL1
DATE	: 10/01/2018	OPERATION #	: 1

View from North

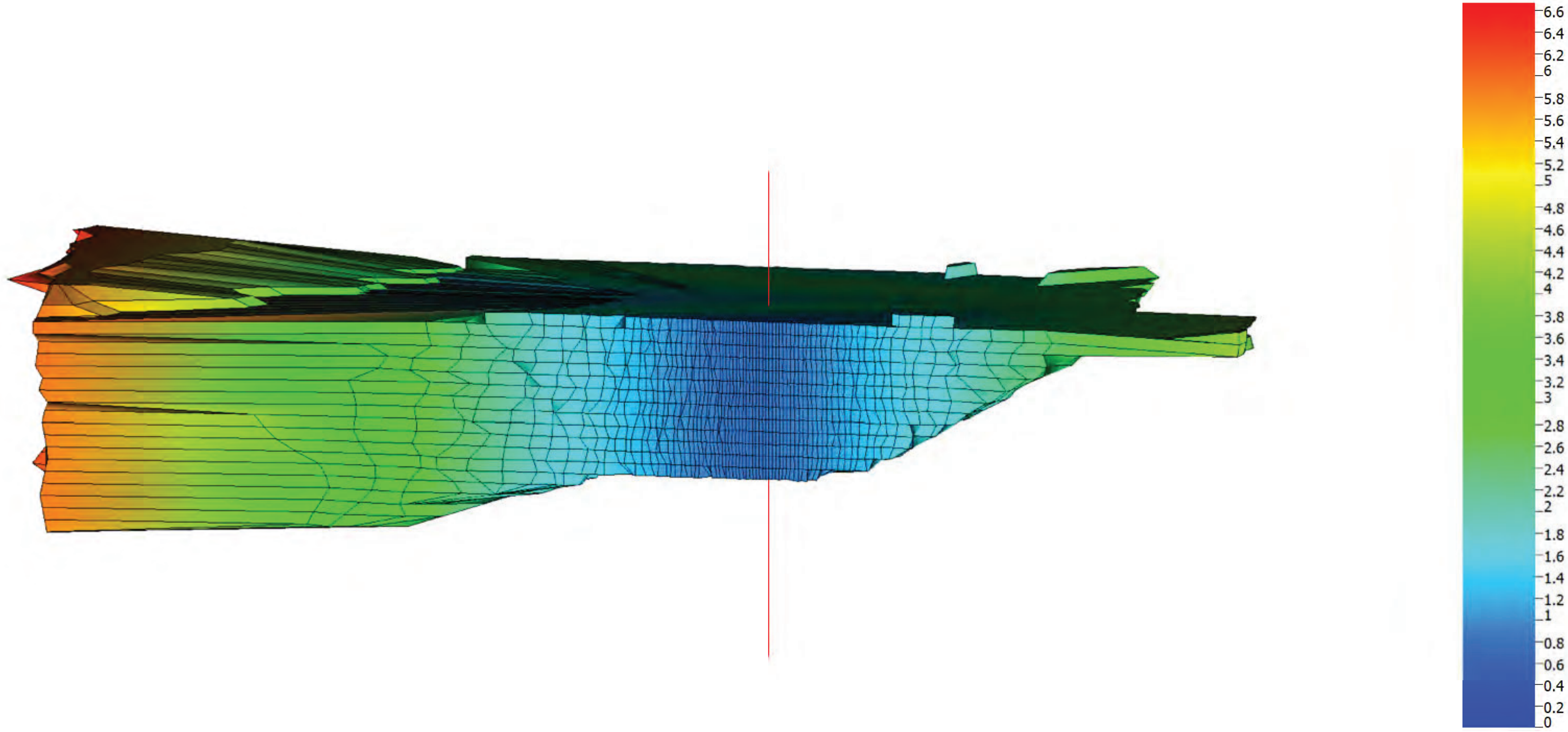
with an overhang of 10°



STRUCTURAL SOILS LTD	CUSTOMER : STRUCTURAL SOILS DATE : 10/01/2018	CAVITY : WELL1 OPERATION # : 1	geoterra FLODIM Challenging the limits

View from East

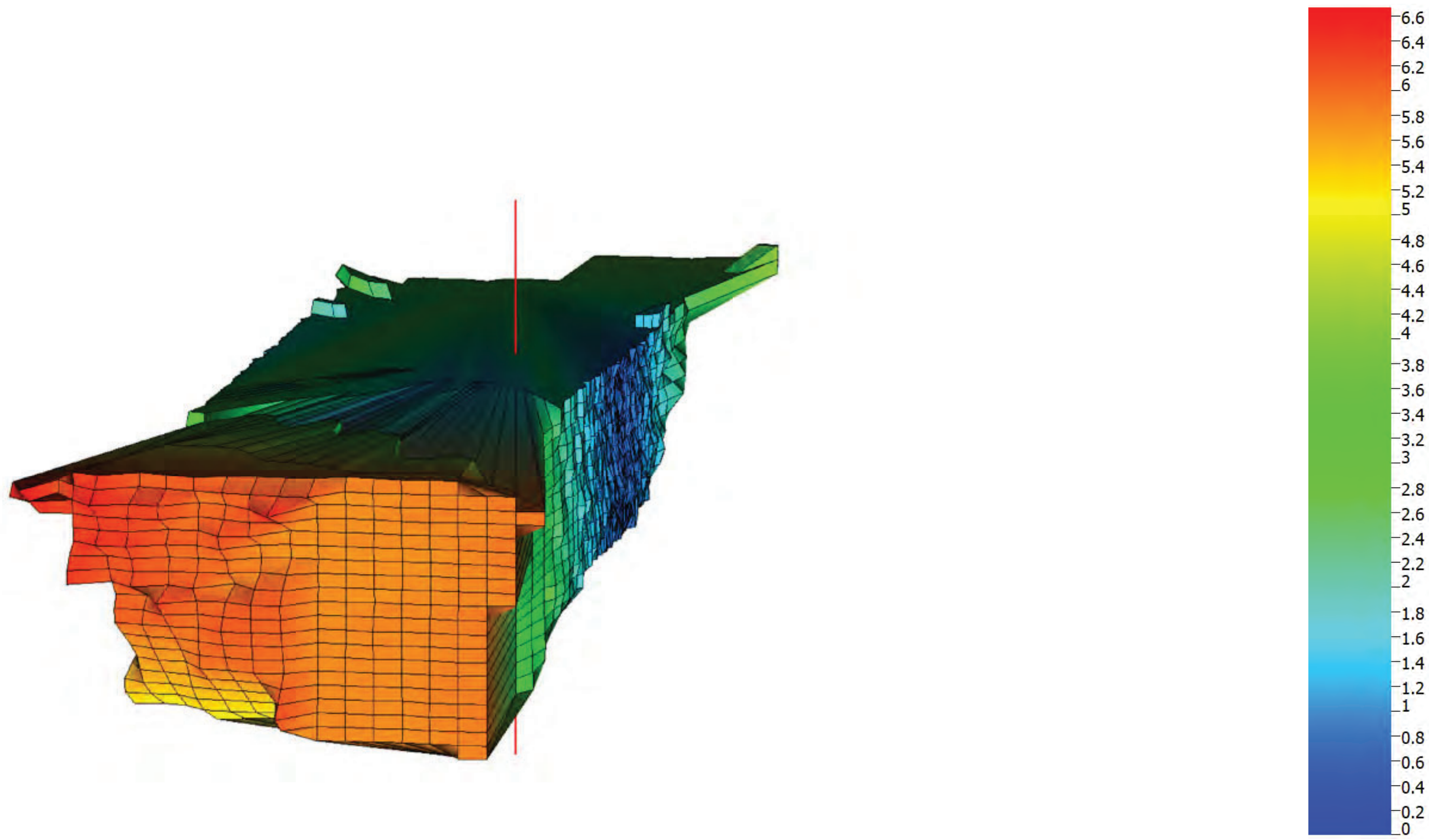
with an overhang of 10°



CUSTOMER	: STRUCTURAL SOILS	CAVITY	: WELL1	
DATE	: 10/01/2018	OPERATION #	: 1	

View from South

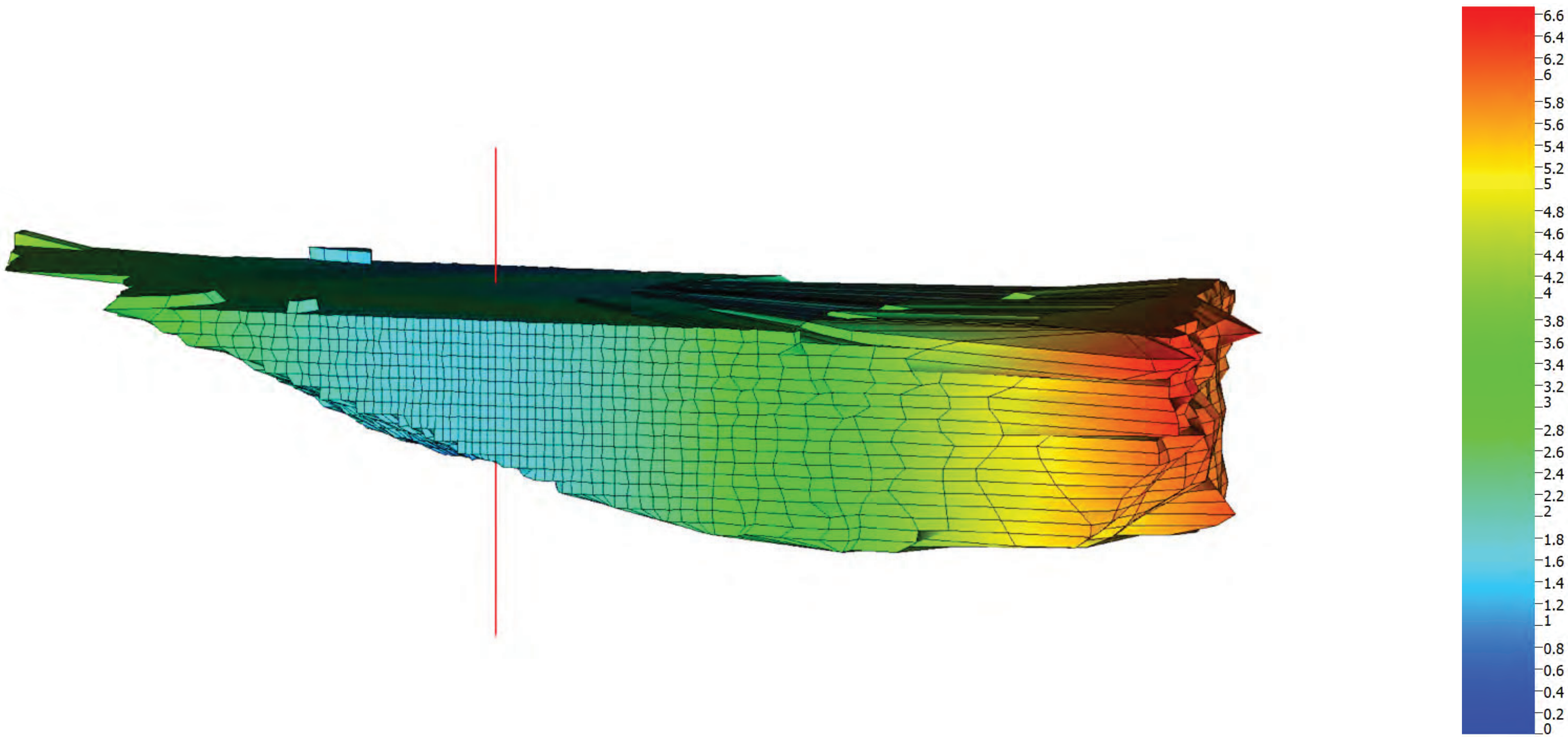
with an overhang of 10°

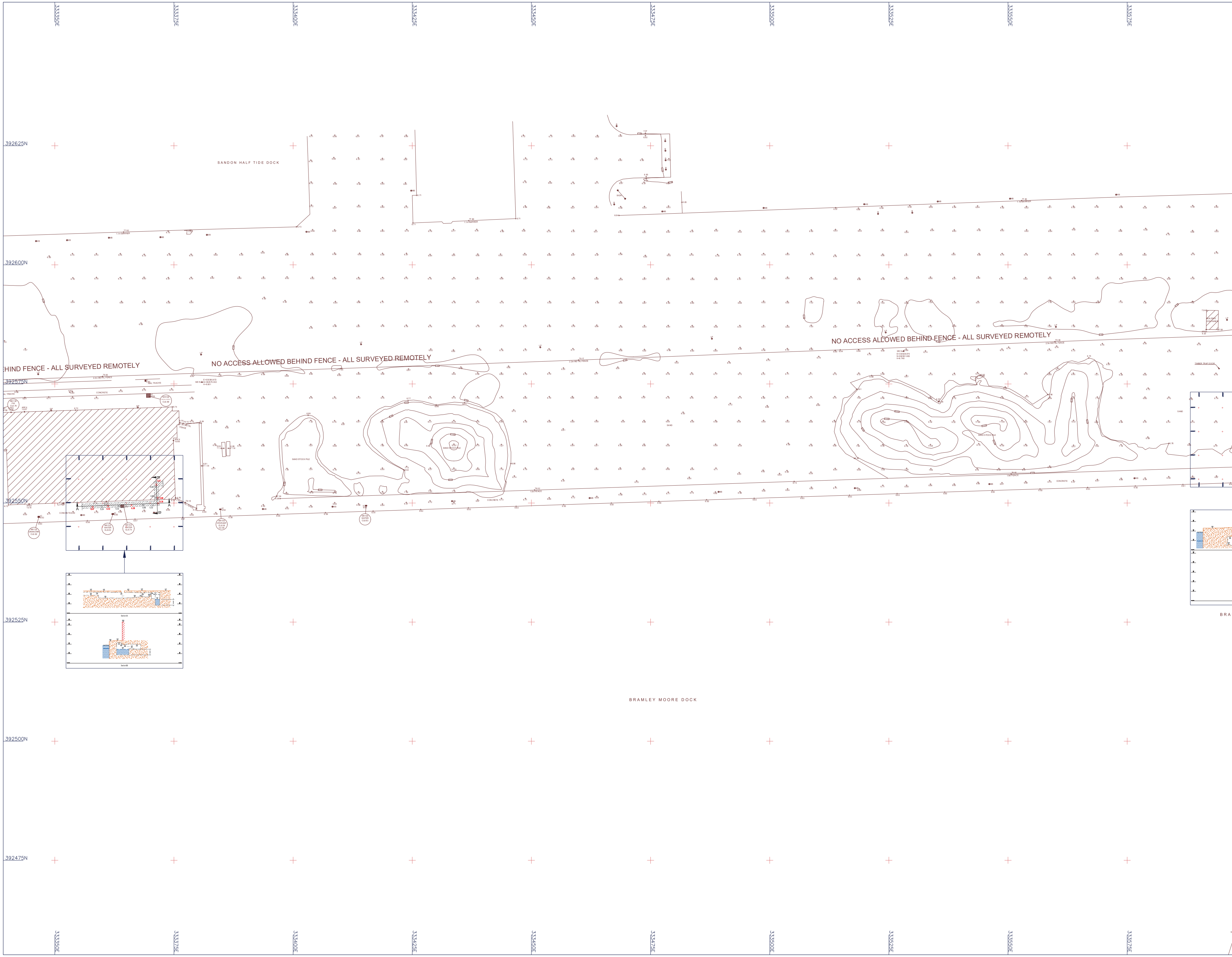


CUSTOMER	: STRUCTURAL SOILS	CAVITY	: WELL1
DATE	: 10/01/2018	OPERATION #	: 1

View from West

with an overhang of 10°





A0

Survey Control

Grid & Datum

Survey Grid: Local Grid ☐ Nat. Grid ☒ Nat. Grid ☐ Existing Grid ☐

Survey Datum: Local Datum ☐ Nat. Grid ☒ Nat. Grid ☐ O.S.B.M. ☐

The survey grid & level datum relate to the Ordnance Survey active GPS network (OSGB36) established via Leica SmartNET, plotted with no scale factor applied.

Rev	Date	Description	CAD
B	24.01.18	Void 2 alignment amended.	NB
A	19.01.18	Water line added to sections A & B.	NB

Client

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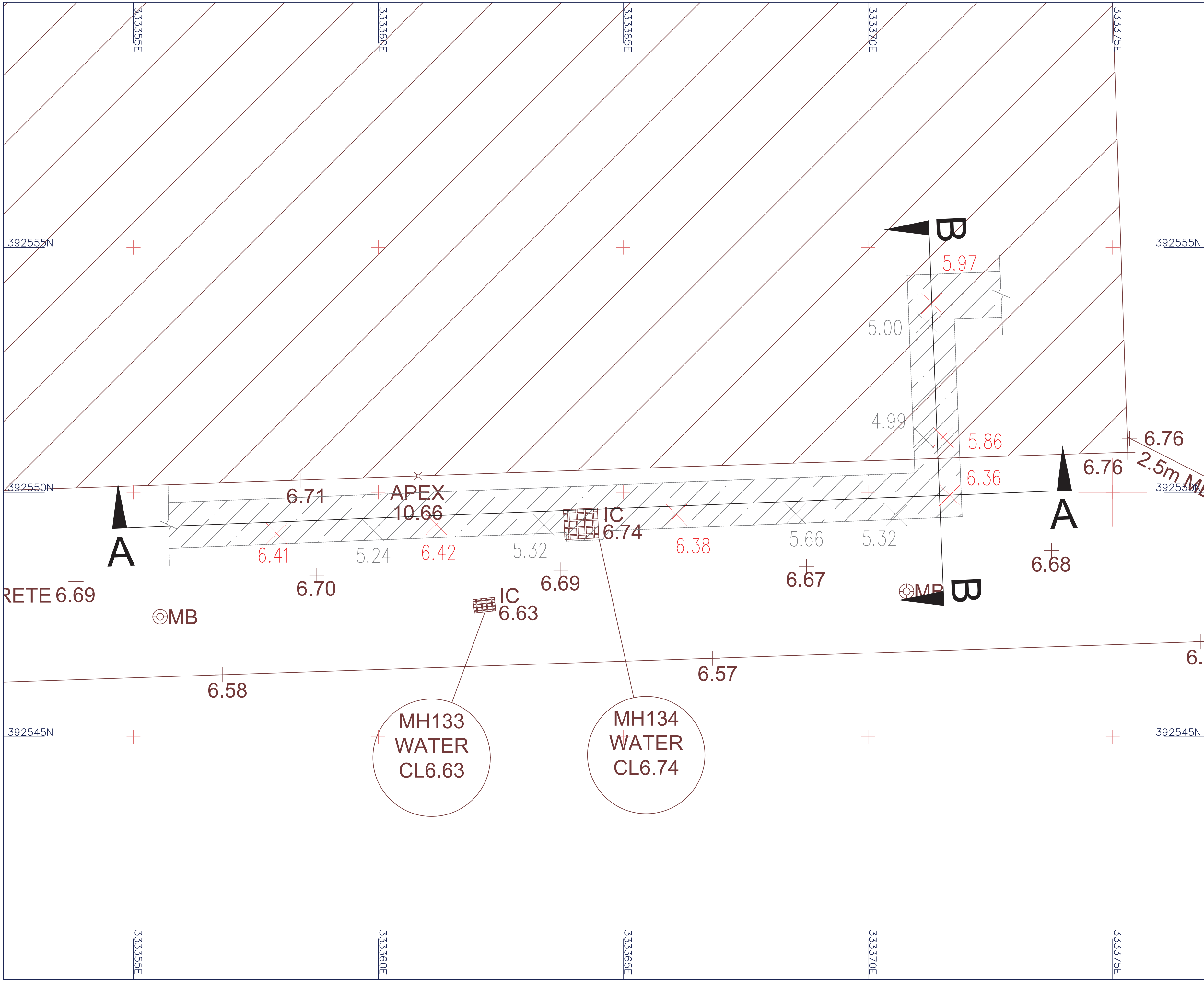
Laser Scan & Sonar Void Survey

Bramley Moore Dock, Liverpool

Surveyed: MH | CAD: NB | Checked: MH | Rev: B

Date of Survey: 10/01/18 | Reference: G18101&G18102B:1:3



A2

This survey has been produced at the survey scale detailed below with its accuracy commensurate with the indicated scale and should only be used for its original intended purpose. Any scaling should only be undertaken using a stable media print produced using the original data The plotted scale may differ (for presentation purposes) from the survey scale.

It is for the use only of the party to whom it has been addressed and no responsibility is accepted to any third party for the whole or part of its contents. This survey has been prepared on the basis that all information and facts, which may affect the survey, have been disclosed to Geoterra Ltd by all parties concerned and no liability, nor responsibility can be accepted, unless full disclosure has been made.

All ground features that were visible at the time of the survey have been located, however there may have been items obscured. Pipe sizes and flow direction have been visually assessed from the surface and should be considered as approximate only.

All data remains in the ownership of Geoterra Ltd and any discrepancies between this survey and any other information should be reported to Geoterra Ltd.

Survey Control

Grid & Datum

Survey Grid: Local Grid ☐ Nat. Grid (OSGB36) ☑ Nat. Grid (Graph. Fit) ☐ Existing Grid ☐

Survey Datum: Local Datum ☐ Nat. Grid (OSGB36) ☑ Nat. Grid (Spot Level) ☐ O.S.B.M. ☐

The survey grid & level datum relate to the Ordnance Survey active GPS network (OSGB36) established via Leica SmartNET, plotted with no scale factor applied.

Rev	Date	Description	CAD
B	24.01.18	Void 2 alignment amended.	NB
A	19.01.18	Water line added to sections A & B	NB

Client

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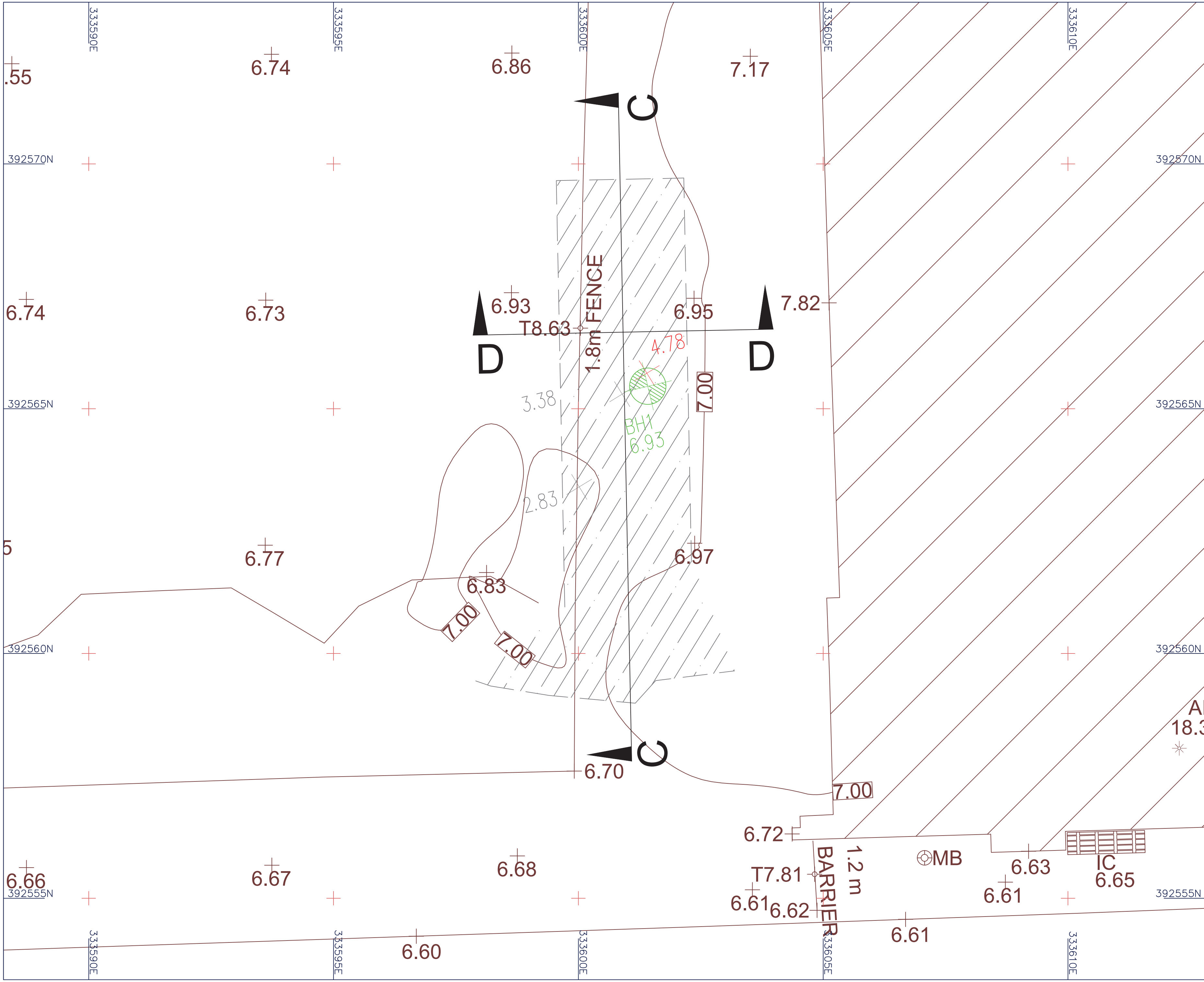
Laser Scan Void Survey

Bramley Moore Dock, Liverpool

Surveyed: MH | CAD: NB | Checked: MH | Rev: B

Date of Survey: 10/01/18 | Reference:G18101&G18102B:2:3



A2

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Survey Control

Grid & Datum

Survey Grid:	Local Grid ☐	Nat. Grid (OSGB36) ☑	Nat. Grid (Graph. Fit) ☐	Existing Grid ☐
Survey Datum:	Local Datum ☐	Nat. Grid (OSGB36) ☑	Nat. Grid (Spot Level) ☐	O.S.B.M. ☐

The survey grid & level datum relate to the Ordnance Survey active GPS network (OSGB36) established via Leica SmartNET, plotted with no scale factor applied.

Rev	Date	Description	CAD
B	24.01.18	Void 2 alignment amended.	NB

Client

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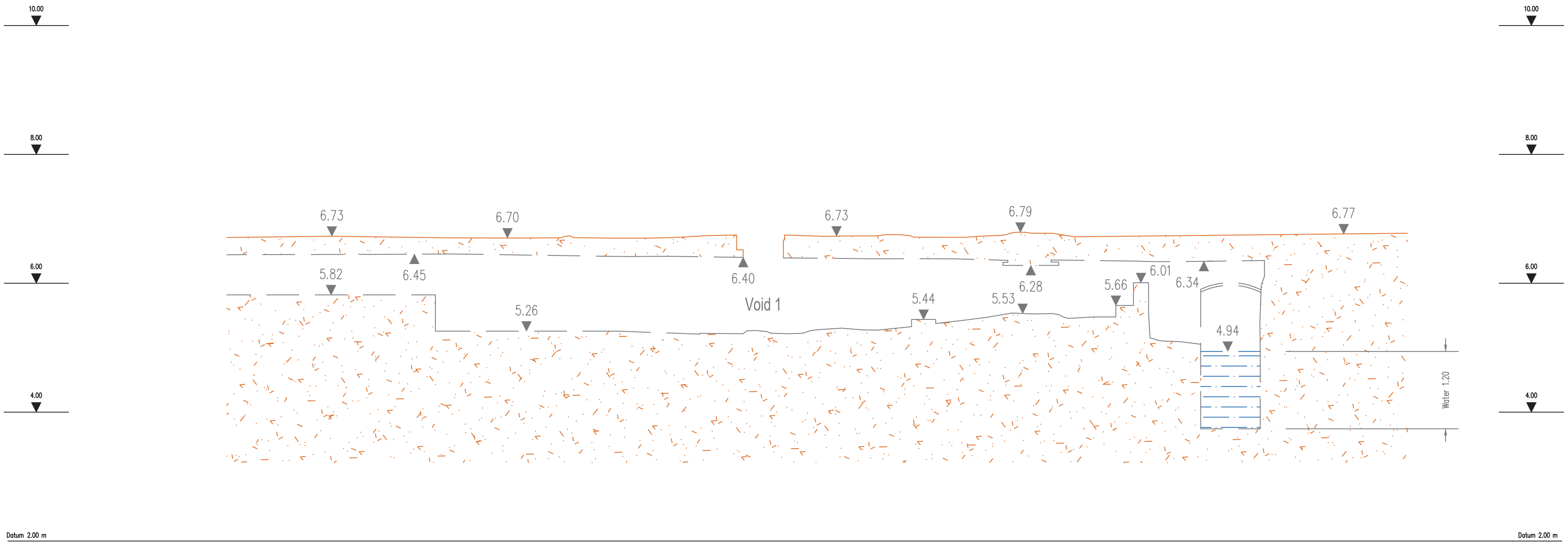
Sonar Void Survey

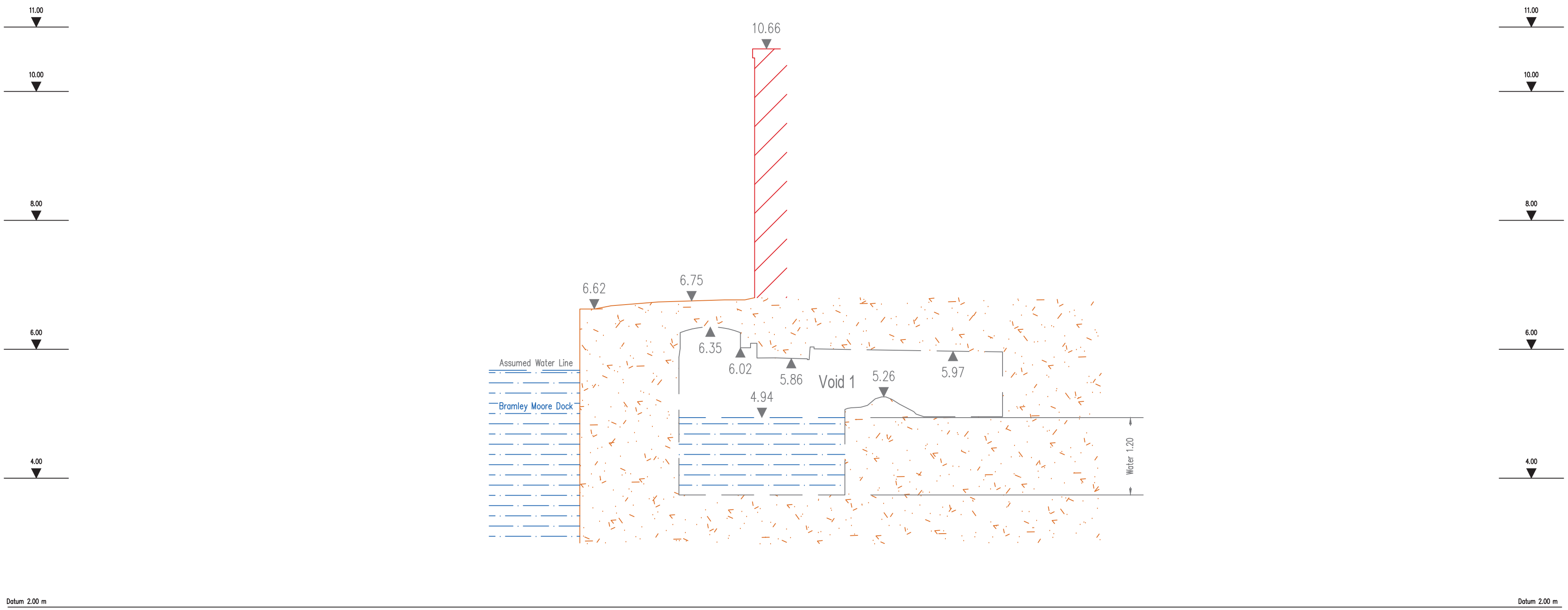
Bramley Moore Dock, Liverpool

Surveyed: MH | CAD: NB | Checked: MH | Rev: B

Date of Survey: 10/01/18 | Reference:G18101&G18102B:3:3



Section AA



Section BB

A2

This survey has been produced at the survey scale detailed below with its accuracy commensurate with the indicated scale and should only be used for its original intended purpose. Any scaling should only be undertaken using a stable media print produced using the original data The plotted scale may differ (for presentation purposes) from the survey scale.

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Survey Control

Grid & Datum

Survey Grid: Local Grid ☐ Nat. Grid (OSGB36) ☑ Nat. Grid (Graph. Fit) ☐ Existing Grid ☐

Survey Datum: Local Datum ☐ Nat. Grid (OSGB36) ☑ Nat. Grid (Spot Level) ☐ O.S.B.M. ☐

The survey grid & level datum relate to the Ordnance Survey active GPS network (OSGB36) established via Leica SmartNET, plotted with no scale factor applied.

Rev	Date	Description	CAD
B	24.01.18	Void 2 alignment amended.	NB
A	19.01.18	Water added to sections A & B	NB

Client

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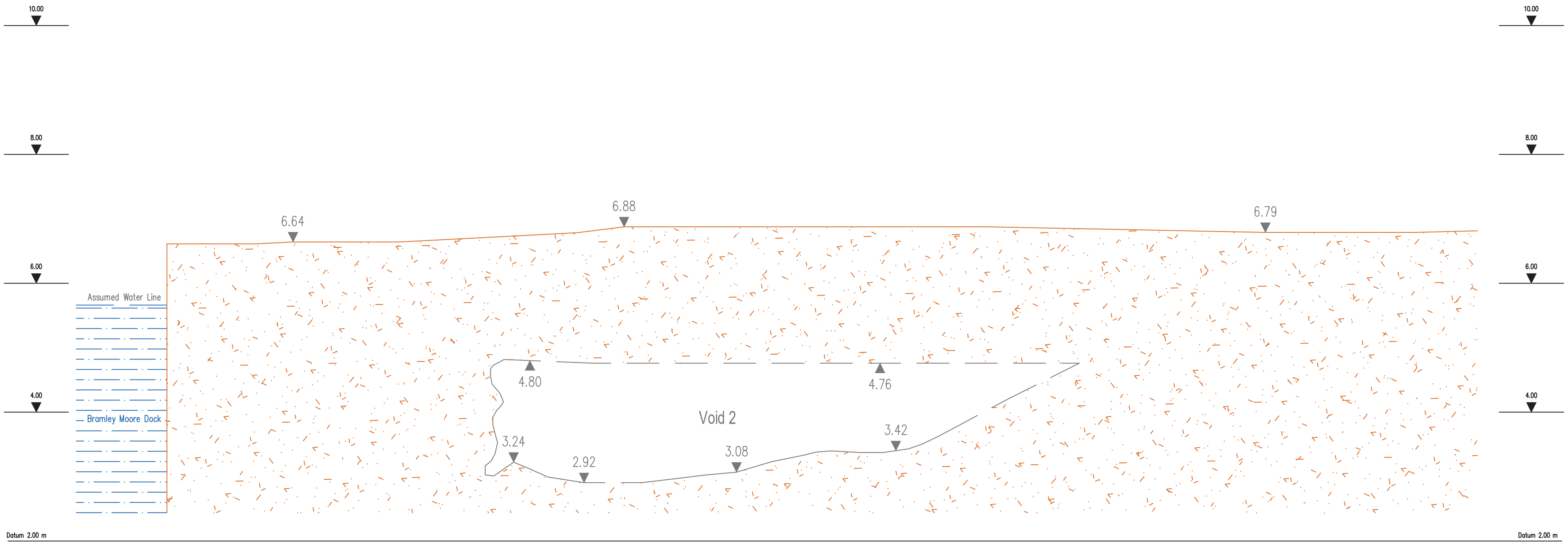
Laser Scan Void Survey

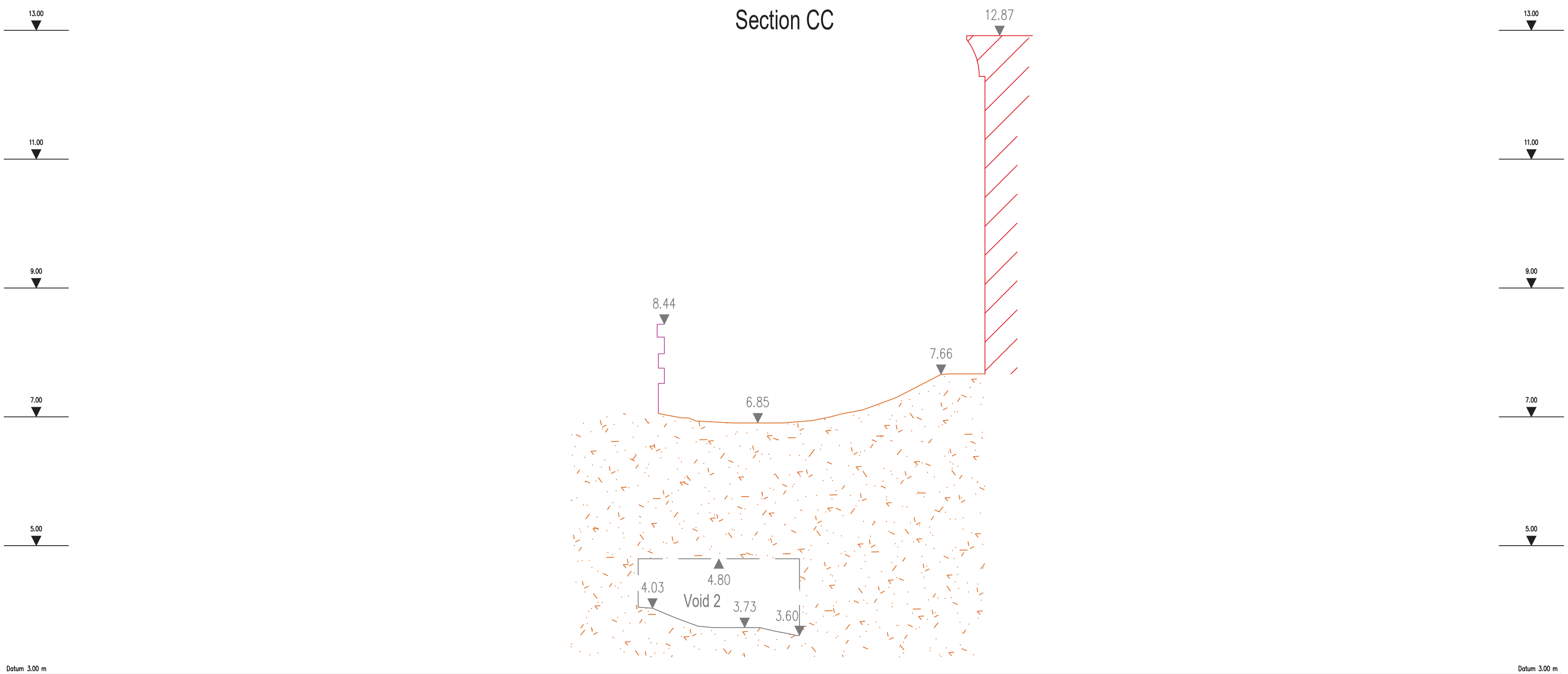
Bramley Moore Dock, Liverpool

Surveyed: MH | CAD: NB | Checked: MH | Rev: B

Date of Survey: 10/01/18 | Reference:G18101&G18102B:1:2



Section CC



Section DD

A2

Survey Control

Grid & Datum

Survey Grid:	Local Grid ☐	Nat. Grid (OSGB36) ☑	Nat. Grid (Graph. Fit) ☐	Existing Grid ☐
Survey Datum:	Local Datum ☐	Nat. Grid (OSGB36) ☑	Nat. Grid (Spot Level) ☐	O.S.B.M. ☐

The survey grid & level datum relate to the Ordnance Survey active GPS network (OSGB36) established via Leica SmartNET, plotted with no scale factor applied.

Rev	Date	Description	CAD
B	24.01.18	Void 2 alignment amended.	NB

Client

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Sonar Void Survey

Bramley Moore Dock, Liverpool

Surveyed: MH	CAD: NB	Checked: MH	Rev: B
Date of Survey: 10/01/18	Reference: G18101&G18102B:2:2		

EXPLOSIVE ORDNANCE (EO) THREAT ASSESSMENT (EOTA)

EVERTON FOOTBALL CLUB, LIVERPOOL, L3 0AP

This assessment draws together all the available information with regards to the site of concern regarding potential Explosive Ordnance (EO) Contamination. It assigns an Explosive Ordnance Threat Level and proposes an appropriate Risk Management Strategy to reduce any associated risks.

This assessment has been produced in compliance with the Construction Industry Research and Information Association guidelines (Report CIRIA 681, dated Dec 08) for the preparation of detailed Risk Assessments in the management of UXO risks in the construction industry, for which PLANIT was an instrumental driver for improved UXO risk management and transparency.

CLIENT CONTACT DETAILS

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POC:	Jonathan Rowe Geotechnical Engineer +44 (0)1225 320600
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OUR CONTACT DETAILS

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Tel:	08000 588 747
Email:	help@planit-international.com

DOCUMENT CONTROL

Copy No.	Recipient
1	PLANIT FILE
2	CLIENT E-COPY
3	CLIENT HARDCOPY (NOT ISSUED)

Document Reference:	
Date of Issue:	**15 May 2017**
Copy No:	**2 of 2**

Document Review	Name	Signature
Author Review:	Daniel WHELAN	
Peer Review:	Andrew HAMILTON	

EXECUTIVE SUMMARY

SITE DESCRIPTION	The site is located within the City centre of Liverpool on the east bank of the Mersey within the Crosby Channel. The site itself is located within the district of Vauxhall occupying the Nelson and Bramley Moore Docks. The site is bounded to the east by Regent Road (A5038), to the west by the River Mersey, to the north by Sandon Half Tide Dock and Wellington Dock and to the south by Salisbury Dock and Collingwood Dock. National Grid Reference is centred on **SJ 334 916** and the nearest Post Code is **L3 7BE**.
POTENTIAL THREAT SOURCE	Within the 'UXO Threat Zone', the following items of explosive Ordnance (EO) are a potential threat source: • WW2-era, German, Air-dropped bombs. • WW2-era, British, Anti-Aircraft Artillery (AAA) projectiles.
THREAT PATHWAY	For the purposes of this assessment, it has been assumed that site investigation works would include boreholes and excavations beyond WW2 ground levels. It is anticipated that personnel or key equipment may complete the risk pathway during excavation operations that may bring them into physical contact with potential threat items.
KEY FINDINGS	• There is excellent evidence that the area immediately surrounding the site of concern was badly affected by bombing during WW2, although there are no bombs recorded on the site itself. • The potential for UXO to have landed within the wet docks on the site and remain unexploded at the bottom of those structures cannot be reasonably ignored especially considering that the docks cover most the site. • It is unlikely that other ordnance contamination events occurred at the site of concern. • There are no Abandoned Bombs or UXBs recorded that would affect the site of concern. • The Ordnance Threat Level varies across the site of concern.
THREAT LEVEL	Ground volumes that have been excavated post-War may be considered effectively free from the threat of Explosive Ordnance (EO). The ordnance Threat Level for these ground volumes is **NEGLIGIBLE**. Ground volumes outside of the 'UXO Threat Zone' may be considered effectively free from the threat of Explosive Ordnance (EO). The ordnance Threat Level for these ground volumes is **NEGLIGIBLE**. Within the 'UXO Threat Zone', the EO Threat Levels are assessed as: Ordnance Type: British AAA, 50kg, 250Kg and 500Kg HE Bombs — Threat Level: **MEDIUM** These threat levels apply regardless of the nature of intrusive engineering to be undertaken.
THREAT MITIGATION	Considering the findings of this assessment, a UXO Threat Mitigation Strategy **IS REQUIRED** to be in place prior to intrusive engineering works at this site of concern.

THREAT REVIEW	*A review of these recommendations must be undertaken considering any additional, relevant information being provided. Such a review may, if the EO Threat Level is deemed to have altered, make alternative recommendations from those made above to implement work safely.*
AIM & METHODOLOGY	The aim of this assessment is to identify any threats that may be posed by EO during the proposed engineering works at the site of concern and, where a threat is identified, to recommend a risk mitigation strategy that will reduce this threat to acceptable levels. This assessment follows the CIRIA 681 Guidelines, which were compiled using, as a main driver of change, PLANIT's innovative approach to EO risk assessment. The following key considerations are addressed in this assessment: • The risk that the site of concern was contaminated by EO. • The risk that EO remains on site. • The risk that EO may be encountered during the proposed engineering works. • The risk that EO may be initiated by proposed engineering works. • The consequences of encountering or initiating EO. If the likelihood of encountering EO is significant, information about the types and natures of that EO and the expected levels of contamination is considered within the source-pathway-receptor context of contamination. Should a confirmed pathway exist, the information is entered into our proprietary Threat Assessment Matrices in order to arrive at a valid and transparent Threat Level. The Threat Level allows relevant conclusions to be made about the EO Risk at the site of concern, which in turn allows an appropriate Risk Mitigation Strategy to be developed. The Threat Mitigation Strategy is intended to give the Client a best-fit, safe solution that will allow the level of risk from EO to be reduced to an acceptable level; providing maximum project planning flexibility. PLANITs approach to EO threat assessment has been fundamental in driving change throughout the UK Commercial EOD Industry and was instrumental in the drafting of CIRIA 681. PLANITs approach provides transparency to our EO risk assessment process allowing the Client to make valid decisions on what is a specialist activity; empowering them to maintain control over this vital aspect of their project - Where necessary, appropriate EO risk mitigation measures will be recommended. This assessment considers general and site specific factors, including: • Historical use of the site in relation to ordnance manufacturing, storage and disposal. • Historical use of the site in relation to Military training and related facilities. • Evidence of offensive aerial and naval bombardment during WW1 and WW2. • Evidence of Unexploded Bombs (UXBs). • Previous EO incidents and/or EO survey/clearance activities. • Extent of post-war redevelopment. • Proposed engineering works.
RELIABILITY OF HISTORICAL RECORDS	This assessment is drawn from detailed research into the available historical evidence. Every effort is made to gather all the relevant material; however, PLANIT cannot be held responsible for any changes to the assessed level of risk or proposed risk mitigation strategies due to subsequent information that may come to light later. The accuracy and detail of wartime historical records is difficult to verify, not least of which is due to the conditions under which much of this information was gathered and recorded. Additionally, recording of information was less formalised in the early days of the German air campaign against the UK mainland (Pre-Bomb Census Record) and much information recorded early on was lost during subsequent air raids. Records for rural, sparsely populated areas are not always reliable, being based on second-hand

	information in many cases; records of attacks on military installations was often recorded independently from general records and many such archives have been lost or remain undisclosed to the public. Consequently, the exact location, quantity and nature of the EO threat cannot be definitive but rather remains subjective and is based on the careful analysis by experts of the available information. PLANIT cannot accept liability for any gaps in the historical record.

CONTENTS

SITE LOCATION & DESCRIPTION

SITE OF CONCERN	The site is located within the City centre of Liverpool on the east bank of the Mersey within the Crosby Channel. The site itself is located within the district of Vauxhall occupying the Nelson and Bramley Moore Docks. The site is bounded to the east by Regent Road (A5038), to the west by the River Mersey, to the north by Sandon Half Tide Dock and Wellington Dock and to the south by Salisbury Dock and Collingwood Dock. The site is a former commercial dock which appears to be currently mostly disused, except for a large warehouse structure which dominates the central quay of the site area, with attendant car parking and vehicle manoeuvre areas. The site is mostly covered in water within the existing wet docks and hard standing. National Grid Reference is centred on **SJ 334 924** and the nearest Post Code is **L3 0AP**. Maps showing the site location and layout are at Annex A.
SCOPE OF PROPOSED WORKS	The specific development works are unknown at the time of this assessment. What is known is that works will involve undertaking a ground investigation and piled foundations following the assumption that the dock will be drained and filled. Both the proposed piles and boreholes will penetrate deeper than the existing base of the dock. It is anticipated that any site investigation and/or redevelopment works are likely to involve deep engineering works including bulk excavation and/or piling below WW2 ground levels.
GEOLOGICAL ENVIRONMENT	The geological environment is not accurately known at the time of this assessment. However, the British Geological Survey maps (Sheet 96), Liverpool, Solid and Draft editions of 1974/ 75 indicate that the site is underlain by Artificial Ground/ Made Ground which is categorised as Worked Ground (Undivided) and Triassic bedrock (Helsby Sandstone Formation). Made Ground is most likely to comprise engineered fill, demolition rubble (brick, sandstone, gravel, concrete etc.) originating during construction. The lining and construction of the docks themselves is unknown.

REVIEW OF RELEVANT DATASETS

SOURCES OF INFORMATION	PLANIT ensures that Explosive Ordnance Threat Assessments (EOTAs) are as comprehensive as possible and detailed research is undertaken to collate all the available EO-related information that relates to the site of concern. Information sources may include, but are not restricted to: • National Historic Archives. • Local Authority & Council Archives. • English Heritage National Monuments Record. • Ministry of Defence Archives • PLANITs extensive archives drawn from many years of detailed research and operational experience of UXO Risk Management activities in the UK and abroad. • Joint Service EOD Centre (JSEOD). • Historic Mapping and Aerial Photography. • Specific UXO-related documents such as military bombing and casualty records. • Local libraries and history groups. • Open sources such as published books and internet searches. • Anecdotal evidence from eye witnesses. *NB: The MoD information office that deals with requests for information relevant to EO clearance operations completed by the MoD is currently facing significant delays. Although a request has been submitted, any information that may be relevant has not yet been forwarded for timely inclusion in this assessment. However, if any relevant information comes to light from this source that affects the threat assessment, this will be notified to the client as a matter of urgency.*

SITE HISTORY

The earliest available mapping of **1851,** shows the entire site area turned over to docklands, encompassing both Nelson and Bramley Moore Docks. Both docks are surrounded by warehouses, and railway infrastructure feeding Bramley Moore Dock in the NE corner of the site. This site layout remains fundamentally unchanged until no later than **1967**, when Nelson Dock sees warehousing removed from around the dock itself apart from to the west.

By **1973**, a new warehouse structure appears across the northern edge of Bramley Moore Docks, but the larger central portion of this feature has gone again by no later **1982**. The attendant railway infrastructure is being dismantled by this time and has entirely gone by **1990**. The site remains largely unchanged from then until now.

ORDNANCE MANUFACTURE & STORAGE

During WW1 and WW2, Liverpool housed several facilities involved in the manufacture, storage, filling and testing of ordnance, which are detailed below. None of these facilities pose a potential threat to the site of concern.

Facility	Operating Period	Nature of Ordnance
Cunard Company, Rimrose Road, National Shell Factory (NSF)	Jun 1915	8, 4.5 and 6in shells.
North Haymarket, NSF	Jun 1915	18 pdr, 4.5 and 6in shells.
Lambeth Road, Tramway Depot, NSF	Jun 1915	15, 18 pdr and 2.75, 4.5, 6in shells.
Aintree, National Filling Factory (NFF)	Jul 1915 – Jul 1918	Filling 8in shells.
Edge Lane, NSF	Sep 1915 – Feb 1916	4.5, 6in shells.
Clyde Street, Bootle, NSF	Nov 1915	Guages
Litherland, Liverpool, Her Majesty's Explosive Factory (HMEF)	Mar 1916	Tri-Nitrotoluene (TNT)

MILITARY HISTORY

There is no evidence to indicate that the site was ever used for military purposes.

CIVIL DEFENCE

Liverpool possessed a peak of 112 Heavy Anti-Aircraft Batteries during WW2, including 4.5, 3.7 and 3- inch Anti-Aircraft (AA) guns, sited in some 70 separate locations. None of these were sited on or near to the site of concern to have created a direct source of potential ordnance contamination.

Due to the relatively high failure rate of Anti-Aircraft Ammunition (AAA) during this time, there remains the possibility that such ordnance fell back to earth creating additional UXO hazards. This type of ordnance had the potential to penetrate the ground to significant depths and cannot be entirely discounted as a potential threat source although its potential presence is impossible to determine with any quantifiable degree of certainty.

As would be expected, Liverpool had several Civil Defence ('Starfish') sites designed to protect the City from aerial attack. Liverpool's Starfish Sites were located at:

Decoy(s)	Grid	Distance from Site (Km)
Hale	SJ 454833	20
Ince	SJ 472767	25
Brimstage	SJ 297833	5

Wallasey	SJ 283914	5
Formby	SD 284048	10
Little Crosby	SD 307017	5
Heswall	SJ 245826	20
Moreton	SJ 247909	10
Llandegla	SJ 222535	50
Llanasa	SJ 096821	22
Fenn's Moss	SJ 491365	50
Little Hilber	SJ 189872	12
Burton Marsh	SJ 286749	18
Gayton	SJ 269796	16

Liverpool also had three RAF airfield decoy sites in its vicinity. These were referred to as 'Q' Sites, a name derived from the 'Q Ships' (warships mocked up to look like merchantmen), and consisted of lighting/fire installations designed to look like airfields to enemy bombers.

RAF Airfield Decoy(s)	Grid	Distance from Site (Km)
Betchton (Q Site)	SJ 787 602	60
Puddington (Q/QF Site)	SJ 313734	20
Bold Heath (QF Site)	SJ 546897	25

None of these sites would indicate the possibility that erroneous Luftwaffe bombing would have produced a consequent UXO risk on the site of concern.

WW1

Great Britain suffered several 'Zeppelin' aerial bombardments and aerial attacks by Gotha and Giant Bombers during WW1 as well as several naval bombardments from the sea. However, none of these are known to have dropped bombs near the site of concern and further, due to the limited number of bombs dropped then, the risks from WW1 unexploded ordnance from this source are negligible.

WW2 – GERMAN AERIAL BOMBING CAMPAIGN

At the outbreak of WW2, the site sat close to several viable Luftwaffe targets such as Railway lines, Docks, Manufacturing and other heavy industry - all infrastructure targets for the Luftwaffe with the local areas affected by several raids – and was itself a target in this context. The high-altitude area bombing during this period was notoriously inaccurate with areas surrounding specific targets suffering during attacks on the targets themselves.

Merseyside was the most important port in Britain outside London during the Second World War. It was a vital route for military equipment and supplies to the country, and so the 'Western Approaches Command' headquarters were transferred from Plymouth to Merseyside in February 1941. The headquarters were based deep underground beneath the Exchange Buildings. Western Approaches Command received intelligence information from the Admiralty and the Air Ministry, and was responsible for protecting supply ships as they entered the port. The docks were also home to important munitions factories and naval 'U-boat hunters' were stationed at Bootle. Heavy bombing had immobilised London's port facilities, and so the Mersey became even more important to the British war effort. The Luftwaffe (German air force) therefore began to target Merseyside.

The first German bombs landed on Merseyside on 9 August 1940 at Prenton, Birkenhead. In the following sixteen months, German bombs killed 2716 people in Liverpool, 442 people in Birkenhead, 409 people in Bootle and 332 people in Wallasey. The worst periods of bombing were the 'Christmas Raids' of December 1940, and the 'May Blitz' of 1941. German bombing over Merseyside was unpredictable in the autumn of 1940. However, the attacks grew heavier towards the end of the year, and by 23 October Merseyside had suffered its 200th air raid. One of the worst single bombings occurred on 3 December 1940, when 180 people were killed in a direct hit on a packed air raid shelter in Liverpool. By 12 December 1940, Merseyside had suffered its 300th air raid.

In the three nights between 20 – 22 December 1940, 365 people throughout Merseyside were killed. On the first night, a bomb that had broken through the ground below two air raid shelters in Liverpool exploded. The force of the blast pinned many of the people inside the shelters against the roof.

Although forty-eight people were rescued, forty-two people died in that incident. Another forty-two people were killed when a series of railway arches in Bentinck Street, Liverpool were directly hit. The arches were being used as unofficial air raid shelters. On 21 December, seventy-four people were killed in another direct hit on an air raid shelter.

The heaviest night of bombing was 3 May, with the biggest single incident of the night being the explosion of the cargo ship Malakand in Huskisson Dock No. 2, carrying one thousand tons of bombs and shells. A partly inflated barrage balloon (an inflatable device used to disrupt air raid attacks) came loose from its moorings and became tangled up in the Malakand's rigging. The balloon burst into flames and landed on the ship's deck. Although this fire was put out, flames from dock sheds that had been bombed soon spread to the Malakand, and the fire services struggled to fight the fire. A few hours after the 'all clear' signal had gone up around Merseyside, signalling the end of the air raids for that night, the Malakand exploded, destroying the entire Huskisson No. 2 dock and killing four people. It took seventy-four hours for the fire to burn out. The final bombs to be dropped on Merseyside during the War landed on 10 January 1942.

Liverpool 'Blitz' timeline:

- **1937** Civil Defence Services for the Merseyside Area established.
- **1939**
    - August - Evacuation preparations in Merseyside begin; children issued with gas masks and name tags.
    - 3rd August - Britain enters the Second World War; 95,000 children are evacuated from Merseyside.
- **1940**
    - 9th August - First bombs dropped on Merseyside at Prenton, Birkenhead. Liverpool's first casualty of the 'Blitz'.
    - 10th August - First bombs dropped on Wallasey.
    - 17th August - First bombs dropped on Liverpool. Liverpool Overhead railway damaged.
    - 19th August - Walton Gaol bombed killing 22 prisoners.
    - 5th September - Liverpool's Anglican Cathedral damaged by bomb blast.
    - 6th September - Children's Convalescent Home bombed, Birkenhead.
    - 26th September - Heavy raid on docks and warehouses. Argyle Theatre, Birkenhead, seriously damaged.
    - 23rd October - Merseyside suffers 200th air raid.
    - 28th November - Heaviest air raids to date; 200 people killed in total as the first land mines dropped on Merseyside. 164 people killed when a shelter underneath the Junior Technical School, Durning Road, collapsed.
    - 3rd December - 180 people killed in attack on a packed air raid shelter.
    - 12th December - Merseyside suffers its 300th air raid.
    - 20th December - Start of the 'The 'Christmas Raids' with 365 people killed over three nights. 42 people killed in a bomb attack on two air raid shelters; another 42 people killed when railway arches being used as unofficial shelters are hit; 1399 children evacuated out of Liverpool.
    - 21st December - 74 people killed in a direct hit on a large air raid shelter.
    - 22nd December - End of the 'Christmas Raids'.
- 1941
    - January - Bad flying weather results in just three air raids in the whole month.
    - 7th February - 'Western Approaches Command Headquarters transferred to Liverpool from Plymouth. Only two raids are carried out on Merseyside in February.
    - 12/13th March - Heavy bombing resumes. Wallasey suffers its heaviest raids as 174 people are killed.
    - 16th March - Baby girl found alive under debris in Wallasey, after being trapped for three and a half days.
    - 25th April 1941 - Winston Churchill visits Liverpool to see the city and port. The Luftwaffe (German air force) limited the raids on Merseyside to just three this month, conserving their forces for the upcoming 'May Blitz'.
    - 1st May - Beginning of the 'The 'May Blitz' 1741 people were killed and 114 people seriously injured by the end of the week.

- 3rd May - Worst night of the 'May Blitz', including the explosion of the cargo ship Malakand in Huskisson Dock.
- 7th May - Final night of the 'May Blitz'.
- 13th May - 550 'Unknown Warriors of the Battle of Britain' are buried in a common grave at Anfield Cemetery.
- 1st June - Heavy raids on Liverpool docks; East Gladstone Dock is badly damaged.
- 24th July - Light air raid on Merseyside.
- 1st November - A light air raid is the final attack on Merseyside in 1941.

- 1942
  - 10th January - Merseyside's final bombing raid of the Second World War sees houses in Upper Stanhope Street demolished.

The site of concern was placed within Region 10 (Manchester) for Civil Defence purposes and the figures for bombs falling in the area are well recorded. Region 10 received some **3 478.8 Tonnes** of HE bombs throughout the war. German aeroplanes dropped **2 315 high explosive bombs**, 119 land mines and countless smaller incendiary devices (fire bombs) during their attacks on Liverpool.

A summary of the bombs that fell on Region 10 Group 6D throughout WW2 is shown below:

Ordnance Type	No of Bombs	% of Total HE
High Explosive (HE)		
50Kg HE	576 (1)	
250Kg HE	368	
500Kg HE	57 (3)	
1000Kg HE	6	
1400Kg HE	-	
1800Kg HE	-	
Parachute Mine	592	
V1 'Doodlebug'	14	
V2 Long Range Rocket Bomb	-	
Anti-Personnel Bomb		
Incendiary		
50kg Phosphorus	Unknown	
Small IBs	Unknown	
Fire Pot	Unknown	
Oil Bomb	202	
Containers	Unknown	
Unclassified	10 658	

By May 1941, concentrated aerial attacks were diverted elsewhere and only sporadic bombing of London and the Southeast of England occurred.

UNEXPLODED BOMBS (UXBs)

Between 1940 and 1945, Bomb Disposal (BD) Teams cleared over 50,000 items of German air-dropped ordnance of 50Kg or larger, 7 000 anti-aircraft (AA) projectiles and more than 30 000 beach mines – This work claimed the lives of 394 Officer's and men. The War Office at the time stated that over 200 000 HE bombs exploded in Britain during WW2 with some 25 195 remaining a threat as UXBs i.e. 11%. Some 93% of all UXBs were 50Kg HE and 250Kg HE aerial bombs.

The types of ordnance discovered as UXBs give an indicator of the type of ordnance that may be encountered on or near the site of concern.

There are no records of UXBs on the site of concern. There were several unexploded bombs (UXB) recorded in the area, from the attack of the 3/4 May 1941:

- Outside the GPO in Oriel Road.
- 16 Salisbury Road.
- 14 Wallace Street.
- 4 Wild Place.
- 49 Orrell Lane.

	• The Junction of Marsh Street & Primrose Road. • Clifford Street. • Hawthorn Road. • Akenside Street. • Beattie Street. • Knowsley Road. • St Johns Road. • Regent Road. • Rimrose Road. • Nevada Street. • And a 1000kg UXB on the north side of No. 2 graving dock at Langton dock. These, as they are recorded on civil defence records, would have been dealt with, either at the time or in subsequent years after the war, as they do not appear on current Ministry of Defence records that detail known UXBs. There are no records of UXBs on or immediately adjacent to the site of concern.
ABANDONED BOMBS	A post-air raid search of damaged buildings and facilities would have included a specific search for bomb entry holes. If such evidence was discovered, then BD Teams would have been tasked (in order of strict priority from Category A, the highest priority, to category D, the lowest) to assess the potential UXB and to recommend a course of action. UXBs that were deemed to be a high enough priority, were tackled by the BD Teams who made strenuous efforts to recover and dispose of these items. However, it was not always possible to recover such bombs either through physical constraints, a lack of resources or a change in priority. Such UXBs were noted as 'Abandoned'. Due to the low priority of abandoned bombs, records that detail them are sketchy and sometimes contradictory. Others were subsequently recovered after the War when time and resources permitted and others remain 'abandoned'. It is worth remembering that 'abandoned' bombs may also include suspected UXBs that were reported but not confirmed, but simply efforts to locate the 'bomb' were exhausted. No Abandoned Bombs are recorded in the wider vicinity of the site of concern.
BOMB CENSUS MAPS	Unfortunately, detailed bomb census maps of the time did not survive the War and therefore cannot be examined for the purposes of this assessment. However, one reference map, the 'Hand Map of the City of Liverpool', produced by the City Engineer T. Molyneux MInst CE survives. This map records 'serious HE damage' which equates to a High Explosive Bomb strike although it does not record the number of bombs that fell to create the damage. This map shows that no high explosive bombs were recorded as landing directly on the site of concern, although several were recorded immediately to the east of the site. Bombs falling into water would have been extremely difficult to spot and would mostly go unrecorded – The bombs recorded by Molyneux were those that detonated upon striking the ground. The relevant extract from Molyneux's work is at Annex B.
HISTORICAL STREEP MAPS	Historical street plans of the period are a useful indicator of whether an area may have suffered bomb damage. The street layout prior to WW2 is the start state and major changes to street layouts or building boundaries may indicate that the change was due to bomb damage. In this instance, there are no significant changes to the site layout between 1938 and 1967, which may indicate potential bomb damage. The relevant Historical Street Plans are at Annex C.

HISTORICAL AERIAL PHOTOGRAPHY	The same rational applies with historic aerial photography as it does when examining historical street plans – changes between pre-war and post-war images may indicate the possibility of damage caused by bombs falling on the site. Sometimes, detail is such that it allows bomb damage to be seen directly on sites of concern. In this instance, no RAF post-War aerial photography is available so no 'before and after' comparison can be made.
THREAT ANALYSIS	
IS THERE EVIDENCE THAT THE SITE WAS AFFECTED BY ANY EXPLOSIVE ORDNANCE CONTAMINATION EVENTS?	**Yes - Possibly.** The historical record is acknowledged as being incomplete from a National perspective but there is good evidence to show that the site of concern is in an area which was badly affected by bombing during WW2; including large air-dropped bombs, and potentially including smaller anti-personnel bombs and/or incendiary bombs. The potential for large, air-dropped bombs to have landed within the wet docks on the site and remain unexploded at the bottom of those structures cannot be reasonably ignored especially considering that the docks cover the majority of the site. The potential for British anti-aircraft artillery falling back to earth as UXBs and remaining on the site undiscovered cannot be entirely ruled out although it is very unlikely. The potential for *ad hoc* military or criminal activity to have generated explosive ordnance contamination at any site is generally unquantifiable but can likely be entirely ruled out in this instance.
IF ENCOUNTERED, WHAT ORDNANCE TYPES ARE ANTICIPATED?	Of all the large bombs that were recorded as falling in Region 10; Less than 1% were 1000kg or larger, 4% were 500kg, 23% were 250kg, 34% were 50kg HE Bombs and the remainder were Parachute Mines. We must also consider the possibility, however remote, that Anti-Aircraft Artillery (AAA) projectiles or Explosive Ordnance (EO) because of military training could remain as a potential threat to the site from both WW1 and WW2. Therefore, the following items of EO may be anticipated to be potentially present on the site of concern: • Large, air-dropped, German HE Bombs including 50, 250, 500 and 1,000kg bombs (of WW2 vintage). • British AAA projectiles.
WHAT IS THE POTENTIAL EO/ UXB ENCOUNTER DEPTH?	**Ministry of Homeland Defence Security Bomb Penetration Studies**. A major study was completed by the Ministry of Homeland Security during WW2, during which the penetration depths of 1 328 air-dropped bombs (as reported by the BD Sections of the day and mostly in the Birmingham area) were recorded. It was concluded, not surprisingly, that the penetration depths of different sized bombs varied according to the geology into which they fell. The average Bomb Penetration Depth (BPD) of 430 x 50Kg HE bombs in London Clay was found to be 4.6m and that for a 250Kg bomb 6.1m. Also, they concluded that a 500Kg bomb, the largest common bomb dropped during the War, had a likely penetration depth of 6m in sand and 8.7m in clay – the maximum observed for a 500Kg was 10.2m and for a 1000Kg bomb was 12.7m. It should be remembered that these depths were achieved unencumbered by obstacles to penetration such as buildings, concrete and brickwork. **The 'J' Curve**. The 'J-curve' describes the path of a bomb (dropped from a normal altitude of about 5 000m) into homogenous ground will continue its line of flight (unless deflected by a substantial obstacle) but then turn upwards towards the surface before it stops. The horizontal distance (the 'offset') between the point of entry and final resting position was typically 1/3 of the ultimate penetration depth for a bomb. Therefore, if a bomb fell close to the exterior of a building or site and did not explode, the path that the bomb subsequently travelled beneath the ground, the "J-Curve", may have delivered it beneath the building or site footprint. The J-curve is often misunderstood, and used to describe the path taken by a bomb dropped from low flying aircraft to which it should not be applied.

	The final penetration depth of an air-dropped depends upon several factors; the velocity (as a function of the mass and speed) of the bomb, – PLANIT uses a standard velocity of 267m/s for assessment purposes – the angle of penetration of the bomb, the physical features through which the bomb travelled prior to impact with the ground, and the geology of the ground into which it entered - Generally, the softer the ground, the deeper the expected penetration depth of the bomb. Peat, alluvium and soft clays are easier to penetrate than gravels and/or sand and water content also plays a part. In addition, it must be remembered that 'barrier geology' such as very dense gravels or bedrock i.e. geology dense enough to stop the progress of a bomb underground, is an important factor in determining the median BPD. The physical characteristics of the site in this instance, would not act to retard the progress of UXBs underground by reducing their overall velocity prior to impact and therefore the maximum potential bomb penetration depths must be applied. The following UXO encounter depths *from WW2 ground levels* are estimated: • Small Incendiary and AP bombs – Surface (WW2 ground level) • Ad hoc legacy EO – Surface (WW2 ground level) • British AAA projectiles – 2m • 50kg HE – 4.5m • 250kg HE – 6m and • 500kg HE – 9m • 1000kg HE – 12m It must be remembered that UXBs can be found *at any depth* from WW2 ground level down to their maximum estimated depths. *For the Docks themselves, the maximum BPD would be estimated to be not much further than the depth of the dock itself, depending upon the nature of the dock's lining.*
HOW COULD AN UNCONTROLLED DETONATION BE BROUGHT ABOUT?	Unexploded Bombs rarely spontaneously explode. High Explosive (HE) requires a great deal of energy to create the necessary conditions for detonation to occur. In the case of WWII German bombs being disturbed during intrusive ground works, there are several scenarios to be considered: • **Direct impact onto the main body of the bomb**. Although this is a possibility, there is little chance of generating enough energy to detonate the explosive fill unless the fuse itself is directly struck. • **Re-starting the mechanical clock-timer in a bomb fuse**. This is a possibility. It is probable that environmental conditions have corroded the fuse sufficiently to prevent clockwork mechanisms from functioning. However, under some conditions, fuse elements will be in a good condition and additional movement of a bomb fuse may be sufficient to restart a previously 'jammed' mechanical clockwork mechanism. • **Induction of a static charge, creating a sufficient current to initiate an electric fuse**. This is an unlikely event. Environmental conditions are likely to have corroded the fuse, degrading its components sufficiently to prevent them from functioning. Any elements of the fuse capable of holding a charge would have dissipated in the time since the bomb failed to function. • **Friction impact initiating fuse elements causing bombs to detonate**. Although remote, this is the most likely scenario that may result in a bomb detonating. Weathering within the fuse pocket can cause the explosives within the fuse to breakdown, crystallize and exude from the fuse itself. Violent physical disturbance of this exuded material carries the remote possibility of initiating the fuse mechanism which in turn will initiate the bomb.
WHAT WOULD THE EFFECTS OF SUCH A	The effects of WWII German bombs detonating have been the subject of several well recorded studies. The general effect of an explosive detonation will depend upon: • The size of the bomb and its Net Explosive Quantity (NEQ) (i.e. how much explosive material it contains).

<table>
<tr><td>DETONATION BE TO THE SITE?</td><td>

The type of fill in the bomb (i.e. high explosive, incendiary, photoflash).
The physical location of the bomb. Whether it is:

On the surface.
Partially buried.
Buried (A bomb can be considered ‘buried’ when it is more than 2½ times its own length below ground level and covered).

The locations of the bomb in relation to other structures.
The strength and design of structures near to the seat of an explosion.
The nature of the ground (i.e. sand, gravel, clay, marsh etc.).
The location of the bomb in relation to human and animal populations.

There would be the potential for ground shock to damage important underground structures including sewers, communication cables, and foundations.
The potential Damage Radii to various underground structures has been assessed by extrapolating from the Joint Service Publication 364 which is the MOD Manual for assessing bomb damage. Potential damage radii for underground structures are assessed as:

Brick Walls - 30m
Foundations - 60m
Cast Iron/ Concrete Pipes - 15m
Earthenware/ brisk Sewers - 25m
Electric Cables/ Steel Pipes - 12m

</td></tr>
<tr><td>WOULD THE SITE CONDITIONS AFFECT THE BOMB FAILURE RATE?</td><td>There is no evidence to suggest that bomb failure rate at the site of concern would have been any different from that routinely experienced, i.e. 10-15% of all bombs dropped.</td></tr>
<tr><td>WOULD UXBs HAVE BEEN DISCOVERED DURING WW2?</td><td>
Density of Bombing. Liverpool received a relatively high density of bombing in WW2 but we know that the site itself did not likely receive any direct bomb strikes on areas around the wet docks which would have not have created extensive blast damage to the area. This fact would have made data gathering at the time easier and the likelihood of overlooking UXBs lower on hard standing areas. The same cannot be said for the wet docks themselves, where this argument cannot be applied, where regardless of surrounding bob damage, the water would have appeared undisturbed post-air raid.
Frequency of Access. The site was a busy, industrial area at the time of the aerial bombing and given its strategic value, it is likely that it would have been subject to thorough post-air raid survey and clearance. Given this fact and that the immediate area around the site was affected by bombing, any post-raid survey activities would have been particularly thorough. This would have made the likelihood of identifying smaller items of EO (such as Incendiaries and AP bomblets) quite high whilst larger UXBs would have been more readily identified, even when you consider that UXB entry holes are diminutive. The same cannot be said for the wet docks themselves, where this argument cannot be applied as there was no means of observing potential damage in any event (unless dredging operations were undertaken).
Ground Cover. The site of concern was predominantly covered by water surrounded by well-constructed, brick/concrete structures, open hard-standing and warehouses. These physical characteristics would act to retard the progress of UXBs underground by reducing their overall velocity prior to impact. Also, any damage caused by either detonating ordnance or UXBs travelling through hard standing structures would allow bomb damage to be readily identified and focus the post-air raid effort, which in turn would increase the chances of discovering UXBs. However, the wet docks across the site at the time would have been impossible to search effectively at the time even if a UXB was suspected of landing within them.
</td></tr>
</table>

	Peripheral Bomb Damage. We know that the site of concern was probably not subject to direct bomb strikes during the War on hard standing areas, which decreases the possibility of post-air raid operations failing to identify entry holes of potential UXBs. The same cannot be said for the wet docks themselves, where this argument cannot be applied as no damage would have been evident.
DOES THE SITE'S DEVELOPMENT HISTORY AFFECT THE POTENTIAL FOR UXO ENCOUNTER?	**Yes.** The fact a limited degree of post-War redevelopment has taken place at the site is worthy of note. Development of the immediate area and the site itself (warehouse installation and infrastructure changes) over the years would likely have encountered shallow UXO contamination at the time, which would have been dealt with. This does not apply to the docks themselves, where no such opportunities have occurred, unless dredging and/or maintenance operations have been conducted within the docks themselves. It is worth noting that historical development either immediately post-War or in the 1960/ 70 and 80s would not have taken any account of the potential for UXBs at the site of concern nor would any effective technology be available to detect such potential threat items at depth. Modern structures tend to have foundation designs that go deeper than historic buildings and risk encountering UXBs at depths beyond existing historic foundation levels that were not detected by excavation or bomb survey. Remember, 'at risk' ground volumes may remain beneath post-War structures, between the maximum engineering depth achieved by the structure when built down the estimated maximum Bomb Penetration Depth (BPD). In addition, bombs may be found anywhere from the surface ***down to*** the estimated maximum BPD).
DOES THE UXO THREAT VARY ACROSS THE SITE?	**Yes.** Volumes of ground within the site already subjected to extensive redevelopment involving the displacement of earth, may be considered free from the threat of UXO/EO ***within the volumes of ground excavated/disturbed***. This would include foundations for post-War, multi-storey buildings and underground utility runs. Volumes of ground within the site already subjected to historical piling post-War may be considered a lower potential risk, ***within the ground volume occupied by the piles***, from large, air-dropped bombs than areas that have not been subjected to the same degree of intrusive engineering. However, this does not equate to no risk. These assumptions are not true for the remainder of the site or for ground volumes that are potentially at risk underneath modern structures or within the docks themselves.
THREAT ASSESSMENT	
POTENTIAL EXPLOSIVE ORDNANCE THREAT ITEMS	Regarding the area of the site outside of the Docks themselves, given the degree and nature of post-War redevelopment, it is likely that UXBs with very shallow penetration depths such as small incendiary and anti-personnel bombs would have been disturbed and discovered by now, if present. By the same token, any Explosive Ordnance (EO) because of *ad hoc* military activity is likely to have been discovered, if present, also. It is reasonable, therefore, to discount these potential threat items as likely to be present within these ground volumes today. The potential for larger items of explosive ordnance (British AAA and German air-dropped bombs) to remain as UXBs is limited across the site outside of the Docks themselves, given that we know that no bombs were recorded as detonating here in WW2. However, the potential for these items to have landed within the wet docks on the site and remain unexploded at the bottom of those structures cannot be reasonably ignored especially considering that the docks cover most the site. Therefore, the following items of EO may be anticipated to be potentially present within the dock basins: • Large, air-dropped, German HE Bombs including 50, 250, 500 and 1,000kg bombs (of WW2 vintage). • British AAA Projectiles.

	Given that the potential for UXO encounter remains realistically only within the Dock Basins themselves, it is reasonable to divide the site into two areas, the 'UXO Threat Zone', i.e. the dock basins and the remainder of the site, i.e. the hardstanding area.
ENGINEERING WORKS	The following engineering processes are thought to be planned: • Ground investigation. • Piled Foundations. Both the proposed piles and boreholes will penetrate deeper than the existing base of the dock.
RISK PATHWAY	For the purposes of this assessment, it has been assumed that site investigation works could include boreholes beyond WW2 ground levels. It is anticipated that personnel or key equipment may complete the risk pathway during intrusive engineering operations that may bring them into physical contact with potential threat items.
CURRENT EXPLOSIVE ORDNANCE THREAT LEVELS	Volumes of ground within the site already subjected to extensive redevelopment involving the displacement of earth, may be considered free from the threat of UXO/EO within the volumes of ground excavated or disturbed. The ordnance Threat Level for these ground volumes is **NEGLIGIBLE**. Volumes of ground within the area of the site covered by hardstanding quays, roadways, trackways etc. outside of the UXO Threat Zone, may be considered free from the threat of UXO/EO. The ordnance Threat Level for these ground volumes is **NEGLIGIBLE**. The Ordnance Threat Levels within the UXO Threat Zone, from the Threat Assessment Matrices are assessed as: Ordnance Type: British AAA, 50kg, 250Kg and 500Kg HE Bombs — Threat Level: **MEDIUM** Within the 'UXO Threat Zone', the maximum BPD would be estimated to be not much further than the depth of the dock itself, say 1m as a safety margin, depending upon the nature of the dock's lining. Beyond this depth there is no UXO-related threat.
WHAT ARE THE CONSEQUENCES OF AN UNCONTROLLED DETONATION?	The following consequences of an uncontrolled detonation are anticipated: For British AAA & 250kg HE Bombs: • People - Lost time injury <7 days • Plant - Item write off • Property - Major damage • Environment - Localised effect For 50 & 500kg HE Bombs: • People - Lost time injury >7 days • Plant - Unit level damage • Property - Major wider damage • Environment - Major effect

THREAT MATRICES

ORDNANCE CATEGORY

The ‘Ordnance Category’ is assessed for the different types of ordnance in terms of the ‘Damage Radii’ that may result were the ordnance subject to an uncontrolled explosion and is a function of the calibre of the ordnance and whether it is encountered on the ‘surface’ or ‘buried’.

	Ordnance Category Description	Danger Radii (m)	Potential Threat Item
0	No Explosive Ordnance (EO) suspected to be present	NA	NA
1	Landmines, Anti-Personnel, HE; HE in Bulk <5Kg; Pyrotechnics	< 75	**British AAA Projectiles**
2	Projectiles, HE <75mm calibre; Projectiles, Mortar, HE 50mm to < 75mm calibre; Grenades, Hand, HE; Grenades, Rifle, HE.	< 100	**50 & 250kg HE Bombs**
3	Projectiles, HE < 125mm calibre; Rockets, HE, Anti-Tank (HEAT); Bombs PIAT, HE; Arial Bombs, HE, 50-250Kg (Surface & Buried); Aerial Bombs, Blast, HE & Sea Mines 20-250Kg; Aerial Bomb, HE, 250-500Kg (Buried)	< 250	**500kg HE Bombs**
4	Bombs, Mortar, HE <105mm calibre; Bombs, Mortar, Spigot, HE; Landmines, Anti-Tank, HE; Aerial Bombs, HE, 250-500Kg (Surface)	< 300	NA
5	Projectile, HE > 125mm calibre; Aerial Bombs, HE, 1500-2500Kg (Surface); Aerial Bomb, Blast, HE & Sea Mines 500-1500Kg (Surface)	< 500	NA
6	Aerial Bombs, HE, 2000-10000Kg (Buried); Aerial Bombs, Blast, HE & Sea Mines 1500-4000Kg (Surface)	< 800	NA

ORDNANCE THREAT

This table assigns the 'Ordnance Threat', which is a function of the Ordnance Category and the anticipated encounter depth. i.e. the smaller and deeper the ordnance the less threat is present to people and property at the surface.

	ORDNANCE CATEGORY						Depth of Encounter (m)
0	1	2	3	4	5	6	
	ORDNANCE THREAT						
							>10
			250kg Bomb	500kg Bomb			5<10
		British AAA	50kg Bomb				2.5<5
							0.5<2.5
							0<0.5
							Surface

ORDNANCE THREAT LEVEL

The 'Ordnance Threat Level' is arrived at by comparing the 'Ordnance Risk' with the 'Likelihood of Encounter' of ordnance as a function of the level of expected ordnance contamination of a given type at a site of concern.

Ordnance Threat	ASSETS AFFECTED				LIKELIHOOD OF ENCOUNTER				
	People	Plant	Property	Environment	Very Unlikely	Unlikely	Likely	Very Likely	Extremely Likely
	No effect								
	First aid injury	Slight damage	Slight damage	Slight Effect					
	Medical injury	Item repair	Minor damage	Minor Effect					
AAA & 250kg	Lost time <7 days	Item write off	Major damage	Local Effect	**AAA & 250kg**				
50 & 500kg bombs	Lost time injury >7 days	Unit level damage	Major wider damage	Major Effect	**50kg & 500kg**				
	Fatality	Multiple damage	Catastrophe	Massive Effect					

ORDNANCE THREAT LEVEL

No special measures required	**NEGLIGIBLE**	
Monitor & manage potential risks	**LOW**	
Review & emplace strict control measures if necessary	**MEDIUM**	**XXXX**
Control measures required to mitigate risks to acceptable levels	**HIGH**	
Intolerable Risk Level. Immediate control measures prior to any further works	**EXTREME**	

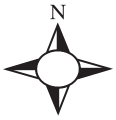
THREAT MITIGATION		
ACTIVITY	**THREAT MITIGATION MEASURES**	**FINAL THREAT LEVEL**
ALL ACTIVITIES	A threat management strategy **IS REQUIRED** to be in place prior to intrusive engineering works within the UXB Threat Zone for the site of concern. **Explosive Ordnance Safety Awareness Briefings.** An explosive ordnance Safety Briefing should be included as part of routine site health and safety training and form a key element of the Site Health & Safety Plan. This should be conducted by a trained specialist and would assist conformance with the CDM Regulations 2015. The briefing will instruct all personnel on the identification of EO hazards, actions to take in the event of an EO incident to protect personnel, key equipment, property and the public. **Explosive Ordnance Site Safety Instructions.** Explosive Ordnance Site Safety Instructions should be drafted for inclusion in the site-specific health and safety manual and would include information on dealing with an EO incident safely and appropriately. These instructions would form part of the permanent site documentation and will be an aide memoire for identifying potential EO hazards, making a preliminary threat assessment as well as specific guidelines on what to do in the event of a confirmed incident.	**AS LOW AS REASONABLY PRACTICABLE (ALARP)**
SITE INVESTIGATION WORKS	Site investigation works should be supported by UXO survey as appropriate. Consideration should be given to whether the works are shallow or deep from the perspective of UXO Survey. 'Shallow' Survey is survey of the ground from 0.0m bgl to 6.5m bgl and 'Deep' UXO Survey is that beyond 6.5mbgl. • **Boreholes.** PLANIT can conduct a non-intrusive survey of a 5m x 5m box which will accurately allow your borehole to proceed into a volume of ground under which there are no ferrous obstructions. Several locations may be provided within a survey box, allowing maximum flexibility for positioning and preventing any boreholes being terminated because of encountering a potential threat item at depth. • **Trial Pits.** Using shallow non-intrusive survey, the area for your trial pit can quickly be surveyed and confirmed as free from ferrous anomalies/UXO. Data is interpreted on-site and therefore locations can be changed very efficiently in the event of a potential obstacle. • **Window Sampling.** Using shallow non-intrusive survey, the area for your window sample can quickly be surveyed and confirmed as free from ferrous anomalies/UXO. Data is interpreted on-site and therefore locations can be changed very efficiently in the event of a potential obstacle.	**AS LOW AS REASONABLY PRACTICABLE (ALARP)**

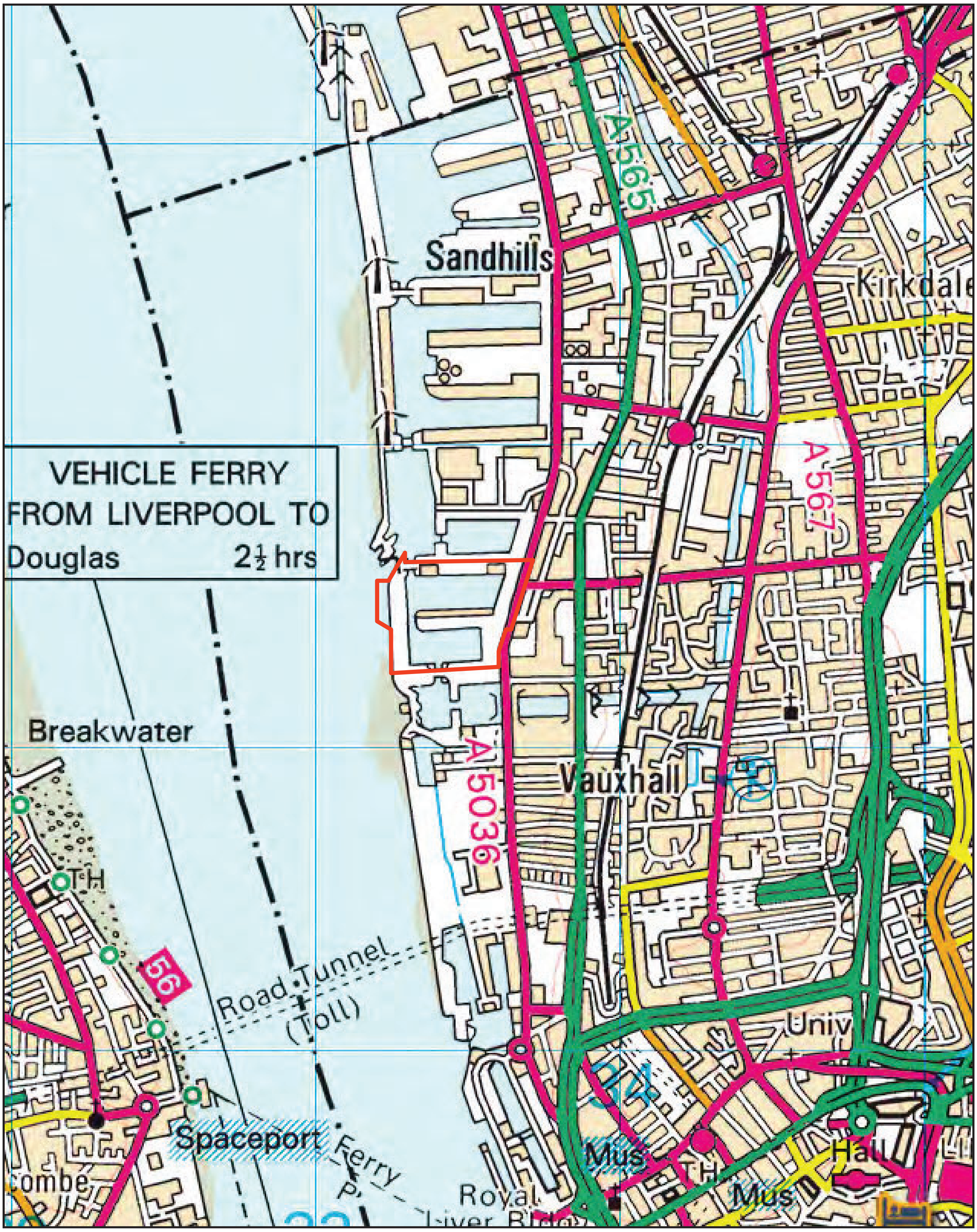
SHALLOW INTRUSIVE ENGINEERING WORKS	There are two options available to effectively deal with the EO Threat when conducting shallow intrusive ground works. **On-Site UXO Support.** On-site UXO Support for shallow ground works would involve the presence of an appropriately trained and experienced UXO Technician during this phase of construction. The role of the UXO Technician is to: • Conduct EO Safety Awareness Briefings as required. • Monitor all intrusive ground works using visual and instrument aided means to locate any EO that may be uncovered during site works. • Provide an immediate and expert assessment of any EO that may be discovered. • Assist in implementing an appropriate and safe response to an EO incident. • Design and emplace protective works as an immediate response to protect personnel, key equipment, property and the public as may be required. • Advise on best safe working practice considering the perceived EO Threat. • Act as the liaison with the Authorities on behalf of the Client in the event of an EO incident. **Shallow Non-Intrusive UXO Survey**. PLANIT can deploy industry leading technology that will survey your site of concern non-intrusively (if ground conditions permit) to identify potential EO Threat Items. Any anomalies identified following the non-intrusive survey that may be EO should then be subject to Controlled Excavation to confirm them as EO and remove the threat or discount them. Once the non-intrusive survey and controlled excavation are complete, there is no further requirement for UXO Support at the site of concern since all EO Threats would have been identified and dealt with.	**AS LOW AS REASONABLY PRACTICABLE (ALARP)**
DEEP INTRUSIVE ENGINEERING	There are several options available to effectively deal with potential EO Threats when conducting deep intrusive ground works. Which approach is applicable will depend upon the ground conditions of the site of concern: **Deep Non-Intrusive UXO Survey.** PLANIT can deploy industry leading technology that will survey your site of concern non-intrusively (if ground conditions permit) to identify potential EO Threat Items at depth – UXO Survey should proceed to the expected UXB penetration depth or maximum depth of intrusive ground works, whichever is shallower. As a benchmark, PLANITs Deep Non-Intrusive Survey is capable of identifying a 500Kg HE bomb to some 8.0m bgl in average ground and larger bombs deeper. This approach is ideal for covering large areas quickly and can be employed to survey piling runs and borehole locations. Any anomalies identified following the non-intrusive survey that may be EO should then be subject to Controlled Excavation to confirm them as EO and remove the threat or discount them. Once the non-intrusive survey and controlled excavation are complete, there is no further requirement for UXO Support at the	**AS LOW AS REASONABLY PRACTICABLE (ALARP)**

	site of concern since all EO Threats would have been identified and dealt with. **Magcone UXB Survey.** PLANIT can deploy world class Magcone Survey Systems to survey either pile locations or small areas ahead of intrusive engineering including piling and drilling. The Magcone system is very versatile and can survey to great depths if required. **Down-Hole Magnetometer UXO Survey**. PLANIT can deploy down-borehole UXO Survey equipment that will clear ahead of a piling or borehole rig as it descends underground. The main drawbacks of this approach are that it is time consuming, 'blind' (insofar as the borehole may proceed for some depth before a potential threat item is identified, at which stage the borehole will have to be terminated and relocated, wasting time and money), equipment heavy and expensive. Any anomalies identified during this survey that may be EO should either be subject to Controlled Excavation to confirm them as EO and remove the threat or discount them or relocate the borehole or adjust the piling plan. UXO Survey should proceed to the expected UXB penetration depth or maximum depth of intrusive ground works, whichever is shallower.	

ANNEXES

A. Site Location & Layout.
B. Bomb Census Summary.
C. Historical Street Maps.
D. UXO Threat Zones.



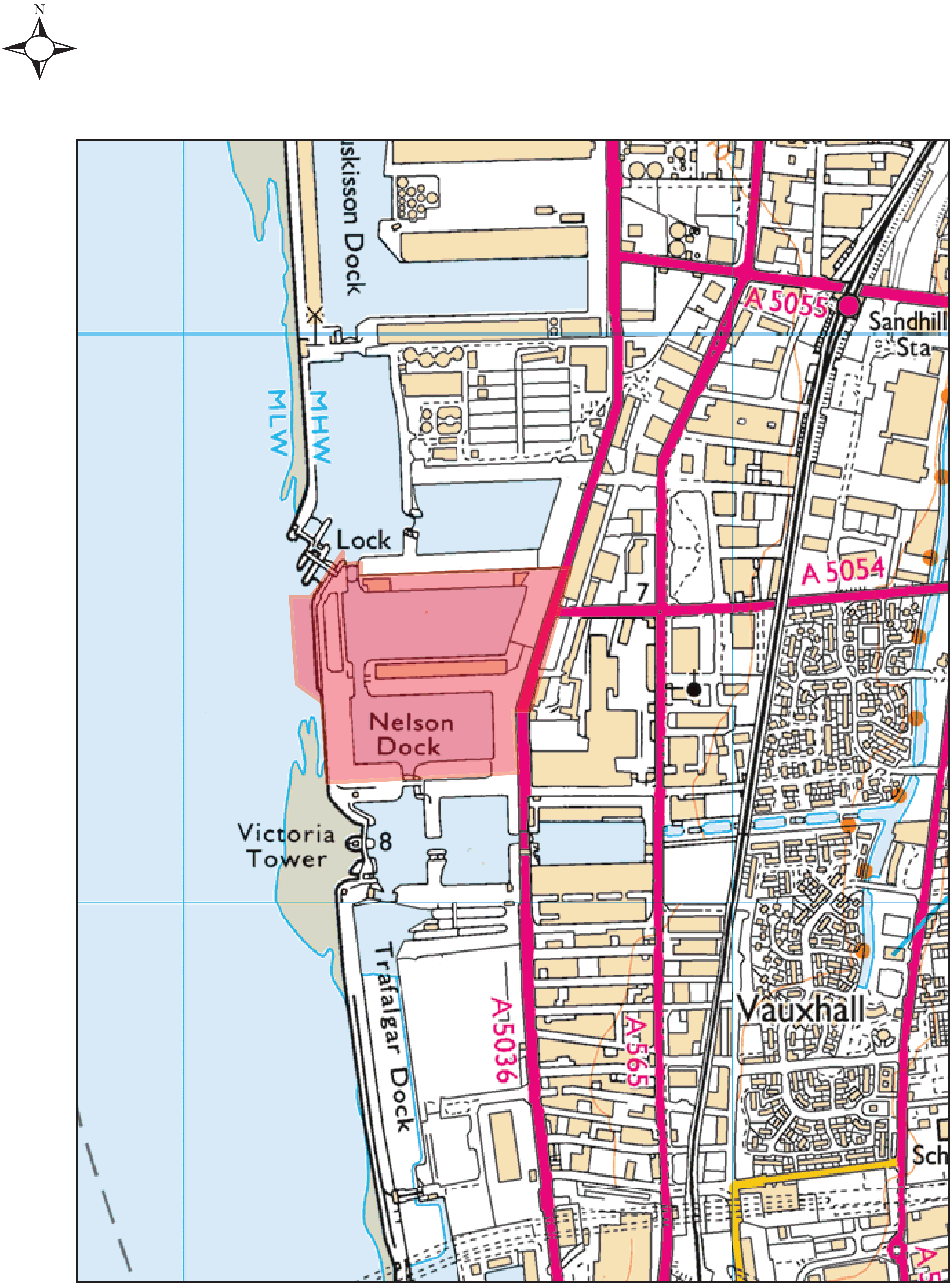


Annex A: Site Location
Client: Buro Happold
Project Ref: Everton FC
Doc Ref: Everton FC 15/05/17

Key:

Site Location

A - 1



Annex A: Site Location
Client: Buro Happold
Project Ref: Everton FC
Doc Ref: Everton FC 15/05/17

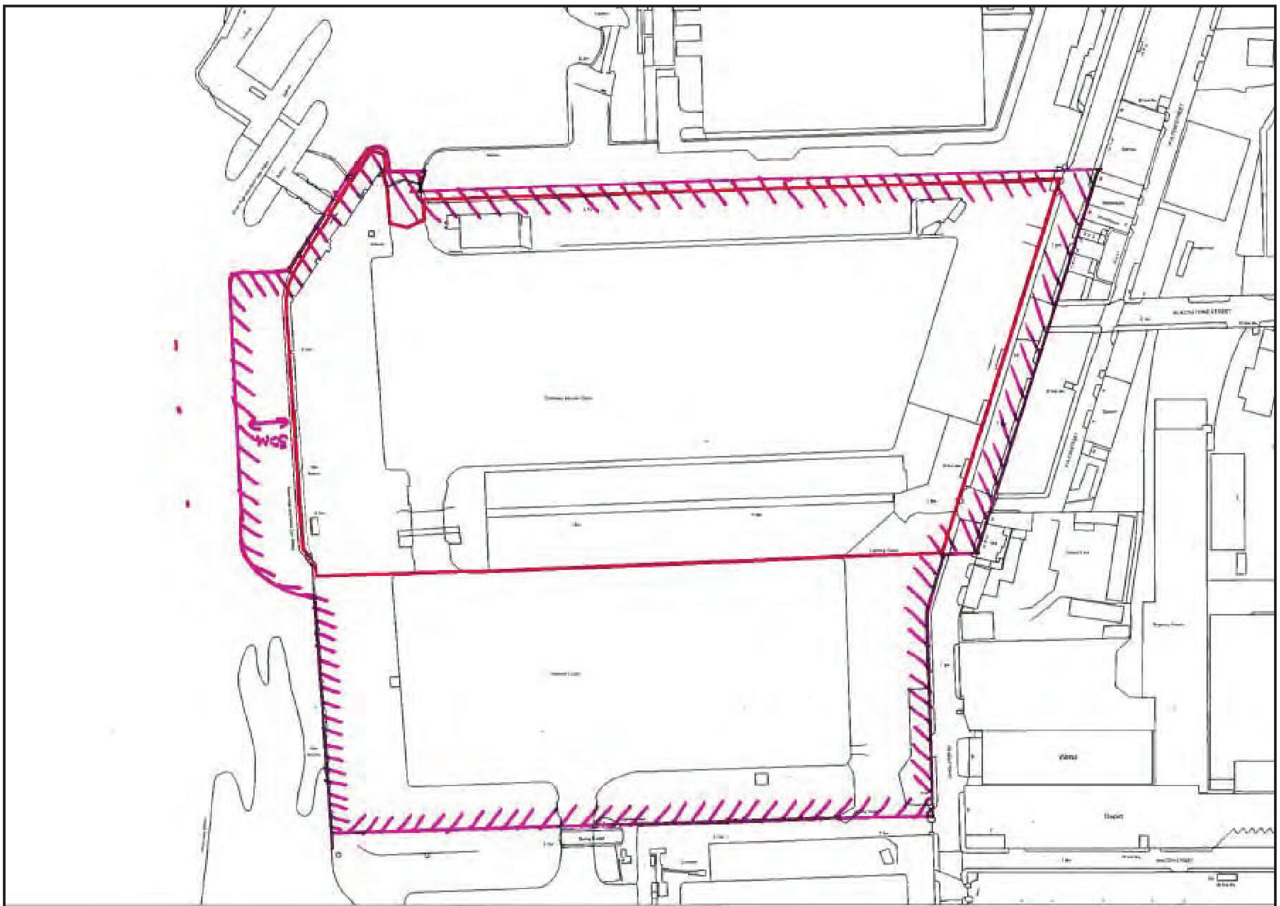
Key:

Site Location

PLANIT RESTORING BALANCE

A - 2

N



Proposed site of Everton Football Club
21.79 acres

Annex A: Site Location
Client: Buro Happold
Project Ref: Everton FC
Doc Ref: Everton FC 15/05/17

Key:

Site Location

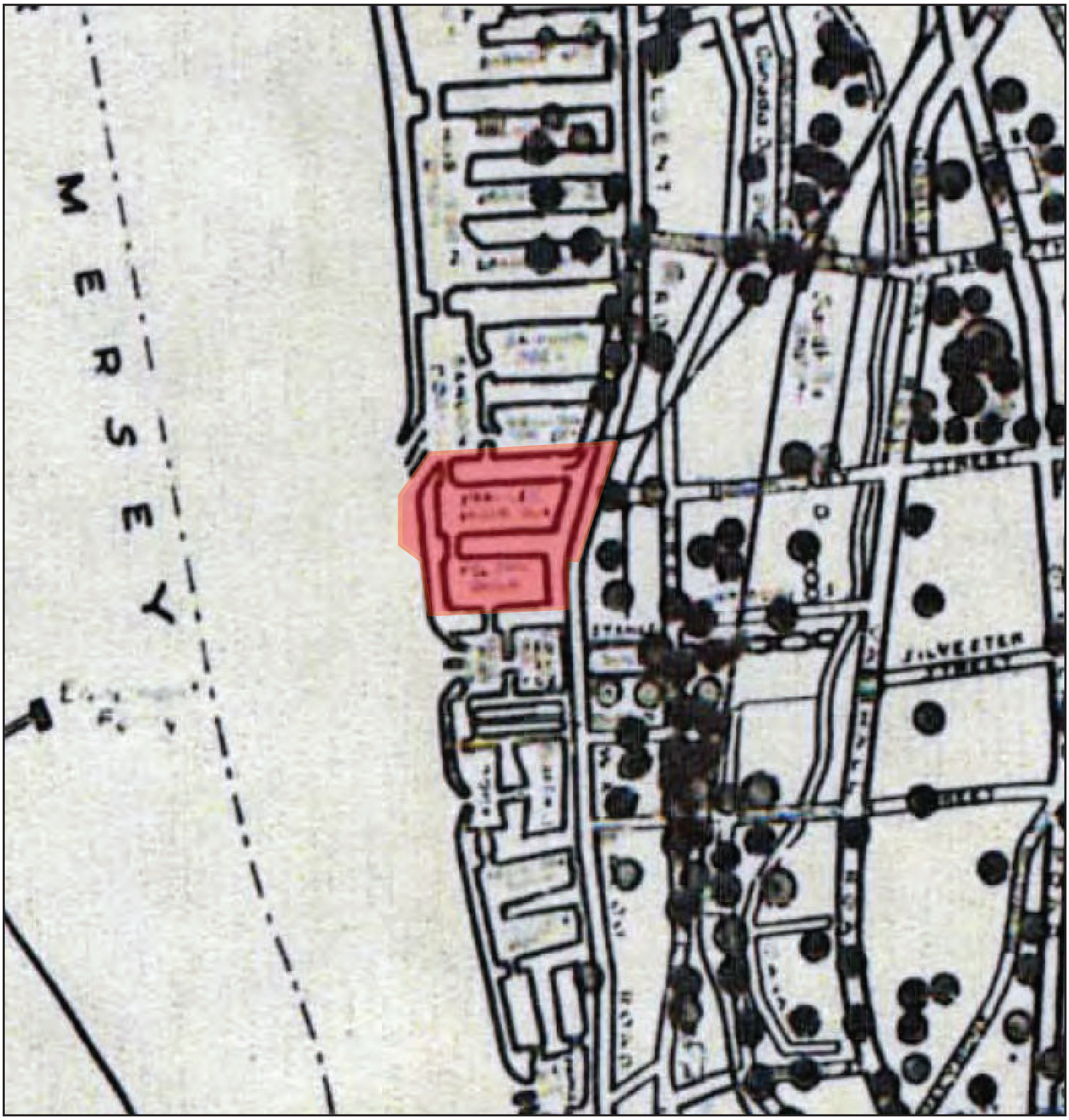
Annex A: Site Location
Client: Buro Happold
Project Ref: Everton FC
Doc Ref: Everton FC 15/05/17

Key:

Site Location

PLANIT
RESTORING BALANCE

N



Key:

Site Location

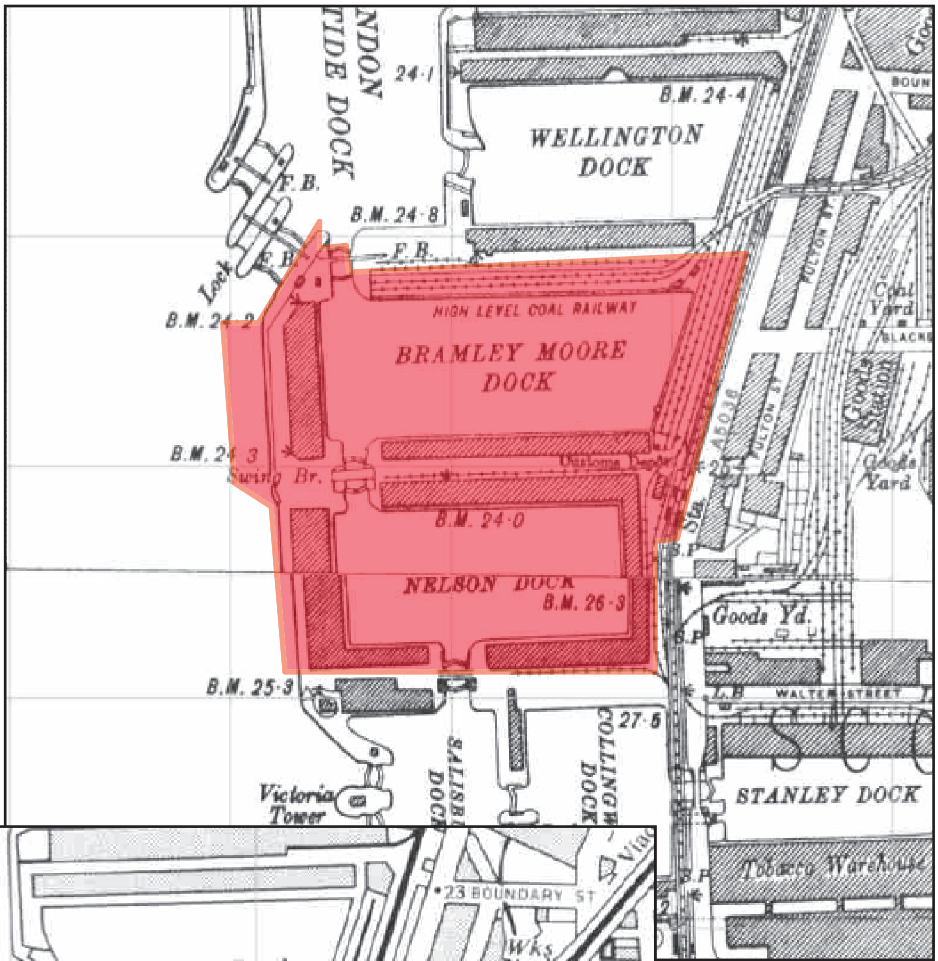
High Explosive Bombs

Annex B: Bomb Census Summary
Client: Buro Happold
Project Ref: Everton FC
Doc Ref: Everton FC 15/05/17

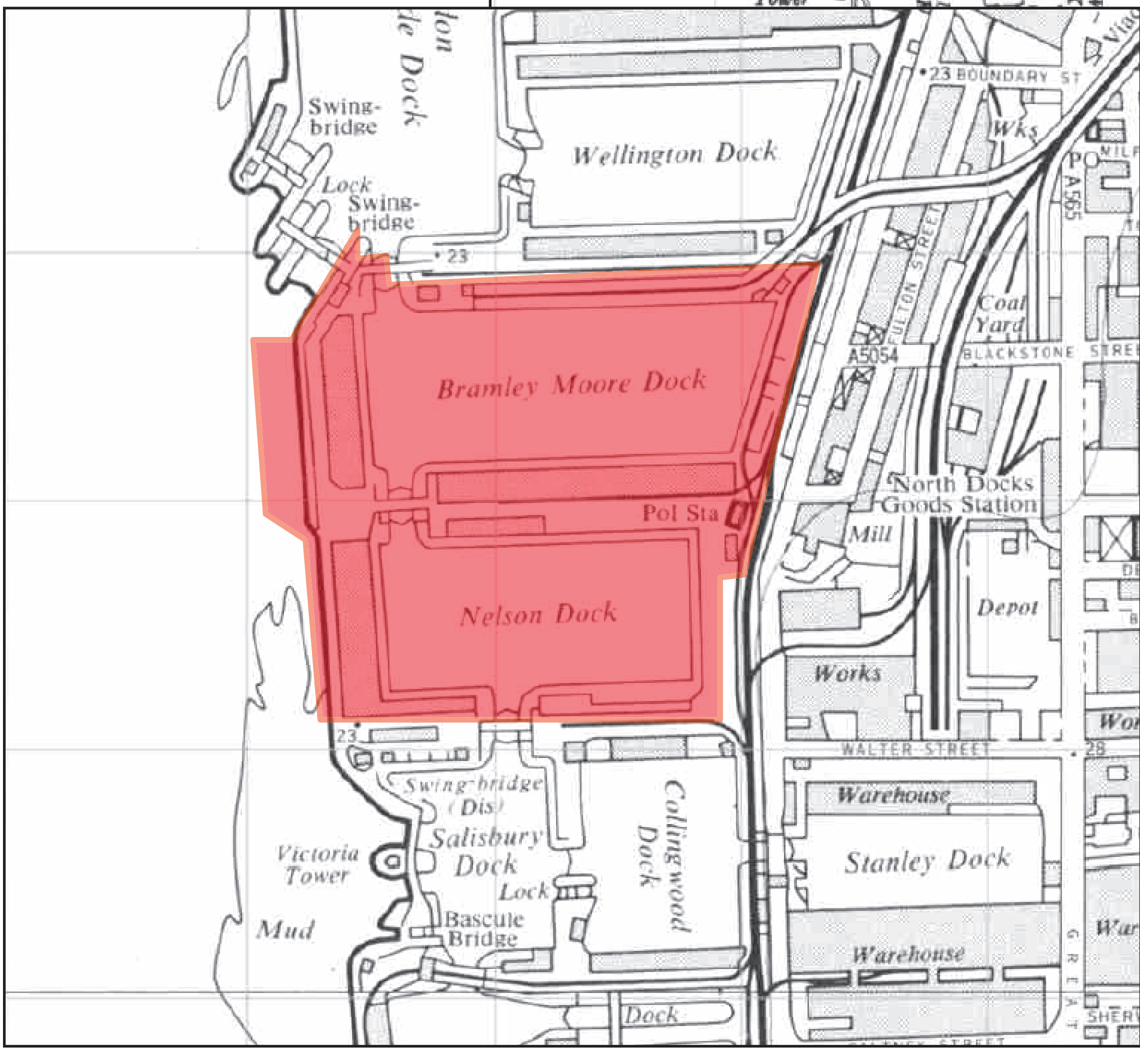
PLANIT RESTORING BALANCE

N

1938



1967



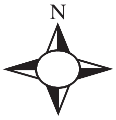
Annex C: Historical Street Maps
Client: Buro Happold
Project Ref: Everton FC
Doc Ref: Everton FC 15/05/17

Key:

Site Location

PLANIT RESTORING BALANCE

C- 1



Key:

Site Boundary

UXO Threat Zone

Annex D: UXO Threat Zone
Client: Buro Happold
Project Ref: Everton FC
Doc Ref: Everton FC 15/05/17

Appendix C - Contamination Risk Assessment Criteria

A risk-based approach is used for the assessment of contamination, requiring identification of a contaminant source, a receptor and a realistic pathway via which the contaminant may reach the receptor. The key receptors considered in this assessment are site end-users, construction workers and controlled waters. In order to perform a generic quantitative risk assessment, the soil test results have been compared with available SGVs, C4SLs, Buro Happold and other industry GAC.

General Contaminants

Analytical data derived from the investigation has been put into context by comparison with published guidance or derived thresholds values. Current UK guidance published thresholds comprise SGVs and C4SLs, which are available for a limited number of determinands and land uses. For contaminants without published SGVs or C4SLs or where soil conditions are different to those assumed for the published guideline values (6% soil organic matter content and sandy loam soil), GACs have been derived. The derivation of GACs has been carried out based on published statutory guidance documents and with consideration of the most sensitive receptors in the respective CLEA standard land- uses scenarios (the 0 to 6 year old child for the residential with and without plant uptake scenarios and the adult for the commercial / industrial land-use scenario) using the software model "CLEA 1.06" and associated handbook and [24]. Contaminant specific model input values have been selected as prescribed by the EA SGV reports. In the absence of SGV reports, contaminant specific input values have been selected as suggested by SC050021/SR7 and / or the LQM report and / or the EIC / AGS report.

Lead: Assessment criteria for Lead have been adopted as derived and detailed in the C4SL documents.

Mercury: Assessment criteria for mercury is based on the published threshold SGV, these have been produced for elemental, inorganic and methyl mercury. Inorganic mercury is the most common form of mercury in the environment. It is recommended by the EA that elemental and methyl mercury are used as SGVs where the Desk Study has identified a potential source otherwise inorganic mercury should be used. Concentrations of elemental mercury will also be considered where concentrations are notably higher than 'natural' background concentrations (e.g. 20mg/kg).

Chromium: Assessment criteria for chromium is based on the published threshold LQM value and have been produced for chromium III (trivalent) and chromium VI (hexavalent). Chromium III is the most common form of chromium in the environment, chromium VI is produced by the oxidation of chromium III through industrial processes. Therefore chromium VI should only be assessed where the Desk Study has identified a potential source otherwise chromium III should be used.

Statistical Analysis

Where appropriate and individual concentrations of contaminants have been found exceeding assessment criteria, the data was analysed statistically in line with the 'Guidance on Comparing Soil Contaminant Data with Critical Concentrations'. Where the distribution of data for particular determinands showed evidence of non-normality, the 95% upper confidence limits (US95) were calculated using the Chebychev Theorem in accordance with this guidance.

Appendix References

Ref. 1 EA. 2009. Soil Guideline Values for nickel in soil - Science Report SC050021 / Nickel SGV.

Ref. 2 EA. 2009. Soil Guideline Values for toluene in soil - Science Report SC050021 / toluene SGV.

Ref. 3 EA. 2009. Soil Guideline Values for selenium in soil - Science Report SC050021 / Selenium SGV.

Ref. 4 EA. 2009. Soil Guideline Values for inorganic arsenic in soil - Science Report SC050021/ arsenic SGV.

Ref. 5 EA. 2009. Soil Guideline Values for xylene in soil - Science Report SC050021 / xylene SGV.

Ref. 6 EA. 2009. Soil Guideline Values for benzene in soil - Science Report SC050021 / benzene SGV.

Ref. 7 EA. 2009. Soil Guideline Values for ethylbenzene in soil - Project SC050021 / ethylbenzene SGV.

Ref. 8 EA. 2009. Soil Guideline Values for mercury in soil - Science Report SC050021 / Mercury SGV.

Ref. 9 Defra. 2014. SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Document.

Ref. 10 Contaminated Land: Applications in Real Environments. 2013 SP1010 – Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination. Final Project Report. 20th December 2013.

Ref. 11 EA. 2005. The UK Approach for Evaluating Human Health Risks from Petroleum Hydrocarbons in Soils. Science Report P5-080/TR3.

Ref. 12 EA. 2009. Updated technical background to the CLEA model. Science Report – SC050021/SR3.

Ref. 13 EA. 2009. Human health toxicological assessment of contaminants in soil. Science Report – SC050021/SR2.

Ref. 14 EA 2009. CLEA Software (Version 1.06).

Ref. 15 EA. 2009. CLEA Software (Version 1.05) Handbook. Science Report – SC050021/SR4.

Ref. 16 EA. 2008. Science report SC050021/SR7 - Compilation of Data for Priority Organic Pollutants for Derivation of Soil Guideline Values.

Ref. 17 LQM / CIEH. 2009. Generic Assessment Criteria for Human Health Risk Assessment – 2nd edition. Land Quality Press.

Ref. 18 Environmental Industries Commission (EIC). The Association of Geotechnical and Geoenvironmental Specialists (AGS) and Contaminated Land: Applications in Real Environments (CL:AIRE), Soil Generic Assessment Criteria for Human Health Risk Assessment, January 2010.

Ref. 19 CL:AIRE and CIEH. 2008. Guidance on Comparing Soil Contaminant Data with Critical Concentrations.

Ref. 20 UK Drinking Water Standards (UK DWS)

Ref. 21 Environmental Quality Standards (EQS) (Freshwater)

Ref. 22 Environmental Quality Standards (EQS) (Coastal and Estuarine)

Ref. 23 World Health Organisation (WHO) drinking water standards. 2010.

Appendix D – Soil, Groundwater and Gas Data Screening Chemical Assessment Sheets

BUROHAPPOLD ENGINEERING

Project: Project Blue - On-shore soil assessment
Project Number: 0040026
Date: 18/12/18

Asbestos

Asbestos Screen	No. Samples	No. samples detected	No. samples ND	% of samples detect
	46	1	40	2.44
Asbestos Quantification	No. Quants	No. samples <0.001%	No. samples >0.001% <0.01%	No. samples >0.01%
	0	0	0	0

Human Health

Soil Organic Matter 1%
N/A = no screening criteria available

No. samples exceeding

		Residential with uptake	Residential without Uptake	Commercial	Exceeding: Residential with uptake	Exceeding: Residential without Uptake	Exceeding: Commercial	No Tests	No <LOD	Min	Max	Location of Maximum
Cyanide	mg/kg	4.6	760	16000				46	45	2.00	2.00	BH04 2mbgl
Arsenic	mg/kg	37	40	640				44	16	2.00	32.00	BH03 0.1mbgl
Barium	mg/kg	N/A	N/A	N/A				24		17.00	153.00	P102.1 0.70mbgl
Beryllium	mg/kg	1.7	1.7	12				24	21	0.60	1.10	SS1.3 1.50mbgl
Boron	mg/kg	290	11000	240000				44	6	0.40	14.00	BH03 0.1mbgl
Cadmium	mg/kg	26	149	410				44	32	0.20	1.30	P102 0.50mbgl
Chromium	mg/kg	910	910	8600				44		5.00	39.00	BH03 0.1mbgl
Copper	mg/kg	2400	7100	68000				44		6.00	298.00	BH114 0.50mbgl
Lead	mg/kg	200	310	2330	6	5		44		4.00	1700.00	BH03 0.1mbgl
Mercury (inorganic)	mg/kg	40	56	58				44	33	0.17	1.70	BH04 2mbgl
Nickel	mg/kg	130	180	980				44		5.00	39.00	BH03 0.1mbgl
Selenium	mg/kg	250	430	12000				44	42	2.00	2.00	P101 1.75mbgl
Vanadium	mg/kg	410	1200	9000				44		8.00	43.00	BH04 2mbgl
Zinc	mg/kg	3700	40000	730000				44		10.00	350.00	BH04 1.00-1.20mbgl
TPH	mg/kg	490	490	38000	6	6		44	9	2.00	14470.00	BH04 1.00-1.20mbgl
Benzene	mg/kg	0.087	0.38	27				44	43	0.01	0.01	P102 0.50mbgl
Toluene	mg/kg	130	869	869				44	43	0.08	0.08	P102 0.50mbgl
Ethyl Benzene	mg/kg	47	83	518				44	43	0.17	0.17	P102 0.50mbgl
m/p Xylenes	mg/kg	56	79	576				44	43	0.17	0.17	P102 0.50mbgl
o Xylenes	mg/kg	60	88	478				44	43	0.12	0.12	P102 0.50mbgl
Xylenes	mg/kg	56	79	576				44	43	0.29	0.29	P102 0.50mbgl
MTBE	mg/kg	N/A	N/A	N/A				44	44			
Naphthalene	mg/kg	2.3	2.3	190	7	7	3	44	23	0.04	1230.00	P102 0.50mbgl
Acenaphthylene	mg/kg	170	2900	83000				44	34	0.01	11.00	BH04 1.00-1.20mbgl
Acenaphthene	mg/kg	210	3000	84000				44	27	0.02	204.00	P102 0.50mbgl
Fluorene	mg/kg	170	2800	63000	1			44	25	0.02	181.00	P102 0.50mbgl
Phenanthrene	mg/kg	95	1300	22000	4			44	14	0.05	1000.00	BH04 1.00-1.20mbgl
Anthracene	mg/kg	2400	31000	520000				44	23	0.05	250.00	BH04 1.00-1.20mbgl
Fluoranthene	mg/kg	280	1500	23000	4			44	16	0.15	760.00	BH04 1.00-1.20mbgl
Pyrene	mg/kg	620	3700	54000	1			44	15	0.13	810.00	BH04 1.00-1.20mbgl
Benzo[a]anthracene	mg/kg	7.2	11	170	6	5	4	44	17	0.05	390.00	BH04 1.00-1.20mbgl
Chrysene	mg/kg	15	30	350	5	4	1	44	18	0.14	420.00	BH04 1.00-1.20mbgl
Benzo[b]fluoranthene	mg/kg	2.6	3.9	44	8	6	4	44	19	0.11	410.00	BH04 1.00-1.20mbgl
Benzo[k]fluoranthene	mg/kg	77	110	1200	2	1		44	23	0.08	200.00	BH04 1.00-1.20mbgl
Benzo[a]pyrene	mg/kg	2.2	3.2	35	9	7	4	44	18	0.04	410.00	BH04 1.00-1.20mbgl
Indeno[123-cd]pyrene	mg/kg	27	45	500	4	4		44	24	0.04	190.00	BH04 1.00-1.20mbgl
Dibenzo[ah]anthracene	mg/kg	0.24	0.31	3.5	9	9	4	44	31	0.09	56.00	BH04 1.00-1.20mbgl
Benzo[ghi]perylene	mg/kg	320	360	3900				44	27	0.08	210.00	BH04 1.00-1.20mbgl
Total USEPA 16 PAHs	mg/kg	N/A	N/A	N/A				44		0.64	5837.00	BH04 1.00-1.20mbgl
Aliphatic C5 - C6	mg/kg	42	42	3200				44	44			
Aliphatic C6 - C8	mg/kg	100	100	7800				44	44			
Aliphatic C8 - C10	mg/kg	27	27	2000				44	37	0.01	0.25	P101 1.00mbgl
Aliphatic C10 - C12	mg/kg	130	130	9700				44	34	1.00	51.80	P101 1.00mbgl
Aliphatic C12 - C16	mg/kg	1100	1100	59000				44	31	4.40	455.00	P101 1.00mbgl
Aliphatic C16 - C21	mg/kg	65000	65000	1600000				44	30	1.80	572.00	P101 1.00mbgl
Aliphatic C21 - C35	mg/kg	65000	64000	1600000				44	29	7.70	490.00	BH03 0.1mbgl
Total Aliphatic	mg/kg	N/A	N/A	N/A				44	27	2.00	1420.00	P101 1.00mbgl
Aromatic C5 - C7	mg/kg	70	370	26000				44	43	0.01	0.01	P102 0.50mbgl
Aromatic C7 - 8	mg/kg	130	860	56000				44	43	0.08	0.08	P102 0.50mbgl
Aromatic C8 - C10	mg/kg	34	47	3500				44	41	0.03	1.04	P102 0.50mbgl
Aromatic C10 - 12	mg/kg	74	250	16000	4	2		44	26	0.90	590.00	BH04 1.00-1.20mbgl
Aromatic C12 - C16	mg/kg	140	1800	36000	5	1		44	20	0.60	1900.00	BH04 1.00-1.20mbgl
Aromatic C16 - C21	mg/kg	260	1900	28000	5	3		44	19	0.40	4700.00	BH04 1.00-1.20mbgl
Aromatic C21 - C35	mg/kg	1100	1900	28000	3	3		44	19	0.90	6400.00	BH04 1.00-1.20mbgl
Total Aromatic	mg/kg	1100	1900	28000	4	4		44	17	2.20	14000.00	BH04 1.00-1.20mbgl
Total Aliphatic and Aromatic	mg/kg	490	490	38000	6	6		44	9	2.00	14470.00	BH04 1.00-1.20mbgl

BUROHAPPOLD
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Project: Project Blue - Off-shore soil assessment
Project Number: 0040026
Date: 18/12/2018

Asbestos

Asbestos Screen	No. Samples	No. samples detected	No. samples ND	% of samples detect
	15	1	14	6.67
Asbestos Quantification	No. Quants	No. samples <0.001%	No. samples >0.001% <0.01%	No. samples >0.01%
	1	0	1	0

Human Health

Soil Organic Matter 1%
N/A = no screening criteria available

No. samples exceeding

		Residential with uptake	Residential without Uptake	Commercial	No. samples exceeding: Residential with uptake	No. samples exceeding: Residential without Uptake	No. samples exceeding: Commercial	No Tests	No <LOD	Min	Max	Location of Maximum
Cyanide	mg/kg	4.6	760	16000				15	15			
Arsenic	mg/kg	37	40	640				15		2.00	31.00	6 0mbgl
Barium	mg/kg	N/A	N/A	N/A				12		69.00	328.00	PAC08A 0.00mbgl
Beryllium	mg/kg	1.7	1.7	12				12	3	0.50	1.00	PAC02A 0.00mbgl
Boron	mg/kg	290	11000	240000				15		7.70	18.50	PAC02A 0.00mbgl
Cadmium	mg/kg	26	149	410				15	2	0.50	2.60	PAC08B 0.00mbgl
Chromium	mg/kg	910	910	8600				15		27.00	90.00	PAC08B 0.00mbgl
Copper	mg/kg	2400	7100	68000				15		41.00	165.00	PAC08B 0.00mbgl
Lead	mg/kg	200	310	2330	3	1		15		46.00	500.00	PAC08A 0.00mbgl
Mercury (inorganic)	mg/kg	40	56	58				15		0.39	2.88	PAC08B 0.00mbgl
Nickel	mg/kg	130	180	980				15		15.00	36.00	6 0mbgl
Selenium	mg/kg	250	430	12000				15	5	1.00	2.00	PAC02A 0.00mbgl
Vanadium	mg/kg	410	1200	9000				12		23.00	53.00	PAC08B 0.00mbgl
Zinc	mg/kg	3700	40000	730000				15		137.00	549.00	PAC08B 0.00mbgl
TPH	mg/kg	490	490	38000	1	1		15	5	2.50	1090.00	6 0mbgl
Benzene	mg/kg	0.087	0.38	27				15	15			
Toluene	mg/kg	130	869	869				15	15			
Ethyl Benzene	mg/kg	47	83	518				15	15			
m/p Xylenes	mg/kg	56	79	576				15	15			
o Xylenes	mg/kg	60	88	478				15	15			
Xylenes	mg/kg	56	79	576				15	15			
MTBE	mg/kg	N/A	N/A	N/A				15	15			
Naphthalene	mg/kg	2.3	2.3	190				15	13	0.17	0.18	PAC08A 0.00mbgl
Acenaphthylene	mg/kg	170	2900	83000				15	12	0.05	0.24	6 0mbgl
Acenaphthene	mg/kg	210	3000	84000				15	11	0.02	0.14	6 0mbgl
Fluorene	mg/kg	170	2800	63000				15	11	0.02	0.29	6 0mbgl
Phenanthrene	mg/kg	95	1300	22000				15	6	0.05	0.62	6 0mbgl
Anthracene	mg/kg	2400	31000	520000				15	12	0.05	0.33	6 0mbgl
Fluoranthene	mg/kg	280	1500	23000				15	10	0.36	3.77	PAC08A 0.00mbgl
Pyrene	mg/kg	620	3700	54000				15	8	0.18	2.60	PAC08A 0.00mbgl
Benzo[a]anthracene	mg/kg	7.2	11	170				15	10	0.17	1.23	PAC08A 0.00mbgl
Chrysene	mg/kg	15	30	350				15	10	0.24	1.41	PAC08A 0.00mbgl
Benzo[b]fluoranthene	mg/kg	2.6	3.9	44				15	4	0.10	1.60	6 0mbgl
Benzo[k]fluoranthene	mg/kg	77	110	1200				15	11	0.29	0.62	6 0mbgl
Benzo[a]pyrene	mg/kg	2.2	3.2	35				15	3	0.11	1.43	PAC08A 0.00mbgl
Indeno[123-cd]pyrene	mg/kg	27	45	500				15	2	0.09	1.63	PAC08A 0.00mbgl
Dibenzo[ah]anthracene	mg/kg	0.24	0.31	3.5	1			15	14	0.26	0.26	PAC08A 0.00mbgl
Benzo[ghi]perylene	mg/kg	320	360	3900				15	4	0.10	1.34	PAC08A 0.00mbgl
Total USEPA 16 PAHs	mg/kg	N/A	N/A	N/A				15		0.64	16.40	PAC08A 0.00mbgl
Aliphatic C5 - C6	mg/kg	42	42	3200				15	15			
Aliphatic C6 - C8	mg/kg	100	100	7800				15	15			
Aliphatic C8 - C10	mg/kg	27	27	2000				15	15			
Aliphatic C10 - C12	mg/kg	130	130	9700				15	15			
Aliphatic C12 - C16	mg/kg	1100	1100	59000				15	11	2.90	24.00	6 0mbgl
Aliphatic C16 - C21	mg/kg	65000	65000	1600000				15	10	7.00	86.00	6 0mbgl
Aliphatic C21 - C35	mg/kg	65000	64000	1600000				15	10	40.50	270.00	6 0mbgl
Total Aliphatic	mg/kg	N/A	N/A	N/A				15	10	72.40	380.00	6 0mbgl
Aromatic C5 - C7	mg/kg	70	370	26000				15	15			
Aromatic C7 - 8	mg/kg	130	860	56000				15	15			
Aromatic C8 - C10	mg/kg	34	47	3500				15	15			
Aromatic C10 - 12	mg/kg	74	250	16000				15	15			
Aromatic C12 - C16	mg/kg	140	1800	36000				15	10	1.40	22.00	6 0mbgl
Aromatic C16 - C21	mg/kg	260	1900	28000				15	6	0.70	140.00	6 0mbgl
Aromatic C21 - C35	mg/kg	1100	1900	28000				15	5	1.60	540.00	6 0mbgl
Total Aromatic	mg/kg	1100	1900	28000				15	5	2.50	710.00	6 0mbgl
Total Aliphatic and Aromatic	mg/kg	490	490	38000	1	1		15	5	2.50	1090.00	6 0mbgl

BUROHAPPOLD ENGINEERING

Project: Project Blue - Off-shore Leachate Data
Project Number: 0040026
Date: 09/03/2018

Average pH and Hardness

Calculated pH	7.6
Calculated hardness	#DIV/0!

Chemical Data Input

Determinand	Environmental Quality Standards 2014 AA Salt	Environmental Quality Standards 2014 MAC Salt	Water Supply Regulations 2016 Potable
pH			6.5 - 9.0
Conductivity			2500
Dissolved Oxygen			
BOD			
Total Dissolved Solids			
Hardness			
Cyanide	1	5	50
Mercury		0.07	1
Arsenic	25		10
Barium			
Beryllium			
Boron			1000
Cadmium	0.2	0.45	5
Chromium			50
Copper	3.76		2000
Lead	1.3	14	10
Nickel	8.6	34	20
Selenium			10
Vanadium			
Zinc	6.8		
Naphthalene	2	130	
Acenaphthene			
Acenaphthylene			
Fluoranthene	0.0063	0.12	
Anthracene	0.1	0.1	
Phenanthrene			
Fluorene			
Chrysene			
Pyrene			
Benzo(a)anthracene			
Benzo(b)fluoranthene		0.017	
Benzo(k)fluoranthene		0.017	
Benzo(a)pyrene	0.007	0.027	0.01
Dibenzo(a,h)anthracene			
Benzo(g,h,i)perylene		0.0082	
Indeno(1,2,3-cd)pyrene			
PAH, Total Detected USEPA 16			
Sum of UK DWS four 7			0.1
Total Aliphatics & Aromatics >C5-35			10

MG / NG		MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG
Sample ID		PAC01A	PAC02A	PAC02B	PAC03A	PAC04A	PAC04B	PAC05A	PAC06A	PAC06B	PAC07A	PAC08A	PAC08B
Depth		Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface	Surface
Determinand	Units												
pH	pH units	7.56	7.69	7.78	7.85	8.11	8.18	7.97	7.75	7.93	8.03	8.05	8.09
Conductivity	mS/cm												
Dissolved Oxygen	mg/l												
BOD	mg/l												
Total Dissolved Solids	g/l												
Hardness	mg/l												
Cyanide	ug/l												
Mercury	ug/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	ug/l	37	64	42	40	31	12	42	6	19	47	8	33
Barium	ug/l	41	26	29	35	30	26	32	26	48	27	61	53
Beryllium	ug/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Boron	ug/l	712	1080	1040	706	631	485	828	861	616	824	614	675
Cadmium	ug/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chromium	ug/l	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
Copper	ug/l	<1	2	1	<1	<1	2	<1	<1	<1	2	<1	<1
Lead	ug/l	<1	<1	1	<1	1	2	<1	<1	<1	1	<1	<1
Nickel	ug/l	1	1	2	<1	1	1	<1	<1	<1	2	<1	<1
Selenium	ug/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Vanadium	ug/l	5	5	8	8	11	11	10	<1	2	4	1	12
Zinc	ug/l	16	14	14	5	7	15	10	3	6	13	13	8
Naphthalene	ug/l	0.22	0.07	0.06	0.09	<0.02	0.14	0.04	<0.02	<0.02	0.12	0.06	<0.02
Acenaphthene	ug/l	<0.02	<0.02	0.14	0.13	0.11	0.14	<0.02	<0.02	<0.02	0.03	0.03	0.02
Acenaphthylene	ug/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Fluoranthene	ug/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	0.02	0.18	0.08	<0.02
Anthracene	ug/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.16	0.03	0.05
Phenanthrene	ug/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.17	0.06	<0.02
Fluorene	ug/l	<0.02	<0.02	0.03	0.02	0.03	0.04	<0.02	<0.02	<0.02	0.03	<0.02	<0.02
Chrysene	ug/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.17	0.04	<0.02
Pyrene	ug/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	0.02	0.16	0.07	<0.02
Benzo(a)anthracene	ug/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.13	0.02	<0.02
Benzo(b)fluoranthene	ug/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.1	<0.02	<0.02
Benzo(k)fluoranthene	ug/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.09	<0.02	<0.02
Benzo(a)pyrene	ug/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.12	<0.02	<0.02
Dibenzo(a,h)anthracene	ug/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.05	<0.02	<0.02
Benzo(g,h,i)perylene	ug/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.07	<0.02	<0.02
Indeno(1,2,3-cd)pyrene	ug/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.09	<0.02	<0.02
PAH, Total Detected USEPA 16	ug/l	0.22	0.07	0.23	0.24	0.14	0.32	0.1	<0.02	0.04	1.67	0.39	0.07
Sum of UK DWS four 7	ug/l												
Total Aliphatics & Aromatics >C5-3	ug/l	214	277	332	321	411	418	340	340	206	220	235	143

BUROHAPPOLD ENGINEERING

Project: Project Blue - Groundwater Data
Project Number: 0040026
Date: 08/03/2018

Average pH and Hardness

Calculated pH	7.9
Calculated hardness	1801.545455

Chemical Data Input

Determinand	Environmental Quality Standards 2014 AA Salt	Environmental Quality Standards 2014 MAC Salt	Water Supply Regulations 2016 Potable
pH			6.5 - 9.0
Conductivity			2500
Dissolved Oxygen			
BOD			
Total Dissolved Solids			
Hardness			
Ammoniacal Nitrogen (NH3-N)			
Ammonia (NH4+)	21		
Ammonium (NH3)			500
Nitrate (NO3-)			50000
Nitrite (NO2-)			500
Cyanide	1	5	50
Mercury		0.07	1
Arsenic	25		10
Barium			
Beryllium			
Boron			1000
Cadmium	0.2	0.45	5
Chromium			50
Copper	3.76		2000
Lead	1.3	14	10
Nickel	8.6	34	20
Selenium			10
Vanadium			
Zinc	6.8		
Naphthalene	2	130	
Acenaphthene			
Acenaphthylene			
Fluoranthene	0.0063	0.12	
Anthracene	0.1	0.1	
Phenanthrene			
Fluorene			
Chrysene			
Pyrene			
Benzo(a)anthracene			
Benzo(b)fluoranthene		0.017	
Benzo(k)fluoranthene		0.017	
Benzo(a)pyrene	0.007	0.027	0.01
Dibenzo(a,h)anthracene			
Benzo(g,h,i)perylene		0.0082	
Indeno(1,2,3-cd)pyrene			
PAH, Total Detected USEPA 16			
Sum of UK DWS four 7			0.1
Methyl tertiary butyl ether (MTBE			
Benzene	8	50	1
Toluene	74	370	
Ethylbenzene			
m,p-Xylene			
o-Xylene			
Sum of detected Xylenes			

MG / NG															
Sample ID		OH101	OH102	OH103	BH101	BH102A	BH108A	BH114	OH101	OH102	OH103	BH101	BH102A	BH108A	BH114
Depth		2.90	3.00	3.10	3.30	4.20	7.50	3.40	3.00	3.20	3.20	3.50	4.50	7.50	3.50
Determinand	Units														
pH	pH units	8.67	8.56	8.01	8.01	8.24	8.52	7.89	8.55	8.53	8.1	8.01	8.35	8.52	8.03
Conductivity	mS/cm														
Dissolved Oxygen	mg/l														
BOD	mg/l														
Total Dissolved Solids	g/l														
Hardness	mg/l	159	698	2480	714	3060	1184	2790	164	717	2286	4243	2859	1151	649
Ammoniacal Nitrogen (NH3-N)	ug/l	170	1360	330	1680	1010	1440	760	300	1520	410	1090	1360	1510	2000
Ammonia (NH4+)	ug/l														
Ammonium (NH3)	ug/l														
Nitrate (NO3-)	ug/l														
Nitrite (NO2-)	ug/l														
Cyanide	ug/l	181	<5	30	<5	<5	25	<5	181	<5	27	<5	<5	<5	<5
Mercury	ug/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.2	0.2	<0.1	<0.1
Arsenic	ug/l	5	3	5	28	3	1	<1	7	5	4	1	4	<1	30
Barium	ug/l	52	156	135	183	68	78	278	63	163	121	136	61	73	197
Beryllium	ug/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Boron	ug/l	153	584	1840	337	2350	1760	1690	166	588	1820	2860	2250	1700	343
Cadmium	ug/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	ug/l	22	<1	1	6	12	12	12	39	8	18	23	11	18	3
Copper	ug/l	5	<1	1	<1	2	<1	3	7	<1	1	3	1	<1	<1
Lead	ug/l	<1	<1	<1	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	<1
Nickel	ug/l	1	<1	2	<1	3	2	<1	2	<1	2	2	3	1	<1
Selenium	ug/l	<1	9	1	<1	<1	1	<1	<1	<1	<1	<1	<1	<1	<1
Vanadium	ug/l	1	2	2	<1	2	3	1	2	2	2	3	2	2	1
Zinc	ug/l	3	<1	1	7	138	157	3	7	8	4	6	579	1135	8
Naphthalene	ug/l	<0.01	2.02	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	1.43	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthene	ug/l	<0.01	5.36	0.06	<0.01	0.01	0.01	<0.01	<0.01	4.34	0.05	<0.01	<0.01	<0.01	<0.01
Acenaphthylene	ug/l	<0.01	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.03	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoranthene	ug/l	<0.01	0.81	0.08	<0.01	<0.01	0.04	<0.01	<0.01	0.41	0.09	<0.01	0.02	0.07	<0.01
Anthracene	ug/l	<0.01	0.39	0.01	<0.01	<0.01	0.01	<0.01	<0.01	0.24	<0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	ug/l	<0.01	1.87	0.03	<0.01	0.01	0.06	<0.01	<0.01	1.21	0.03	<0.01	<0.01	0.04	<0.01
Fluorene	ug/l	<0.01	2.67	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	1.9	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	ug/l	<0.01	0.08	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	0.02	<0.01	<0.01	0.01	<0.01
Pyrene	ug/l	<0.01	0.53	0.06	<0.01	<0.01	0.03	<0.01	<0.01	0.29	0.05	<0.01	0.01	0.05	<0.01
Benzo(a)anthracene	ug/l	<0.01	0.07	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	0.02	<0.01	<0.01	<0.01	<0.01
Benzo(b)fluoranthene	ug/l	<0.01	0.03	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.02	<0.01	<0.01	<0.01	<0.01
Benzo(k)fluoranthene	ug/l	<0.01	0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)pyrene	ug/l	<0.01	0.02	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01
Dibenzo(a,h)anthracene	ug/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(g,h,i)perylene	ug/l	<0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Indeno(1,2,3-cd)pyrene	ug/l	<0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PAH, Total Detected USEPA 16	ug/l	<0.01	13.88	0.38	<0.01	0.04	0.15	<0.01	<0.01	9.91	0.29	<0.01	0.03	0.17	<0.01
Sum of UK DWS four 7	ug/l														
Methyl tertiary butyl ether (MTBE)	ug/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Benzene	ug/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	ug/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ethylbenzene	ug/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
m,p-Xylene	ug/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
o-Xylene	ug/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sum of detected Xylenes	ug/l	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2

Sum of detected BTEX			
Aliphatics >C5-C6			
Aliphatics >C6-C8			
Aliphatics >C8-C10			
Aliphatics >C10-C12			
Aliphatics >C12-C16			
Aliphatics >C16-C21			
Aliphatics >C21-C35			
Total Aliphatics >C12-C35			
Aromatics >EC5-EC7			
Aromatics >EC7-EC8			
Aromatics >EC8-EC10			
Aromatics >EC10-EC12	0.4	1.4	
Aromatics >EC12-EC16			
Aromatics >EC16-EC21			
Aromatics >EC21-EC35			
Total Aromatics >EC12-EC35			
Total Aliphatics & Aromatics >C5			10

Sum of detected BTEX	ug/l														
Aliphatics >C5-C6	ug/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	<1	<1	<1	<1
Aliphatics >C6-C8	ug/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Aliphatics >C8-C10	ug/l	<1	12	<1	<1	<1	<1	<1	<1	2	<1	<1	<1	<1	<1
Aliphatics >C10-C12	ug/l	<5	1019	<5	<5	<5	<5	<5	<5	16	<5	<5	<5	<5	<5
Aliphatics >C12-C16	ug/l	<5	7043	<5	<5	<5	<5	<5	<5	222	<5	<5	<5	<5	<5
Aliphatics >C16-C21	ug/l	<5	7991	<5	<5	<5	<5	<5	<5	269	<5	<5	<5	<5	<5
Aliphatics >C21-C35	ug/l	<5	2500	<5	45	83	<5	<5	<5	107	<5	<5	<5	<5	<5
Total Aliphatics >C12-C35	ug/l	<5	18565	<5	45	83	<5	<5	<5	615	<5	<5	<5	<5	<5
Aromatics >EC5-EC7	ug/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Aromatics >EC7-EC8	ug/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Aromatics >EC8-EC10	ug/l	<2	6	<2	<2	<2	<2	<2	<2	<3	<2	<2	<2	<2	<2
Aromatics >EC10-EC12	ug/l	<5	106	<5	<5	<5	<5	<5	<5	47	<5	<5	<5	<5	<5
Aromatics >EC12-EC16	ug/l	<5	2340	<5	<5	<5	<5	<5	<5	248	<5	<5	<5	<5	<5
Aromatics >EC16-EC21	ug/l	<5	3352	<5	<5	<5	<5	<5	<5	202	<5	<5	<5	<5	<5
Aromatics >EC21-EC35	ug/l	<5	1174	<5	<5	<5	<5	<5	<5	140	<5	<5	<5	<5	<5
Total Aromatics >EC12-EC35	ug/l	<5	6978	<5	<5	<5	<5	<5	<5	639	<5	<5	<5	<5	<5
Total Aliphatics & Aromatics >C5-	ug/l	<5	25543	<5	45	83	<5	<5	<5	1254	<5	<5	<5	<5	<5

Gas Risk Assessment Spreadsheet

Data entered by: Nina Sopp

Site Name: Project Blue
Job Number: 0040026

Methodology based on Wilson et al, 2006, Assessing Risks Posed by Hazardous Ground Gases to Buildings, CIRIA Report C665

Step 1: Summary of Monitoring Data

Table 1

Borehole	Maximum Flow rate (l/hr)	Minimum flow rate (inc Negative) (l/hr)	Peak Methane concentrations* (%)	Peak Carbon Dioxide concentrations* (%)	Minimum Oxygen concentrations (%)	Peak Carbon Monoxide concentrations (ppm)	Peak Hydrogen Sulphide concentrations (ppm)
BH101	0.2	0	0	0.4	18.2	0	0
BH114	0.4	0	0	4.8	9.7	0	0
OH101	0.3	0	0	1.3	17.7	0	0
OH102	0.1	0	0	3.7	3.1	1	0
OH103	0.4	0	0	1.5	20.1	0	0
Worst Case Example+	0.4	0	0	4.8	3.1	1	0

*Using 0.05% instead of 0% as this is half the minimum detection limit of the monitoring instrument used

+ Using highest concentration and highest flow rate

Situation A: All other development excluding low rise housing with gardens

Ref. 1 defines gas screening value (GSV) of gas = Chg/100 x q
Where: C_{hg} = hazardous gas concentrations (% v/v)
q = flow rate (litres/hour)

Table 2

Borehole	Peak CH4 GSV (l/hr)	CH4 GSV for peak gas concentration and flow rate (Table 8.5 - Ref. 1)	Peak CO2 GSV (l/hr)	CO2 GSV for peak gas concentration and flow rate (Table 8.5 - Ref. 1)
BH101	0.0000	1	0.0008	1
BH114	0.0000	1	0.0192	1
OH101	0.0000	1	0.0039	1
OH102	0.0000	1	0.0037	1
OH103	0.0000	1	0.0060	1
Worst Case Example+	0.0000	1	0.0192	1

Lower limit (l/hr)		Upper limit (l/hr)
0	1	0.07
0.07	2	0.7
0.7	3	3.5
3.5	4	15
15	5	70
70	6	

Based on Wilson *et al*, 1999, Reliability and Risk in Gas Protection Design

Situation B: Low rise housing with gardens

Ref. 1 defines gas screening value (GSV) of gas = Chg/100 x q
Where: C_{hg} = hazardous gas concentrations (% v/v)
q = flow rate (litres/hour)

Table 3

Borehole	CH4 Peak GSV (l/hr)	CH4 GSV for peak gas concentration and flow rate (Table 8.7 - Ref. 1)	CO2 Peak GSV (l/hr)	CO2 GSV for peak gas concentration and flow rate (Table 8.7 - Ref. 1)
BH101	0.00	Green	0.0008	Green
BH114	0.00	Green	0.0192	Green
OH101	0.00	Green	0.0039	Green
OH102	0.00	Green	0.0037	Green
OH103	0.00	Green	0.006	Green
Worst Case Example+	0.00	Green	0.02	Green

CH4

Lower limit (l/hr)	Upper limit (l/hr)		Typical Maximum
0	Green	0.16	1
0.16	Amber 1	0.63	5
0.63	Amber 2	1.56	20
1.56	Red		

CO2

Lower limit (l/hr)	Upper limit (l/hr)		Typical Maximum
0	Green	0.78	5
0.78	Amber 1	1.56	10
1.56	Amber 2	3.13	30
3.13	Red		

Based on Boyle and Witherington, 2006, Guidance on Evaluation of Development Proposals on Sites Where Methane and Carbon Dioxide are Present, Incorporating 'Traffic Lights'

Ref. 1: Wilson et al, 2007, Assessing Risks Posed by Hazardous Ground Gases to Buildings, CIRIA Report C665

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