



# e3p

Pile Design Contaminated Land Risk Assessment  
Land off Don Street, Middleton

Reference: 14-554-R7-1  
Date: March 2023



# PILE DESIGN CONTAMINATED LAND RISK ASSESSMENT

Land off Don Street  
Middleton

Prepared for:



**Report Ref: 14-554-R7-1**  
**Date Issued: March 2023**



**Don Street**

Pile Design Contaminated Land Risk Assessment

March 2023

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**QUALITY ASSURANCE**

|                       |                                          |  |  |
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## 1. INTRODUCTION

### 1.1. BACKGROUND

E3P has been instructed by Kellen Homes to undertake a contamination risk assessment for penetrative foundation systems, which is referred to as a Contamination Piling Risk Assessment, for a proposed low-rise residential development at the land off Don Street, located to the northeast of Middleton.

### 1.2. PROPOSED DEVELOPMENT

Kellen Homes intends to construct a low-rise residential development with associated gardens, estate roads and infrastructure. Drawing 14-554-002- (Appendix III) identifies the proposed development layout.

A snapshot of the proposed development layout is indicated in Figure 1.1.

FIGURE 1.1 SNAPSHOT OF THE PROPOSED DEVELOPMENT



Coopers have produced a foundation zoning plan for the site provided as Drawing 5639/Fd/02A in Appendix III.

A snapshot of the proposed foundation plan is indicated in Figure 1.2, plots labelled "V" in yellow are proposed for vibro stone column piles (VSC), and plots labelled "P" in red are proposed for pre-cast driven piles.

**FIGURE 1.2 COOPERS FOUNDATION ZONING PLAN**



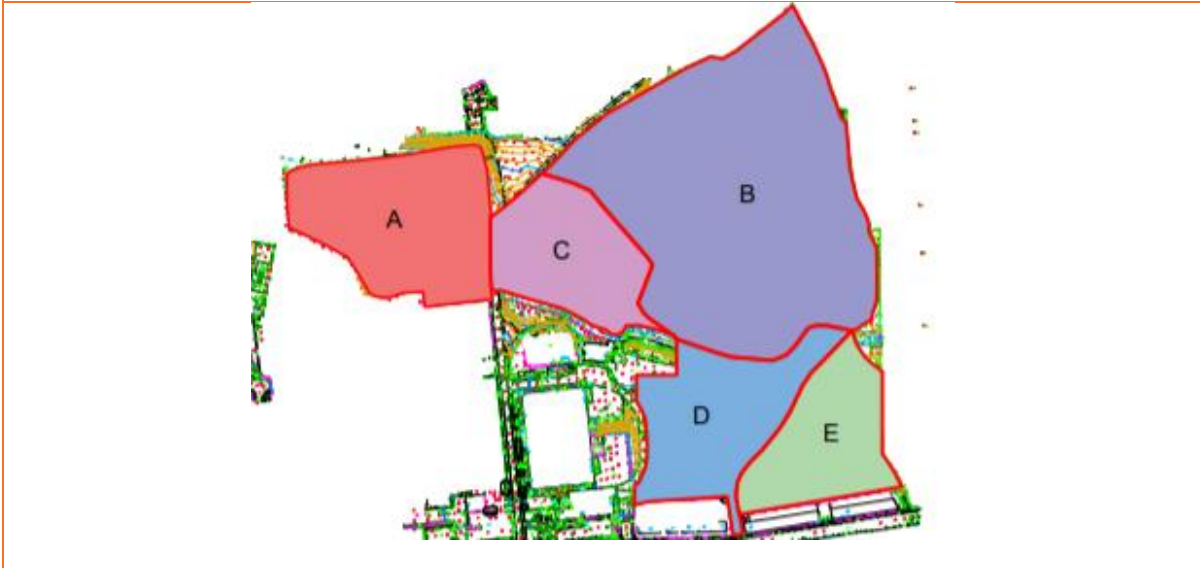
For ease the site has been divided into the following 5 No. discrete parcels in line with the previous report completed by Coopers in 2013. The parcels are:

- ✳ **Parcel A** - the former Rex Mill,
- ✳ **Parcel B** - former playing fields,
- ✳ **Parcel C** - apron between Rex Mill and former playing fields,
- ✳ **Parcel D** - Wagon/trailer park, open ground and Hexpol car park
- ✳ **Parcel E** - Wooded area in the south eastern corner of the site.

A plan showing the defined parcels is presented in Figure 1.3.



FIGURE 1.3 SITE AREAS PLAN



### 1.3. SCOPE OF WORKS

E3P has prepared this Contamination Piling Risk Assessment in due consideration of the Regulatory Authority requirement to demonstrate that the proposed construction works will not present any unacceptable risk to controlled waters of the wider environ.

### 1.4. PREVIOUS WORKS

The following phases of Geo-Environmental investigations have previously been carried out at the site:

- ✿ **REFA Consulting Engineers** – Ground Investigation Report. Report Reference: 05122, dated September 2006;
- ✿ **Coopers** – Site Investigation Report. Report Reference: 5639si, dated 28th May 2013;
- ✿ **E3P** – Phase I and II Geoenvironmental Site Assessment Report Ref: 14-554-R1-2;
- ✿ **E3P** – Supplementary Assessment: Report Ref: 14-554-L5 dated January 2023;
- ✿ **E3P** – Remediation and Enabling Works Strategy, dated July 2022, Ref 14-554-R2-10; and
- ✿ **E3P** – Parcel A, Parcel B-C, Parcel D-E, Ground Gas Assessment(s), dated December 2021, Ref 14-554-R3-1

These reports have been used to form the basis of this Piling Risk Assessment.

### 1.5. CONFIDENTIALITY

E3P has prepared this report solely for the use of the client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from E3P; a charge may be levied against such approval.



## **2. GROUNDWATER CONTAMINATION RISK ASSESSMENT**

### **2.1. GROUND CONDITIONS**

#### **2.1.1. MADE GROUND**

##### **PARCEL A**

Made Ground deposits were encountered within all exploratory hole locations to depths between ground level and in excess of 5.45 m bgl although, in general, Made Ground was encountered to a depth of less than 1.00 m bgl.

The full depth of Made Ground was not proven at twelve locations (TP202, TP204, TP205, TP206, TP208, TP209, TP210, TP211, WS202A, WS203, WS204 and WS208). These locations were terminated due to obstructions, significant water strikes and a potential encounter of drainage infrastructure. Where obstructions were encountered, it is assumed that these are related to the former mill.

Concrete was encountered at thirteen locations between ground level and 0.20 m bgl. Asphalt was encountered at TP210 (in the north) between ground level and 0.15 m bgl. Both the asphalt and concrete were underlain by a grey sandy gravel of limestone at all locations to 0.50 m bgl.

Across the site Made Ground deposits generally comprised of a red sandy gravel with frequent cobbles of brick or a dark/light brown slightly clayey gravelly sand with gravel of brick, mudstone, concrete, glass and ash.

A reworked clay containing gravels of brick and asphalt were encountered in the north of site below the current area of hardstanding within TP203 (in the north of the site) between 1.00 m and 1.80 m bgl and in TP207 (in the north of the site) between 0.40 m and 2.60 m bgl.

Clinker was identified as present within the gravel within three isolated exploratory holes across the site, including; TP209 between 0.30 and 3.40 m bgl, TP211 between 0.30 m and 0.80 m bgl and WS209 between 0.30 m and 2.20 m bgl.

A significant hydrocarbon odour and sheen was encountered at TP204 (in the area of the former tanks in the south of the site) between 0.30 m and 1.10 m bgl. A slightly hydrocarbon odour was encountered 1.50 m and 2.50 m bgl at WS202 and at WS203 between 1.50 m and 4.45 m bgl located in the west of the site.

A Depth of Made Ground Plan is presented as Drawing 14-544-006 in Appendix III.

##### **PARCEL B & C**

Made Ground was encountered within the majority of exploratory holes to a maximum proven depth of 5.90 m bgl. The southern area of parcel B (former landfill) was found to comprise a brown sandy gravelly clay with inert wastes including brick, concrete, occasional coal, polythene sheeting, tyres, slag and vegetation including tree stumps.

The southern area of parcel B (former landfill) was found to comprise a brown sandy gravelly clay with inert wastes including brick, concrete, occasional coal, polythene sheeting, tyres, slag and vegetation including tree stumps. The former landfill was proven to a maximum depth of 4.00m in CP303 with potential that it does proceed beyond this to beyond 5.45m in WS311 however, this borehole was inconclusive due to poor recovery.



Within the Coopers Report, an area of fill was encountered to a maximum proven depth of 2.60 m bgl in the area of the former pond on the northern boundary of Parcel B. This comprised circa 0.60 m of ash and clinker overlain by circa 1.30 m of reworked clay, reworked sand and topsoil. It was noted that the centre of the pond was not accessible therefore deeper Made Ground may be present in this location. E3P were unable to investigate this area further due to proximity to a medium pressure gas main.

In the western area (Parcel C) the Made Ground comprised a clay bound brick fragmented backfill to a maximum proven depth of 2.70 m bgl. Occasional ash and clinker were also encountered.

A Depth of Made Ground Plan is presented as Drawing 14-554-006 in Appendix III.

## **PARCEL D & E**

Made Ground deposits were encountered within all exploratory hole locations to a maximum proven depth of 5.45m in WS401.

The shallow Made Ground deposits generally comprise asphalt, concrete or a reworked topsoil of dark brown slightly clayey medium sand with rootlets.

The deeper Made Ground deposits generally comprise brown to black gravelly clay or brown to dark grey gravelly coarse sand. Gravel comprised mudstone, concrete and brick.

Slight hydrocarbon odours were noted in the Made Ground in TP409 at 1.60 m and in TP411 between 0.20 m to 2.50 m bgl. No hydrocarbon odours were noted in TP414 or TP416.

A Depth of Made Ground Plan is presented as Drawing 14-554-006 in Appendix III.

### **2.1.2. TOPSOIL**

Topsoil was encountered in the north of Parcel B (playing fields) to a maximum proven depth of 0.80 m bgl. This topsoil is deemed to be potentially reworked as part of the levelling in this area in preparation of the ground for a playing field.

No topsoil was recorded within the south of Parcel B (former landfill) or within remaining Parcels (A, C, D and E).

### **2.1.3. DRIFT DEPOSITS**

## **PARCEL A**

Drift deposits were encountered within the majority of exploratory locations. The drift deposits varied across the site however, the majority of the site is underlain by granular deposits with sporadic beds of clay within in the upper 3 metres.

The granular deposits varied in density from very loose to becoming dense typically beyond 3.00 m bgl, it is assumed that the loose deposits are caused by the shallow groundwater on the site.

Where CLAY was encountered as a band, it was typically a firm to very stiff very high strength orange, brown slightly gravelly CLAY with gravel of mudstone.

## **PARCEL B & C**

Drift deposits were encountered within the majority of exploratory locations with the exception of several locations where the full depth of Made Ground could not be proven, predominantly within the area of the former landfill (TP101, TP102, TP103, TP119, TP120, TP121, TP123, TP125, TP127, TP129, TP131, TP134, TP147, TP148, TP149, TP150, TP151, TP152, WS105, WS111, WS117A, WS117B, WS117C).



Drift deposits across the Parcel B and C were encountered between ground level to a maximum proven depth of 28.00 m bgl. Deposits encountered typically comprise a loose to medium dense SAND or SAND and GRAVEL with occasional bands of silty CLAY within some locations.

PEAT deposits were noted within three exploratory hole locations in the Coopers Report within the west (Parcel C) between the depths of 1.30 m bgl and 3.00 m bgl with a maximum proven thickness of 0.30 m. E3P encountered PEAT within one exploratory hole location (WS301) within Parcel C at a thickness of 0.20 m. However, within these areas E3P did identify organic alluvial silts at ~2.00m that will require further delineation.

## **PARCEL D & E**

Drift deposits were encountered where the full depth of Made Ground could be proven.

The drift deposits are varied, generally comprising soft low strength to stiff high strength sandy CLAY and loose to medium dense clayey medium SAND to a maximum proven depth of 32.80 m bgl (RB408).

The rotary boreholes generally recorded granular drift deposits at depth, comprising light brown fine to medium SAND with occasional bands of clay and gravel.

### **2.1.4. SOLID GEOLOGY**

#### **PARCEL A**

The solid bedrock geology was encountered between 3.90 m and 14.90 m bgl. The solid geology comprises grey MUDSTONE interbedded with grey SANDSTONE and coal bands. Generally, the bedrock deepens from west to east with no significant topographical variance at the surface.

In-tact Coal was encountered within RB208 – 27.90 m-29.00 m, RB204 – 19.10 m to 20.00 m and RB202 – 20.00 m to 20.80 m bgl, RB201 3.30 m – 3.90 m bgl and 27.90 m to 29.00 m bgl

Total loss of flush was encountered in RB207 from 7.80 m-10.00 m

In historical boreholes coal workings were similarly identified within the west of the site and therefore are consistent with E3Ps findings.

The Coal within the west of the site which appears to have been worked is likely the Cannel Seam with seams identified in the east being the Bent Seam.

#### **PARCEL B & C**

The solid bedrock geology was encountered between 17.80 m and 28.00 m bgl and comprised light-grey MUDSTONE which is interbedded with grey SANDSTONE with occasional traces of coal.

#### **PARCEL D & E**

The solid bedrock geology was encountered as SILTSTONE in RB208 between 32.80 m and 47.00 m bgl. No coal seams or voids were identified during this ground investigation.

### **2.1.5. GROUNDWATER**

Groundwater strikes were encountered as seepages. The depth of the seepages is shown on the exploratory hole records in Appendix V and are summarised in Table 2.1.



TABLE 2.1 SUMMARY GROUNDWATER STRIKES

| LOCATION              | DEPTH TO STRIKE (m) | NOTES                             |
|-----------------------|---------------------|-----------------------------------|
| <b>Area A</b>         |                     |                                   |
| TP204                 | 0.40                | Perched water in Made Ground      |
| TP205                 | 0.70                |                                   |
| TP207                 | 0.50                |                                   |
| TP209                 | 0.80                |                                   |
| TP210                 | 2.30                |                                   |
| TP211                 | 0.70                |                                   |
| TP211                 | 1.90                |                                   |
| WS201 A               | 1.00                |                                   |
| WS201 B               | 1.00                |                                   |
| WS201 C               | 1.00                |                                   |
| WS202 A               | 1.00                |                                   |
| WS202 B               | 1.00                |                                   |
| WS204                 | 0.40                |                                   |
| WS206                 | 1.30                |                                   |
| WS207                 | 3.00                | Seepage within SAND strata        |
| <b>Area B &amp; C</b> |                     |                                   |
| TP301                 | 2.30                | Steady ingress within Made Ground |
| TP302                 | 2.30                | Fast ingress within Made Ground   |
| TP303                 | 2.30                |                                   |
| TP304                 | 2.50                | Slow ingress within SAND          |
| TP305                 | 2.60                | Fast ingress within SAND          |
| TP324                 | 0.40                | Slow ingress within Made Ground   |
| TP328                 | 0.50                |                                   |
| TP329                 | 2.30                |                                   |
| TP330                 | 2.40                | Fast ingress within SAND          |
| WS303                 | 2.10                | Water strike within natural SAND  |
| WS306                 | 3.00                |                                   |
| WS309                 | 2.00                |                                   |
| WS310                 | 2.00                |                                   |
| WS308                 | 3.00                |                                   |
| WS314                 | 4.80                |                                   |
| WS319                 | 3.70                |                                   |
| WS321                 | 3.80                |                                   |
| CP301                 | 0.70                | Water strike within Made Ground   |



| LOCATION   | DEPTH TO STRIKE<br>(m) | NOTES                            |
|------------|------------------------|----------------------------------|
| CP303      | 5.50                   | Water strike within natural SAND |
| CP303      | 7.30                   |                                  |
| Area D & E |                        |                                  |
| TP404      | 3.0                    | Seepage                          |
| TP407      | 2.0                    | Perched seepage                  |
| TP413      | 1.9                    | Seepage                          |
| TP414      | 2.9                    |                                  |
| WS402      | 3.0                    |                                  |
| WS403      | 2.0                    |                                  |
| WS404      | 3.0                    |                                  |
| WS405      | 3.0                    |                                  |
| WS407      | 5.0                    |                                  |
| WS411      | 2.0                    |                                  |

## 2.2. PREVIOUS INVESTIGATIONS

### 2.2.1. REFA INVESTIGATION (2006)

As part of the REFA investigation that took place in 2006, groundwater and leachate samples obtained during drilling were submitted for analysis by REFA from the Rex Mill site (Parcel A). A summary of the exceedances is provided in Table 2.2 and Table 2.3.

The analysis undertaken determined that groundwater contained heavy metals, phenols and PAH compounds. However, TPH compounds were noted to contain concentrations between 420 ug/l and 4400 ug/l (total TPH). The greatest concentrations were associated with boreholes BH2 and BH3, which were situated in the northeastern and southwestern corners of the site within Parcel A. There was no indication within the borehole logs of hydrocarbon lustres or odours.

These boreholes were targeted by the most recent E3P monitoring wells, which are discussed in Section 2.4.



TABLE 2.2 - SUMMARY OF REFA GROUNDWATER EXCEEDANCES

| LOCATION (GROUNDWATER) | EQS EXCEEDANCES                                                |
|------------------------|----------------------------------------------------------------|
| <b>BH1 2.5 m</b>       | Zinc 24 ug/l, Total TPH 420 ug/l                               |
| <b>BH2 1.6 m</b>       | Total TPH 960 ug/l                                             |
| <b>BH2 2.5 m</b>       | Cadmium 2.0 ug/l, Copper 16 ug/l                               |
| <b>BH2 4.2 m</b>       | Zinc 68 ug/l, Total TPH 4400 ug/l                              |
| <b>BH3 1.0 m</b>       | Cadmium 2.0 ug/l, Zinc 17 ug/l, Total TPH 3700 ug/l            |
| <b>BH4 0.6 m</b>       | Zinc 24 ug/l, Total TPH 500 ug/l                               |
| <b>BH5 1.1 m</b>       | Zinc 15 ug/l                                                   |
| <b>TP4 1.0 m</b>       | Cadmium 2.0 ug/l, Copper 96 ug/l, Lead 210 ug/l, Zinc 440 ug/l |
| <b>TP8 2.0 m</b>       | Copper 10 ug/l, Zinc 29 ug/l                                   |

TABLE 2.3 - SUMMARY OF REFA LEACHATE ANALYSIS

| LOCATION (LEACHATE) | EQS EXCEEDANCES             |
|---------------------|-----------------------------|
| <b>TP02 0.5 m</b>   | -                           |
| <b>TP03 0.3 m</b>   | Zinc 12 ug/l                |
| <b>TP04 0.5 m</b>   | -                           |
| <b>TP05 1.0 m</b>   | -                           |
| <b>TP06 0.3 m</b>   | Zinc 12 ug/l, Lead 1.8 ug/l |

### 2.3. COOPERS INVESTIGATION (2013)

As part of the Coopers investigation in 2013 comprising of 54 No. Trial Pits, 15 No. Rotary Open Holes, 6 No. Cable Percussive Boreholes and 19 No. Window Sample Probeholes.

Three samples of groundwater were analysed from trial pits TP1 (Rex Mill), TP11 (apron between Rex Mill and former playing field) and TP30 (former pond in northern area of northern playing field). All samples were filtered to remove suspended sediment from within the trial pits however, it must be noted that this sampling method is not considered representative and, therefore, at this time, the results from the trial pit samples are discounted. A summary of the sample exceedances is presented in Table 2.4.

WS17, which exceeded the threshold for groundwater impact on surface water (166ug/l). This borehole was drilled off the proposed development site along the southern bank of the River Irk. The sample analysed recorded significantly elevated concentrations of TPH compounds (13mg/l – total TPH), the presence of ethylbenzene (0.079mg/l) and m & p xylene (0.24mg/l). No evidence of groundwater contamination spreading from WS17 has been noted at this time. During the remediation works a watching brief will be undertaken along the boundary of the site in this area.

Hydrocarbon compounds had been noted extensively within the Rex Mill area of the site by REFA, however, these were not noted during the works undertaken by Coopers.



TABLE 2.4 - SUMMARY OF COOPERS GROUNDWATER ANALYSIS

| LOCATION (GROUNDWATER) | EQS EXCEEDANCES                         |
|------------------------|-----------------------------------------|
| <b>TP11</b>            | Chromium 12 ug/l, Copper 5.5 ug/l       |
| <b>TP1</b>             | Copper 2.1 ug/l                         |
| <b>TP30</b>            | Copper 1.8 ug/l                         |
| <b>WS17</b>            | TPH C6-C35, Ethylbenzene, m- & p-Xylene |

Coopers have also analysed 3 No. Samples of river water from the River Irk to assess whether the quality of the river changes as it runs through the site. The samples were taken from where the river enters the site from beneath the railway embankment in the east (water 1), just upstream from the Don Street bridge and downstream of the pedestrian bridges that cross the river (water 2) (downstream from the wagon workshop), and as the western boundary of Rex Mill where the river passes the site (water 3). The results identified marginally elevated lead and zinc with the concentrations decreasing downstream showing that the site was not adding pollutants to the river, hence a pathway between source and receptor was not evident.

A summary of the Coopers surface water exceedances is presented within Table 2.5.

TABLE 2.5 - SUMMARY OF COOPERS SURFACE WATER ANALYSIS

| LOCATION (SURFACE WATER- RIVER IRK) | EQS EXCEEDANCES            |
|-------------------------------------|----------------------------|
| <b>Water 1</b>                      | Lead 15 ug/l, Zinc 11 ug/l |
| <b>Water 2</b>                      | Lead 2.5 ug/l              |
| <b>Water 3</b>                      | Copper 1.4 ug/l            |

## 2.4. E3P INVESTIGATIONS

### 2.4.1. E3P INVESTIGATION - JANUARY TO MARCH 2021

E3P completed a ground investigation between the 27th January 2021 and 30th March 2021. With the summary of exceedances of groundwater, surface water and leachate analysis below. A detailed discussion of the ground investigation and assessment is provided within report Phase 1 & 2 Geoenvironmental Site Assessment (Ref: 14-554-R1-2 October 2022).

A summary of the exceedances is presented within Table 2.6, Table 2.7 and Table 2.8.

TABLE 2.6 -SUMMARY OF E3P GROUNDWATER SAMPLE RESULTS - 2021

| LOCATION (GROUNDWATER) | EQS EXCEEDANCES                            |
|------------------------|--------------------------------------------|
| <b>WS205</b>           | Arsenic 10.3 ug/l, Copper, Nickel 8.9 ug/l |
| <b>WS201</b>           | Copper 9.0 ug/l, Zinc 17 ug/l              |
| <b>WS208</b>           | Copper 68 ug/l, Nickel ug/l                |

TABLE 2.7 -SUMMARY OF E3P LEACHATE SAMPLE RESULTS - 2021

| LOCATION (LEACHATE) | EQS EXCEEDANCES                                               |
|---------------------|---------------------------------------------------------------|
| <b>WS202B 1.9 m</b> | Arsenic 28 ug/l, Copper 4.1 ug/l, Lead 4.1 ug/l, Zinc 13 ug/l |
| <b>WS206 0.90 m</b> | Copper 12 ug/l, Lead, Zinc                                    |
| <b>TP204 0.80 m</b> | Nickel 4.3 ug/l                                               |



TABLE 2.8 - SUMMARY OF E3P SURFACE WATER SAMPLE RESULTS - 2021

| LOCATION (SURFACE WATER- RIVER IRK) | Date of Samples   | EQS EXCEEDANCES                                 |
|-------------------------------------|-------------------|-------------------------------------------------|
| Upstream                            | 22nd January 2021 | Copper 3.9 ug/l                                 |
| Downstream                          | 22nd January 2021 | Copper 7.0 ug/l, Cyanide 7.0 ug/l, Zinc 20 ug/l |
| Upstream                            | 23rd March 2021   | Copper 6.5 ug/l, Cyanide 1.4 ug/l               |
| Downstream                          | 23rd March 2021   | 6.0 ug/l, Cyanic 1.2 ug/l                       |
| Upstream                            | 14th April 2021   | Copper 4.6 ug/l,                                |
| Downstream                          | 14th April 2021   | Copper 3.6 ug/l, Cyanide 1.3 ug/l               |
| Upstream                            | 8th March 2022    | Copper 5.5 ug/l,                                |
| Downstream                          | 8th March 2022    | Copper 7.5 ug/l, Zinc 12 ug/l                   |

Two groundwater samples from below the former Rex Mill (WS202C and WS207) were analysed for PFOA and PFOS, neither were present at detectable levels.

Widespread heavy metal and PAH contamination and limited TPH contamination were identified in the soil, leachate and groundwater analysis at the site. It is noted that where there are exceedances in soils, there are exceedances within leachates. Thus, the source of the contaminants can be attributed to the point source of historical industrial uses and the heavy metal and PAH contamination is considered present on a site wide basis. The TPH contamination is around historical features such as tanks and will be delineated, removed and material subject to treatment as part of the remediation works.

A comparison of the River Irk surface water samples to the Tier 1 criteria has shown exceedances in copper within samples upstream and downstream of the site on all 4 visits between January 2021 and March 2022. As a result of this, it can be said that elevated levels of these determinants cannot be attributed to the site, due to their presence within upstream samples. This is consistent with the surface water exceedances identified as part of the Coopers works which showed that the site was not causing the heavy metals exceedances within the river as they were present upstream of the site.

The full detailed assessment is presented within the E3P Phase 1 and Phase 2 Report (ref: 14-554-R1 dated October 2022).

#### 2.4.2. E3P INVESTIGATION - JUNE 2022

E3P completed a supplementary investigation that is detailed within report 'Supplementary Site Assessment Letter' (ref: 14-554-L1-2 June 2022).

The investigation involved the undertaking of additional trial pits across parcels A, B and C, window samples in Parcel D and cable percussive holes within the former landfill and Parcel D. The main aim of this further investigation was to collect geotechnical information, but further chemical analysis was undertaken as part of the investigation.

Table 2.9 and 2.10 provide a summary of EQS exceedances from leachate samples and surface water samples collected.



TABLE 2.9 -SUMMARY OF E3P LEACHATE RESULTS – JUNE 2022

| LOCATION (LEACHATE) | EQS EXCEEDANCES                                                        |
|---------------------|------------------------------------------------------------------------|
| <b>TP504 1.20 m</b> | Copper 29 ug/l, Nickel 5.0 ug/l, Zinc 11 ug/l                          |
| <b>TP509 1.00 m</b> | Copper 21 ug/l, Lead 10 ug/l, Zinc 26 ug/l                             |
| <b>TP502 1.40 m</b> | Copper 19 ug/l, Lead 4.6 ug/l Nickel 4.8 ug/l, Zinc 16 ug/l            |
| <b>TP516 0.80 m</b> | Copper 15 ug/l, Lead 6.7 ug/l, Nickel 4.4 ug/l, Total cyanide 2.3 ug/l |
| <b>TP506 0.70m</b>  | Cadmium 0.26 ug/l, Copper 13 ug/l, Lead 5.4 ug/l, Zinc 13 ug/l         |

The surface water samples noted upstream and downstream were taken upstream and downstream of the River Irk. Whilst Pond N and Pond S were taken from the on-site pond in the southeast of the site.

TABLE 2.10 -SUMMARY OF E3P SURFACE WATER SAMPLE RESULTS – JUNE 2022

| LOCATION (SURFACE WATER- RIVER IRK) | EQS EXCEEDANCES               |
|-------------------------------------|-------------------------------|
| <b>Upstream</b>                     | Copper 5.5 ug/l               |
| <b>Downstream</b>                   | Copper 7.5 ug/l, Zinc 12 ug/l |
| <b>Pond N</b>                       | Copper 5.0 ug/l               |
| <b>Pond S</b>                       | Copper 4.5 ug/l               |

It should be noted that the majority of the exceedances were noted within the leachate samples, and only copper and zinc were found in exceedance in the surface water samples collected from the on-site watercourse which is consistent with all former surface water samples.

Copper was found in exceedance in each of the four surface water samples, whereas zinc was only found in exceedance (12 ug/l compared to EQS value of 10.9 ug/l) in the downstream water sample. It is noted that this is a relatively minor exceedance and generally lower than the concentrations in the leachate, thus indicating limited leaching and migration is occurring.

An M-BAT assessment has been completed for the surface water samples to determine the bioavailability of copper, nickel and zinc. The risk characterisation ratio assessment confirmed that copper, nickel and zinc have a RCR value less than 1 and are therefore not bioavailable. Manganese was found to have a RCR value of 1.4, within the sample taken from the southern pond only.

## 2.5. E3P INVESTIGATION - SEPTEMBER TO OCTOBER 2022

Following discussion with Lindsey Berends at the Environment Agency, further groundwater and surface water sampling was to be undertaken to form a more robust controlled waters assessment.

The further works involved the collection of water samples from along the River Irk, water samples from on-site drains along with the drilling of 5 additional boreholes to install groundwater monitoring wells in areas where REFA had previously identified contaminants within the groundwater.

E3P window samples labelled WS800 series were placed to target the relevant REFA boreholes as detailed below:

✿ WS801- REFA BH1

✿ WS802- REFA BH2

✿ WS803- REFA BH3



-  WS804- REFA BH4
-  WS805- REFA BH5/BH5A

Further groundwater samples were also gathered from the previously installed wells listed below:

-  WS202
-  WS208
-  WS311

Samples from on-site drains and River Irk are labelled as per the below:

-  A – Area A drain
-  B – Area A drainage ditch
-  C – Area A manhole (drainage ditch feeds into)
-  D – Area A River Irk Downstream
-  E – Area A River Irk After Weir Pool
-  F – Area C Reservoir Outfall
-  G – Area C Culvert Outfall to River Irk
-  H – Area C Hexpol Outfall
-  I – Area B Land drain out of historic landfill area
-  J – Area B Land drain out of historic landfill area
-  K – Area E Pond
-  L – Area C River Irk After reservoir outfall and culvert
-  M – Area C River Irk After Hexpol works
-  N – Area C River Irk After land drains from historic landfill area
-  O – Area E River Irk Upstream of site
-  P – Area B On site as stream enters culvert
-  Q – Area B northern stream/drainage ditch

Surface water sample locations are provided on drawing 14-554-023 – Surface Water Sampling Plan within Appendix III.

### **2.5.1.      PARCEL A**

#### **SURFACE WATER DRAIN**

Surface water samples were collected from Parcel A from on-site surface water drains. The chemical testing results have identified copper exceedances compared to EQS values within four locations, (A,B,C,D) with concentrations recorded between 4.9 µg/l and 1.6 µg/l.



Elevated total cyanide was also recorded in two locations (E and D), with concentrations of 2.2 and 2.00 µg/l respectively.

No other exceedances have been recorded within the surface water within Parcel A.

#### GROUNDWATER

Groundwater samples were collected from WS801 – WS805 Groundwater analysis has identified the following contaminants when compared to EQS values within Parcel A.

-  Copper
-  Nickel
-  Zinc
-  Selenium
-  TPH C10-C12
-  TPH C12-C16
-  Naphthalene
-  Anthracene
-  Benzo(b)fluoranthene
-  Benzo(k)fluoranthene
-  Benzo(a)pyrene
-  Indeno(123-cd)pyrene
-  Fluoranthene

Elevated PAHs and TPHs have only been identified within WS805 (Ref BH5) , located within very close proximity to the REFA BH5 borehole. TPH concentrations were only identified at concentrations of 54ug/l for TPH C10-C12 and 22ug/l for TPH C12-C16 which is significantly lower than the max total TPH concentration of 4400ug/l identified by REFA thus showing that the source has been removed and very minor residual impact remains. It must be noted that E3P did not identify elevated TPH impact in any of the other REFA locations where high TPH concentrations were previously identified.

Heavy metal exceedances were noted across Parcel A in both the surface water drains and groundwater.

It is likely that once soils with exceedances of TPHs have been removed from Parcel A in line with the current remediation strategy the pollutant link will be removed. It must be noted that TPHs are not being identified within the River Irk therefore a link between source and receptor is not currently present.

The proposed development will create hardstanding cover across the majority of the site, thus reducing the amount of infiltration generated and the risk posed to controlled waters receptors.

### 2.5.2. PARCEL B

#### SURFACE WATER DRAIN

Five locations within Parcel B identified copper exceedances when compared to EQS values (P,Q,N,I J) with concentrations ranging from 4.9 µg/l to 1.5 µg/l.



Elevated total cyanide was also recorded in two locations (I and N), with concentrations of 3.6 µg/l and 1.1 µg/l respectively.

#### GROUNDWATER

Groundwater analysis has identified the following contaminants when compared to EQS values within Parcel B:

-  Copper
-  Total Cyanide

Both of which have been encountered within the River Irk, therefore there is potential for a link between the groundwater and surface water however, it must be noted that the exceedances are relatively minor.

The proposed development will create hardstanding cover across the majority of the site, thus reducing the amount of infiltration generated and the risk posed to controlled waters receptors.

### 2.5.3. PARCEL C

#### SURFACE WATER DRAIN

Four locations within Parcel C identified copper exceedances when compared to EQS values (F,H,L,G) with concentrations ranging from 3.6 µg/l to 2.7 µg/l.

Elevated zinc with a concentration of 22 µg/l has been identified with location H, which was collected from the Hexpol Works Outfall.

Elevated total cyanide was also recorded in four locations (H,F,G,L), with concentrations ranging between 4.2 µg/l and 1.1 µg/l respectively.

No pollution linkage between the on-site heavy metals contamination and receptors can currently be made.

### 2.5.4. PARCEL D

#### SURFACE WATER

No exceedances were recorded for surface water within Parcel D.

### 2.5.5. PARCEL E

#### SURFACE WATER

Location O within Parcel E has identified a copper exceedance compared to EQS values with a concentration recorded of 3.6 µg/l.

Elevated total cyanide was also recorded in two locations (K and O), with concentration of 1.3 µg/l.

### 2.5.6. RIVER IRK

Several surface water samples were taken from the River Irk following its flow through the site, (D, E, L, M, N and O). Samples D and E are located downstream with sample O located upstream.

From the water results within the table appended to this letter, higher concentrations of metals are recorded downstream of the Hexpol works, whilst cyanide is identified as present throughout the site, with concentrations decreasing downstream.

Therefore, it can be considered that site is not leaching cyanide and heavy metals and no pollutant link is present generated on site into the River Irk.



Overall, it can be determined that there is a low risk to controlled waters on site, due to the capping of the site in hardstanding during development and the lack of other pollutant linkages for heavy metals on site.

## **2.6. CONTROLLED WATER CONCLUSIONS**

- ✿ There have been multiple phases of ground investigation, this has enabled reasonable characterisation of the pollution risk and potential to impact the critical receptors.
- ✿ The primary receptors are identified as the River Irk to the south and the underlying Secondary A Aquifers.
- ✿ The further water sampling undertaken during this round of investigation has identified the following in consideration with the historical assessments.

### **2.6.1. RIVER IRK AND SURFACE WATER DRAINS**

The River Irk contains very slightly elevated concentrations of heavy metals which are mainly copper and zinc throughout the water samples taken from the most upstream location to the most downstream. There is no obvious link between contaminant sources on-site and the River Irk.

The surface water drains have also noted very slightly elevated heavy metals exceedances and therefore it is likely that this is indicative of the local geology and history of the area and cannot be attributed to the subject site. Further an MBAT assessment has been undertaken for all the samples from the River Irk and there are no exceedances for copper, zinc and nickel. Only sample J returned a Manganese RCR of 1.03 and the pond sample returned a Manganese RCR of 1.4. Where the Risk Characterisation Ratio (RCR) is greater than 1, this indicates the bioavailable concentration is above the EQS and the receptor is therefore at risk. Given the marginal exceedances of the RCR for Manganese, E3P do not consider the site to pose an unacceptable level of risk to surface waters.

### **2.6.2. GROUNDWATER**

The site is underlain by a mixed geology; the granular deposits across the site will afford less protection to the underlying Secondary A Aquifer in the bedrock and the adjacent River Irk in comparison to the centre of the site, where clay deposits have been identified in excess of 5.00 m in areas. Impacted groundwater has the potential to migrate laterally and vertically towards nearby controlled water receptors, including the river and aquifers, because of this high permeability strata. Controlled water receptors are therefore deemed to be at a high risk to on-site contamination, particularly in the south of the site.

Widespread heavy metal and PAH contamination and limited TPH contamination has been identified in the soil, leachate, and groundwater analysis at the site. It is noted that where there are exceedances in soils, there are exceedances within leachates. Thus, the source of the contaminants can be attributed to the point source of historical industrial uses and the heavy metal and PAH contamination is considered present on a site wide basis. The TPH contamination is around historical features such as tanks and will be delineated, removed and material subject to treatment.

## **2.7. DETAILED CONTROLLED WATERS RISK ASSESSMENT**

Following a review of previous investigation information and a controlled waters risk assessment completed based on the most recent phase of groundwater sampling, a theoretical risk to controlled waters has been identified from the following sources:

- ✿ Source Area 1 – Historic Landfill (Parcel B)
- ✿ Source Area 2 – Made Ground (Parcels A, C, D & E)



As part of the remediation works, the landfill area will be processed in order to ensure the remaining soils don't pose a risk to human health or controlled waters. Human health screening levels have been developed for the site however, the risk to controlled waters needed to be considered. Following discussion with the EA it was decided that Level 3 Site Specific Remediation Targets needed to be generated for the landfill material in Parcel B and for the Made Ground across the remainder of the site. The below assessment details how these were generated.

A primary source has not been identified. A secondary source area has been defined as 5 m by 5 m, based on the likely area of impacted soils requiring remediation within the historic landfill. This is considered to be a conservative assessment based on the ground investigation data and absence of any significant evidence of a pollution source.

The historic landfill in Parcel B and the Made Ground across the site is considered to be a potential source of organic contamination and leachable metals, given the identified exceedances in soil and groundwater samples.

The Tier 1 risk assessment from the original site investigation has confirmed that specifically naphthalene, arsenic, copper, cyanide, mercury, lead and zinc have been identified as posing a theoretical risk to the identified receptors (River Irk and underlying aquifers) and have therefore been modelled to generate site specific remediation targets (SSRTs). The above compounds are selected as 'indicator species' as they are considered to represent the most likely source with the highest potential for migration toward a critical receptor.

Based on the identified results and the requirement for remediation, a detailed controlled water risk assessment will be required in order to generate site-specific remedial targets which will enable the source area to be remediated to a point where they will pose no unacceptable risk to the controlled water receptors.

A model using the EA RTM P20 has been completed, and the details of such are included in this section.

### **2.7.1. CONTAMINANTS**

Concentrations of naphthalene, arsenic, copper, cyanide, mercury, lead and zinc in the location of the historic landfill (Parcel B) and in the general Made Ground (Parcels A, C, D & E) are considered to pose a potential risk to the River Irk.

Subject to the removal of all significantly impacted soils and a small quantity of perched groundwater and subsequent validation to demonstrate compliance with Site Specific Remediation Targets for the protection of controlled waters, the site can be delivered and remediated in a manner that would ensure the land poses no significant risk to controlled waters or the wider environ.

In light of the potential for the creation of a complete pollutant linkage, E3P has developed Site Specific Remediation Targets (SSRT's) to facilitate further informed understanding to which the site poses a serious risk to controlled waters and the wider environ.

This initial phase of Tier 2 Quantitative Risk Assessment modelling has been completed to provide an assessment of the actual issues and determine the viability of remediation targets and the methodology by which the secondary source at the site can be treated to minimise the degree of future risk to controlled waters and the wider environs.

The Tier 1 Controlled Waters Risk Assessment determined that the following groups of potentially soluble / mobile hydrocarbon compounds could present a theoretical risk to the identified receptors.



TABLE 2.11 – CONTAMINANT EXCEEDANCES

| Contaminant Exceedance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  Arsenic<br> Copper<br> Total Cyanide<br> Mercury<br> Lead<br> Zinc<br> Naphthalene |

The DQRA has been undertaken using the soil data obtained over the various phases of works in order to calculate RTM values for the shallow soils and to model the theoretical migration of the identified contaminants through the Made Ground (landfill) deposits towards the River Irk.

This DQRA with respect to controlled waters has been completed to calculate Remedial Target Values for soil which will be used to ensure that all soil remaining post-remediation will pose no significant level of risk to the controlled waters receptors.

TABLE 2.12 MAXIMUM SITE CONCENTRATIONS – SOURCE AREA 1 – HISTORIC LANDFILL

| Contaminant          | Max Conc in Soil (mg/kg) | Site Source |
|----------------------|--------------------------|-------------|
| <b>Arsenic</b>       | 140                      | TP507       |
| <b>Copper</b>        | 150                      | TP323       |
| <b>Total Cyanide</b> | <1.0                     | N/A         |
| <b>Mercury</b>       | 4.5                      | TP507       |
| <b>Lead</b>          | 420                      | TP507       |
| <b>Zinc</b>          | 1600                     | TP16        |
| <b>Naphthalene</b>   | 17                       | TP351       |

TABLE 2.13 MAXIMUM SITE CONCENTRATIONS – SOURCE AREA 2 – MADE GROUND (PARCEL A, C, D & E)

| Contaminant          | Max Conc in Soil (mg/kg) | Site Source          |
|----------------------|--------------------------|----------------------|
| <b>Arsenic</b>       | 320                      | TP5 (Parcel A)       |
| <b>Copper</b>        | 3600                     | TP4 (Parcel A)       |
| <b>Total Cyanide</b> | 37                       | TP107 (Parcel D & E) |
| <b>Mercury</b>       | 7.8                      | BH2 (Parcel D & E)   |
| <b>Lead</b>          | 3100                     | BH1 (Parcel A)       |
| <b>Zinc</b>          | 13000                    | TP301 (Parcel C)     |
| <b>Naphthalene</b>   | 14                       | TP409 (Parcel D & E) |

## 2.7.2. RESULTS

The results of the risk assessment are summarised in Table 2.14 and Table 2.15. Leachate and soil target values have been generated as these will be utilised for soil samples taken during remediation.

The results provide remediation target concentrations for the soils which may be used for validation purposes of the landfill area of Parcel B and the Made Ground across the remainder of the site following the remediation of the Made Ground impacted by naphthalene and heavy metal compounds.



As an alternative to the EQS, the target concentration has been reduced to 0.001 mg/l for arsenic and zinc in the RTM model to calculate Level 3 remediation targets which are considered to be protective of controlled waters.

TABLE 2.14 RESULTS SOURCE AREA 1 (PARCEL B LANDFILL)

| Contaminant          | Source Concentration<br>used in RTM Model | Level 3 Remedial Target Concentration |                  |
|----------------------|-------------------------------------------|---------------------------------------|------------------|
|                      |                                           | Soils (mg/kg)                         | Leachate (mg/l)  |
| <b>Arsenic</b>       | <b>140</b>                                | 128                                   | 0.255 (255 ug/l) |
| <b>Copper</b>        | <b>150</b>                                | 128                                   | 0.255 (255 ug/l) |
| <b>Total Cyanide</b> | <1.0                                      | 128                                   | 0.255 (255 ug/l) |
| <b>Mercury</b>       | 4.5                                       | 128                                   | 0.255 (255 ug/l) |
| <b>Lead</b>          | <b>420</b>                                | 153                                   | 0.306 (306 ug/l) |
| <b>Zinc</b>          | <b>1600</b>                               | 128                                   | 0.255 (255 ug/l) |
| <b>Naphthalene</b>   | 17                                        | 22.7                                  | 0.552 (552 ug/l) |

TABLE 2.15 RESULTS SOURCE AREA 2 (MADE GROUND – PARCEL A, C, D &amp; E)

| Contaminant          | Source Concentration<br>used in RTM Model | Level 3 Remedial Target Concentration |                  |
|----------------------|-------------------------------------------|---------------------------------------|------------------|
|                      |                                           | Soils (mg/kg)                         | Leachate (mg/l)  |
| <b>Arsenic</b>       | <b>320</b>                                | 159                                   | 0.318 (318 ug/l) |
| <b>Copper</b>        | <b>3600</b>                               | 159                                   | 0.318 (318 ug/l) |
| <b>Total Cyanide</b> | 37                                        | 159                                   | 0.318 (318 ug/l) |
| <b>Mercury</b>       | 7.8                                       | 159                                   | 0.318 (318 ug/l) |
| <b>Lead</b>          | <b>3100</b>                               | 191                                   | 0.382 (382 ug/l) |
| <b>Zinc</b>          | <b>13000</b>                              | 159                                   | 0.318 (318 ug/l) |
| <b>Naphthalene</b>   | 14                                        | 48.4                                  | 0.705 (705 ug/l) |

Remediation Target Concentrations have been produced from the RTM model which may be used to compare validation samples of the soil following remediation of the impacted soils to confirm there will be no long-term risk to the controlled water receptors.

Where the existing contaminant concentration, identified during the various phases of intrusive investigation, exceeds the remedial target value, the value has been highlighted in orange where the exceedances appear to be present.

The impact identified is considered to be stable and not expanding as there is no ongoing source that is generating potential contaminants. The leachate values generated will be utilised as the SSRT criteria within the E3P Remediation & Enabling Works Strategy.



### 3. PILE DESIGN CONTAMINATION RISK ASSESSMENT

#### 3.1. PILE DESIGN

Upon completion of enabling works, the foundation solutions within the development will comprise Ground Improvement by the construction of stone columns (VSC) within fill material, to support a shallow strip or spread foundation for the majority of the site.

A driven pile found solution will be required in the following areas:

- ✿ Soft clays and silts; and
- ✿ Deep Made Ground where the full extent of Made Ground cannot be turned over and re-engineered.

#### 3.2. CONTAMINATION RISK ASSESSMENT

The purpose of the piling risk assessment is to ensure that the proposed piling method will not have an adverse impact by creating new pathways for the migration of contamination, considering the protection both of water resources and human health.

The piling risk assessment considers six pollution scenarios based on the site setting and ground investigation findings. These are discussed in Table 3.1.

TABLE 3.1 POTENTIAL POLLUTION SCENARIO

| GENERIC POLLUTION SCENARIO                                                                                              | RISK | SITE CONSIDERATIONS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-------------------------------------------------------------------------------------------------------------------------|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Creation of preferential pathways associated with potentially soluble phase compounds within the perched aquifer</b> | Low  | <p><b>Vibro Stone Columns (VSC)</b></p> <p>VSC may create a granular permeable layer that has the potential to create a pathway within the upper stratum for soluble phase compounds to migrate through. Groundwater analysis from samples within the perched groundwater in the Made Ground has not identified potentially significant concentrations with only locally elevated concentrations of heavy metals determined when compared against highly conservative EQS values. VSCs bearing onto the bedrock within Parcel A cannot be discounted. However, prior to VSCs the removal of all significantly impacted soils and a small quantity of perched groundwater is to be undertaken with subsequent validation to demonstrate compliance with Site Specific Remediation Targets is to be undertaken. This will remove the contamination source and add protection for controlled waters, to ensure no significant risk to controlled waters or the wider environ. Additionally, VSC is not proposed to be undertaken up to the River Irk, as such, no preferential pathway will be created between perched aquifers and surface water features. Given the above, the risk is considered low.</p> <p><b>Driven piles</b></p> <p>The maximum proposed depth for driven piles is 16 m bgl, as per Figures 1.2 and 1.3, where driven piles are proposed the minimum depth to bedrock is 11 m bgl (Parcel C), as such it is possible in some areas of Parcel C driven piles will be extended to within the</p> |



| GENERIC POLLUTION SCENARIO                                                                                                                                                   | RISK | SITE CONSIDERATIONS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Creation of preferential pathways associated with potentially soluble phase compounds within the perched aquifer</b><br>Cont..                                            | Low  | <p>underlying bedrock, however, in the majority of locations and remaining parcels (A, B, D, E) driven piles are to be set within the underlying competent cohesive and granular drift deposits.</p> <p>Where low permeability CLAYs are the founding strata, given the piles are not extending to the bedrock, the aquitard will not be fully punctured and no ne preferential pathway will be created.</p> <p>Where granular drift is the founding strata, given the high permeability of the deposits, no aquitard is deemed to be present and a potential pathway for contamination from shallow soils through the granular drift deposits already exists prior to the use of piles across the site.</p> <p>Where bedrock is the founding strata, there is potential for the aquitard to be punctured, however, where driven piles are utilised, soils are displaced horizontally, with the density of the soils around the piles increasing which in turn reduces soil permeability. As such, no new preferential pathway will be created between perched aquifers and controlled water receptors. Additionally, the likelihood of down-ward vertical migration along the driven pile shaft, particularly in view of lateral compaction, is significantly reduced and the risk low.</p> |
| <b>Creation of preferential pathways, through a low permeability surface layer, to allow upward migration of landfill gas, soil gas or contaminant vapors to the surface</b> | Low  | <p>Following completion of remediation and enabling works within each parcel, a round of post remediation ground gas monitoring is to be undertaken. The findings of which will direct the appropriate gas protection measures required in the proposed development for protecting end users of the site.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Direct contact of site workers and others with contaminated soil arising that have been brought to the surface.</b>                                                       | Low  | <p>The use of VSC and driven piles will not generate any return materials to the surface.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Direct contact with the pile and potentially contaminated soil and leachable compounds</b>                                                                                | Low  | <p>For driven piles the concrete will be specified to a recognised standard according to the pH and sulphate concentrations recorded in the E3P site investigation.</p> <p>For VSC stone to be imported and used within the columns will be chemically validated to ensure no risk.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>The driving of solid contaminants down into the aquifer during piling</b>                                                                                                 | Low  | <p>The proposed piling methods of VSC and precast concrete driven pile are displacement methods.</p> <p>Laboratory analysis of Made Ground samples has recorded locally elevated areas of heavy metals, non-volatile PAH and hydrocarbon fractions C10-C35 in isolated areas across the site.</p> <p>Driven piles and VSC may extend into the bedrock within some locations (Parcel A and C), the primary movement of soil during piling is lateral with a small potential for soils in contact with the sides and that base to be dragged down slightly before it is displaced. However, document EA NC/99/73 concludes that there are no recorded cases of this occurring.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |



| GENERIC POLLUTION SCENARIO                                                                               | RISK | SITE CONSIDERATIONS                                                                                                                                                                                                                                                                                                                                                                                  |
|----------------------------------------------------------------------------------------------------------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>The driving of solid contaminants down into the aquifer during piling</b><br>Cont...                  | Low  | Additionally, the underlying secondary A aquifer is considered low sensitivity, with the site not located within a source protection area or within a drinking water safeguard zone. As the proposed piling methods are only likely to result in minimal vertical displacement of soils through the underlying drift and given the low sensitivity of the receptor the risk is considered to be low. |
| <b>Contamination of groundwater and, subsequently, surface waters by concrete, cement paste or grout</b> | Low  | Both VSC and precast driven pile methods do not utilise liquid cement or grout.                                                                                                                                                                                                                                                                                                                      |

In addition to the above, E3P has developed a diagrammatic conceptual model for both VSC and driven piles at the proposed development, which considers the factors in Table 3.1. This is available as Drawing 14-554-031 and 14-554-032 in Appendix III, a snapshot is included in Figure 3.1 and 3.2.

FIGURE 3.1 VSC CONCEPTUAL MODEL

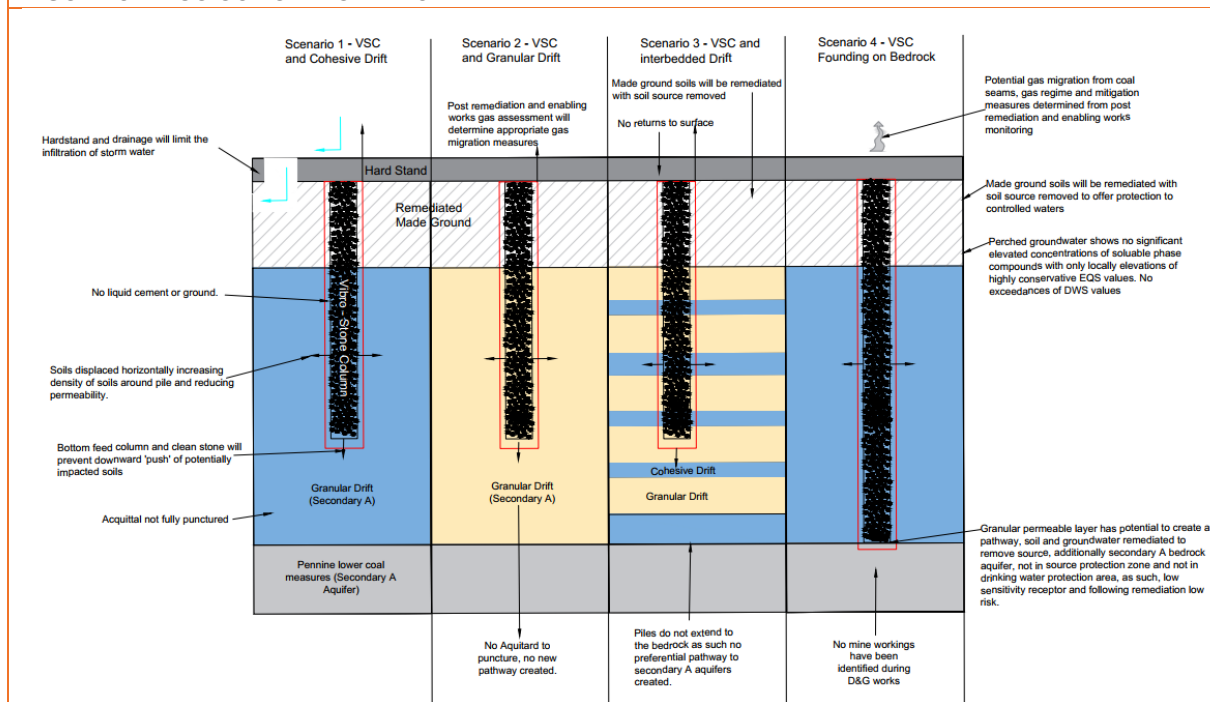
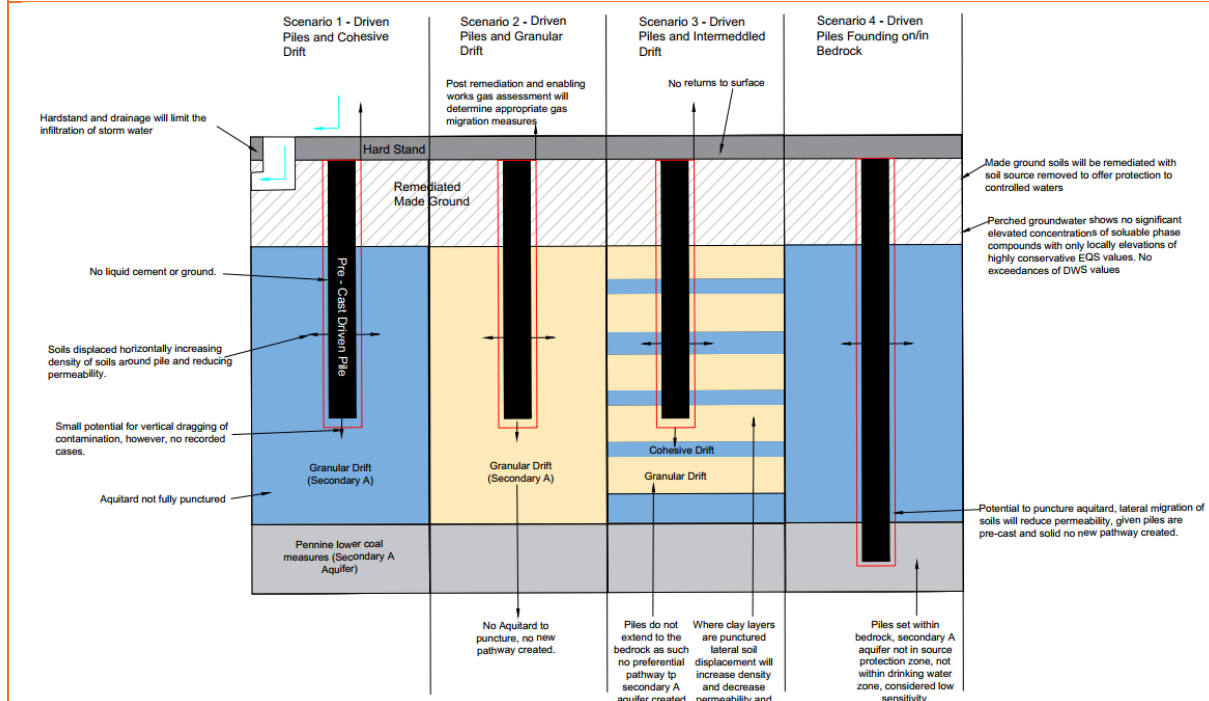


FIGURE 3.2 DRIVEN PILE CONCEPTUAL MODEL



## 4. CONCLUSION

The Piling Risk Assessment has determined that based on the ground and perched groundwater conditions within the Made Ground and underlying drift strata, the use of a driven pre cast piles and VSC bearing within the underlying drift will pose a low risk.

**END OF REPORT**



# APPENDIX I

# LIMITATIONS

1. This report and its findings should be considered in relation to the terms of reference and objectives agreed between E3P and the Client as indicated in Section 1.3.
2. For the work, reliance has been placed on publicly available data obtained from the sources identified. The information is not necessarily exhaustive and further information relevant to the site may be available from other sources. When using the information it has been assumed it is correct. No attempt has been made to verify the information.
3. This report has been produced in accordance with current UK policy and legislative requirements for land and groundwater contamination which are enforced by the local authority and the Environment Agency. Liabilities associated with land contamination are complex and requires advice from legal professionals.
4. During the site walkover, reasonable effort has been made to obtain an overview of the site conditions. However, during the site walkover, no attempt has been made to enter areas of the site that are unsafe or present a risk to health and safety, are locked, barricaded, overgrown, or the location of the area has not been made known or accessible.
5. Access considerations, the presence of services and the activities being carried out on the site limited the locations where sampling locations could be installed and the techniques that could be used.
6. Site sensitivity assessments have been made based on available information at the time of writing and are ultimately for the decision of the regulatory authorities.
7. Where mention has been made to the identification of Japanese Knotweed and other invasive plant species and asbestos or asbestos-containing materials, this is for indicative purposes only and do not constitute or replace full and proper surveys.
8. The executive summary, conclusions and recommendations sections of the report provide an overview and guidance only and should not be specifically relied upon without considering the context of the report in full.
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10. New information, revised practices or changes in legislation may necessitate the re-interpretation of the report, in whole or in part.



# **APPENDIX II**

## **GLOSSARY**

## TERMS

|              |                                                            |                |                                                      |
|--------------|------------------------------------------------------------|----------------|------------------------------------------------------|
| <b>ACM</b>   | Asbestos-containing material                               | <b>MMP</b>     | Materials management plan                            |
| <b>ADS</b>   | Acoustic design statement                                  | <b>ND</b>      | Not detected                                         |
| <b>AST</b>   | Above-ground storage tank                                  | <b>NDP</b>     | Nuclear density probe                                |
| <b>BGS</b>   | British Geological Survey                                  | <b>NMP</b>     | Noise management plan                                |
| <b>BSI</b>   | British Standards Institute                                | <b>NPSE</b>    | Noise policy statement for England                   |
| <b>BTEX</b>  | Benzene, toluene, ethylbenzene, xylenes                    | <b>NR</b>      | Not recorded                                         |
| <b>CA</b>    | Coal Authority                                             | <b>PAH</b>     | Polycyclic aromatic hydrocarbon                      |
| <b>CBR</b>   | California bearing ratio                                   | <b>PCB</b>     | Polychlorinated biphenyl                             |
| <b>CIEH</b>  | Chartered Institute of Environmental Health                | <b>PI</b>      | Plasticity index                                     |
| <b>CIRIA</b> | Construction Industry Research Association                 | <b>PID</b>     | Photo ionisation detector                            |
| <b>CLEA</b>  | Contaminated land exposure assessment                      | <b>POS</b>     | Public open space                                    |
| <b>CML</b>   | Council of Mortgage Lenders                                | <b>PPE</b>     | Personnel protective equipment                       |
| <b>CoC</b>   | Contaminants of concern                                    | <b>ProPG</b>   | Professional practice guidance                       |
| <b>CSM</b>   | Conceptual site model                                      | <b>QA</b>      | Quality assurance                                    |
| <b>DNAPL</b> | Dense non-aqueous phase liquid (chlorinated solvents, PCB) | <b>SGV</b>     | Soil guideline value                                 |
| <b>DWS</b>   | Drinking water standard                                    | <b>SPH</b>     | Separate-phase hydrocarbon                           |
| <b>EA</b>    | Environment Agency                                         | <b>SPT</b>     | Standard penetration test                            |
| <b>EQS</b>   | Environmental quality standard                             | <b>SVOC</b>    | Semi-volatile organic compound                       |
| <b>FFL</b>   | Finished floor level                                       | <b>TPH</b>     | Total and speciated petroleum hydrocarbon            |
| <b>GAC</b>   | General assessment criteria                                | <b>TPH CWG</b> | Total Petroleum Hydrocarbon (Criteria Working Group) |
| <b>GL</b>    | Ground level                                               | <b>UKWIR</b>   | United Kingdom Water Infrastructure Risk             |
| <b>GSV</b>   | Gas screening value                                        | <b>UST</b>     | Underground storage tank                             |
| <b>HCV</b>   | Health criteria value                                      | <b>VCC</b>     | Vibro-concrete column                                |
| <b>ICSM</b>  | Initial conceptual site model                              | <b>VOC</b>     | Volatile organic compound                            |
| <b>LEL</b>   | Lower explosive limit                                      | <b>VRSC</b>    | Vibro-replacement stone columns                      |
| <b>LMRL</b>  | Lower method reporting limit                               | <b>VSC</b>     | Vibro-stone columns                                  |
| <b>LNAPL</b> | Light non-aqueous phase liquid (petrol, diesel, kerosene)  | <b>WHO</b>     | World Health Organisation                            |
| <b>MCV</b>   | Moisture condition value                                   | <b>WRAP</b>    | Waste and Resources Action Programme                 |
| <b>MIBK</b>  | Methyl isobutyl ketone                                     | <b>WTE</b>     | Water table elevation                                |



**Don Street**

Pile Design Contaminated Land Risk Assessment

March 2023

|              |                                             |                         |                                         |
|--------------|---------------------------------------------|-------------------------|-----------------------------------------|
| <b>m</b>     | Metres                                      | <b>ppm</b>              | Parts per million                       |
| <b>km</b>    | Kilometres                                  | <b>mg/m<sup>3</sup></b> | Milligram per metre cubed               |
| <b>% v/v</b> | Percent volume in air                       | <b>m bgl bgl</b>        | Metres below ground level               |
| <b>mb</b>    | Millibars (atmospheric pressure)            | <b>m bcl</b>            | Metre below cover level                 |
| <b>l/hr</b>  | Litres per hour                             | <b>mAOD</b>             | Metres above ordnance datum (sea level) |
| <b>µg/l</b>  | Micrograms per litre (parts per billion)    | <b>kN/m<sup>2</sup></b> | Kilonewtons per metre squared           |
| <b>ppb</b>   | Parts per billion                           | <b>µm</b>               | Micrometre                              |
| <b>mg/kg</b> | Milligrams per kilogram (parts per million) |                         |                                         |



# **APPENDIX III**

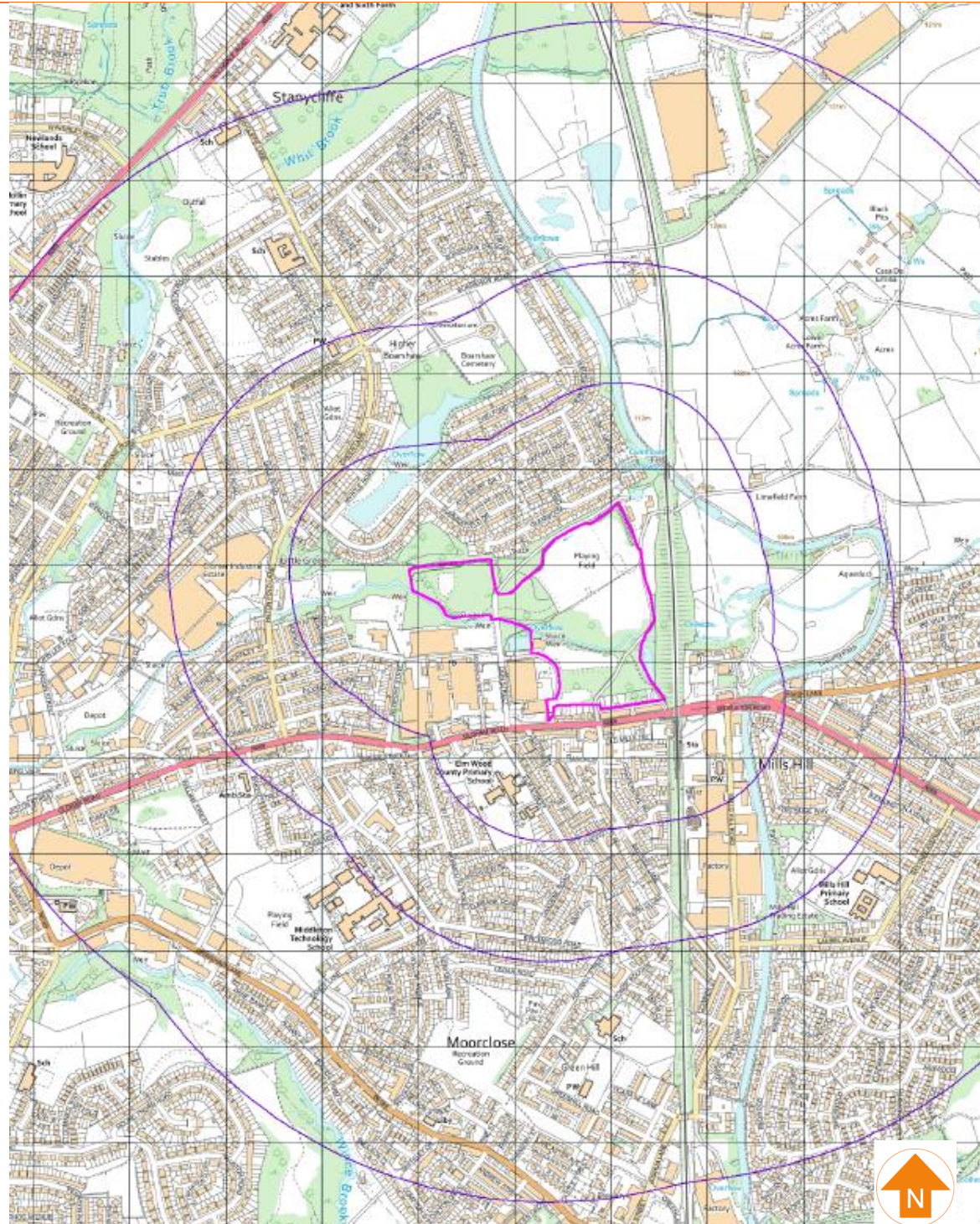
## **DRAWINGS**

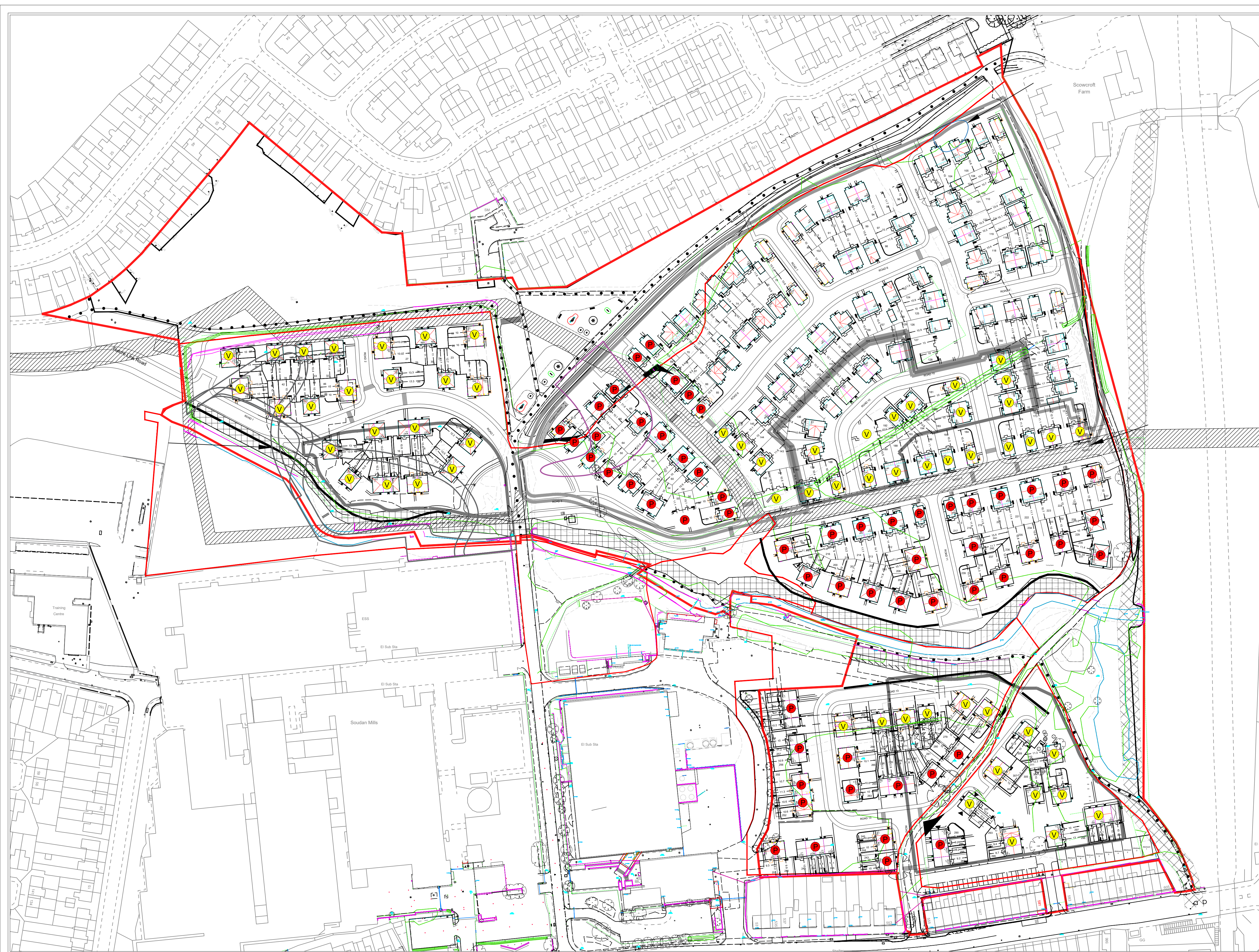
## Don Street

Pile Design Contaminated Land Risk Assessment

March 2023

### DRAWING 14-554-001 – SITE LOCATION PLAN





| Summary of Heave Precaution Requirements                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                               |                                                                                                  |                                                                      |                                                                           |     |                                                          |     |     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|--------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|---------------------------------------------------------------------------|-----|----------------------------------------------------------|-----|-----|
| Volume Change Potential                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Required Foundation Depth (m) | Minimum Void Dimensions for Foundations, Ground Beams & Suspended In-Situ Concrete Ground Floors |                                                                      | Minimum Void Dimensions Under Pre-Cast Concrete & Suspended Timber Floors |     |                                                          |     |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                               | Thickness of Void Former Against Side of Foundation of Ground Beam (mm)                          | Thickness of Void Former on Underside of Edge Beam & Floor Slab (mm) | Void Dimension (mm)                                                       |     |                                                          |     |     |
| Low Volume Change Potential (<20%)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | >2.00                         | No Special Precautions                                                                           |                                                                      | 200                                                                       |     |                                                          |     |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 2.00-2.50                     | -                                                                                                | 50                                                                   |                                                                           |     |                                                          |     |     |
| Medium Volume Change Potential (20-40%)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 1.50-2.00                     | 25                                                                                               | 50                                                                   | 250                                                                       |     |                                                          |     |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 2.00-2.50                     | 25                                                                                               | 100                                                                  |                                                                           |     |                                                          |     |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | >2.50                         | Engineer Design                                                                                  |                                                                      | Engineer Design                                                           |     |                                                          |     |     |
| High Volume Change Potential (>40%)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 1.50-2.00                     | 25                                                                                               | 75                                                                   | 300                                                                       |     |                                                          |     |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 2.00-2.50                     | 35                                                                                               | 150                                                                  |                                                                           |     |                                                          |     |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | >2.50                         | Engineer Design                                                                                  |                                                                      | Engineer Design                                                           |     |                                                          |     |     |
| Minimum Width of Strip Footings                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                               |                                                                                                  |                                                                      |                                                                           |     |                                                          |     |     |
| Type of Ground (Including Engineered Fill)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Condition of Ground           | Total Load of Load-Bearing Walling more than (kN/linear metre)                                   |                                                                      |                                                                           |     |                                                          |     |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                               | 20                                                                                               | 30                                                                   | 40                                                                        | 50  | 60                                                       | 70  |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                               | Minimum Width of Strip Foundation (mm)                                                           |                                                                      |                                                                           |     |                                                          |     |     |
| Gravel                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Sand                          | Medium Dense to Dense                                                                            | 250                                                                  | 300                                                                       | 400 | 500                                                      | 600 | 650 |
| Clay                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Sandy Clay                    | Stiff                                                                                            | 250                                                                  | 300                                                                       | 400 | 500                                                      | 600 | 650 |
| Clay                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Sandy Clay                    | Firm                                                                                             | 300                                                                  | 350                                                                       | 450 | 600                                                      | 750 | 850 |
| Items Considered                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                               |                                                                                                  |                                                                      |                                                                           |     |                                                          |     |     |
| Bearing Capacity                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                               |                                                                                                  | TBC                                                                  |                                                                           |     |                                                          |     |     |
| Trees                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                               |                                                                                                  | TBC                                                                  |                                                                           |     |                                                          |     |     |
| Historical                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                               |                                                                                                  | TBC                                                                  |                                                                           |     |                                                          |     |     |
| Groundwater Table                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                               |                                                                                                  | TBC                                                                  |                                                                           |     |                                                          |     |     |
| FFL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                               |                                                                                                  | TBC                                                                  |                                                                           |     |                                                          |     |     |
| Client Layout                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                               |                                                                                                  | TBC                                                                  |                                                                           |     |                                                          |     |     |
| Contamination                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                               |                                                                                                  | TBC                                                                  |                                                                           |     |                                                          |     |     |
| Remediation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                               |                                                                                                  | TBC                                                                  |                                                                           |     |                                                          |     |     |
| Volume Change Potential                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                               |                                                                                                  | TBC                                                                  |                                                                           |     |                                                          |     |     |
| Root Protection Areas                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                               |                                                                                                  | TBC                                                                  |                                                                           |     |                                                          |     |     |
| Is the Site Affected by Shallow Mining?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                               |                                                                                                  | Yes/No                                                               |                                                                           |     |                                                          |     |     |
| Are Mine Entries Present on or Within Influencing Distance of the Site?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                               |                                                                                                  | Yes/No                                                               |                                                                           |     |                                                          |     |     |
| Residual Risks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                               |                                                                                                  |                                                                      |                                                                           |     |                                                          |     |     |
| Foreseeable Risks That Cannot be Avoided                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Applicable (Y/N)              | Action to Reduce Risk                                                                            |                                                                      |                                                                           |     | Justification for Design Decision                        |     |     |
| Deep Excavations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Y                             | Identify locations on drawing and depths on schedule                                             |                                                                      |                                                                           |     | Lesser risk than other alternatives                      |     |     |
| Trench Collapse                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Y                             | Risk highlighted on drawing                                                                      |                                                                      |                                                                           |     | Lesser risk than other alternatives                      |     |     |
| Use of Working Platform for Pile/Vibro Operations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Y                             | Compliance with working platform directive required                                              |                                                                      |                                                                           |     | Pile/Vibro foundation less risky than other alternatives |     |     |
| Notes:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                               |                                                                                                  |                                                                      |                                                                           |     |                                                          |     |     |
| Coal Mining Foundation Notes:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                               |                                                                                                  |                                                                      |                                                                           |     |                                                          |     |     |
| Where foundations are located over treated shallow workings spread and trench fill foundations (strips and rafts) are required to be suitably reinforced to span soft spots (3m span and 1.5m cantilever). It is desirable to maintain bearing pressures below 160kN/m2 at the grouted horizons - Piles are not generally suitable unless founded below the grouted horizons (typically, this cannot be achieved with driven piles) and would require further detailed assessment. There is also a potential for pile installation to disturb workings or shafts Refer to CIRIA SP32 and C758 for details. Foundations, which encounter coal, should be brought below the coal. The sides of foundations should be protected when they are in contact with coal. |                               |                                                                                                  |                                                                      |                                                                           |     |                                                          |     |     |

Anticipated Foundation Types

- TS

Traditional Strip Foundations

Minimum depth 1200mm below proposed First Finished Level

Maximum safe bearing pressure limited to 100kN/m2
- MT

Mass Trench Fill Foundations

Minimum depth 1200mm below proposed First Finished Level

Maximum safe bearing pressure limited to 100kN/m2
- V

Vibro Stone Ground Compaction

In accordance with NBSIC Chapter 4.2
- P

Piled Foundations

Where the maximum bearing pressure exceeds 250kN/m2 a piled foundation option rather than a trench fill / deep reinforced strip foundations may be adopted. Columns or tie beams supported by ground beams.
- R

Raft Foundations

Minimum safe bearing pressure limited to 50kN/m2 on approved engineered ground. Raft foundations to be designed by a structural engineer in accordance with Chapter 4.3 of BSIC 2015. Raft foundations are considered subject to collapse against planing failure of clay. Please refer to BSIC 2015, section 2.10.
- TB

Traditional Strip / Trench Block Foundations

Foundations may be limited to 400mm lower corner level with wall up to Trench Block and subsequent backfill to development level.
- Colours on Plot Corners to be Used When Referring to Foundation Schedule.

(Shading First Level & Levels)

Depth to Target Founding Strata

- Footings 0.75 - 0.90m Deep

From First Finished Level

In accordance with NBSIC Chapter 4.2
- Footings 0.90 - 1.25m Deep

From First Finished Level

In accordance with NBSIC Chapter 4.2
- Footings 1.25 - 1.50m Deep

From First Finished Level

In accordance with NBSIC Chapter 4.2
- Footings 1.50 - 1.75m Deep

From First Finished Level

In accordance with NBSIC Chapter 4.2
- Footings 1.75 - 2.00m Deep

From First Finished Level

In accordance with NBSIC Chapter 4.2
- Footings 2.00 - 2.25m Deep

From First Finished Level

In accordance with NBSIC Chapter 4.2
- Footings 2.25 - 2.50m Deep

From First Finished Level

In accordance with NBSIC Chapter 4.2

Engineered Foundation Solutions

- Footings >2.50m Deep

From First Finished Level

In accordance with NBSIC Chapter 4.2
- Vibro
- Low Volume Change Potential Clay

Heave precautions required to underside of cast in-situ floor slab (with no sub-floor void) within corrected zone of free influence. Heave precautions not required to foundation.

Notes:

Drawing is based on Coopers FZP

|       |       |            |       |         |
|-------|-------|------------|-------|---------|
| P1    | REVC  | 06.03.2023 | HM    | MD      |
| P1    | REVB  | 01.03.2023 | LM    | MD      |
| P1    | REVA  | 10.10.2022 | EB    | SE      |
| Phase | Issue | Date       | Drawn | Checked |

Client:

Kellen Homes

Job Title:

Donn Street, Middleton

Job No:

14-554

Drawing No:

015

Drawing Title:

Concept Foundation Zoning Plan

Date:

06.03.2023

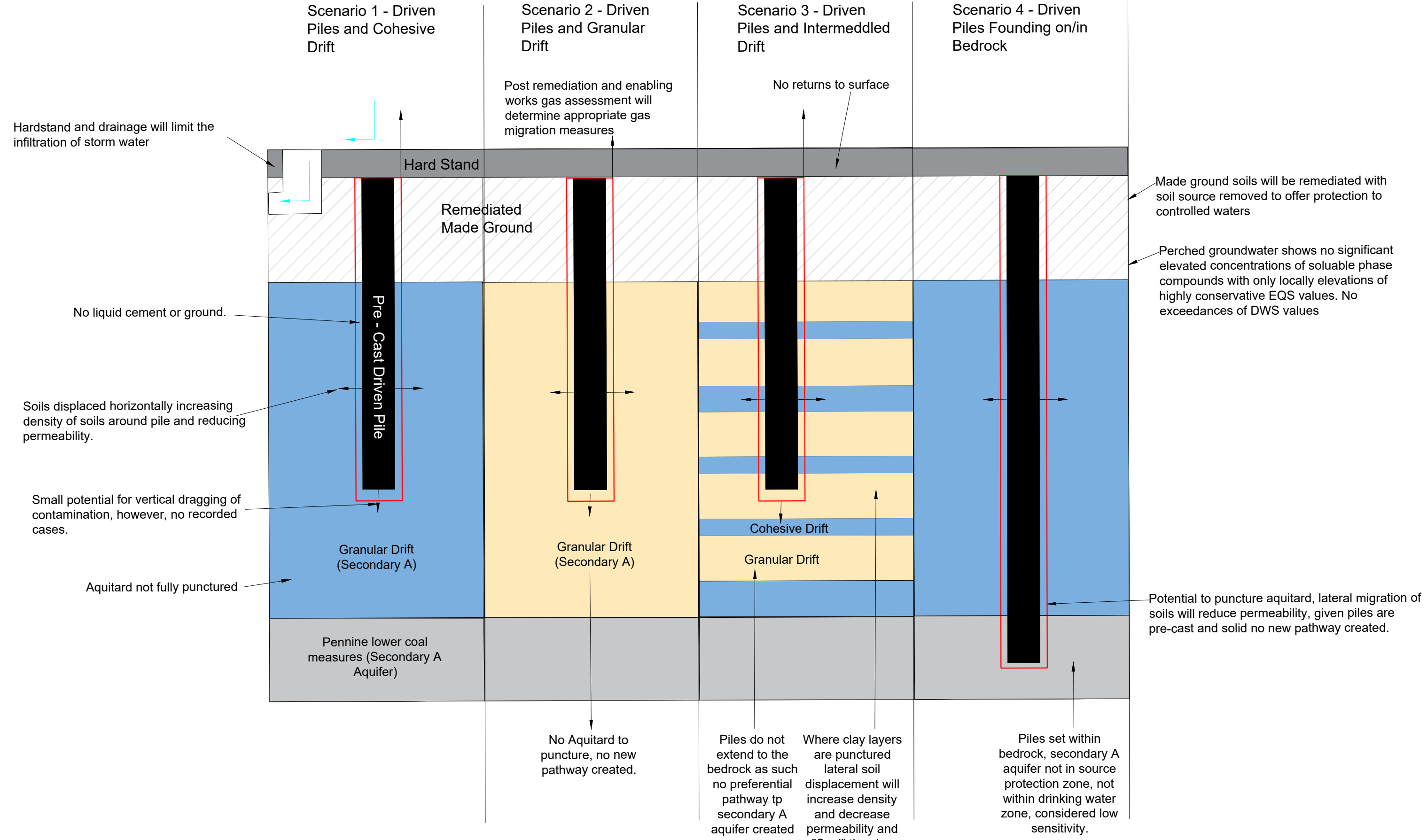
Scale:

NTS@ A1

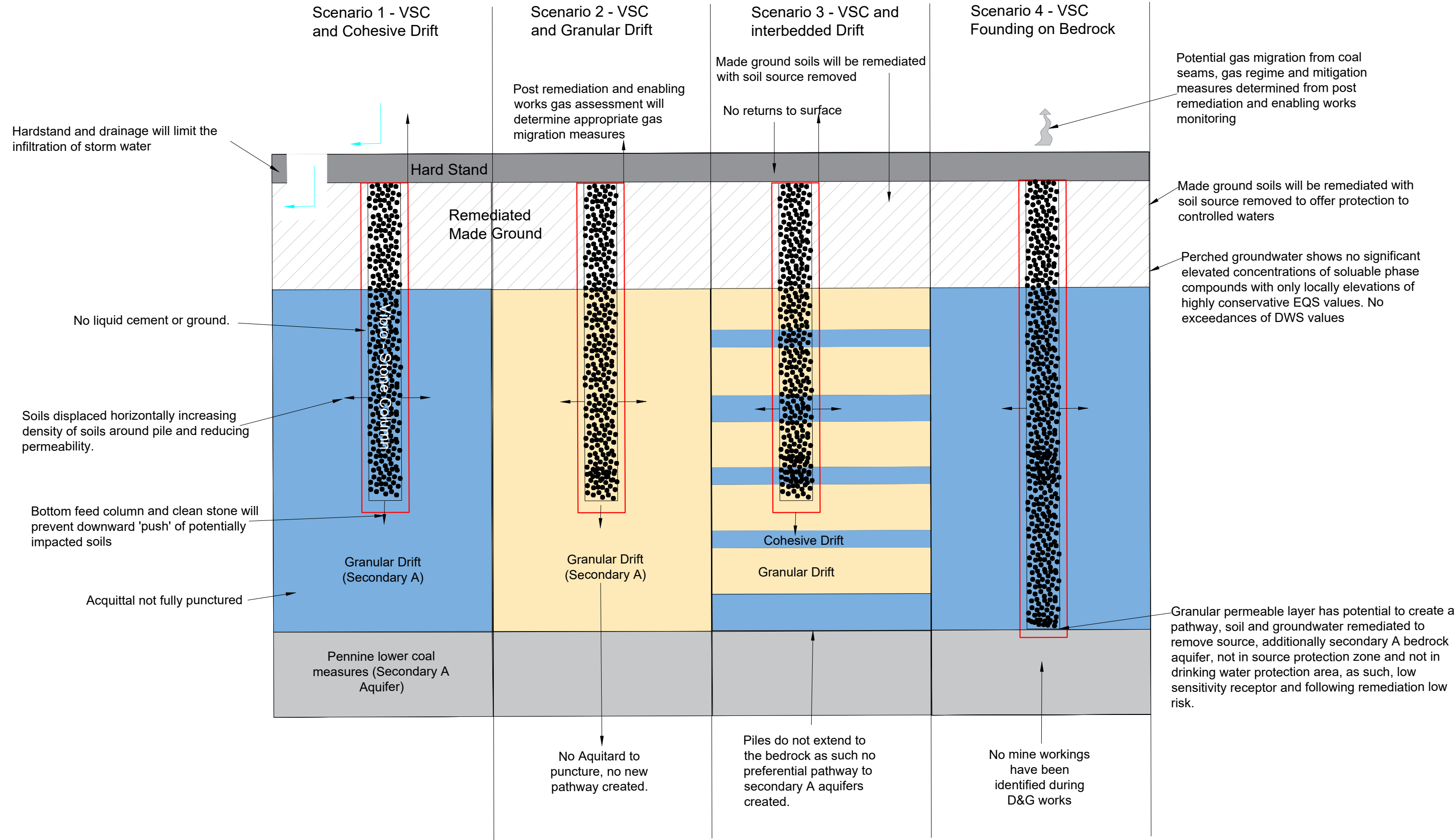


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|                                                                                                                                                                                                                                                     |       |            |       |         |                   |      |            |    |    |                                                                               |      |                                      |                                        |                                                                                                                                                                                                                                                  |       |       |      |       |         |                                                             |  |  |  |  |                                       |  |                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------------|-------|---------|-------------------|------|------------|----|----|-------------------------------------------------------------------------------|------|--------------------------------------|----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-------|------|-------|---------|-------------------------------------------------------------|--|--|--|--|---------------------------------------|--|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| <div>Geology Key</div> <div><div>Granular Drift</div><div>Cohesive Drift</div><div>Hard Stand</div><div>Made Ground</div></div>                                                                                                                     |       |            |       |         | <div>Notes:</div> |      |            |    |    | <div>Client:</div> <div>Kellen Homes</div>                                    |      | <div>Job No:</div> <div>14-554</div> | <div>Date:</div> <div>06.03.2023</div> | <div><div><div></div></div><div>e3p</div><div>Environmental Engineering Partnership Ltd<br/>Taylor Road, Trafford Park<br/>Urmston, Manchester, M41 7JQ<br/>Tel: 0161 707 9612<br/>E-mail: info@e3p.co.uk<br/>Website: www.e3p.co.uk</div></div> |       |       |      |       |         |                                                             |  |  |  |  |                                       |  |                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
| <table><tr><td>P1</td><td>REVB</td><td>06.03.2023</td><td>HM</td><td>MD</td></tr><tr><td>P1</td><td>REVA</td><td>23.02.2023</td><td>OW</td><td>MD</td></tr><tr><td>Phase</td><td>Issue</td><td>Date</td><td>Drawn</td><td>Checked</td></tr></table> |       |            |       |         | P1                | REVB | 06.03.2023 | HM | MD | P1                                                                            | REVA | 23.02.2023                           | OW                                     | MD                                                                                                                                                                                                                                               | Phase | Issue | Date | Drawn | Checked | <div>Job Title:</div> <div>Donn Street,<br/>Middleton</div> |  |  |  |  | <div>Drawing No:</div> <div>031</div> |  | <div>Scale:</div> <div>NTS</div> | <div><div>The client must not amend any drawing, design or other intellectual property produced by E3P Ltd without permission in writing from E3P Ltd in advance of any amendments being made. In the event that such written permission is not obtained in advance of the amendments being made, E3P Ltd shall not be liable for any damage and/or losses occurring as a result of the amended drawing, design or intellectual property.</div></div> |  |
| P1                                                                                                                                                                                                                                                  | REVB  | 06.03.2023 | HM    | MD      |                   |      |            |    |    |                                                                               |      |                                      |                                        |                                                                                                                                                                                                                                                  |       |       |      |       |         |                                                             |  |  |  |  |                                       |  |                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
| P1                                                                                                                                                                                                                                                  | REVA  | 23.02.2023 | OW    | MD      |                   |      |            |    |    |                                                                               |      |                                      |                                        |                                                                                                                                                                                                                                                  |       |       |      |       |         |                                                             |  |  |  |  |                                       |  |                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
| Phase                                                                                                                                                                                                                                               | Issue | Date       | Drawn | Checked |                   |      |            |    |    |                                                                               |      |                                      |                                        |                                                                                                                                                                                                                                                  |       |       |      |       |         |                                                             |  |  |  |  |                                       |  |                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
|                                                                                                                                                                                                                                                     |       |            |       |         |                   |      |            |    |    | <div>Drawing Title:</div> <div>Conceptual Site<br/>Model - Driven Piles</div> |      |                                      |                                        |                                                                                                                                                                                                                                                  |       |       |      |       |         |                                                             |  |  |  |  |                                       |  |                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |



**Geology Key**

- Granular Drift
- Cohesive Drift
- Hard Stand
- Made Ground

**Notes:**

|       |       |            |       |         |
|-------|-------|------------|-------|---------|
| P1    | REVB  | 06.03.2023 | HM    | MD      |
| P1    | REVA  | 23.02.2023 | OW    | MD      |
| Phase | Issue | Date       | Drawn | Checked |

**Client:**

Kellen Homes

**Job No:**

14-554

**Drawing No:**

032

**Job Title:**

Donn Street, Middleton

**Date:**

06.03.2023

**Scale:**

NTS

**Drawing Title:**

Conceptual Site Model - Vibro - Stone Columns

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