



CHALK MINE STABILISATION PROJECT HIGHBARNNS, HEMEL HEMPSTEAD

Treatment Area 2: Nos. 10 and 12 Pond Road

Report Number: 0013-UA000857-TR-01-TAR-0002


OCTOBER 2015



Incorporating

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1 INTRODUCTION

Dacorum Borough Council (DBC) has commissioned Arcadis Consulting (UK) Ltd (Arcadis) (formerly Hyder Consulting (UK) Limited) to oversee the treatment and validation of abandoned chalk mines identified beneath residential areas in the Nash Mills area of Hemel Hempstead, Hertfordshire. The mine workings identified at the site have been assessed to comprise a single level of chalk mine galleries in the vicinity of Highbarns, Pond Road and East Green Road junction. The mine treatment has been funded under the Land Stabilisation Programme (LSP), administered by the Homes and Communities Agency (HCA).

The background to the scheme, interpretation of the mine, and treatment works are set out in the overarching Treatment Report (Arcadis, 2015). This report forms an addendum to the above report and should be read in conjunction with it.

The objective of this report is to set out the works that were undertaken to treat the mines and provide the results of post mine treatment validation probing. The properties discussed in this report are as follows:

- Nos 10 and 12 Pond Road.
- Pond Road outside Nos 12, 14 and 16.

The broader site location, treatment areas and interpreted extent of mine workings within the Derelict Land Clearance Order site boundary are shown in the overarching Treatment Report (Arcadis, 2015), Figures 1, 2 and 3 respectively.

This Treatment area, validation probes and extent of grouting work specific to this treatment area are shown on Drawings TA0002-01 and 02 in Appendix A.

Factual information relating to the investigative probes, validation probes and extent of grouting work are contained in the BAM Ritchies' Sectional Validation Report for Nos. 10 and 12 Pond Road, (BAM, 2015).

2 SUBSURFACE INVESTIGATIONS

The subsurface investigations at these properties were undertaken in response to historical subsidence events across the site.

The pre-contract investigations were undertaken by Soil Engineering Ltd in 2012 and included investigative dynamic probes and dynamic windowless sampled boreholes. A review of historical information, the natural topography and the geotechnical investigations were used to identify zones of probable mining related disturbed ground.

Following and during each stage of the treatment works, validation dynamic probing was undertaken to establish the effectiveness of the mine treatment.

The scope of the validation dynamic probing completed during and following the treatment works for Nos. 10 and 12 Pond Road are summarised in table 1 below.

Table 1: Summary of Validation Investigations

Type of Investigations	Number
Total No. of External Validation Dynamic Probes (VP)	63
Total No. of Internal Validation Dynamic Probes (VP)	0

The results of the validation dynamic probes undertaken during and after treatment works are presented in the relevant sectional factual report VR002 for this treatment

area (BAM Ritchies, 2015). For the purposes of this report, additional dynamic probes undertaken concurrently with the grouting works in order to further investigate the extent of mine workings are designated validation probes.

Findings of the pre-contract design phase ground investigation undertaken by Soil Engineering and subsequent interpretations are contained in the Interpretive Ground Investigation Report for the site (Hyder, 2012a).

3 MINE TREATMENT

Mine treatment works have been undertaken in accordance with the Specification for Site Works (Hyder, 2012b). The techniques of mine treatment adopted at the site consisted of bulk infilling of open voids and compaction grouting of collapsed ground.

A summary of the treatment works are set out in Table 2 below.

Table 2: Summary of Treatment Works

Property	Location	Type of Hole	Number of Holes	Range of Grout takes ¹ (m ³)	Total Grout take ¹ (m ³)
No. 10 Pond Road (Total Grout Holes = 1, Total Grout Volume = 31.308m ³)	Front of Property	Vertical compaction grout holes	1	7.534 (CGV618)	7.534
	Front of Property	Inclined compaction grout holes	4	0.596 (CGI644) to 15.93 (CGI632)	23.774
No. 12 Pond Road (Total Grout Holes = 1, Total Grout Volume = 2.384m ³)	Front garden	Vertical compaction grout holes	1	2.384 (CGV28)	2.384
Pond Road (Total Grout Holes = 12, Total Grout Volume = 47.588m ³)	Pond Road	Vertical compaction grout holes	12	1.903 (CGV35) to 6.598 (CGV36)	47.588

Notes:

The above extract is based on data from BAM Ritchies' Sectional Validation Report for Nos. 10 and 12 Pond Road. (BAM, 2015). The factual report should be referenced for further details of treatment works including the volumes of grout injected and injection pressures per grout hole.

The treatment was undertaken in a phased approach with several stages of grouting and validation dynamic probe testing. Additional stages of grouting and validation testing were completed where validation testing raised doubts as to the extent of the grout penetration beneath properties or where additional mining related disturbed ground was identified.

4 VALIDATION

Validation of the treatment works has been based upon a combination of factors including a comparison of pre-treatment investigations, validation probing and grout volumes recorded during treatment. The number of grout holes, their location and the

phasing of the grouting was adjusted as the work proceeded in order to accommodate the findings of the treatment works. Experience gained from other chalk mine projects has identified that dynamic probe blow counts of less than 3 per 100mm penetration is indicative of the presence of mine workings. Consequently, treatment was only considered complete where validation probes proved blow counts greater than 3 per 100mm penetration at the level of the suspected mine as interpreted from the pre-contract investigations.

A detailed scope of validation procedures adopted during the treatment works is presented in the Highbarns Chalk mine Stabilisation Treatment Report (Arcadis, 2015).

This treatment area is outside the DLCO boundary but it was deemed necessary to treat under the gardens and Pond Road due to the weaknesses in the ground uncovered in dynamic probes at adjacent No. 8 Pond Road. This phase of treatment works located outside of the DLCO boundary was undertaken as a separate phase of work and funding was provided by Hertfordshire County Council.

The grout volumes at 10 & 12 Pond Road did not generally indicate open mines but, in some locations, are in excess of what might be expected from natural ground. Grout volumes across the treatment area generally ranged between a minimum of 1.58m³ and a maximum of 6.598m³ with an average grout volume of around 3.0m³ indicating the treatment of weak or collapsed ground rather than open mine voids. Results of validation testing undertaken at No. 10 and 12 Pond Road and along Pond Road generally indicate an overall improvement of the relative density of the ground following treatment.

Specific observations for each property are set out in the subsequent sections.

4.1 No. 10 Pond Road

Grouting of No. 10 Pond Road was designed to treat the possible mine passage trending northeast-southwest beneath the front gardens that appears to be an extension of the mine passage beneath No. 8 Pond Road.

Validation probing located in No. 8 Pond Road identified weakness in the ground which prompted further work to investigate the extent of suspected mining disturbed ground beneath No. 10 Pond Road. A row of validation probes (VP496, VP497 & VP498) were initially undertaken during September 2013 in the passageway between No. 8 & No. 10 Pond Road. Low blow counts indicative of collapsed mine workings were recorded between depths of 12.9m and 13.4m bgl in VP497. Grouting works were therefore carried out in the passageway to treat the weak ground identified in VP497. This comprised a grout volume of 7.534m³ in grout hole CGV618 which indicated treatment of mining collapsed ground rather than an open void.

A secondary row of validation probes (VP617, VP618 & VP619) located along the boundary with No. 8 were undertaken to investigate whether the mine could extend under the buildings. These validation probes were undertaken to 20.0m bgl and the results showed competent ground throughout the depth of investigation with no indication of mined ground.

Further validation probing was undertaken in the front garden of No. 10 Pond Road to confirm the possible mine passage suspected to trend towards the northeast and across Pond Road. Validation probe blow counts indicative of mined ground were recorded in VP854 between depths of 17.6m and 18.6m bgl and in VP914 between depths of 14.0m and 17.0m bgl. Grout hole CGV24A was undertaken to treat the weak ground identified and a total grout volume of only 4.48m³ was injected.

Validation probing undertaken in other areas of the front garden of No. 10 Pond Road did not indicate the presence of mining disturbed ground.

4.2 No. 12 Pond Road

Grouting of No. 12 Pond Road was designed to treat the possible second mine passage trending northeast-southwest leading off the passageway identified in front of No. 10 Pond Road. This is considered to be an extension of the mine passage from beneath No. 10 Pond Road which prompted validation probing and subsequent treatment at No. 12 Pond Road. An interpretation of the expected mine layout for No. 12 Pond Road is shown on Drawing TA0002-02 presented in Appendix A.

An initial row of 2 No. validation probes were undertaken during April 2014 in the front garden of No. 12. Low blow counts were recorded between depths of 13.0m and 14.0m bgl in VP930 and between 12.0m and 12.9m bgl in VP931, indicative of mining disturbed ground. Grout hole CGV28A was undertaken to treat the front garden of No. 12 Pond Road and a grout volume of only 2.384m³ was injected. Validation probing undertaken subsequent to the treatment works and between the mine passage and the house (VPP19 & VP932) proved competent ground to 20.0m bgl. Two validation probes (VPP1 & VPP2) undertaken within the eastern side of the front garden No. 12 Pond Road proved competent ground to 20.0m bgl.

Validation probing was also undertaken at No. 14 Pond Road to confirm the expected absence of mining within the property. Validation testing comprised 2 No. dynamic probes (VPP28 and VPP29) undertaken to depths of 12.1m and 20.0m bgl. The results of this validation probing did not indicate the presence of mining affected ground.

4.3 Pond Road

Grout along Pond Road was designed to treat the possible mine passage trending northeast-southwest extending from No. 12 Pond Road suspected to be present following validation probing and treatment at No. 10 and No. 12 Pond Road. An interpretation of the expected mine layout for Pond Road is shown on Drawing TA0002-02 presented in Appendix A.

A row of validation probes (VP917, VP918 & VP919) were initially undertaken close to the southern edge of Pond Road to investigate the presence of the suspected northeast trending mine passage. Validation probes were undertaken to 20.0m bgl and results showed competent ground indicating the absence of mine workings.

A second row of validation probes (VP920, VP921, VP922 & VP923) were undertaken towards the northern edge of Pond Road to investigate the presence of the suspected northeast trending mine passage. Low blow counts were recorded between depths of 15.3m and 17.1m bgl in VP922. Grouting works were therefore undertaken at CGV34 and CGV35 and grout volumes of 3.97m³ and 1.903m³ respectively were recorded

Validation probes were undertaken beyond the last row of probes and within the pedestrian footpath of Pond Road to confirm the extent of the northeast trending mine passage. Validation probes were undertaken to depths of between 13.0m and 20.0m bgl. Results showed competent ground with no indication of mining disturbed ground, confirming the extent of the northeast trending mine passage.

An additional row of validation probes (VPP5, VPP8, VPP9 & VPP10) within Pond Road were undertaken in July 2014 to investigate the possible presence of mining disturbed ground extending from known passages identified in No. 10 & No. 12 Pond Road. Results did not indicate the presence of a mine passage, however a single validation probe (VPP13) undertaken in the middle of Pond Road recorded low blow counts between 12.5m and 13.5m bgl. Grout hole CGV31 was subsequently undertaken to treat this ground with a grout volume of 6.164m³ indicating the treatment of mining collapsed ground rather than an open void.

Further validation probing (VPP14, VPP15, VPP16, VPP31, VPP34, VPP35 & VPP36) was undertaken beyond this treatment towards the northern side of Pond Road in a north-easterly direction. Validation probing was undertaken to depths of between 18.5m and 22.9m. Results were marginally indicative of weak ground, therefore four grout holes (CGV31A, CGV33, CGV36 & CGV37) were undertaken to treat possible weak ground. Grout volumes ranged between 1.975m³ and 6.598m³ indicating the treatment of weak or collapsed ground rather than an open void.

5 CONCLUSIONS

Grouting has been completed under Nos. 10 and 12 Pond Road and along Pond Road to stabilise mining related disturbed ground due to former chalk mining. From the investigations and treatment work undertaken and the subsequent validation testing it can be reasonably concluded that;

- based upon the evidence, all mined ground encountered has been treated and that compaction and consolidation of collapsed voids and mine shafts has taken place;
- as a result of the above assessment, significant risk from chalk mine workings within the treatment area has reduced to an acceptably low level following treatment;
- there is no evidence of any adverse impacts on groundwater quality beneath the site as a consequence of the work;
- there is no evidence of any significant movement or other adverse effects on buildings or infrastructure during the works; and
- the risks from further untreated workings in the treatment area is considered to be no higher than elsewhere in Hemel Hempstead.

The grouting work undertaken has only targeted the treatment of mined ground for the current site use and building layout. It is still the responsibility of the land owner to seek appropriate design advice prior to future development.

Dacorum Borough Council Building Control should be informed if any evidence of mine workings (such as shafts, voids or collapsed ground) is found during any future works undertaken as part of redevelopment.

6 REFERENCES

1. Arcadis Consulting (UK) Limited (2015), Chalk Mine Stabilisation Project, Highbarns, Hemel Hempstead, Treatment Report, No 0013-UA000857-TR-01, October 2015.
2. BAM Ritchies (2015), *Highbarns Sectional Validation Reports ref. BBK704U*, VR-001 to 012. March 2015.
3. Hyder Consulting (UK) Limited (2012a), *Highbarns Chalk Mines Project, Interpretive Ground Investigation Report*, No 0010-UA000857-GDR-01, September 2012.
4. Hyder Consulting (UK) Limited (2012b), Highbarns, Hemel Hempstead, Chalk Mine Stabilisation Project, Specification for Site Works, No 0007-UA000857-GDR-01, September 2012.

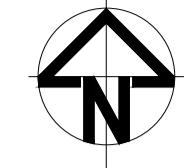
APPENDIX A

**Drawing TA02-01 – Treatment Area Plan for TAR0002
with Grout Holes**

**Drawing TA02-02 – Treatment Area Plan for TAR0002
with Validation Probes**



SITE MAP
NTS



- NOTES:
1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.
 2. ALL LEVELS IN METRES UNLESS NOTED OTHERWISE.
 3. VALIDATION AND GROUTING DATA BASED ON BAM RITCHIES' SECTIONAL VALIDATION REPORT (IBK706E VR0001 TO VR00012) AND DATED APRIL 2015.
 4. VOIDS IDENTIFIED BY LASER SURVEYS UNDERTAKEN IN 2008 AND REMEDIATED IN 2008 ARE BASED ON PETER BRETT ASSOCIATES (2008), INTERPRETATIVE GEOTECHNICAL REPORT - PHASE 1, NO 2024.7/004.3/INT01/REV.2, JULY 2008.
 5. VOIDS IDENTIFIED BY LASER SURVEYS UNDERTAKEN IN 2012 ARE BASED ON INSPECTAHIRE (2012), CALS AND CCTV INSPECTION OF VOIDS REPORT NO 6658, ISSUE 02, AUGUST 2012.

LEGEND	
PATTERN	DETAIL
	TREATMENT AREA BOUNDARY
	DERELICT LAND CLEARANCE ORDER BOUNDARY
	INTERPRETED MINE EXTENTS FOLLOWING TREATMENT
	VOIDS IDENTIFIED BY LASER SURVEYS UNDERTAKEN IN 2012 (SEE NOTE 5)
	VOIDS IDENTIFIED BY LASER SURVEYS UNDERTAKEN IN 2008 AND REMEDIATED IN 2008 (SEE NOTE 4)
	CGV138 / CGVM138 COMPACTION VERTICAL GROUT HOLES
	CGI138 / CGIM138 COMPACTION INCLINED GROUT HOLES (ORIENTATION INDICATED BY DASHED LINE WHERE INFORMATION PROVIDED IN FACTUAL REPORT (SEE NOTE 3))
	CGI138 COMPACTION GROUT HOLES (INCLINED OR VERTICAL (SEE NOTE 3))
	BGI138 / BGHM138 BULK GROUT INFILL HOLES (SEE NOTE 3)

GROUTING LEGEND	
PATTERN	DETAIL
	CGV138 CGI108 COMPACTION GROUT HOLES (0.0-1.0m³)
	CGV138 CGI108 COMPACTION GROUT HOLES (1.0-2.0m³)
	CGV138 CGI108 COMPACTION GROUT HOLES (2.0-5.0m³)
	CGV138 CGI108 COMPACTION GROUT HOLES (5.0-10.0m³)
	CGV138 CGI108 COMPACTION GROUT HOLES (>10.0m³)

Rev	Date	Auth	Description	AH	RB
A01	15.10.15	AB	FIRST ISSUE		



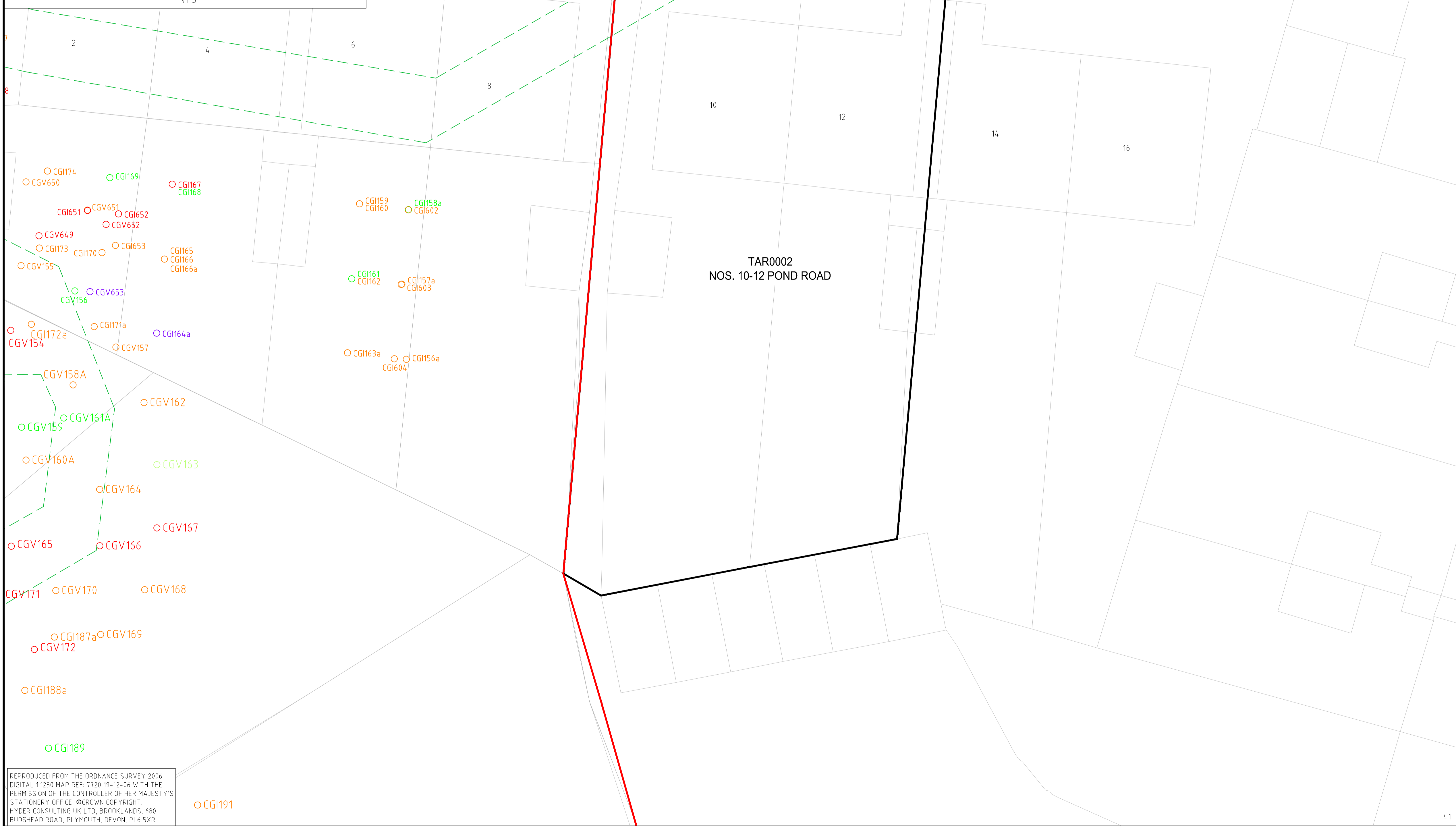
Project: HIGHBARNES CHALK MINE STABILISATION PROJECT

Drawing status: PRELIMINARY

Drawing title: TREATMENT AREA PLAN FOR TAR0002 WITH GROUT HOLES

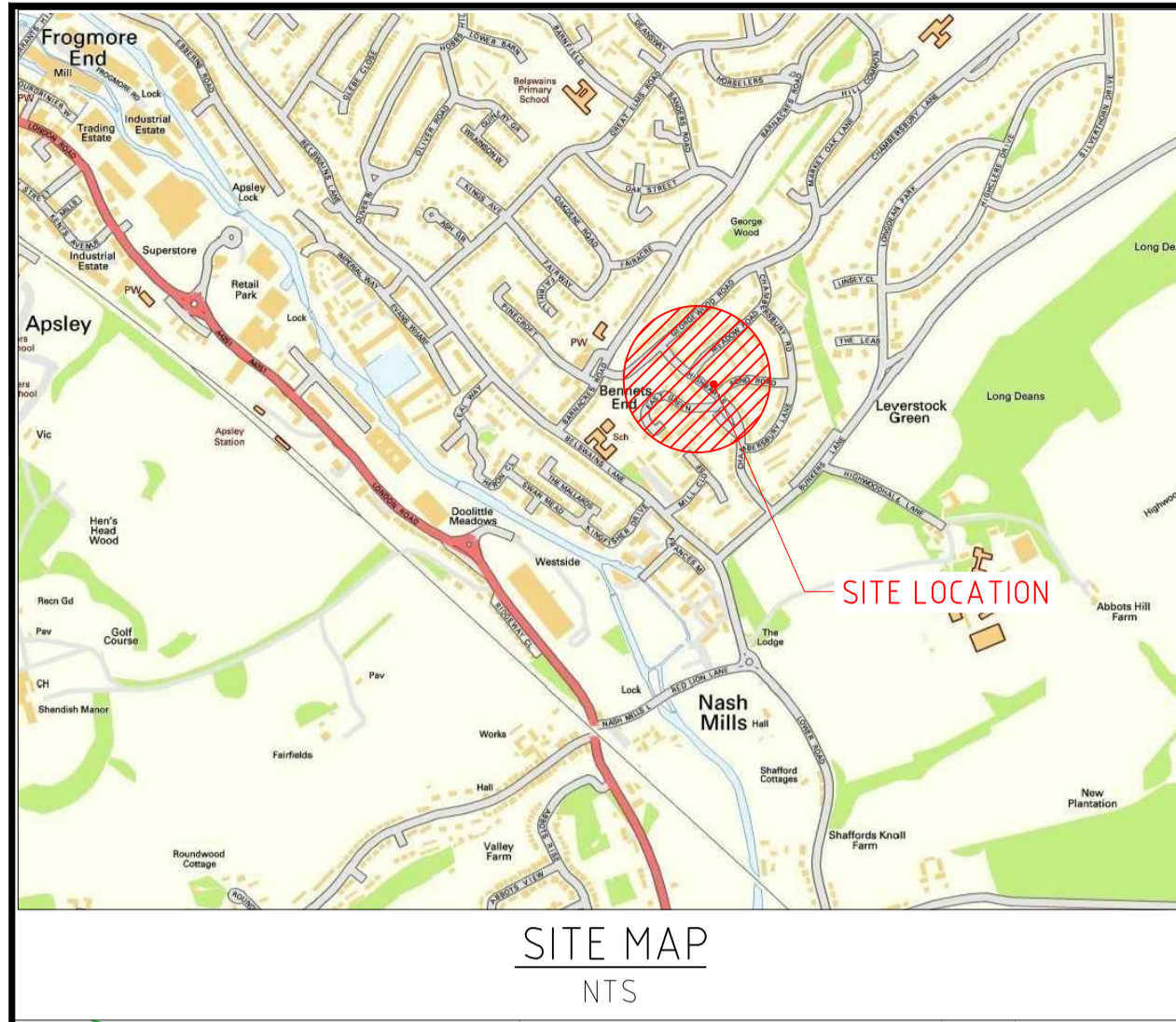
Drawn by: D.MORE	Date: 15.10.15	Author: A.BLAKE	Date: 15.10.15
Checker: A.HOPE	Date: 15.10.15	Approver: R.BARSBY	Date: 15.10.15

Scale: AS SHOWN ON DRAWING	Sheet No.: 01
Drawing No: TA0002-01	Revision: A01

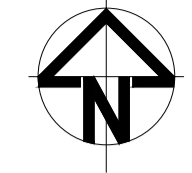


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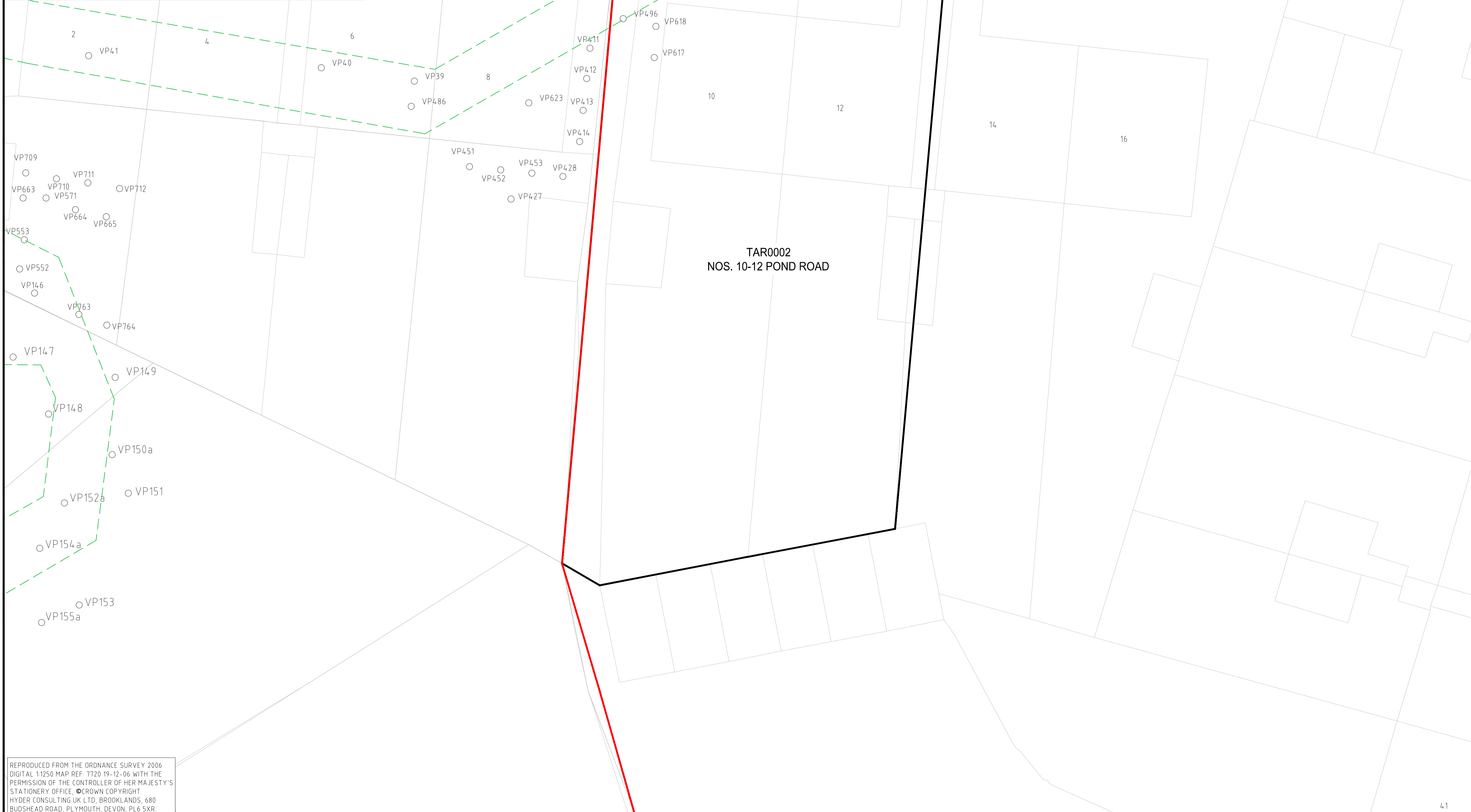
TREATMENT AREA PLAN
SCALE 1:100



SITE MAP
NTS

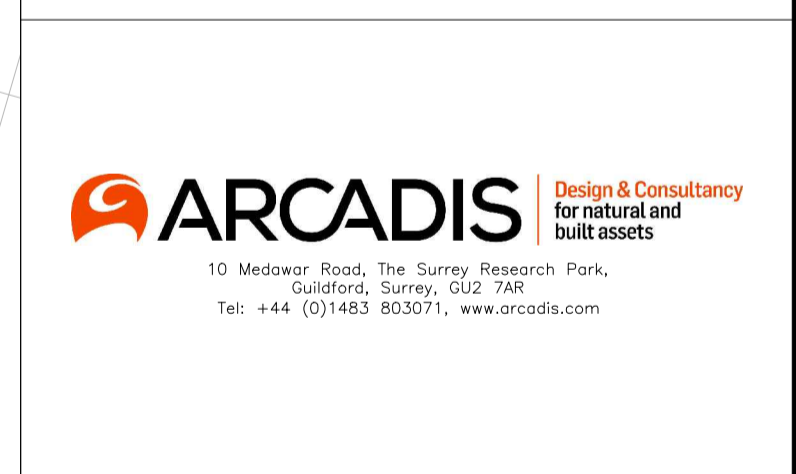


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LEGEND	
PATTERN	DETAIL
	TREATMENT AREA BOUNDARY
	DERELICT LAND CLEARANCE ORDER BOUNDARY
	INTERPRETED MINE EXTENTS FOLLOWING TREATMENT
	VOIDS IDENTIFIED BY LASER SURVEYS UNDERTAKEN IN 2012 (SEE NOTE 5)
	VOIDS IDENTIFIED BY LASER SURVEYS UNDERTAKEN IN 2008 AND REMEDIATED IN 2008 (SEE NOTE 4)
	VP249/VPM249/ DPM249/VPP249 VALIDATION DYNAMIC PROBES

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TREATMENT AREA PLAN
SCALE 1:100

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