CHALK MINE STABILISATION PROJECT
HIGHBARNS, HEMEL HEMPSTEAD

Treatment Area 8: Nos. 28, 29 & 30 East Green

Report Number: 0013-UA000857-TR-01-TAR-0008

OCTOBER 2015

Incorporating

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APPENDICES

APPENDIX A

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 28, 29 & 30 East Green.

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 TA0008-01 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. 28, 29 and 30 East Green (BAM Ritchies, 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 28, 29 & 30 East Green are summarised in Table 1 below.

Table 1: Summary of Validation Investigations

Type of Investigations	Number
Total No. of External Validation Dynamic Probes (VP)	20
Total No. of Internal Validation Dynamic Probes (VP)	1

The results of the validation dynamic probes undertaken during and after treatment works are presented in the relevant sectional factual report VR008 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 Volumes[1] (m^3)	Total Grout Volume[1] (m^3)
No. 28 East Green (Total Grout Holes = 10, Total Grout Volume = 56.2m^3)	Beneath the property	Inclined compaction grout holes	7	1.01 (CGI281) to 6.02 (CGI241)	20.59
	Back garden	Vertical compaction grout holes	3	3.43 (CGV408) to 23.38 (CGV406)	35.63
No. 29 East Green (Total Grout Holes = 17, Total Grout Volume = 144.6m^3)	Front garden	Vertical compaction grout holes	5	2.19 (CGV350) to 18.253 (CGV351)	38.83
	Beneath the property	Inclined compaction grout holes	8	1.735 (CGI239) to 30.904 (CGI238)	92.21
	Back garden	Vertical compaction grout holes	4	1.89 (CVG405) to 5.69 (CGV403	13.59
No. 30 East Green (Total Grout Holes = 16, Total Grout Volume = 158.6m^3)	Front garden	Vertical compaction grout holes	3	2.92 (CGV346) to 9.50 (CGV348)	12.44
	Beneath the property	Inclined compaction grout holes	4	3.06 (CGI251) to 20.10 (CGI253)	39.96
	Back garden	Vertical compaction grout holes	9	0.77 (CVG398) to 43.44 (CGV401)	106.22

Notes:

The above extract is based on data from BAM Ritchies' Sectional Validation Report for Nos. 28, 29 & 30 East Green. (BAM Ritchies, 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 Chalk Mine Stabilisation Treatment Report (Arcadis, 2015).

The total volumes of grout at 28, 29 & 30 East Green Road are generally comparable to the expected volumes as indicated by the pre-contract ground investigation, microgravity and dynamic probe validation surveys.

4.1 No. 28 East Green Road

Treatment works carried out at No. 28 East Green were designed to treat mined ground uncovered following pre-treatment investigation works. Three high grout takes along the back garden at CGV406 (23.4m^3), CGV407 (8.8m^3) and CGV408 (3.4m^3) suggested further mine workings outside the original extents. Inclined grout holes (CGI241 –CGI246) originally designed to treat the property from the back garden were drilled from an adjacent open space due to access constraints. These grout volumes suggested generally collapsed mine workings with the volumes injected decreasing as treatment works progressed along the back garden. Grouting works carried out from the front of the property resulted in typically average grout volumes, despite the presence of known voids uncovered prior to treatment works close to the front of the property, indicating successful treatment.

Validation probing carried out along the front and back gardens following grouting works revealed more competent ground conditions than pre-treatment. A total volume of 56.2m3 of grout was injected into ten vertical and inclined compaction grout holes targeted at this property.

4.2 No. 29 East Green Road

Pre-treatment investigation works carried out at No. 29 East Green identified the presence of mine workings extending under the property before converging at a suspected mine junction located along the front garden where the presence of open voids were identified. High grout volumes at CGI238 (30.9m^3) and CGI240 (20.4m^3), confirmed the presence of open voids in the area and further high grout volumes were recorded along the front of the property in the area of the anticipated mine junction. A general reduction in grout volumes was noted in successive grout holes drilled along the back garden and beneath the property. Grouting under the house was made possible only from inclined holes drilled in the back garden of the adjacent property No. 30 East Green.

The validation dynamic probe (VP229) carried out inside the building following treatment did not record any residual weaknesses in the chalk. Likewise validation probing carried out in front of the property with VP179 revealed competent ground conditions following treatment.

A total grout volume of 144.6m^3 of grout was injected into seventeen vertical and inclined compaction grout holes located at this property.

4.3 No. 30 East Green Road

Pre-treatment investigation works carried out close to the property identified the presence of mine workings along the back garden of No. 30 East Green and extending under the property. The anticipated mine gallery was thought to converge with further mine workings along the front of the adjacent property.

Vertical compaction grout holes carried out along the back garden resulted with high grout volumes at CGV399 (15.4m^3) and CGV401 (43.4m^3) suggestive of open mine workings at the mine junction. A gradual reduction in grout volumes was observed at the remaining treatment locations in the back garden. Further inclined grout holes were also undertaken beneath the property from the back garden. Following the initial high grout takes at CGI253 (20.1m^3) and CGI254 (12.4m^3), subsequent grout volumes were seen to reduce to site-wide average grout takes at CGI251 (3.1m^3) and CGI252 (4.4m^3).

Treatment along the back garden resulted in a high grout take at CGV401 (43.4m^3) which was assumed to be located within the mine junction. Following this grout hole, generally consistent minimal grout volumes were recorded.

Several validation dynamic probes were carried out along the back garden and side of No. 30 East Green to determine the termination of mine-related disturbed ground in the area. The results confirmed competent treatment of the area, suggesting the scope of works designed had been adequate to treat the extent of interpreted mine workings.

A total grout volume of 158.6m^3 of grout was injected into sixteen vertical and inclined compaction grout holes located at the property.

5 CONCLUSIONS

Grouting has been completed under 28, 29, and 30 East Green 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 void | collapsed voids has taken place;
- as a result of the above assessment, the risk of settlement 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.

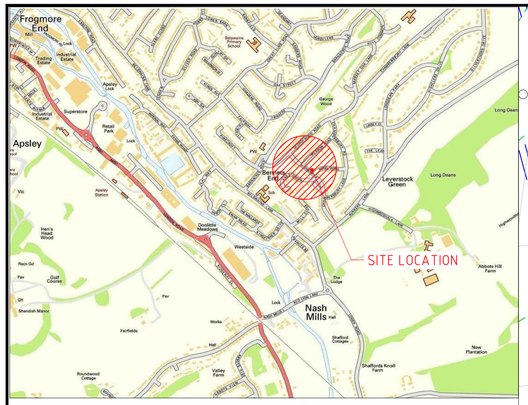
6 REFERENCES

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 TA08-01 – Treatment Area Plan for TAR0008 with Grout Holes

Drawing TA08-02 – Treatment Area Plan for TAR0008 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 (BBK706E 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 20247/0043/INT01/REV2, 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)
	INTERPRETED SHAFT LOCATION FOLLOWING TREATMENT
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))
CG138	COMPACTION GROUT HOLES (INCLINED OR VERTICAL (SEE NOTE 3))
BG138 / 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	Ckd	Apprd
A01	15.10.15	AB	FIRST ISSUE	AH	RB

Client: BOROUGH COUNCIL

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Project:
HIGHBARNS
CHALK MINE STABILISATION PROJECT

Drawing status:
PRELIMINARY

Drawing title:
TREATMENT AREA PLAN
FOR TAR0008
WITH GROUT HOLES

Drawn by:	Date:	Author:	Date:
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Checker:	Date:	Approver:	Date:
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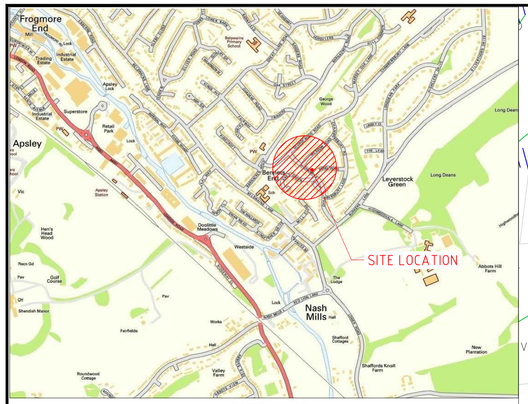
Scale: AS SHOWN ON DRAWING
Sheet No.: 01
Drawing No: TA0008-01
Revision: A01

TAR0008
NOS. 28-30
EAST GREEN

TREATMENT AREA PLAN
SCALE 1:100



SITE MAP
NTS

TAR0008
NOS. 28-30
EAST GREEN

EAST GREEN

NOTES:

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	VOIDS IDENTIFIED BY LASER SURVEYS UNDERTAKEN IN 2008 AND REMEDIATED IN 2008 (SEE NOTE 4)
	INTERPRETED SHAFT LOCATION FOLLOWING TREATMENT
VP249/VPM249/ DPM249/VPP249	VALIDATION DYNAMIC PROBES

Rev	Date	Auth	Description	Ckd	Apprd
A01	15.10.15	AB	FIRST ISSUE	AH	RB

Client

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TREATMENT AREA PLAN
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WITH VALIDATION PROBES

Drawn by:	Date:	Author:	Date:
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Scale: AS SHOWN ON DRAWING
Sheet No.: 01
Drawing No: TA0008-02
Revision: A01

TREATMENT AREA PLAN
SCALE 1:100

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