

## Appendix 3.4

# SLOPE STABILITY REPORT



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FORT HALSTEAD

Slope Stability Report  
For Armstrong (Kent) LLP  
February 2015



# Slope Stability Report

Fort Halstead, Kent

February 2015

**Waterman Energy, Environment & Design Limited**

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# Slope Stability Report




Fort Halstead, Kent

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## Quality Assurance – Approval Status

This document has been prepared and checked in accordance with Waterman Group's IMS (BS EN ISO 9001: 2008, BS EN ISO 14001: 2004 and BS OHSAS 18001:2007))

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Issue	Date	Prepared by	Checked by	Approved by
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8.1.8	February 2015			

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## Executive Summary

### Aims and Objectives

Waterman Energy, Environment & Design Limited (“Waterman”) was instructed by Armstrong (Kent) LLP to undertake a Slope Stability Assessment for the proposed redevelopment of Fort Halstead (hereafter termed “the Site”). A review of available information (previous relevant reports, aerial photos, British Geological Survey maps and memoirs) and a walkover survey was undertaken.

### Conclusions and Recommendations

The Site and its immediate vicinity are dominated by a chalk escarpment that extends in a south-west – north-east direction with the lower lying Darent River Valley to the south. The development area of the Site is located on the top of the chalk escarpment ridge on relatively flat land on the upper part of the ‘dip slope’ of the escarpment.

Gradients within the proposed development are typically less than 1 in 20. The southern part of the Site (beyond the development area) lies on the escarpment which slopes steeply from 210m to 120m AOD at angles of less than 30°.

Aerial photos and satellite imagery do not indicate the site to be affected by any significant slope instability.

No evidence of slope instability such as cracking of structures, soil creep, hummocky ground, slip scars, leaning of trees etc, was observed on Site during the walkover.

A qualitative assessment of development risk based on slope gradient has been undertaken and it has been concluded that the development area falls in the lowest development risk category. As such it is unlikely that any significant mitigation measures will be required as part of the proposed development.

The more steeply sloping land to the south of the development area forms part of the natural chalk escarpment. Natural chalk slopes and escarpments formed at angles of less than 30° are highly likely to be stable. As the escarpment gradient is much less than 30°, it is concluded that there is no significant stability risk associated with the escarpment slope.

With regard to the objectives of this report, it is concluded that:

- The site and immediately surrounding areas are not affected by historic instability.
- The site is stable and has an adequate margin of stability. No significant mitigation measures are required as part of the development works.
- The site is not likely to be affected by reasonably foreseeable slope instability originating outside the boundaries; and
- The development is not likely to result in slope instability which will affect either the development or nearby property.

The following precautionary recommendations are made with regard to maintaining the existing margin of stability at the site during development:

- The Site has moderate potential for ground dissolution stability hazards. A ‘watching brief’ for solution cavities and voids should be undertaken by an appropriately qualified person during the course of the development works.
- Ground levels should not be increased close to the top of the existing chalk escarpment or other existing slopes. Additionally, new foundations should not be placed so that they increase the loads at the top of existing slopes.
- The existing pattern of land drainage must not be affected during development and the placement of fill during development must not inhibit pre-existing natural land drainage.
- With regard to temporary works, all excavation and filling activity should be planned and due consideration given to providing temporary support or suitable battering. Excavations should be regularly inspected by a competent engineer to ensure continued safety and stability.
- Visual monitoring and assessment of site-wide slope stability should be undertaken during development.

## 1. Introduction

### Objectives

- 1.1 Waterman Energy, Environment & Design Limited (“Waterman”) was instructed by Armstrong (Kent) LLP to undertake a Slope Stability Assessment of land located at Fort Halstead, Sevenoaks in Kent (the ‘Site’) This report has been prepared for the exclusive use of Armstrong (Kent) LLP for the purpose of assisting them in assessing the effects of site development on slope stability both within the site area and its immediate vicinity.
- 1.2 The Site (**Figure A1, Appendix A**) is currently occupied by the Defence Science and Technology Laboratory (DSTL) and QinetiQ, which provide scientific research to the Ministry of Defence. The Site largely reflects the built form and highways on the land at Fort Halstead and covers an area of circa 62.7 hectares (ha). The perimeter of the Site is occupied mainly by woodland and grassland on a sloping terrain.
- 1.3 The planning application boundary of the Site is shown by the red line in **Figure A2 (Appendix A)**. The Site is proposed to be re-developed for mixed land use with the majority of the existing buildings and structures to be demolished, with the exception of the buildings within, and adjacent to the Fort, and within the area currently occupied by QinetiQ (known as the ‘X Area’). The scheme would comprise employment uses, a village centre (retail, office and community uses), residential and open amenity space, together with landscape and ecological enhancements on the Site and adjacent land within the Applicants ownership (hereafter collectively referred to as the ‘Development’).
- 1.4 The objectives of this report are to:
  - Investigate whether the site or immediately surrounding areas are affected by historic instability and, if so, a definition of their extent in plan and section;
  - Assess whether the site is stable and has an adequate margin of stability, or can be made stable as part of the development works.
  - Assess if the site is likely to be threatened or affected by reasonably foreseeable slope instability originating outside the boundaries; and
  - Confirm that the development is not likely to result in slope instability which will affect either the development or nearby property.



## Proposed Development

- 1.5 The Applicant intends to submit an outline planning application seeking permission for the demolition of buildings and development of a mixed-use development comprising a business area (Use Classes B1 and B2 with ancillary energetic material testing), up to 450 residential units, a hotel of up to 80 beds, a village centre (Use Classes A1, A3, B1a, D1 and D2), use of the Fort Area and bunkers as an historic interpretation centre (Use Class D1), and works associated with the development including roads, landscaping, security fencing, formal and informal open space, pedestrian, cyclist and public transport infrastructure, utilities infrastructure, sustainable urban drainage system, cycle and car parking (with all matters reserved); and detailed approval for two access points at Otford Lane/Crow Drive (primary) and Star Hill (secondary). **All the built form would be within the Site boundary**, although ecological enhancement measures such as grassland management would be off the 'wider Survey Area' (blue line in **Figure A2, Appendix A**).
- 1.6 The Fort Scheduled Monument would form the focus of the historic interpretation centre with all the buildings and structures retained in the Fort and the majority being opened up for public use.
- 1.7 To facilitate the redevelopment, the majority of existing buildings and structures on the Site (with the exception of the listed buildings, the buildings within and immediately adjacent to the Fort Scheduled Monument, and a number of the buildings within the 'X Area' of the Site (to be retained for future operations by QinetiQ)) and a number of the bunkers in the 'M Area' would be demolished, together with part of the current security fence of DSTL. The development would be phased, with the main construction phase commencing in 2018 following the relocation of DSTL and completion and operation of the development in 2027.

## Constraints

- 1.8 The assessment was undertaken in accordance with the scope agreed between Waterman and Armstrong (Kent) LLP and with Waterman's standard Terms of Appointment.
- 1.9 Constraints to the investigation include:
- The assessment undertaken was based on visual site inspection and review of available information only.
  - Site walkover within Fort Halstead was mainly undertaken at the crest of the slope; access into certain areas was not permitted during the walkover owing to the sensitive nature of the Site.
  - The majority of the slopes are within woodland or covered with thick vegetation, and as such, inspection of the slope was limited.
- 1.10 Waterman has endeavoured to assess all information provided to them during this investigation, but makes no guarantees or warranties as to the accuracy or completeness of this information.
- 1.11 The findings of this study are based upon an engineering review of the available information and we rely upon professional judgement in its interpretation. Our study is a review of general site conditions to identify the slope stability issues that may affect the proposed mixed use development of the Site.
- 1.12 The conclusions resulting from this study are not necessarily indicative of future conditions or operating practices at or adjacent to the site.
- 1.13 The report has not assessed the neighbouring road network (A224) as these are under the management and maintenance of Kent Highways and are outside the application boundary.

## **2. Methodology**

2.1 The slope stability assessment consisted of the following works:

- Review of available information, i.e., previous relevant reports (See Section 3.0), aerial photos, British Geological Survey maps and memoirs.
- A Site walkover survey was undertaken by Waterman on November 25, 2014 with a security escort throughout the visit providing access to non-restricted areas inside Fort Halstead. The survey was also undertaken along Crow Drive (entrance to the Site) and in areas immediately adjoining the Site boundary (A224/Polhill to the east and Lime Pit Lane to the south).

### 3. Site Setting

- 3.1 The Site is located at National Grid Reference 549741, 159317 off Crow Drive (**Figure A1, Appendix A**), Sevenoaks in Kent, TN14 7BS, approximately 4km north-east of Sevenoaks. Site access is from Polhill Road (A224)/Crow Drive to the north-east of the Site and Star Hill Road to the south-west. The entrances to the secured area of the Site, demarcated by a security fence, are manned with security barriers.
- 3.2 The majority of the Site is occupied by QinetiQ and DSTL which provide scientific and technical research services to the Ministry of Defence. The site is bound to the east by Anisbirches Wood (beyond this is A224 Polhill), Dutchmore Wood and grassland to the south (beyond this is Starhill Road-Lime Pit Lane), Great Stockholme Wood to the west and north.
- 3.3 The buildings on the Site range from single to three storeys in height. The existing built area is surrounded by areas of landscaping, mature trees and several wooded areas. The woodland includes plantations, semi-ancient and ancient woodland. The southern part of the Site comprises grassland.
- 3.4 Topographically, the Site and its immediate vicinity are dominated by a chalk escarpment that extends in a south-west – north-east direction with the lower-lying Darent River Valley to the south. The scarp slope of the escarpment faces both south, across the Kent Weald, and east across the Darent Valley. The Site is located on the top of the chalk escarpment ridge on relatively flat land on the upper part of the ‘dip slope’ of the escarpment. The ground levels across the Site vary from approximately 220m Above Ordnance Datum (AOD) at the highest point in the centre of the Site west of the Fort Scheduled Monument, to approximately 170m AOD in the north-east of the Site. However, the southern part of the Site slopes steeply from 210m to 180m AOD. See **Figure A2, Appendix A**.
- 3.5 Selected Site photographs (Plates 1 to 22) taken during the November 2014 walkover are included in **Figures B1 to B4 in Appendix B**. All photographs were taken with permission, and were checked and approved for security purposes on completion of the Site walkover.

## 4. Previous Reports

- 4.1 Previous investigations related to the Site mainly focussed on ground contamination sources. These investigations are summarised in Fort Halstead – Data Review, Preliminary and Generic Environmental Risk Assessments, Document Ref. EED12715-100\_R\_1\_7\_1GP\_KH dated December 2014.
- 4.2 A summary of previous Site investigations undertaken at the Site, including field work activities is provided in **Table 1**.

Table 1: Summary of previous site investigations at Fort Halstead

Phase of Work.	Activity	Contractor	Date
<b>2002 EnviroS Aspinwall Investigation</b>			
<ul style="list-style-type: none"> <li>DERA Fort Halstead Land Quality Assessment Phase Two Site Investigation, Land Quality Assessment Report (Ref. 11469)</li> <li>DERA Fort Halstead Land Quality Assessment Phase Two Site Investigation, Technical Note (Ref. 11469)</li> </ul>			
Radiological survey	Exploratory hole locations were subjected to a surface survey prior to any excavation works taking place.	Enviros Aspinwall	15 November to 10 December 1999
Trial Pit investigation	8 trial pits to 4m bgl max. depth.	Enviros Aspinwall	15 November to 2 December 1999
Window Sample investigation	79 window sample locations to 6m bgl max. depth.	Enviros Aspinwall	22 November to 3 December 1999
Solid stem auger investigation	7 solid stem auger boreholes to 15m bgl max. depth.	Enviros Aspinwall	1 to 2 December 1999
<b>2005 Jacobs Investigation</b>			
<ul style="list-style-type: none"> <li>QinetiQ Fort Halstead, Documents Review and Intrusive Investigations (Ref. J23008G0)</li> <li>QinetiQ Fort Halstead, Drainage Review, Toxicological and Explosive Buildings Survey, Gaseous Emissions Review, Radiological Source Review and Asbestos Document Review (Ref. J23008G0)</li> </ul>			
Health physics monitoring	15 window samples and 23.No hand dug pits were screened.	RWE NUKEM	22 to 31 August 2005
Window sample investigation	34 window sample locations to 5m bgl max. depth.	Jacobs	15 August to 13 September 2005
Hand dug pit investigation	63 hand dug pits to 1.2m bgl max. depth.	Jacobs	15 August to 13 September 2005
Surface sample investigation	4 surface samples to 0.3m bgl max. depth.	Jacobs	15 August to 13 September 2005

<b>Phase of Work.</b>	<b>Activity</b>	<b>Contractor</b>	<b>Date</b>
<b>2005 BAE Systems Investigation</b>			
<ul style="list-style-type: none"> <li>• <b>Assessment and Summary of Laboratory Testing for Explosives Fort Halstead (Ref. A0482-00-R2-C)</b></li> <li>• <b>Explosive Building Survey Report (Ref. A0482-00-R3-1)</b></li> </ul>			
Explosive residues investigation	76 samples to 4.5m bgl max. depth (from X, M and R Areas).	BAE Systems	15 August to 13 September 2005
<b>2008 BAE Systems Pink Water Remediation</b>			
<ul style="list-style-type: none"> <li>• <b>Explosives Remediation – Pink Water Area, Fort Halstead, Completion Report (Ref. A0697-00)</b></li> </ul>			
Explosives remediation	32 hand dug validation sampling locations followed by removal of almost 60 tonnes of contaminated soil.	BAE Systems	April to December 2007

## 5. Geology

- 5.1 The British Geological Survey (BGS) map, sheet 287 for Sevenoaks (solid and drift edition) and previous Waterman report (Fort Halstead – Data Review, Preliminary and Generic Environmental Risk Assessments, Document Ref. EED12715-100\_R\_1\_7\_1GP\_KH dated December 2014) indicate the superficial deposits on Site comprise Clay-with-flints over the northern and central parts of the Site. The Clay-with-flints is absent on a narrow strip in the east of the Site and in the south-east of the Site. The Clay-with-flints is underlain by the Upper Chalk, Middle Chalk and Lower Chalk. A thin covering of Made Ground, typically to a depth of 1m, up to a maximum of 4m locally, has been encountered on the Site. The Made Ground is generally described as silty clay with some ash / clinker and occasional building rubble.
- 5.2 A summary of the geology is provided in **Table 2**.

Table 2: Site geology

Stratum	Area Covered	Estimated Thickness	Typical Description
Topsoil	Partial coverage	0.1m to 0.8m	Dark brown, silt with medium to coarse sub-angular to angular gravel and cobbles of flint.
Made Ground	Partial coverage in previously developed areas	0m to 4m	Black grey, sandy, gravelly soil with ash and cobbles of brick. Gravel is fine, sub-angular to angular. Whole brick is present.
Clay-with-flints	Whole Site	0 to >11.9m	Red and orange brown silty CLAY with much fine to coarse sub-angular to angular gravel and cobbles of gravel of nodular flint.
Upper Chalk Formation	Whole Site	40m	Massively bedded white CHALK with many horizontal bands of nodular flints.

- 5.3 The Site has very low potential for collapsible ground stability hazards; moderate potential for ground dissolution stability hazards; low potential for landslide ground stability hazards and shrinking/swelling clay ground stability hazards. The closest area of recorded landslip is approximately 10km south east of the Site in the area of Wilmot Cottage (BGS website online search).
- 5.4 The Site is not in an area that could be affected by coal mining activity or any metalliferous mining in the area.
- 5.5 There are no surface water features on or close to the Site. The Twitton Brook is located approximately 1km east of the Site, which drains into the River Darent and is located approximately 1.5km east of the Site at its closest point.

### Structural Geology and Geomorphology

- 5.6 The main geomorphological features of the area are the prominent Chalk escarpment which runs approximately NE-SW along the southern boundary of the site and the Lower Greensand escarpment which runs parallel to it, approximately 4 miles to the south.
- 5.7 The development area of the site is located at the top of the Chalk escarpment at levels between 185m and 200m AOD in the north east, at approximately 210m AOD in the south east, at

approximately 195m aOD in the north west, and between 215m and 220m AOD in the south west (**Figure A2, Appendix A**). Gradients in the proposed development area of the Site are typically less than 1 in 20 except at the firing range area (south west of the fort) where the slope is about 1 in 5; it should be noted that buildings will not be located within this area.

- 5.8 Parts of the 'blue line' ('wider' Survey Area) area of the site lie on the slope of the main escarpment, where gradients are typically in the range 1 in 5 to 1 in 11. The base of the Chalk escarpment immediately to the south of the site is at approximately 120m AOD.
- 5.9 Between the two escarpments lies a valley known as the Vale of Holmesdale which is approximately 4 miles wide, and contains Sevenoaks and the River Darent. The solid geology in the base of the valley comprises Lower Greensand and Gault deposits.
- 5.10 There are no faults crossing the Site or within 50m of the Site. The Chalk Formation typically dips at 5° to the north west.
- 5.11 Based on the BGS map, the nearest landslip to the Site is located approximately 10km south of the Site, associated with the Lower Greensand escarpment where the Atherfield Clay formation intersects the slope. It is noted that the Atherfield Clay does not affect the Chalk escarpment to the south of the site and there is no indication of landslipping close to the site indicated on the geological map.

### **The Stability of Natural Chalk Slopes**

- 5.12 Clark and Small <sup>1</sup>(1982) noted that the maximum inclination of natural chalk slopes is typically about 30–35°, which corresponds well to the effective angle of friction of the most highly weathered material.
- 5.13 Williams<sup>2</sup> (1990) summarised the performance of slopes “within the high porosity Middle and Upper Chalk in Southern England”, and concluded that instability within natural weathered chalk slopes formed at a slope of 1 on 1.5 (33°) is rare although washout of infilled dissolution features is not uncommon.
- 5.14 Based on the above, it can be concluded that natural chalk slopes and escarpments formed at angles of less than 30° are highly likely to be stable.

<sup>1</sup> CLARK, M J and SMALL, R J (1982)

*Slopes and weathering*. Cambridge University Press, Cambridge, p 80

<sup>2</sup> WILLIAMS, R E (1990)

Performance of highway cuttings in Chalk. Keynote address in: *CHALK. Proc Int Chalk Symp, Brighton Polytechnic, 1989*. Thomas Telford, London, pp 469–476

## 6. Results of Investigation

### Aerial Photos

- 6.1 Interpretation of aerial photos and satellite imagery does not indicate the site to be affected by any significant slope instability. Owing to the relatively shallow slope angle of the Site, prominent geomorphological features are not highlighted.

### Walkover Survey

- 6.2 The areas of investigation can be grouped in four areas as shown in **Figure A3 (Appendix A)**. A photo location plan is shown in **Figure A4 (Appendix A)**:

i.) Area 1 - Crow Drive to Fort Halstead main reception (**Plates 1 to 6, Appendix B**)

Access to Fort Halstead is via Crow Drive, which is approximately 1km long from the entrance to the main reception. Residential properties are sporadically located off the road with trees and vegetation on both sides of the road and woodland to the south east.

The slope to the east of the road varies in elevation from 160m AOD to 180m AOD, sloping down generally to the east. The topographic survey does not cover the wooded area.

ii.) Area 2 - Inside Fort Halstead (**Plates 7 to 15, Appendix B**)

A walkover survey was undertaken in majority of the areas within the compound under the supervision of a DSTL representative, focussing on the slopes to the east (woodland) and south east (firing range area) boundaries of the site. It should be noted that the majority of the QinetiQ buildings to the south east boundary of the site will be retained. Development works to the east are located within the footprint of existing buildings, west of the woodland.

The slope to the east/south east of the compound varies in elevation from 175m AOD to 205m AOD sloping down generally to the east.

iii.) Area 3 - Lime Pit Lane (Plates 16 to 18, Appendix B)

The open land to the south east of the firing range was inspected via Lime Pit Lane. The slope in this area varies in elevation from 117m AOD to 190m AOD, sloping down to the south east.

iv.) Area 4 - A224 Polhill (Plates 19 to 22, Appendix B)

The walkover was undertaken along the slope cuttings immediate to the Site boundary starting from the intersection of Otford Lane and A224 and driving down to the south of the old quarry (North Downs Business Park).

The road varies in elevation from 160m AOD to 110m AOD sloping down to the south.

- 6.3 Springs or any form of surface water features were not observed during the time of visit.



## Interpretation

- 6.4 No evidence of slope instability such as cracking of structures, soil creep, hummocky ground, slip scars, leaning of trees etc, was observed on Site during the walkover.
- 6.5 The walkover survey indicated that several trees in Areas 1, 2 and 3 are inclined downslope. However, conversation with the DSTL representative suggested that these trees were likely to be affected by the Great Storm of October 1987.
- 6.6 Based on visual inspection, the slopes in the development areas are typically less than 1 in 20 (i.e. no significant mitigation required for development) and that the slope of the main escarpment is less than 300 (i.e. naturally stable angle). The slope cuttings along A224 Road (Area 4) is steeper and are likely to be  $>15^\circ$ .
- 6.7 A qualitative assessment of development risk based on slope gradient can be made with reference to the slope categorisation of Clark, M.J., and Small, R.J., 1982 (Slopes and weathering: Cambridge University Press, Cambridge, England, p. 112) summarised in Table 3.
- 6.8 The proposed development will remain within the footprint of the existing development where gradients are typically less than 1 in 20. By inspection, the development area is suitable for the proposed mixed use development and falls in the lowest development risk category and as such it is unlikely that any significant mitigation measures will be required.
- 6.9 Furthermore, no reports of cracks or signs of distress on buildings were reported to date; the walkover survey in accessible areas also did not show any signs of distress on the buildings and on the ground.

Table 3: Slope steepness (Clark, M.J., and Small, R.J., 1982)

Degrees (°)	Gradient	Associated Risks		
		Housing and Construction	Construction Machinery	Road and Rail Lines
>15	Greater than 1 in 4	Development of Housing and construction sites likely to require extensive site preparation and expensive precautionary works to mitigate attendant risk of triggering slope instability in some locations	Road building is difficult. Absolute limits are approached for most wheeled vehicles	Road and rail construction require increased site works (eg. Cuttings) and costs as gradients increase. In general, it is more economic to locate rail lines and major roads to take advantage of less steep terrain
11-15	Approx. 1 in 5 to 1 in 4		Problems for most wheeled vehicles	
7-11	Approx. 1 in 8 to 1 in 5	Development for housing and construction likely to require increased costs for site preparation	Use of wheeled construction vehicles becoming difficult.	
3-7	Approx. 1 in 20 to 1 in 8			

Degrees (°)	Gradient	Associated Risks		
		Housing and Construction	Construction Machinery	Road and Rail Lines
<3	Less than 1 in 20	Suitable for most land uses where other physical constraints are not present and there is no risk of flooding. Poor drainage likely on flat clayey ground and flood risk present on low-lying areas		

## **7. Conclusions and Recommendations**

- 7.1 Waterman EED Ltd has undertaken a preliminary slope stability assessment of at land located at Fort Halstead, Sevenoaks in Kent.
- 7.2 The site is intended to be re-developed for employment-led mixed land use with the majority of the existing buildings and structures to be demolished, with the exception of the buildings within, and adjacent to the Fort, and the majority of buildings within the area currently occupied by QinetiQ (the future QQ enclave).
- 7.3 Topographically, the Site and its immediate vicinity are dominated by a chalk escarpment that extends in a south-west – north-east direction with the lower lying Darent River Valley to the south. The development area of the Site is located on the top of the chalk escarpment ridge on relatively flat land on the upper part of the 'dip slope' of the escarpment.
- 7.4 Ground levels across the Site vary from approximately 220m above Ordnance Datum (AOD) at the highest point in the centre of the Site west of the Fort Scheduled Monument, to approximately 170m AOD in the north-east of the Site. Gradients within the proposed development are typically less than 1 in 20.
- 7.5 The southern part of the Site lies on the escarpment itself which slopes steeply from 210m to 175m at slopes of between 1 in 5 and 1 in 11.
- 7.6 Aerial photos and satellite imagery do not indicate the site to be affected by any significant slope instability.
- 7.7 No evidence of slope instability such as cracking of structures, soil creep, hummocky ground, slip scars, leaning of trees etc, was observed on Site during the walkover.
- 7.8 A qualitative assessment of development risk based on slope gradient has been undertaken and it has been concluded that the development area falls in the lowest development risk category. As such it is unlikely that any significant mitigation measures will be required as part of the proposed development.
- 7.9 The more steeply sloping land to the south of the development area, forming the natural chalk escarpment, is considered to be at a stable gradient based on observation / inspection and the work of Williams (1990) who noted that slopes within the Middle and Upper Chalk of Southern England are stable at angles of less than  $30^{\circ}$  (i.e. less than 1 in 1.7).
- 7.10 With regard to the objectives of this report, it is concluded that:
- The site and immediately surrounding areas are not affected by earlier instability.
  - The site is stable and has an adequate margin of stability. No significant mitigation measures are required as part of the development works.
  - The site is not likely to be affected by reasonably foreseeable slope instability originating outside the boundaries; and
  - The development is not likely to result in slope instability which will affect either the development or nearby property.
- 7.11 The following precautionary recommendations are made with regard to maintaining the existing margin of stability at the site during development:

- The Site has moderate potential for ground dissolution stability hazards. A 'watching brief' for solution cavities and voids should be undertaken by an appropriately qualified person during the course of the development works.
- Ground levels should not be increased close to the top of the existing chalk escarpment or other existing slopes. Additionally, new foundations should not be placed so that they increase the loads at the top of existing slopes.
- The existing pattern of land drainage must not be affected during development and the placement of fill during development must not inhibit pre-existing natural land drainage.
- With regard to temporary works, all excavation and filling activity should be planned and due consideration given to providing temporary support or suitable battering. Excavations should be regularly inspected by a competent engineer to ensure continued safety and stability.
- Visual monitoring and assessment of site-wide slope stability should be undertaken during development.

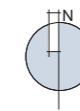
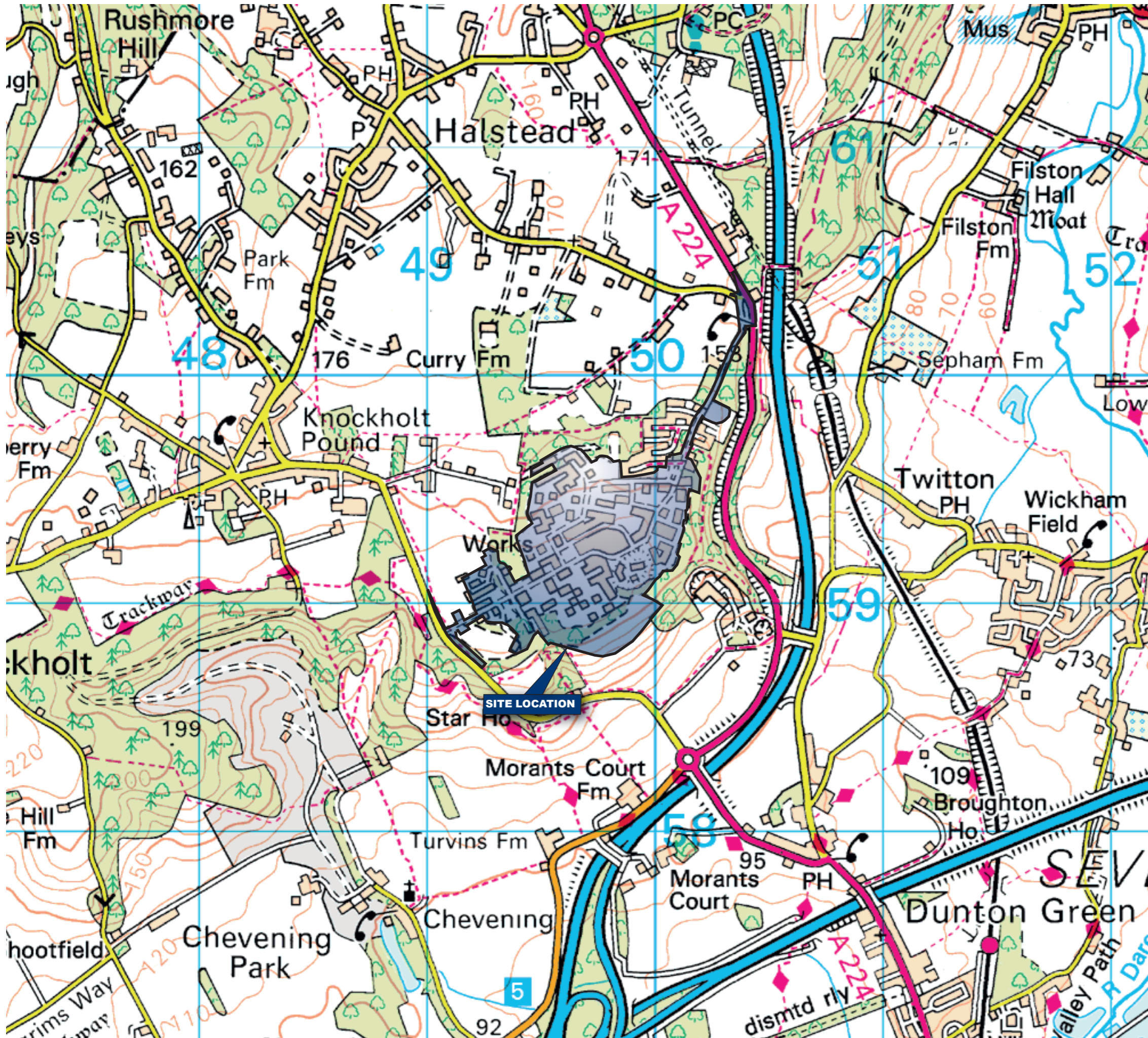


## **APPENDICES**

## **Appendix A**

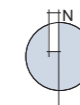
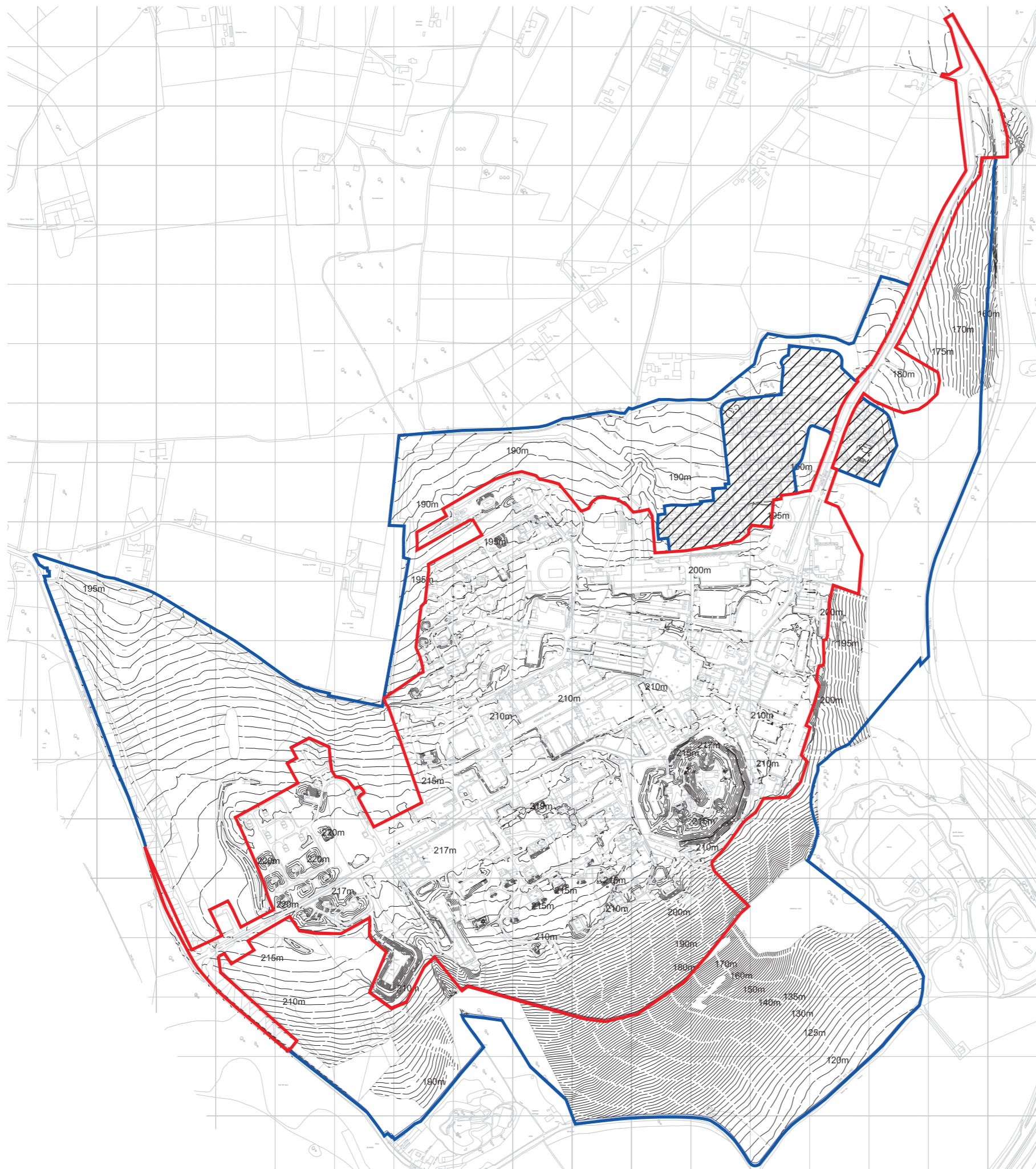
### **Site Plans**

- **Site Location Plan (Fig. A1)**
- **Topographical Survey Map (Fig. A2)**
- **Plan Showing the Locations of Slopes Inspected (Fig. A3)**
- **Photograph Location Plan (Fig. A4)**










Project Details	EED12715-102: Fort Halstead
Figure Title	Figure A1: Site Location Plan
Figure Ref	EED12715-102_GR_ES_A1A
Date	January 2015
File Location	\\nt-incs\weed\projects\eed12715\102\graphics\eia\issued figures

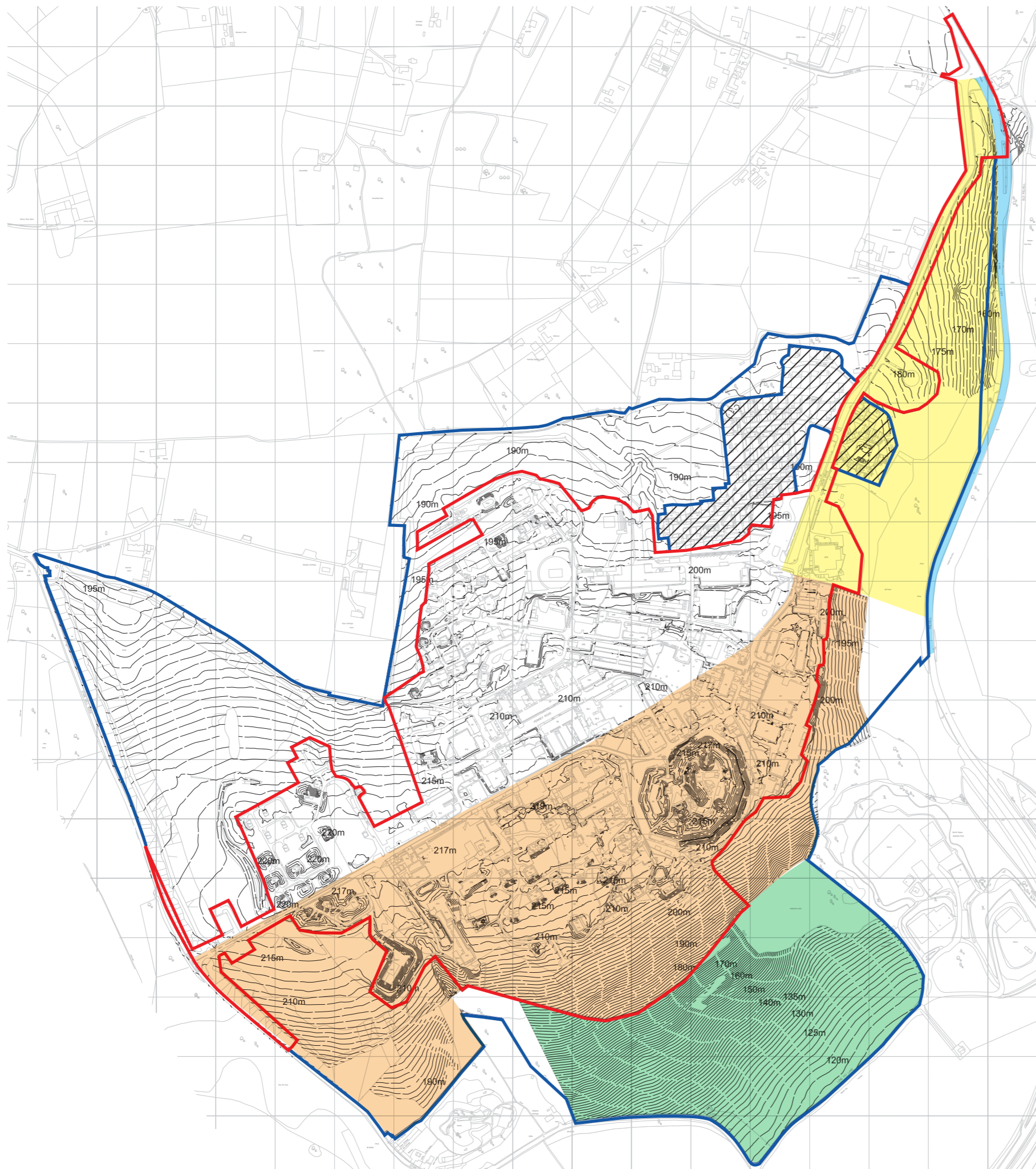
-  Planning Application Boundary
-  Applicant's Land Ownership Boundary
-  Area Outside of Land Ownership Boundary



Project Details	EED12715-102: Fort Halstead
Figure Title	Figure A2: Topographical Survey Map
Figure Ref	EED12715-102_GR_ES_A2A
Date	January 2015
File Location	\\nt-incs\weed\projects\eed12715\102\graphics\eia\issued figures

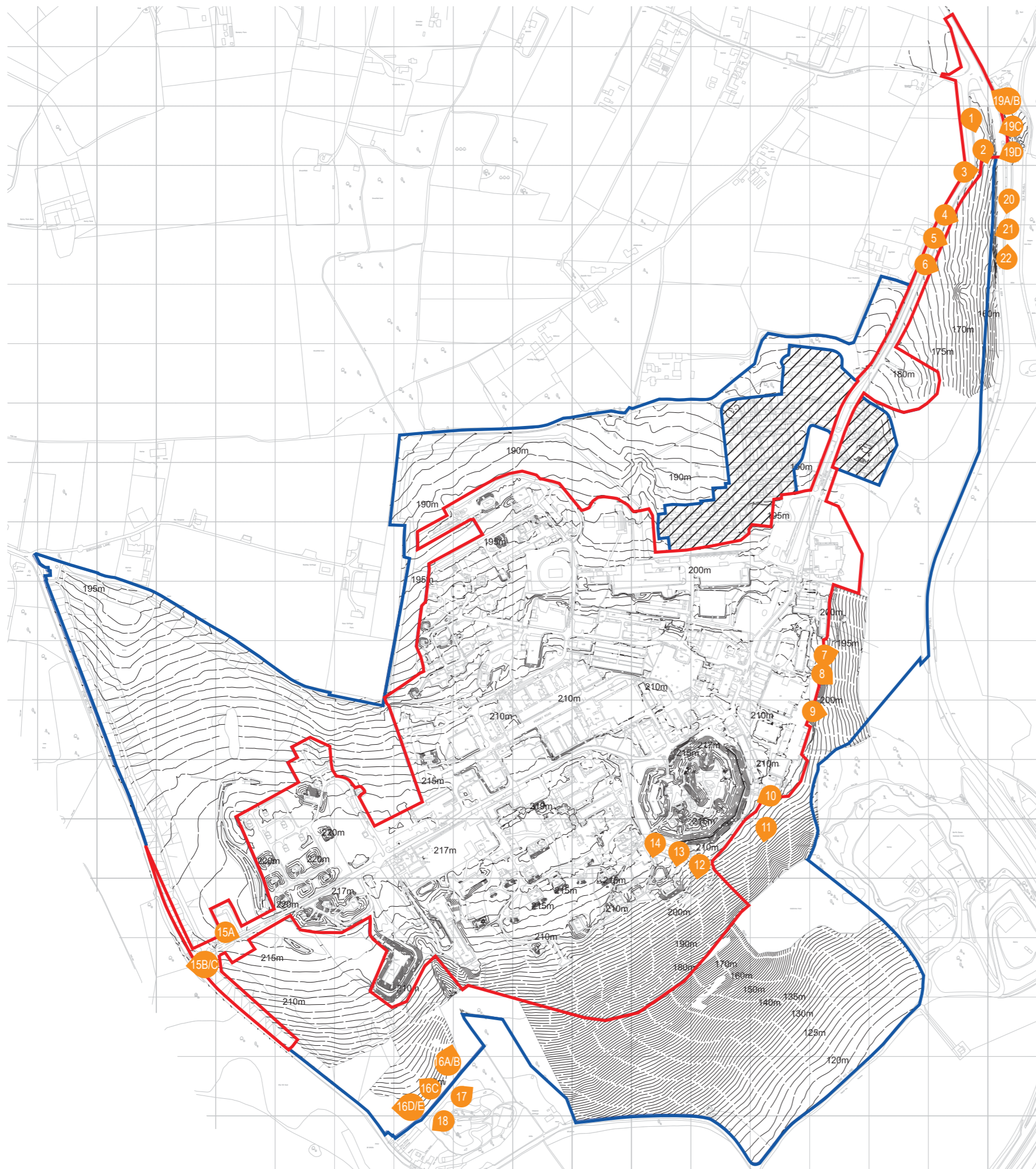


-  Planning Application Boundary
-  Applicant's Land Ownership Boundary
-  Area Outside of Land Ownership Boundary
-  Area 1
-  Area 2
-  Area 3
-  Area 4



Project Details	EED12715-102: Fort Halstead
Figure Title	Figure A3: Plan Showing the Locations of Slopes Inspected
Figure Ref	EED12715-102_GR_ES_A3A
Date	January 2015
File Location	\\nt-incs\weed\projects\eed12715\102\graphics\eia\issued figures

-  Planning Application Boundary
-  Applicant's Land Ownership Boundary
-  Area Outside of Land Ownership Boundary
-  Photograph Location



Project Details	EED12715-102: Fort Halstead
Figure Title	Figure A4: Photograph Location Plan
Figure Ref	EED12715-102_GR_EIA_A4
Date	January 2015
File Location	\\nt-lncs\weed\projects\eed12715\102\graphics\eia\issued figures
	<a href="http://www.watermangroup.com">www.watermangroup.com</a>



## **Appendix B**

### **Site Photographs**

- **Plates 1 to 22 (4 pages)**

**Area 1 - Crow Drive to Fort Halstead main reception**



Plate 1 – Entrance to Crow Drive (looking south).



Plate 2 – Slope to the east of Crow Drive (looking south east).



Plate 3 – Slope towards A224 (looking north east).



Plate 4 – Slope to the east of Crow Drive (looking south east).



Plate 5 – Slope to the east of Crow Drive (looking south east).



Plate 6 – Crow Drive (looking south east).

**Area 2 – Inside Fort Halstead**



Plate 7 – Slope to the east of Crow Drive (looking north east).



Plate 8 – Slope to the east of Crow Drive (looking south east).



Plate 9 – Slope to the east of the car park (looking east).

Project Details	EED12715-102: Fort Halstead
Figure Title	Figure B1: Site Photographs
Figure Ref	EED12715-102_GR_ES_B1A
Date	January 2015
File Location	\\nt-lncs\weed\projects\eed12715\102\graphics\eia\issued figures



Plate 10 –Footpath to the east of the fort (looking south).



Plate 11 – Inclined trees towards the downslope direction (looking south).



Plate 12 – Towards the practice firing range area (looking south).



Plate 13a – Slope towards the practice firing range area (looking south).



Plate 13b – Slope towards the practice firing range area (looking south).



Plate 14 – Slope towards the practice firing range area (looking south west).



Plate 15a – Slope to the south east of Crow Drive (looking east).



Plate 15b – Slope to the south east of Crow Drive (looking south west).



Plate 15c – Slope to the south east of Crow Drive (looking south west).

Project Details	EED12715-102: Fort Halstead
Figure Title	Figure B2: Site Photographs
Figure Ref	EED12715-102_GR_ES_B2A
Date	January 2015
File Location	\\nt-lncs\weed\projects\eed12715\102\graphics\eia\issued figures



Plate 16a – Slope along Lime Pit Lane to the south east of the site boundary (looking north east).



Plate 16b – Slope along Lime Pit Lane to the south east of the site boundary (looking north east).



Plate 16c – Slope along Lime Pit Lane to the south east of the site boundary (looking north west).



Plate 16d – Slope along Lime Pit Lane to the south east of the site boundary (looking south west).



Plate 16e – Slope along Lime Pit Lane to the south east of the site boundary (looking south west).



Plate 17 –Lime Pit Lane (looking north east).



Plate 18 –Lime Pit Lane (looking south west).

Project Details	EED12715-102: Fort Halstead
Figure Title	Figure B3: Site Photographs
Figure Ref	EED12715-102_GR_ES_B3A
Date	January 2015
File Location	\\nt-lncs\weed\projects\eed12715\102\graphics\eia\issued figures



Plate 19a – Slope cutting along A224 to the east of the site (looking north west).



Plate 19b – Slope cutting along A224 to the east of the site (looking north west).



Plate 19c – Slope cutting along A224 to the east of the site (looking west).



Plate 19d – Slope cutting along A224 to the east of the site (looking southwest).



Plate 20 – The lay-by to the south of Polhill Arms public house (looking south).



Plate 21 – A224 (looking south west)

Project Details	EED12715-102: Fort Halstead
Figure Title	Figure B4: Site Photographs
Figure Ref	EED12715-102_GR_ES_B4A
Date	January 2015
File Location	\\nt-lncs\weed\projects\eed12715\102\graphics\eia\issued figures

# UK and Ireland Office Locations

