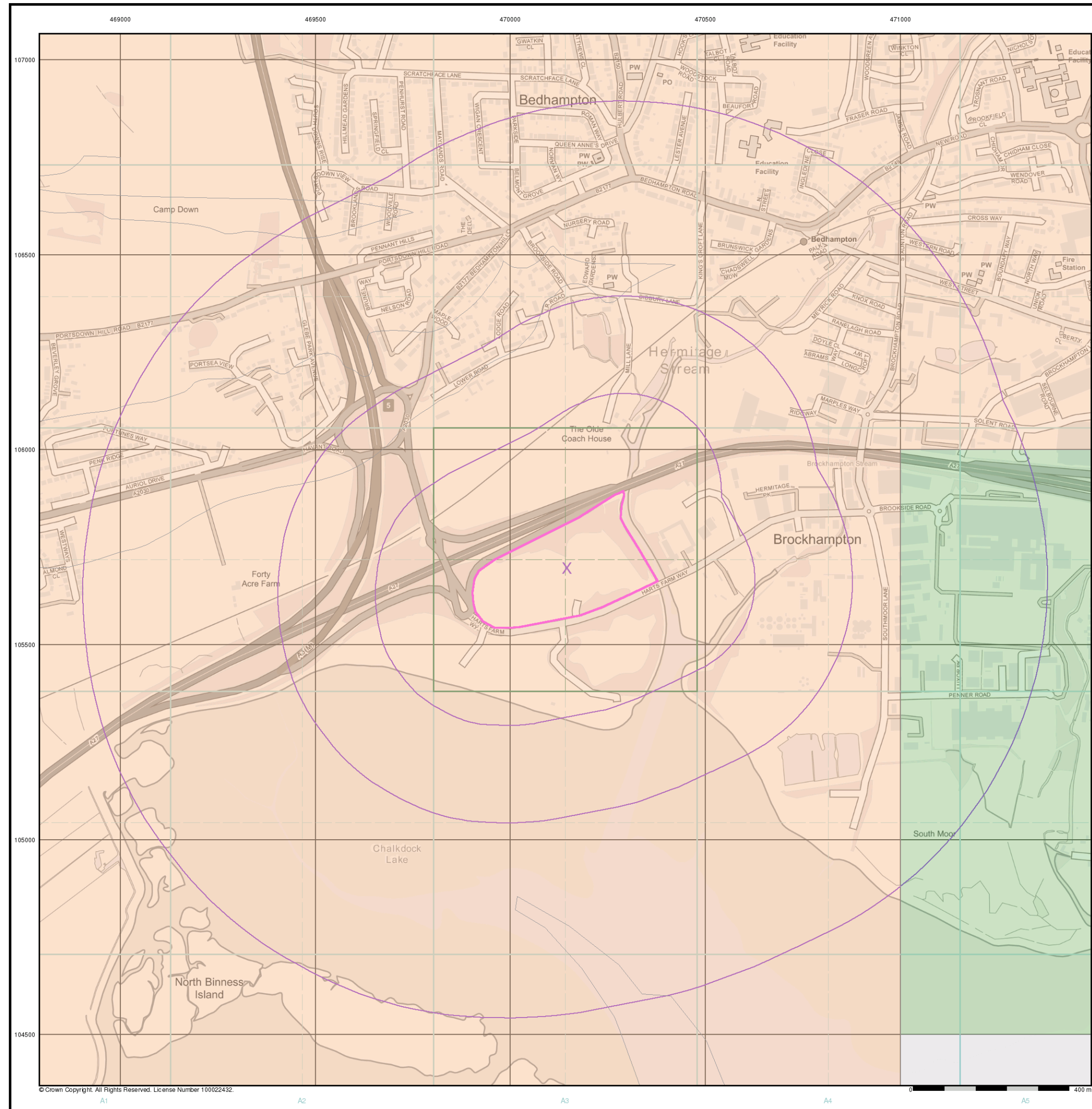
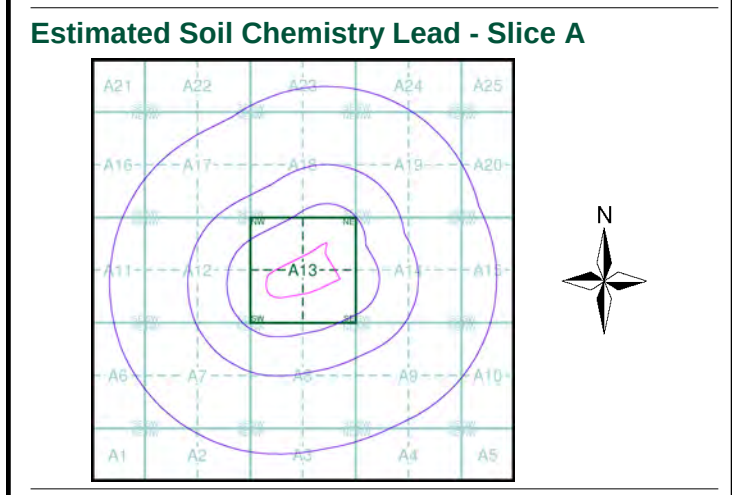
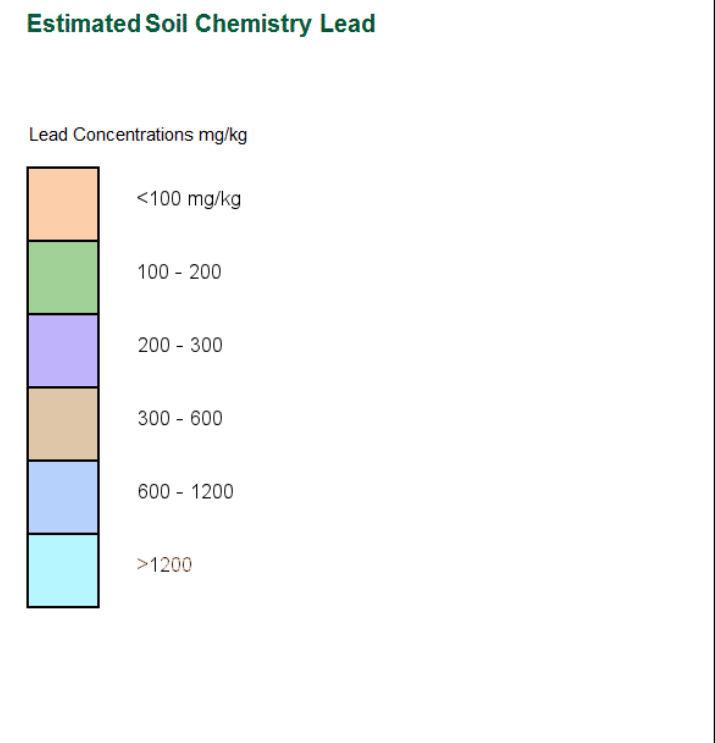




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General

Specified Site Specified Buffer(s) Bearing Reference Point

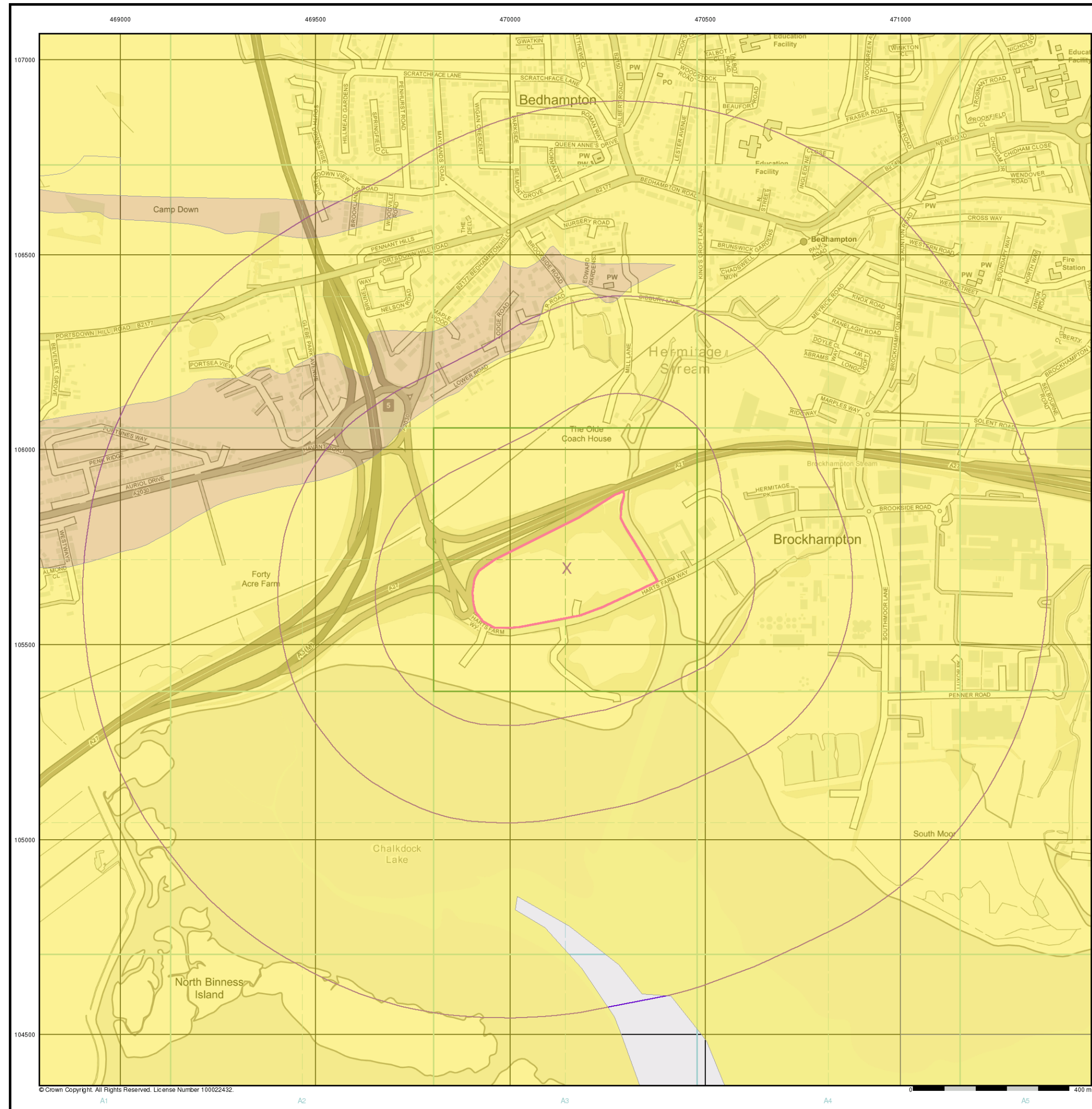


Order Details

Order Details: 271595310_1_1
Customer Ref: 19-2099.01
National Grid Reference: 470150, 105700
Slice: A
Site Area (Ha): 9.27
Search Buffer (m): 1000

Site Details

Dolly Stuff, 31A, Broadmarsh Business & Innovation Centre,
Harts Farm Way, HAVANT, PO9 1HS



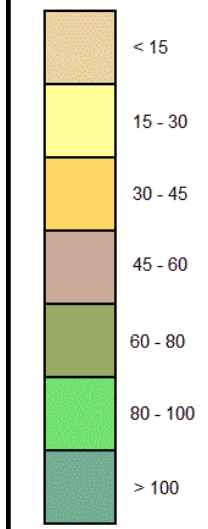
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General

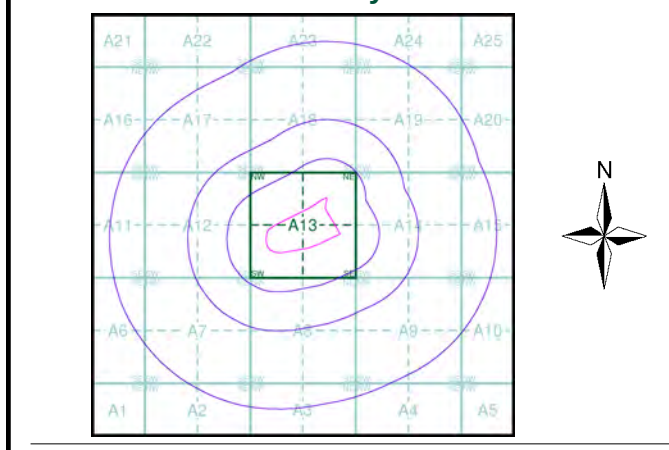
- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

Estimated Soil Chemistry Nickel

Nickel Concentrations mg/kg



Estimated Soil Chemistry Nickel - Slice A

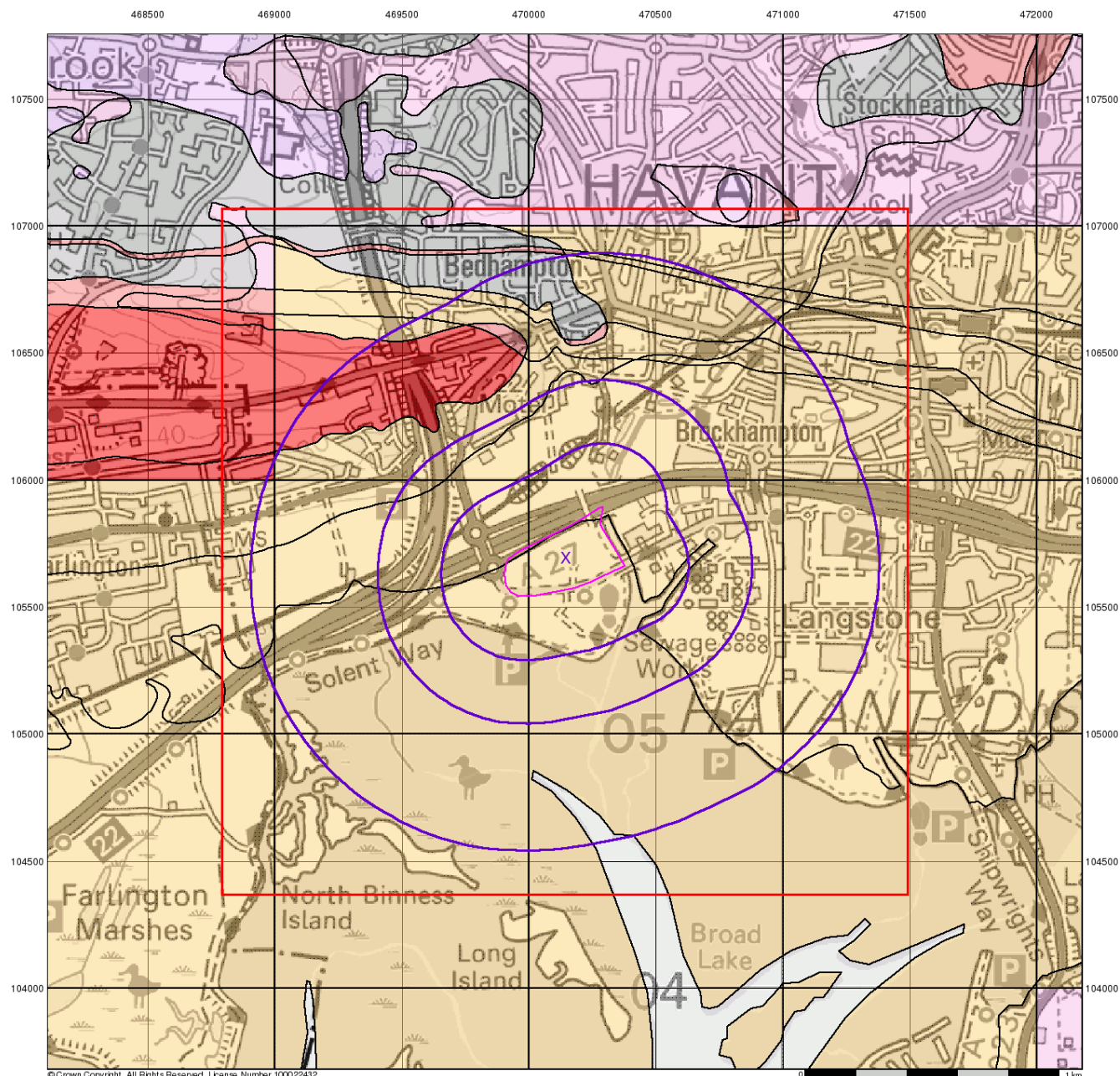


Order Details

Order Details: 271595310_1_1
 Customer Ref: 19-2099.01
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 Search Buffer (m): 1000

Site Details

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Groundwater Vulnerability

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Slice
- Map ID

Agency and Hydrological

Bedrock Aquifers

- High Vulnerability, Principal Aquifer
- High Vulnerability, Secondary Aquifer
- Medium Vulnerability, Principal Aquifer
- Medium Vulnerability, Secondary Aquifer
- Low Vulnerability, Principal Aquifer
- Low Vulnerability, Secondary Aquifer

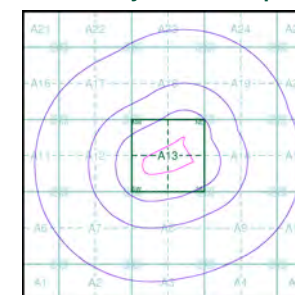
Superficial Aquifers

- High Vulnerability, Principal Aquifer
- High Vulnerability, Secondary Aquifer
- Medium Vulnerability, Principal Aquifer
- Medium Vulnerability, Secondary Aquifer
- Low Vulnerability, Principal Aquifer
- Low Vulnerability, Secondary Aquifer

Unproductive Aquifer

Soluble Rock

Site Sensitivity Context Map - Slice A



Order Details

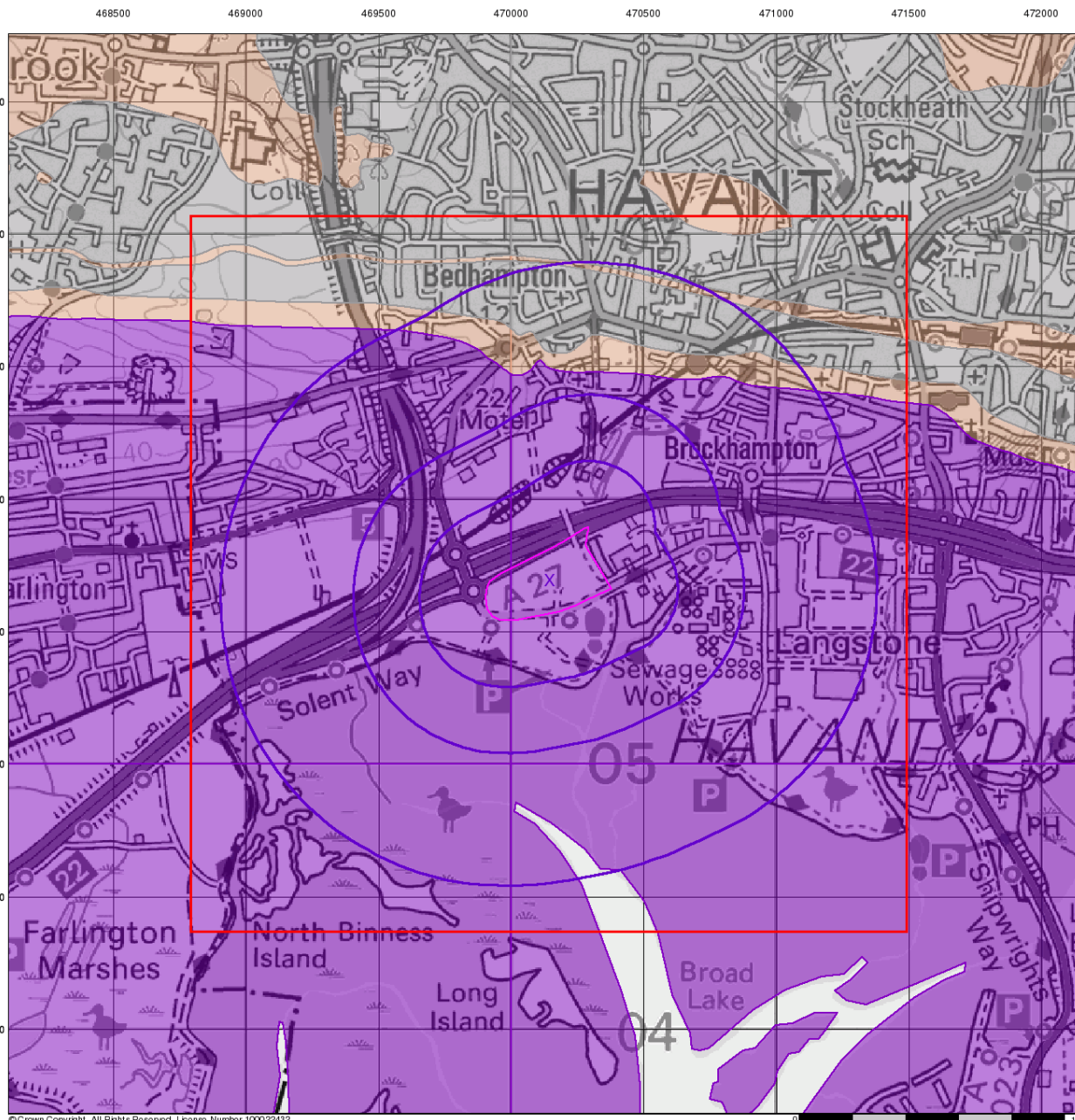
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 National Grid Reference: 470150, 105700
 Slice: A
 Site Area (Ha): 9.27
 Search Buffer (m): 1000

Site Details

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0 1 km

Bedrock Aquifer Designation

General

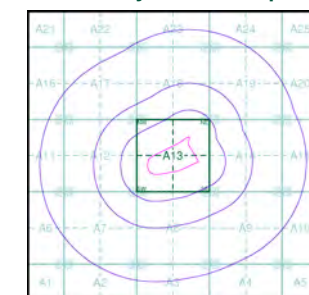
- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Slice
- Map ID

Agency and Hydrological

Geological Classes

- Principal Aquifer
- Secondary A Aquifer
- Secondary B Aquifer
- Secondary Undifferentiated
- Unproductive Strata
- Unknown
- Unknown (Lakes and Landslip)

Site Sensitivity Context Map - Slice A

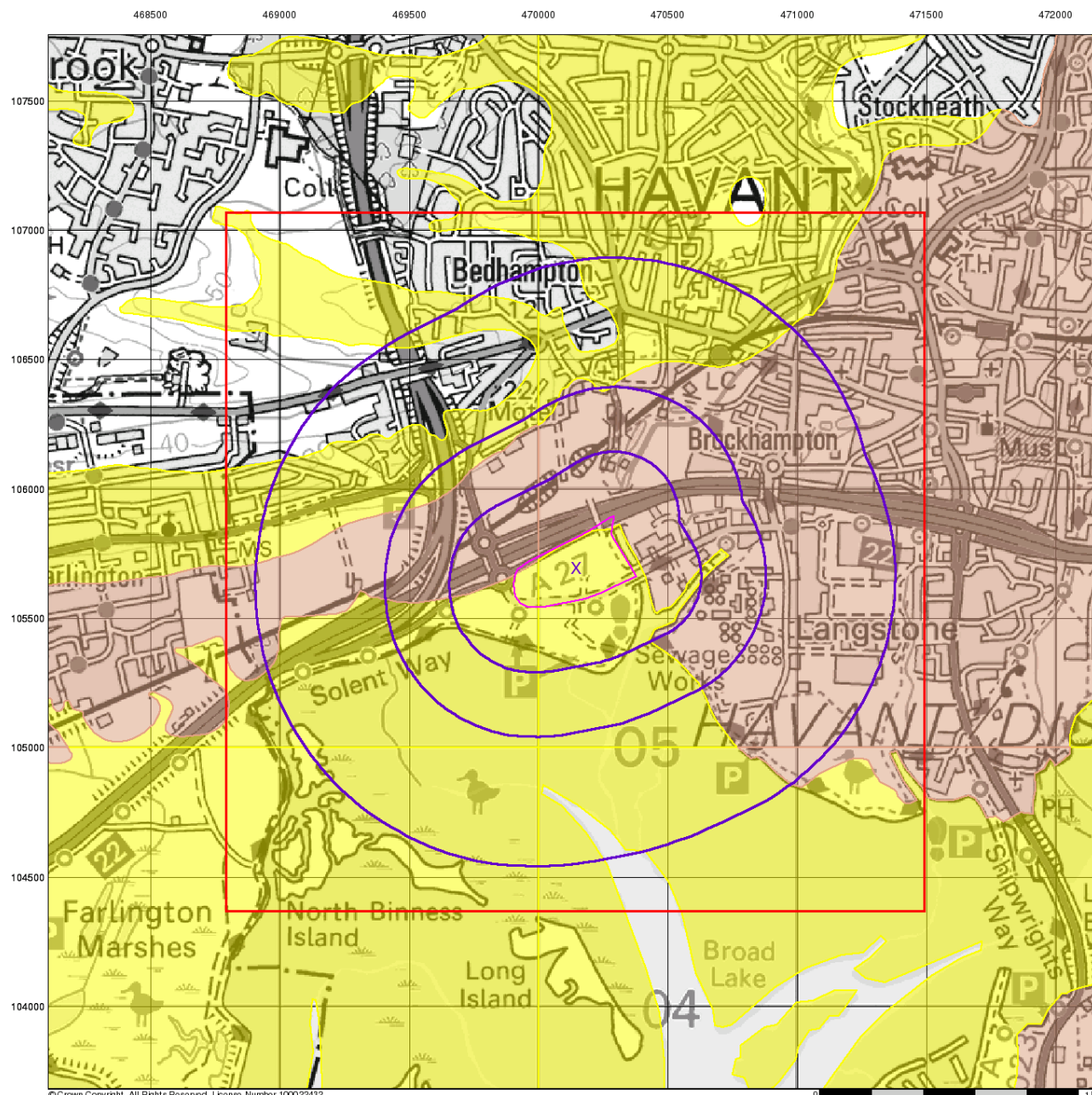


Order Details

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Site Details

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0 1 km

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Superficial Aquifer Designation

General

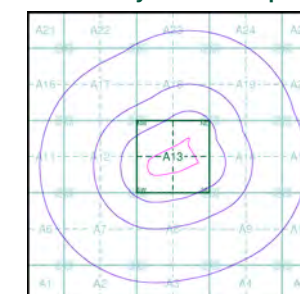
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- Specified Buffer(s)
- Bearing Reference Point
- Slice
- Map ID

Agency and Hydrological

Geological Classes

- Principal Aquifer
- Secondary A Aquifer
- Secondary B Aquifer
- Secondary Undifferentiated
- Unproductive Strata
- Unknown
- Unknown (Lakes and Landslip)

Site Sensitivity Context Map - Slice A



Order Details

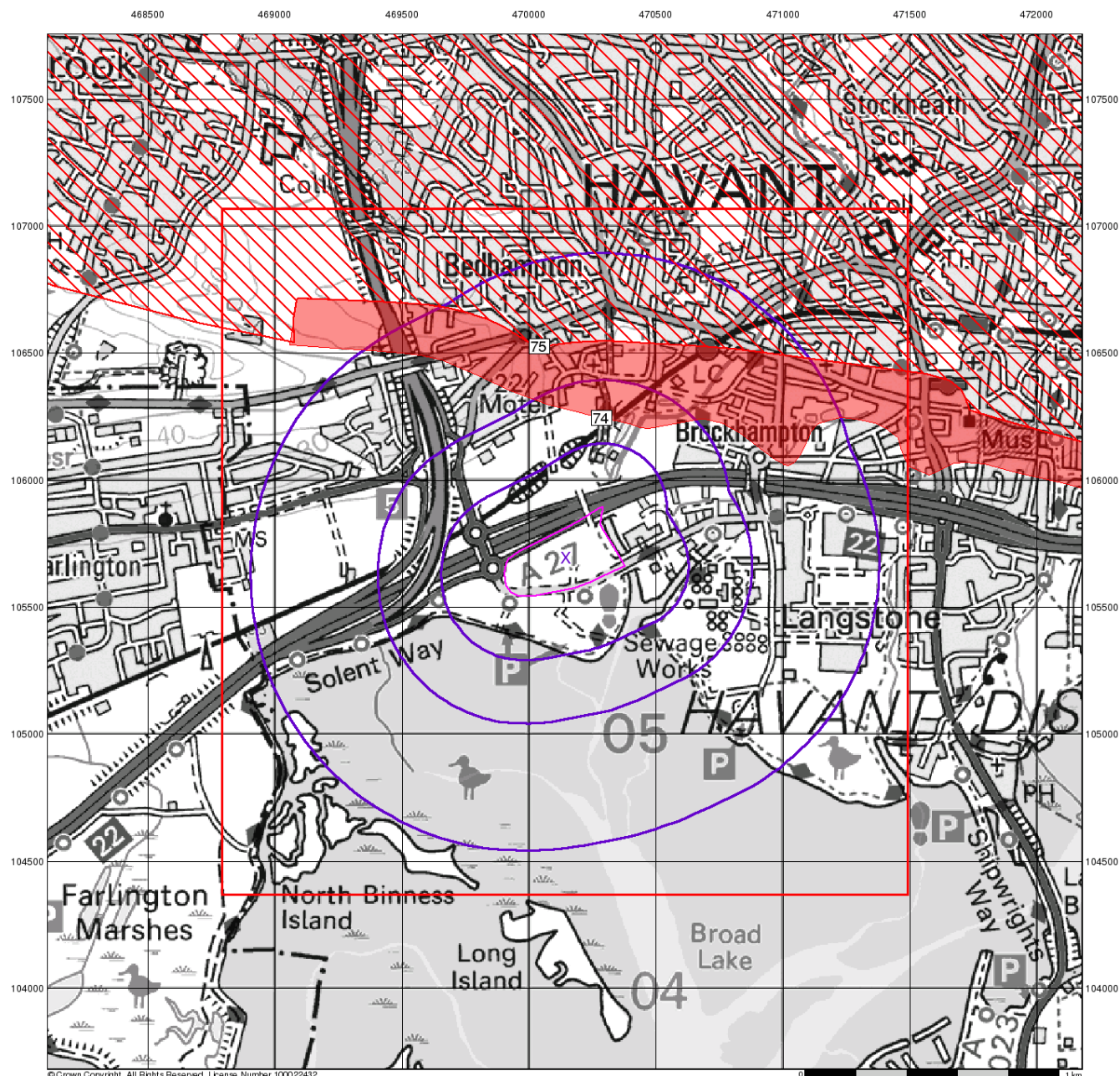
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 Site Area (Ha): 9.27
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Site Details

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Source Protection Zones

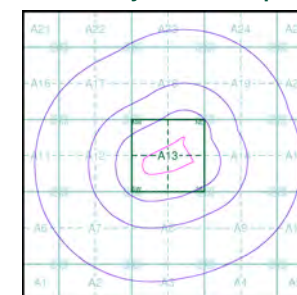
General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Slice
- Map ID

Agency and Hydrological

- Inner zone (Zone 1)
- Inner zone - subsurface activity only (Zone 1c)
- Outer zone (Zone 2)
- Outer zone - subsurface activity only (Zone 2c)
- Total catchment (Zone 3)
- Total catchment - subsurface activity only (Zone 3c)
- Special interest (Zone 4)

Site Sensitivity Context Map - Slice A

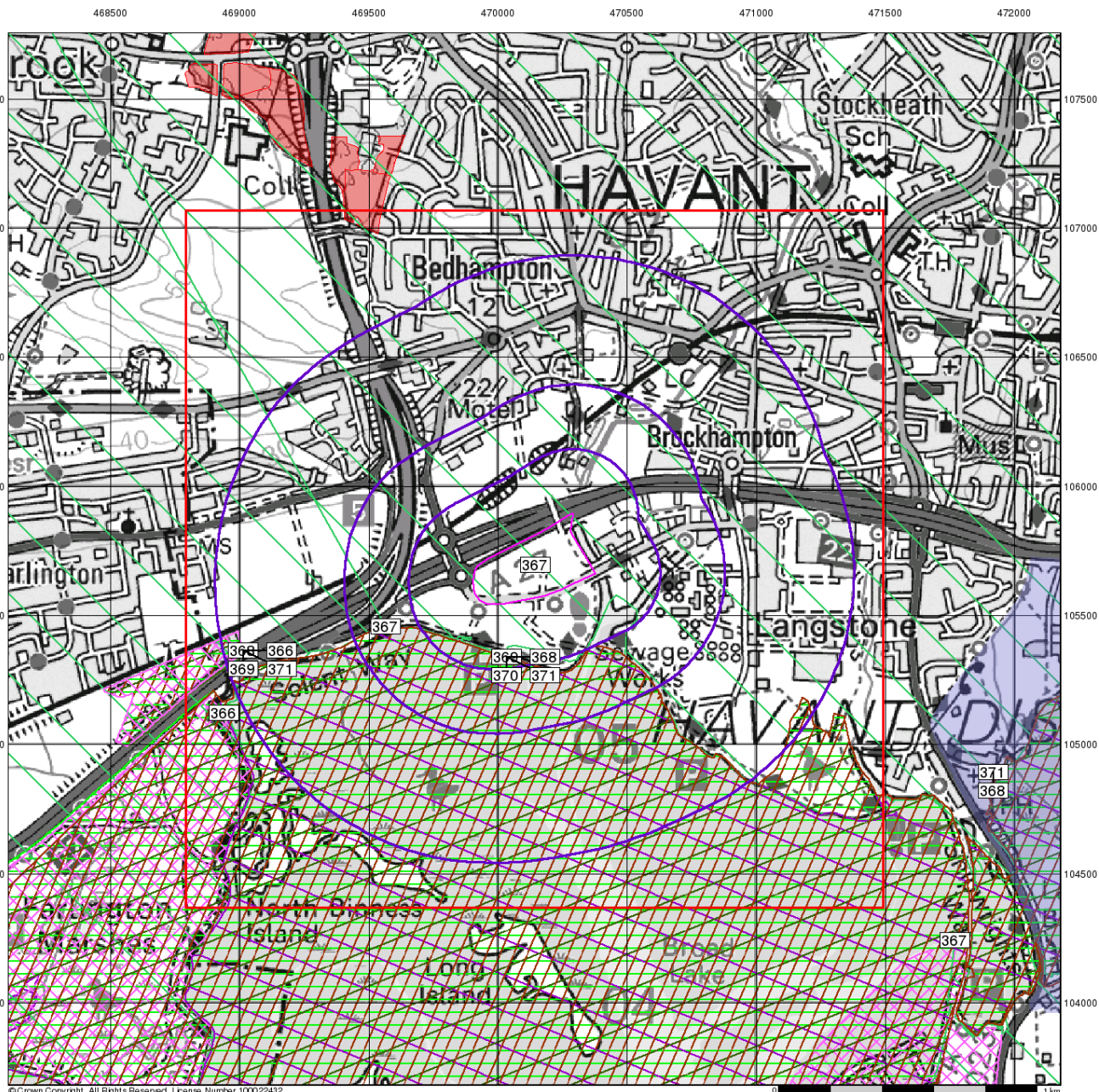


Order Details

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 Site Area (Ha): 9.27
 Search Buffer (m): 1000

Site Details

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Sensitive Land Uses

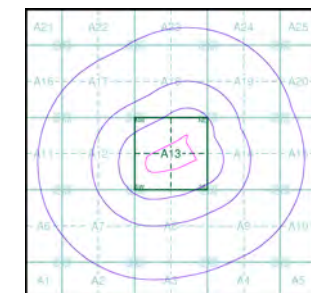
General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Slice
- Map ID

Sensitive Land Uses

- Ancient Woodland
- Area of Adopted Green Belt
- Area of Unadopted Green Belt
- Area of Outstanding Natural Beauty
- Environmentally Sensitive Area
- Forest Park
- Local Nature Reserve
- Marine Nature Reserve
- National Nature Reserve
- National Park
- Nitrate Sensitive Area
- Nitrate Vulnerable Zone
- Ramsar Site
- Site of Special Scientific Interest
- Special Area of Conservation
- Special Protection Area
- World Heritage Sites

Site Sensitivity Context Map - Slice A

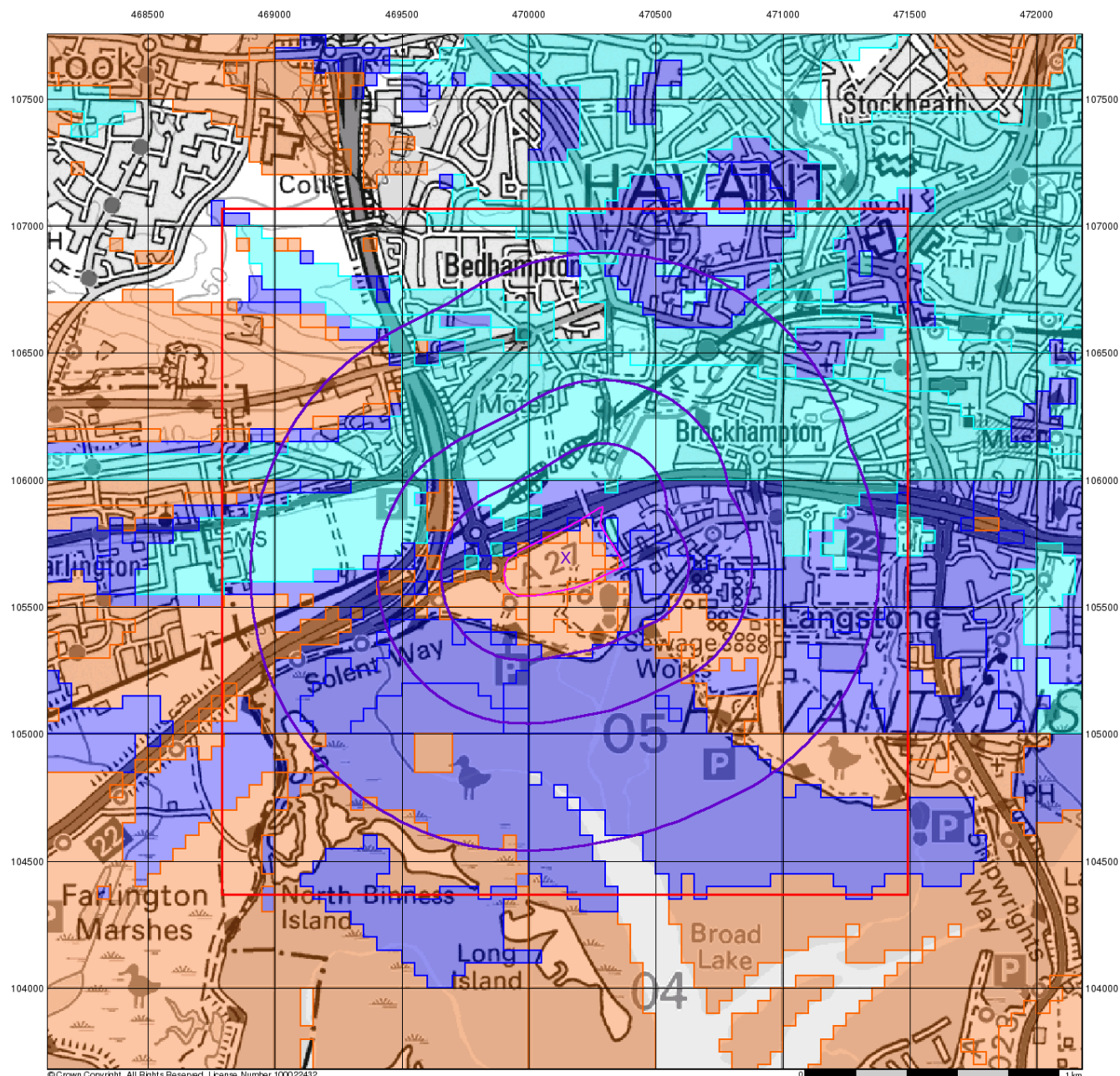


Order Details

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 Slice: A
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Site Details

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BGS Flood GFS Data

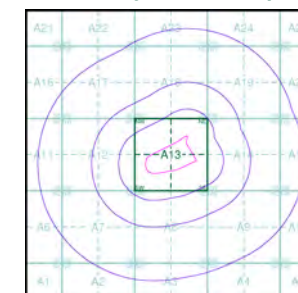
General

- ◇ Specified Site
- Specified Buffer(s)
- X Bearing Reference Point
- Slice

Agency and Hydrological (Flood)

- Limited Potential for Groundwater Flooding to Occur
- Potential for Groundwater Flooding of Property Situated Below Ground Level
- Potential for Groundwater Flooding to Occur at Surface

Site Sensitivity Context Map - Slice A



Order Details

Order Number: 271595310_1_1
 Customer Ref: 19-2099.01
 National Grid Reference: 470150, 105700
 Slice: A
 Site Area (Ha): 9.27
 Search Buffer (m): 1000

Site Details

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Landmark
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 Fax: 0844 844 9951
 Web: www.envirocheck.co.uk

Appendix F – Regulatory Authority Information

To: David Jackson
Subject: FW: Information Request 19-356

From: HBC Info Requests <InfoRequests@havant.gov.uk>
Sent: 19 November 2019 13:45
To: Aimee Brown <Aimee.Brown@deltasimons.com>
Subject: Information Request 19-356

Dear Aimee,

Freedom of Information request

Thank you for your request for information under the Freedom of Information Act 2000, which has been received by Havant Borough Council. You have requested the following:

Following on from my previous enquiry for environmental information on Brockhampton West, Portsmouth, PO9 1HS, could I please request some more information? I have contacted the Environmental Authority to ascertain information about the historical landfill that existed on this Site, but received very little information in the response.

It is understood that Storhouse Lake Tip landfill is a historical landfill that exists on-Site (I have included a boundary of the Site in this email).

In addition to the previous information I have requested below, I would be grateful if you could provide information on the following:

- **The dates of operation of the landfill**
- **The nature of the materials deposited there**

Are the council aware of issues with ground gas or contamination associated with the landfilling of the Site and surrounding area? If so, has this resulted in any remediation works undertaken at the Site or any ongoing monitoring requirements? If so, please can you provide any associated documents or reports?

- The attached documents provide a summary of documentary information relating to the means of containment, the area proposed for tipping, and the material(s) permitted to be tipped.
- It is understood that formal tipping commenced in June 1969, and continued at the wider consented site until 1989.
- It is understood that the subject site (subject to this EIR) represented the first-phase of tipping at this site
- The landfill was constructed as a 'dilute and disperse', initially being completed (it is believed) with soil cover not engineered to be impermeable. Hampshire County Council information notes a 'Discharge to Estuary' against the summary information for this site. Subsequent consent ref 98/54097/2/HBC is thought to relate to the further raising of land at the subject site by 1m, with clay material.
- The landfill has no formal basal containment to the best of my knowledge.
- The Council is aware of an incident of reported 'noxious discharge' from a penstock structure associated with the tip, recorded under 26081/1 and dated 22 February 1979. Anecdotally, I understand that some work was undertaken by the Council to seal one of the penstock / outfall structures. I do not have a specific date for-, or any documentation of- that work.
- Gas issues are known in the vicinity of this former tip (CH₄ present within it's explosive range, measured within service ducts of built structures), however it should be noted that those structures are associated with separate areas of fill, and that appropriate protection is now in place.
- No permanent structures are associated with the subject site, and the Council is not aware of any documented monitoring of soil gas. The original construction & completion of the site would be expected to permit diffuse vertical migration of generated gas to atmosphere within the boundary of the landfill (i.e. the lateral migration is expected to be limited). The absence of adjacent ground-gas-vulnerable structures is considered to weigh against the likelihood of proactive gas monitoring having been undertaken at the site previously, and so it is not thought likely that gas data will be present in the site information archive(s). It has not been identified during prior systematic searches of files, to the best of my knowledge.

Please accept this email as completion of your request.

The information contained in this response is released under an Open Government Licence, for more information please visit the Councils

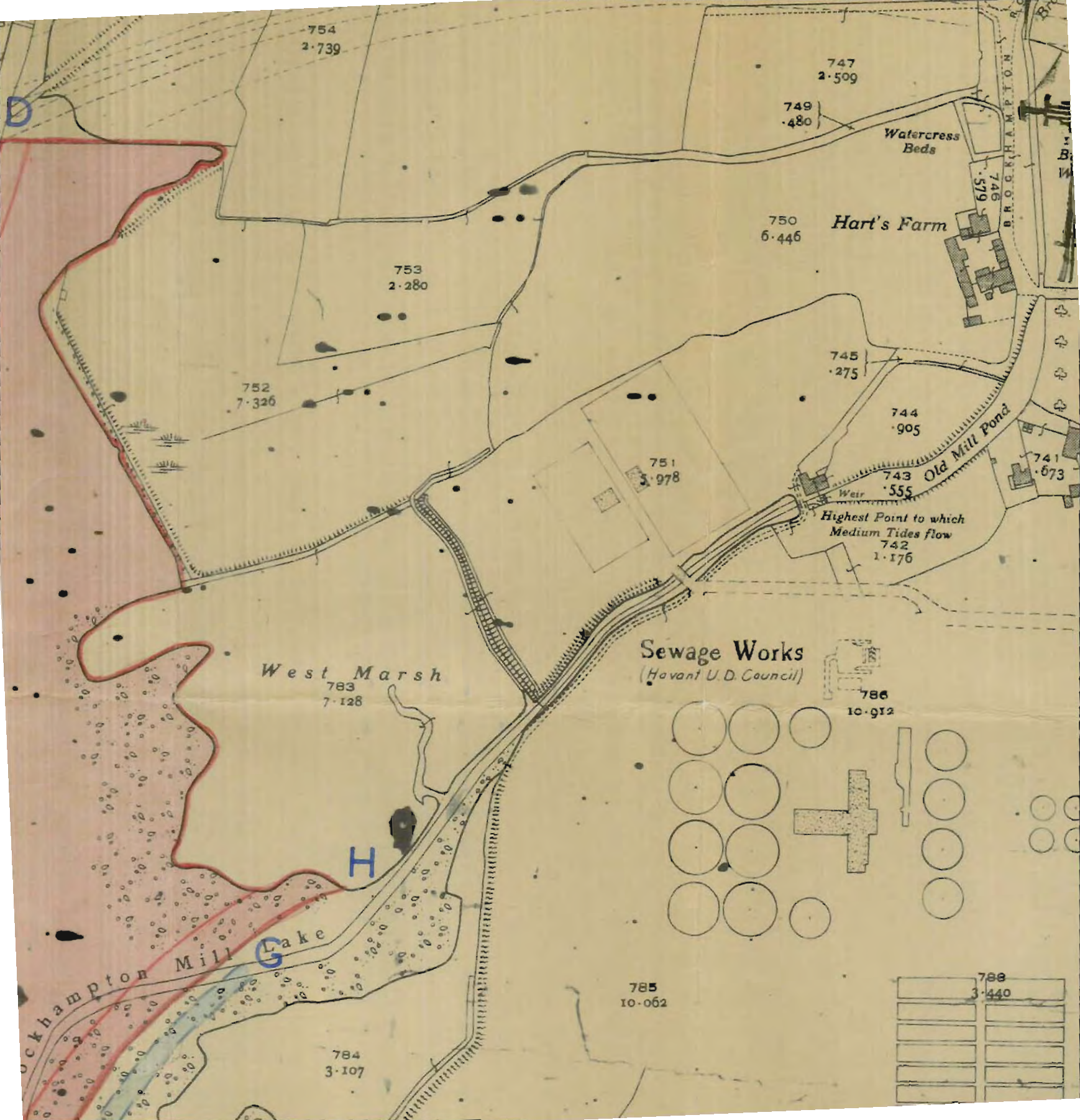
website; <http://www.havant.gov.uk/re-use-public-sector-information-regulations>

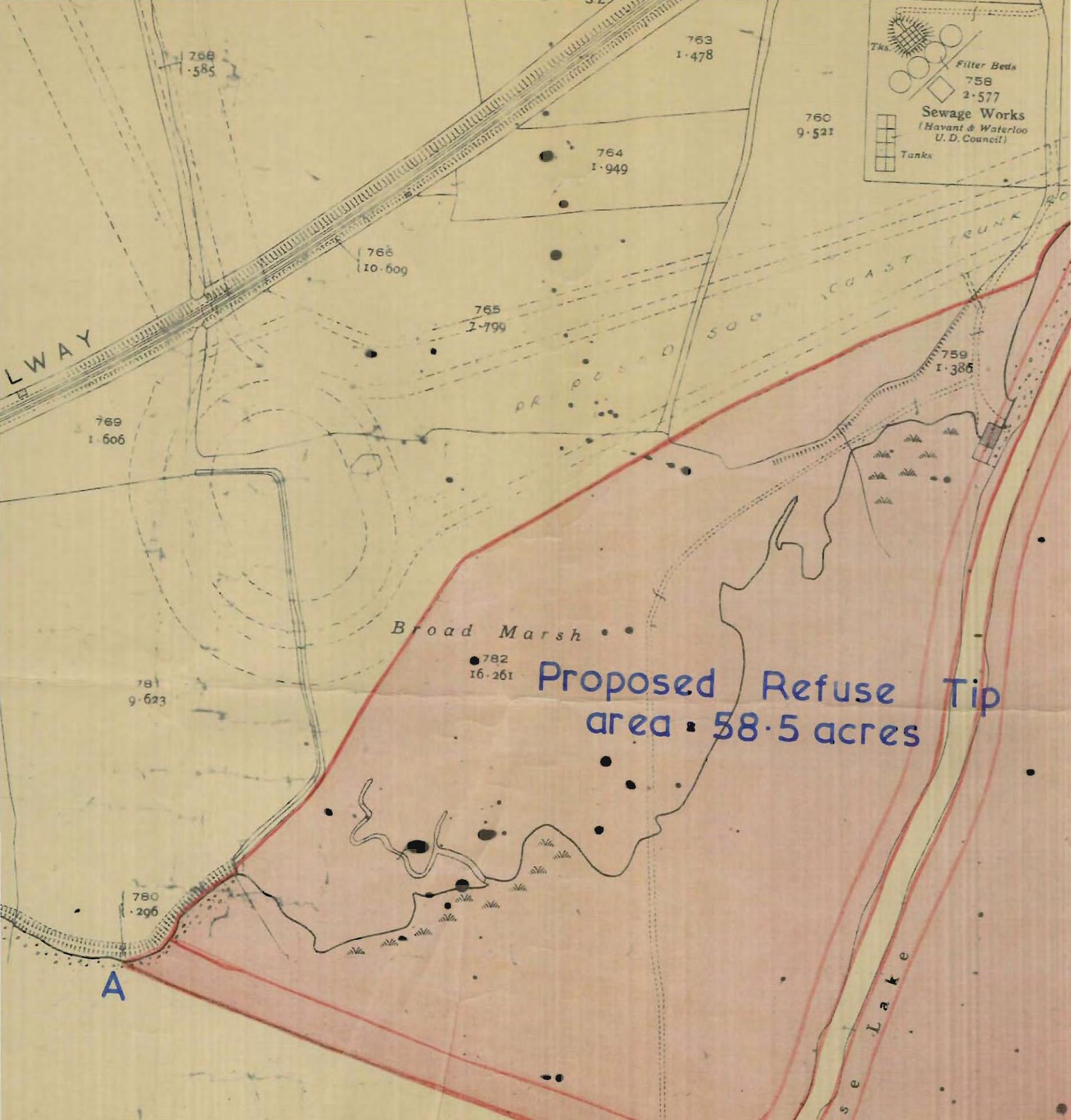
If you are dissatisfied with the outcome of your request, please contact our Information Governance Department on governance@havant.gov.uk and we will conduct an internal review. Upon review, If you are still dissatisfied, you may appeal our decision by contacting the Information Commissioner's Office; for more information please visit the [ICO's website](#).

Please be aware, if we do not receive an appeal within 40 days of you receiving this letter we will assume that you are satisfied with our response. If you wish to make any further requests for information please do not hesitate to contact us on inforequests@havant.gov.uk.

Kind regards,

Information Governance
Havant Borough Council
Public Service Plaza
Civic Centre Road
Havant PO9 2AX





HAMPSHIRE COUNTY COUNCIL

Box: A

TOWN AND COUNTRY PLANNING ACT, 1962

TOWN AND COUNTRY PLANNING GENERAL DEVELOPMENT ORDER, 1963

To:— Havant & Waterloo Urban District Council,
c/o Engineer and Surveyor,
Elmleigh Road,
HAVANT.

Plan No.: HMU.14239/3

In pursuance of their powers under the above-mentioned Act and Order, the Council, as the local planning authority, hereby PERMIT use of land at Storehouse Lake, Bedhampton, as a controlled tip, Quay, slip-way and dinghy park and construction of channel diversion and road,

~~for a limited period only terminating on the~~

in accordance with your application dated 9th. November 1967.

and the plans

and particulars submitted in connection therewith and subject also to due compliance with the conditions specified hereunder:—

Conditions (1)–(22) on attached schedule.



The reasons for the foregoing conditions are:—

In order to protect the amenities of the area and to minimise the effect of the development on this stretch of coast line;

To reduce the interference with the safety and free flow of Trunk Road traffic which will be caused by additional vehicles entering or leaving the Trunk Road;

To facilitate the smooth entry of vehicles to the roundabout thereby reducing interference with the safety and free flow of Trunk Road traffic.

NOTE:—(1) This permission does not purport to convey any approval or consent which may be required under the Town and Country Planning Act, 1962, otherwise than under Sections 17–20 of that Act or which may be required under any other Acts, including any Byelaws, Orders or Regulations made under such other Acts.

(2) **Public Rights of Way.** Developers are reminded that the grant of planning permission does not entitle them to obstruct a right of way and that, if it is necessary to stop up or divert a right of way in order to enable the development to be carried out, they should apply without delay to the Minister of Transport for an Order under Section 153 of the Town and Country Planning Act, 1962; development must not be started until this has been obtained.

Clerk of County Council

On behalf of the Local Planning Authority.

THE CASTLE,
WINCHESTER.

Date 12 SEP 1968

P.T.O.

NOTIFICATION

(1) If the applicant is aggrieved by the decision to refuse permission or approval for the proposed development, or to grant permission or approval subject to conditions, he may, by notice served within one month of receipt of this notice, appeal to the Minister of Housing and Local Government in accordance with Section 23 of the Town and Country Planning Act, 1962.

The Minister has power to allow a longer period for the giving of a Notice of Appeal and he will exercise his power in cases where he is satisfied that the applicant has deferred the giving of notice because negotiations with the local planning authority in regard to the proposed development are in progress. The Minister is not, however, required to entertain such an appeal if it appears to him that permission for the proposed development could not have been granted by or on behalf of the local planning authority, or could not have been so granted otherwise than subject to the conditions imposed by them, having regard to the provisions of the development order and to any directions given under the order.

(2) If permission to develop the land is refused, or granted subject to conditions, whether by or on behalf of the local planning authority or by the Minister of Housing and Local Government, and the owner of the land claims that the land has become incapable of reasonably beneficial use in its existing state and cannot be rendered capable of reasonably beneficial use by the carrying out of any development which has been or would be permitted, he may serve on the Council of the county borough or county district in which the land is situated a purchase notice requiring that Council to purchase his interest in the land in accordance with the provisions of Part VIII of the Town and Country Planning Act, 1962.

(3) In certain circumstances, a claim may be made against the local planning authority for compensation, where permission is refused, or granted subject to conditions by the Minister on appeal or on a reference of the application to him. The circumstances in which such compensation is payable are set out in Section 123 of the Town and Country Planning Act, 1962.

(4) An applicant who wishes to appeal against a decision should write to the Minister of Housing and Local Government, Whitehall, London, S.W.1.

(5) The applicant is recommended to retain this form with the title deeds of the property.

(6) In cases where a Government Department has expressed views on the proposals which are incorporated in the reasons for refusal or for the imposition of conditions and the applicant wishes to lodge an appeal against such decision then a representative from that Government Department will attend any Planning Inquiry and be available to give evidence if the appellant asks for the presence of such a witness at the Inquiry. In such cases the appellant should notify the Council at the address given on the front of this form without delay. The representative would not be liable to cross-examination on questions of Ministerial policy but only on matters of fact and expert opinion.

NOTICE

Attention is drawn to the fact that any failure to adhere to the details of the plans hereby approved or to comply with any conditions detailed in this notice would constitute a contravention of the provisions of the Town and Country Planning Act, 1962, in respect of which enforcement action might be taken.

If it is desired to depart in any way from the proposals as approved, an amended application should be made to the Council at the address overleaf.

- (1) The submission and subsequent approval of satisfactory detailed plans of the proposed quay, slipway and ancillary works, including access to the slipway;
- (2) Before any refuse is deposited on the land, a detailed working scheme (together with a phasing programme) of the proposed bund construction, tipping, landscaping and means of access during and after completion, shall be agreed with the Local Planning Authority, or in default of agreement, be determined by the Minister;
- (3) Such scheme shall take account of and be subject to the provisions following and shall include provisions for excavation and storing of covering materials, sequence and orientation of tipping operations, protection of the site from the sea, and for maintaining existing land drainage, finished levels, supervision and restoration of the land;
- (4) The first stage of such programme shall include that portion of the site within 300 ft. of the boundary of the recently constructed Havant By-pass road; the finished levels of such land shall not exceed those of the carriageway measured at the nearest point;
- (5) Refuse shall be tipped in layers not exceeding 6 ft. in depth;
- (6) All refuse exposed to the air shall be covered each day with at least 9 ins. of earth or other suitable inert material capable of forming an effective seal, provided that a surface not exceeding 80 sq.yds. at any one time may be left uncovered during daily tipping operations;
- (7) Deposits mainly of animal or fish wastes shall be covered forthwith with at least 2 ft. of earth or other suitable inert material capable of forming an effective seal;
- (8) Screens or other suitable apparatus shall be provided so as to ensure that no paper or debris is blown by the wind from the place of deposit;
- (9) Tins, hollow vessels and other loose debris shall not be left lying on or about the place of deposit. Large containers likely to cause voids shall be filled or flattened before being deposited in the tip;
- (10) No refuse shall be burnt on the site;
- (11) The approved scheme of landscaping shall be carried out to the satisfaction of and by a date approved by the Local Planning Authority;
- (12) The development road access shall be constructed and maintained to the satisfaction of the Local Planning Authority;
- (13) No substance shall be deposited on the land other than the following:
 - (i) Soil, chalk, sand, gravel, hard core and other earth spoil;
 - (ii) Trade refuse and domestic refuse;
- (14) All reasonable precautions shall be taken to prevent fire, and if a fire occurs, the area of the fire shall be effectively sealed off and no further tipping shall take place until the fire has been extinguished for a period of 12 hours at least;
- (15) All buildings, plant and machinery shall be removed within three months after the Local Planning Authority have determined that they are no longer required either for the purpose for which they were installed or for reinstatement;
- (16) Written notice shall be given to the Local Planning Authority when operations have been completed;
- (17) This permission shall endure only for the benefit of Havant and Waterloo Urban District Council - tipping only;

A. H. M. Smyth
Clerk of County Council

Continued.....

12 SEP 1965

SCHEDULE OF CONDITIONS.

HWU 14239/3.

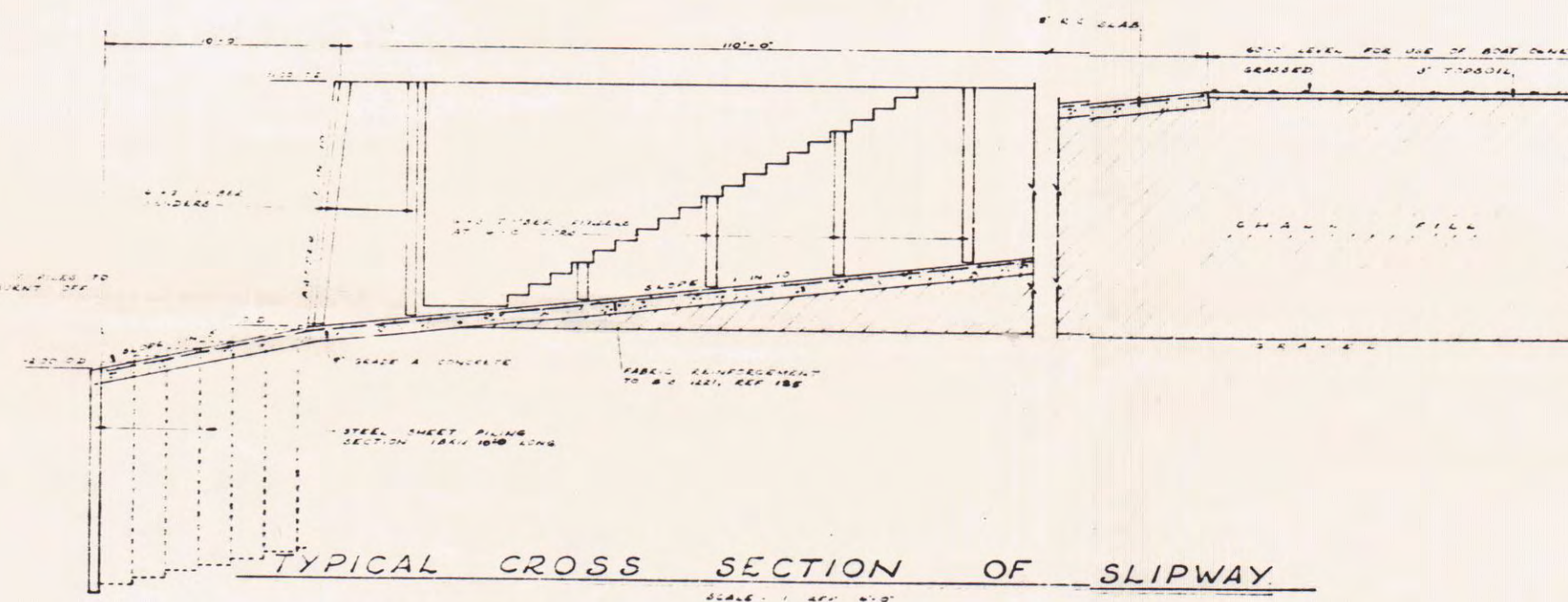
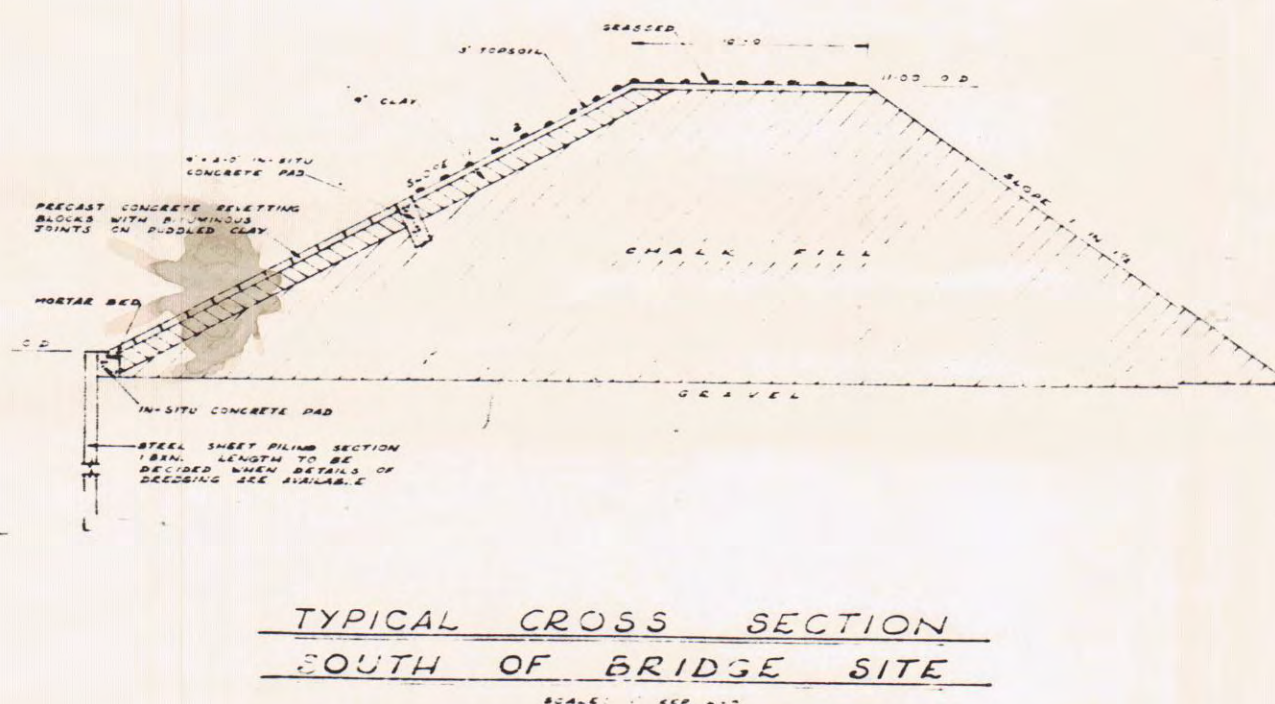
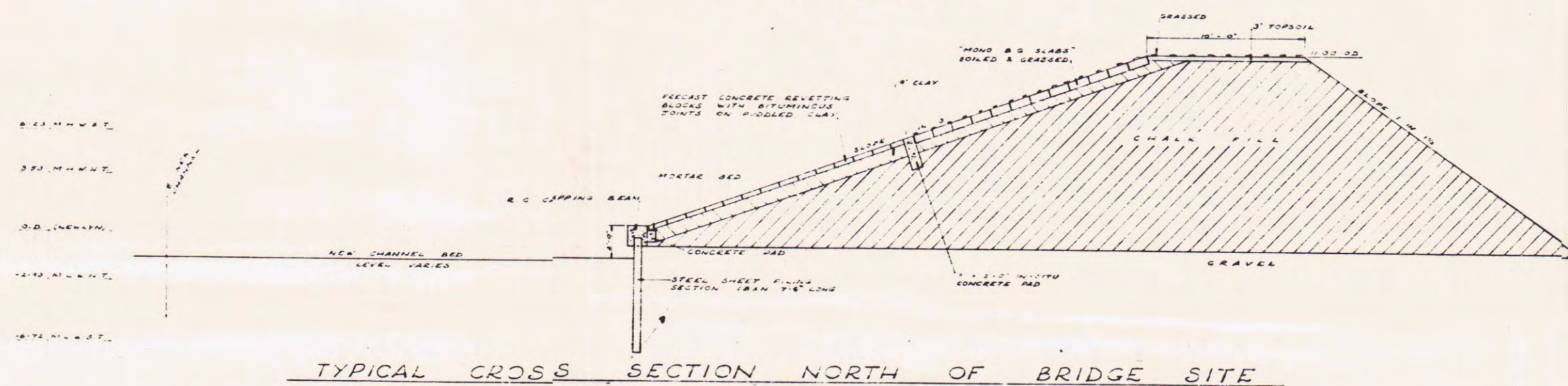
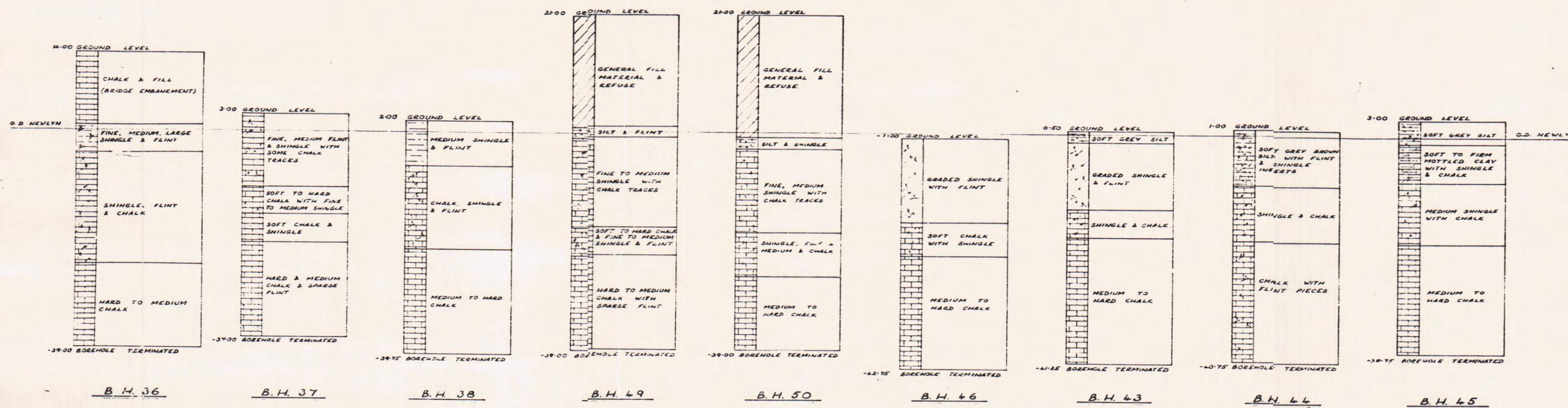
- (18) No phenolic waste shall be deposited on the site without the prior consent of the Local Planning Authority;
- (19) There shall be no access to development from the trunk road, either temporary or permanent, other than from the Broadmarsh Roundabout, (direction of the Minister of Transport);
- (20) Adequate sight lines, both horizontal and vertical, shall be provided at the connection to Broadmarsh Roundabout to the satisfaction of the Local Planning Authority; (direction of the Minister of Transport);
- (21) An adequate length of level carriageway shall be provided where the access road joins the roundabout (direction of the Minister of Transport);
- (22) Notwithstanding the provisions of the Town and Country Planning (Control of Advertisements) Regulations, 1960, no advertisement shall be displayed on the site without the prior consent of the Local Planning Authority.

A. H. M. Smyth
Clerk of County Council

On behalf of the Local Planning Authority.

Date....12 SEP 61....

THE URBAN DISTRICT COUNCIL OF HAVANT & WATERLOO.



From: Wickens, Tom <tom.wickens@environment-agency.gov.uk>
Sent: 12 January 2021 18:32
To: David Jackson
Subject: RE: 20-2099.04 - Consultation on Proposed Site Investigation at Brockhampton West Landfill Site, Havant

Dear David,

I have had a bit of a look through the proposal and put together some comments below.

2.0 Existing Information

Suggests the reclamation of Broad Marsh to create the landfills was done with steel sheet piles and clay (Delta-Simons have not yet identified supporting evidence); *From a controlled waters perspective determining any containment of the landfill, particularly if this is likely to impact on Langstone harbour is crucial.*

Recognises the likely tidal influence of groundwater elevations in the chalk below the Site, but provides no data to demonstrate this; - *My understanding of the site, is that this landfill came from depositing waste on top of the superficial raised marine deposits. I would have thought it is likely that the chalk is permanently saturated. I would agree though it would be good to confirm this. Tidal influences may though also have a degree influence in groundwater movement.*

Does not adequately characterise the groundwater regime in the chalk (flow direction and quality as it arrives/leaves below the Site);

Does not present a sufficiently robust data set on groundwater quality in the chalk; *With regards to the chalk in this location. While it is notionally a principal aquifer, we recognise that given the site setting, it is unlikely to have significant resource potential. While we would have concerns if gross contamination was present, our principal concern with the chalk, would be the potential that it could act as a pathway to sensitive surface water receptors, principally Langstone Harbour itself.*

We would as such agree that it is important to confirm if the chalk has been impacted by the site, as this could act as a pathway to associated sensitive surface water receptors. Our principal concern though is likely to be potential for lateral movement of perched water/leachate into Langstone Harbour itself (i.e. though issues with sheep piling etc).

Indicates that there is water/leachate perched within the waste mass, but the picture is unsurprisingly confused with some of the consistently shallowest water levels nearest the Hermitage Stream on the east of the Site;

Has not extensively demonstrated the base of the waste mass – none of the window sample locations were advanced to a depth which proved it; - *Would certainly agree that characterise both of these (particularly the leachate presences) is extremely important.*

3.0 Aims and Objectives

Avoid adversely affecting sensitive receptors (principal aquifer, LH-SAC); - *Of these LH-SAC was this would be regarded as the most important.*

Inform re-use/disposal/management of the waste materials on Site; - *We remain of the opinion that finding a solution to this that is acceptable to all parties and regulatory viable remains the most significant issue.*

Suitable characterisation of Ground engineering characteristics of the existing capping; - *We remain of the opinion that detailed characterising the composition of the "mounded" area within the eastern section of the site would enable far greater certainty of the options available for management/reuse of this material. If it becomes clear that this mounded area is primarily inert type material then there area likely to be far greater options for reuse. Though a few trial pits/shallow boreholes where installed in this area during the previous investigation, the findings where very varied.*

4.0 Proposed Scope of Works

The proposed scope looks broadly appropriate, though dependent on any results of any investigations, further work may be required.

We would though also just reiterates, our most significant controlled waters concern, would be the potential lateral movement of contaminants, from leachate/waste mass to Langstoe Harbour SAC. And determining the potential risks from this should be a significant element of any investigation. Of particular concerns would be any nitrogen species (such as ammonia) which may result in increasing nitrates within the SAC.

Additional comments

If there was evidence of significant current losses of nitrogen species from the landfill to Langstone Harbour, then it may be worth engaging with Havant BC about potential nutrient neutrality benefits from any remedial works undertaken to address these losses. I believe that the lead for nutrient neutrality for Havant, was the former case officer dealing with the redevelopment proposal for this site, so would have knowledge of this site.

I should also highlight that detailed assessment of reports/investigation by ourselves, prior to submission thought the planning process is chargeable.

If I get a chance will try and give you a quick call tomorrow to discuss.

Kind Regards

Tom

Tom Wickens

Technical Specialist - (Groundwater Quality and Contaminated Land)
Solent and South Downs
Environment Agency

Romsey Office, Canal Walk, Romsey ,Hampshire,SO51 8DU
Tel - 07867 200775

tom.wickens@environment-agency.gov.uk

From: David Jackson [<mailto:David.Jackson@deltasimons.com>]

Sent: 08 January 2021 16:15

To: Wickens, Tom <tom.wickens@environment-agency.gov.uk>

Subject: 20-2099.04 - Consultation on Proposed Site Investigation at Brockhampton West Landfill Site, Havant

Dear Tom,

I hope you are well.

By way of introduction I am the project manager for a upcoming Site investigation at the above Site. As a former regulator (Contaminated Land Officer at Wakefield Council) I appreciate the importance of consultation pre works with the regulators for the sites that have potential for significant ground risk. On that basis I have produce a regulatory consultation document (attached) that is being sent to both yourself at the Environment Agency and also the Contaminated Land Officer (Jonathan Driver) at Havant Borough Council. The aim being to try and involve the regulators for contaminated land early on in the process to garner your thoughts/inputs on the proposed scope of the investigation.

It would be extremely useful if we could receive your comments back by the 5th February 2021.

Appreciate any time you can spare on this in these busy/difficult times

Kind regards

David Jackson
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From: Driver, Jonathan <Jonathan.Driver@havant.gov.uk>
Sent: 20 January 2021 15:46
To: Tom Bywater
Subject: RE: Brockhampton West, Harts Farm Way, Havant, Hampshire, PO9 1HS - Contaminated Land Enquiry

Good afternoon Tom,

I can confirm that the site has not been previously determined to be Contaminated Land, and that the site has not previously been scheduled for inspection pursuant to considering such a determination. The site does appear on the Council's 'risk register' and given it's proximity to habitat with European level protection designations; it does remain a potentially determinable site.

Best Regards,

Jonathan Driver
Environmental Control Officer

Havant Borough Council Environmental Health
Public Service Plaza, Civic Centre Road, Havant, Hants PO9 2AX

Tel (Direct Dial): 023 9244 6677
Tel (Mobile) : 07887 951 106
Tel (Team Admin): 023 9244 6670

Email: jonathan.driver@havant.gov.uk

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From: Tom Bywater <Tom.Bywater@deltasimons.com>
Sent: 14 January 2021 13:39
To: Driver, Jonathan <Jonathan.Driver@havant.gov.uk>
Subject: Brockhampton West, Harts Farm Way, Havant, Hampshire, PO9 1HS - Contaminated Land Enquiry

Hi Jonathan,

I have been passed on your details from one of my colleagues who said that you may be able to help me with a contaminated land enquiry for the following Site:

Brockhampton West, Harts Farm Way, Havant, Hampshire, PO9 1HS

The corresponding red line boundary is attached.

With regards to the enquiry for the site above, could you please comment on the following:

- Is the site (or has the Site ever been) classified as Contaminated Land, or on a register designating it as such; and,
- Is the site (or has the Site ever been) due for inspection under Part 2A of the Environmental Protection Act, 1990?

Kind regards,

Tom

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From: Driver, Jonathan <Jonathan.Driver@havant.gov.uk>
Sent: 04 February 2021 13:41
To: David Jackson
Subject: RE: 20-2099.04 - Consultation on Proposed Site Investigation at Brockhampton West Landfill Site, Havant

Good afternoon David,

I have now found opportunity to review the proposed scope of works, and it would appear to be comprehensive in both its aims and scope. I note that leachate testing of soils / waste materials is omitted, but I understand that items 3, 5 & '4+6' of the scope of works aim to differentiate between conceptual groundwater bodies, and I would agree in principle that actual perched water quality within the waste body is probably more informative as to actual rates of liberation of contaminants from waste to groundwater (than would leachate tests from samples of solids).

I also welcome the proposal to install continuous ground gas monitors – this is probably necessary to reliably characterise the gas regime at this site, and I would agree that the distribution & duration proposals are appropriate. The dual-siting of wells (waste & chalk) for groundwater monitoring purposes will minimise uncertainties in interpretation (provided that construction detailing minimises the risk of cross contamination to the lowest possible levels-) and should provide good contrast to assist in determining or discounting hydraulic continuity.

I have had a look at the expected location of natural topographic lows beneath the waste body, and I note that 5 proposed boreholes are coincident. In the event that structureless upper chalk provides a functional or substantial aquitard, it might be expected that the underlying topography may represent an important migration pathway. Selection of well response zones will be critical to the clarity of results obtained from the investigation, and I expect that this will be a focus for the personnel on site undertaking the intrusive works.

The only item I might suggest is perhaps a pair of surface water sample locations within the Brockhampton stream, up- & down- flow of the site, alongside the inclusion of channel headwalls in the walkover survey (between the two sample points). This might have been discounted given that this section of the watercourse is within the intertidal zone and given the proximity of the Budds No1. outfall, which together could complicate interpretation. Nevertheless, these could provide helpful information to assist the detailed controlled waters risk assessment.

As an aside – I have just yesterday responded to a request for Environmental Information relating to technical documentation from the original landfill consent / construction. Our information-requests team does not indicate the identity of the party requesting information, but my assumption is that the request may have been submitted by Delta Simons. Whilst searching the available archive / hard-copy records for the documents specifically requested, I have come across additional geo-environmental / geo-technical intrusive investigations of which I was previously unaware (and which may not have been present in the planning archive). Additionally, it would appear that Environmental Health does hold a near complete set of bund construction & site section drawings, alongside technical details of headwalls (all as proposed). Geotechnical documentation both predates tip construction (1967) and I think also post-dates completion (I'm afraid I didn't note down the year before sending the files for

digitisation). Given that one of the principle aims of the investigation is to determine the base of the landfill, this documentation may provide informative contextual information to aid interpretation.

If you may be interested in any of the documentation referred to above, you will be able to put in a request with our information requests team. My expectation is these files will be available in electronic format in the next few weeks.

I trust that the above meets with your requirements.

Best Regards,

Jon

Jonathan Driver
Environmental Control Officer

Havant Borough Council Environmental Health
Public Service Plaza, Civic Centre Road, Havant, Hants PO9 2AX

Tel (Direct Dial): 023 9244 6677
Tel (Mobile) : 07887 951 106
Tel (Team Admin): 023 9244 6670

Email: jonathan.driver@havant.gov.uk

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www.twitter.com/havantborough

From: David Jackson <David.Jackson@deltasimons.com>
Sent: 08 January 2021 16:17
To: Driver, Jonathan <Jonathan.Driver@havant.gov.uk>
Subject: 20-2099.04 - Consultation on Proposed Site Investigation at Brockhampton West Landfill Site, Havant

Dear Jonathan,

I hope you are well.

By way of introduction I am the project manager for an upcoming Site investigation at the above Site. As a former regulator (Contaminated Land Officer at Wakefield Council) I appreciate the importance of consultation pre works with the regulators for the sites that have potential for significant ground risk. On that basis I have produce a regulatory consultation document (attached) that is being sent to both yourself at the Local Authority and also the relevant Contaminated Land Contact (Tom Wickens) at the Environmental Agency. The aim being to try and involve the regulators for contaminated land early on in the process to garner your thoughts/inputs on the proposed scope of the investigation.

It would be extremely useful if we could receive your comments back by the 5th February 2021.

Appreciate any time you can spare on this in these busy/difficult times

Kind regards

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Principal Consultant
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Appendix G – Previous Reports



Brockhampton West

A102760

Havant Borough Council



Havant
BOROUGH COUNCIL

August 2017



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Executive Summary

Introduction	A Phase 2 Geo-environmental investigation of land at Brockhampton West has been completed in order to review risks associated with ground conditions in view of potential development of the site for commercial / industrial use
Site Location and Description	The site comprises a predominantly rectangular shaped plot of land, approximately 9 hectares in size. It is a grassed / vegetated open space, which is predominantly used by dog walkers.
Geology	The site is underlain by Made Ground (including landfill material). The superficial natural strata is understood to comprise predominantly Raised Marine Deposits that are variably granular and cohesive but with potential River Terrace and Tidal Flat Deposits and alluvium encroaching onto northern, southern and eastern areas of the site respectively. The solid geology is characterised by the presence of Chalk (Seaford or Newhaven Formations).
Hydrogeology	The superficial deposits are characterised as Secondary Aquifers. The underlying Chalk is characterised as a Principal Aquifer, however the site is not located within a Source Protection Zone.
Hydrology	Immediately east of the site is the Hermitage Stream. The northern edge of the Langstone Harbour is situated approximately 170m south of the site, at its closest point.
Site History	Up until the late 1960's / 1970's, the site comprised tidal, mud flats, surface water and marshland. It is understood that the site was reclaimed using a clay and steel sheet pile bund and that various phases of landfilling between the 1970's – 1990's took place resulting in the deposition of domestic landfill, incinerator waste and road construction waste; further groundworks (activities unknown) are also evident from aerial photographs post 2000 in the south west of the site.
Ground Investigations	Ground investigation works comprised 6No. cable percussive boreholes (to depths up to 35m bgl) and 10 window sample boreholes with dual purpose landgas and groundwater monitoring apparatus installed in each. A total of 11 trial pits were excavated. Soil samples were obtained for laboratory assessment and 6No. Return monitoring visits (land gas and groundwater monitoring) were undertaken.
Ground Conditions Encountered	Ground conditions encountered during the investigation were consistent with those identified in the published literature and comprised a consistently thick layer of Made Ground (up to 11.5m thick) comprising variably a cohesive 'capping material' and landfill; the landfill thickness ranged from approximately 4.5-7.4m thick across the site. Beneath the made ground in the east of the site River Terrace Deposit (maximum 5m thick) comprising sand gravel were recorded. Beneath the made ground in the west of the site alluvium (maximum 3.5m thick) was recorded comprising sandy gravelly clay or silty clay. White chalk was encountered beneath superficial strata in the east and west and directly beneath the chalk in the centre of the site. Groundwater strikes were recorded in both landfill and superficial strata at depths ranging between 3.9 and 11.5m bgl during the investigation; during return monitoring visits, the depth to groundwater was typically in excess of 5m.

Geotechnical Recommendations	Actual rate of settlement of Made Ground on site should be monitored prior to development considerations. For light industrial / commercial units, the ground should be pre-loaded (following guidance on BRE FB75) and constructed on raft foundations, with gas protection measurements. Heavily loaded structures should be founded into the underlying Chalk. With consideration to negative shaft frictions due to long-term ground settlement and the type of pile construction e.g. continuous flight augers with the use of temporary casing to seal out contaminated water. Excavations within the made ground for temporary works should consider the stability of the ground and potential ground gas concentration. Man, entry into excavations should be avoided. Concrete used for construction should conform to advice given within BRE SD1.
Contamination Findings	Elevated levels of land gas (maximum 98% CH₄, 46% CO₂) have been measured within monitoring wells across the site and occasionally high flow rates were recorded. Asbestos fibres were detected in 15 of 40 soil samples collected from made ground (capping material and landfill). Locally, in shallow soil, elevated concentrations of PAH compounds relative to human health based screening criteria were encountered. Concentrations of hydrocarbons, ammoniacal compounds and cyanide exceeding relevant water quality standards were recorded in groundwater samples collected from wells installed in the landfill and also (in one location only) chalk.
Conceptual Site Model	Based on the review of desk study information and the Phase 2 ground investigation the following risk levels have been identified: • Future site users – Public Open Space – Low / Moderate (assuming site remains unchanged) or Moderate (assuming space enhancement and increased usage). • Future site users – Commercial – High – driven by risks associated with land gas. • Construction workers (during redevelopment of the site) – High risks have been identified associated with both land gas and asbestos fibres. • Offsite neighbours – Low / Moderate risks to neighbours have been identified associated with potential land gases. Moderate risks have been identified associated with potential release and exposure to asbestos during redevelopment / groundworks. • Groundwater of the Superficial Secondary Aquifers – Moderate • Groundwater in the deep Chalk Principal Aquifer - Moderate • Surface Water – Moderate • Onsite property/buildings and services – High risks to buildings have been identified associated with potentially hazardous land gases.
Conclusions and Recommendations	Further monitoring from wells installed in the Chalk is recommended in order to verify the levels of contamination recorded in groundwater to date. Engagement with the regulators is also recommended in order to gain a better understanding in relation to the regulators expectations and requirements regarding potential groundwater contamination. It is recommended that prior to any redevelopment of the site that additional gas monitoring be undertaken. Based on current data it is considered likely that gas protection measures required for future buildings will need to comply with a Characteristic Situation 3 or 4. During any future construction phase a number of precautions are likely to required including provision of dust suppression measures, boundary monitoring of dust / fibres, use of appropriate PPE, welfare and decontamination facilities, UXO support during deep piling and high standards of waste management



1.0 Introduction

Havant Borough Council (HBC) instructed WYG Environment Planning & Transport (WYG) to complete a site investigation at the land referred to as Brockhampton West, Havant.

Instructions to proceed were given in March 2017, with the contract being signed on 30th March 2017

1.1 Project Background

A ground investigation was scoped by WYG and proposed to HBC in a tender dated March 2017. HBC required information on the ground conditions at the land at Brockhampton West. HBC would like to ascertain the feasibility of potential development options at the site.

The ground investigation scoped by WYG comprised the following broad objectives:

- Identify potential constraints to redevelopment associated with ground contamination;
- Identify the depth and nature of fill materials and their potential for land gas generation;
- Assess the deeper geotechnical characteristics of the natural soils / White Chalk to allow an assessment of piled foundations;
- Provide recommendations for risk management efforts to address any health and safety or environmental concerns associated with redevelopment of the site;
- Provide preliminary recommendations to support foundation design at any future building at the site; and
- Provide suitable robust investigation / assessment reports to satisfy expectations and concerns identified during the feasibility assessment.

The report herein describes a ground investigation, detailing the ground conditions encountered from the exploratory holes and in-situ and laboratory testing and provides an assessment of key geotechnical and environmental issues pertaining to the redevelopment proposal.

This report, prepared in line with the agreed brief, is subject to the report conditions presented in **Appendix A**.



1.2 Objectives and Scope

The overarching objective of this assessment is to review risks associated with ground conditions in view of potential development of the site for commercial / industrial use.

In summary, the scope of work comprised the following;

- Site walkovers undertaken on 30th March 2017 & during site field works;
- A review of historical records to understand the sites development history and identify potential geo-environmental and geotechnical risks associated with the sites historical development;
- A review of site setting including topography, geology, hydrogeology and hydrology;
- A review of the risk of unexploded ordnance being present at the site;
- A geotechnical and ground contamination intrusive investigation consisting of 6No Cable percussion boreholes, 10No Window Sample boreholes, both with standard penetration testing (SPTs) and 11No machine excavated trial pits. Soil samples taken issued for laboratory analysis and initial geotechnical characterisation;
- Interpretation of the data collected to define a Conceptual Site Model (CSM) and to undertake qualitative risk assessment and semi-quantitative risk assessment grading the pollutant linkages in accordance with a risk matrix;
- Development of an outline geotechnical model of ground conditions with discussion of characteristic geotechnical parameters; and
- Provision of recommendations pertaining to potential development constraints, further assessment requirements and management options.

1.3 Proposed Development

It is the understanding of WYG that HBC, would like to develop the land known as Brockhampton West for an employment /commercial use, if such development is considered economically viable.

1.4 Terms and Conditions

This report presents a full factual record of all site work carried out during the period 2nd - 12th May 2017. The recommendation and opinions expressed in this report are based on the information provided and other sources of readily available information. Where use has



been made of other report or information provide from the client, or from other third party sources, such data has been reviewed in good faith and it has been assumed that their contents are correct, as it is impractical to fully validate this data. WYG is unable to guarantee any third party information.

The information contained in this report is intended for the use of HBC and their consultant partners. WYG can take no responsibility for the use of this information by any third party for uses other than that described in this report.

It should be noted that physical and chemical characteristics of the site can vary with time. The results obtained may therefore only be representative of the conditions at the time of the investigation.

Attention is drawn to the report conditions contained in **Appendix A** and the terms and conditions of the engagements.

2.0 Site Description

This section provides a summary of factual information previously collated and presented in full within the Phase 1 Desk Study Report.

2.1 Site Location

The site is situated to the north of Harts Farm Way, and to the south of the A27 bypass 1.5km to the south west of Havant, Hampshire, details are summarised in **Table 2.1** below.

Table 2.1 Site Location Details

Site Address	Land known as Broadmarsh Open Space, Harts Farm Way, Approx postcode – PO9 1HS.
Site Area	9.20Ha
National Grid Reference	470185,105679

Site layout and location are illustrated figuratively in **Appendix B**, Drawings 001 & 002.



2.2 Site Description

The site comprises a predominantly rectangular shaped plot of land, approximately 9 hectares in size. It is a grassed / vegetated open space, which is predominantly used by dog walkers.

Towards the centre / eastern end of the site, there is a hard standing driveway which leads to a wide open car parking area / turning circle. There is a locked gate at the entrance to which Council contractors have access.

To the west of the hard standing the site is predominantly flat with footpaths worn into the grass / vegetation.

To the east of the hard standing the site is mounded with footpaths worn into the grass / vegetation.

The site is bounded to the north by the A27 dual carriage way and to the east by Hermitage Stream which feeds into Langstone Harbour. To the south is Harts Farm Way with Broadmarsh Coastal Park and Langstone Harbour further beyond. To the west is the junction (tear drop in shape) of the A27 and A3(M).

Around the perimeter of the site, there is more substantial vegetation, including shrubs and small trees. At the eastern and northern sides of the site there are more mature trees, which screen the A27 and Hermitage Stream.

3.0 Ground Investigation

The ground investigation was designed and scoped by WYG as detailed within the tender document (dated 1st March 2017). A combination of cable percussion boreholes, window sample boreholes and machine excavated trial pits were advanced across the site to permit the inspection of subsurface ground conditions and to facilitate the collection of soil samples. Site investigation works were undertaken by WYG between the dates of the 2nd and 12th of May 2017 and comprised the following:

- 6No. Cable percussion boreholes to a maximum depth of 35m bgl;
- 10No. Window Sample boreholes to a maximum depth of 5.00m bgl;
- 11No. machine excavated trial pits to a maximum depth of 4.00m bgl.
- Geo-Environmental, Landfill Forensic & Geotechnical Laboratory Testing of soils;
- Return Groundwater & Ground Gas Monitoring (total six return visits);
- Well development and Ground Water sampling and water quality testing.

Further details of the intrusive investigation methodology is provided in the following sub-sections.

The exploratory hole locations are depicted within Drawing 003 in Appendix B. A selection of photographs taken during the investigation are presented in **Appendix C**. Exploratory hole logs are provided in **Appendix D**. Further factual data relating to the investigation is included with Appendices E-I.

3.1 Site Investigation Standards

Site investigation activities were undertaken in general accordance with BS5930:1999 – “Code of Practice for Site Investigations” incorporating Amendment 2 (2010), which incorporates EN14688-1&2, Eurocode 7, Geotechnical Design (ref. BS-EN 1997-2:200) and BS10175:2011_A1:2013 “Investigation of Potentially Contaminated Land”.

3.2 Service / UXO Clearance

Prior to breaking ground a non-intrusive survey comprising Ground Penetrating Radar (GPR) and Electromagnetic Scanning was undertaken to help locate buried service routes and thereby to inform the selection of “safe” investigation locations.

Inspection pits were hand excavated at each cable percussion and window sample location to a depth of 1.20m bgl, before deeper works were progressed using mechanical methods.

An Explosive Ordnance Disposal (EOD) specialist was in attendance during the drilling of the deeper cable percussion boreholes. A down-hole magnetometer was used at one metre intervals to check for ferrous materials potentially associated with Unexploded Ordnance (UXO).

3.3 Cable Percussion Boreholes

A total of six cable percussion boreholes were drilled at the site between 2nd-12th May 2017. The boreholes were advanced to a maximum depth of 35m bgl using a Dando 4000 rig. This is a standard cable percussive rig comprising a diesel winch supported by an A-frame which can raise and drop steel casing and percussive drilling tools in to the borehole. SPTs were undertaken in addition to undisturbed sampling using standard U100 samples (100mm diameter sampling tubes).

Aquifer protection measures were employed when drilling the deeper boreholes. This entailed drilling in wider (200mm diameter) casing through the Made Ground, then placing a bentonite clay plug at the base of the Made Ground. Well casing (150mm diameter) was then lowered and drilled through the 200mm diameter and bentonite plug. This approach seals the annulus of the well and prevents the potential for water and contaminants in the landfill to ingress into the Chalk aquifer.

Monitoring wells were installed in each of the boreholes using 50mm internal diameter HDPE piping with screened sections in either the landfill or the Chalk. The three deep boreholes were installed with dual installs. Details of individual well installations are shown on the exploratory hole logs provided in **Appendix D**. Each well was completed at surface with "top hat", above ground well covers.

3.4 Window Sampling Boreholes

A total of ten window sample boreholes were advanced across the site between the 9th-10th May 2017. The window sample boreholes were completed using an Archway Competitor Dart tracked dynamic sampling rig, which functions by driving hollow steel tubing into the ground using a percussive mechanism. Upon extractions, the tubes contain soil cores which can be subsequently logged, sampled and tested. In addition to allowing

inspection and sampling, the rig was used to complete SPT tests prior to each run. Maximum depth achieved during window sampling was 5m bgl.

Monitoring well installation were completed using 35mm internal diameter PVC piping. Screened sections were installed, at variable depths according to the geology encountered. Each well was completed at surface with a top hat well cover, apart from WS09 which was completed with a flush traffic rated cover within the area of hardstanding. Full engineering soil logs are presented within **Appendix D**.

3.5 Machine Excavated Trial Pits

A total of eleven trial pits were completed between the 9th-10th of May 2017 using an 8 tonne tracked excavator. Trial pits were excavated to maximum depth of 4m bgl. The ground conditions encountered within each trial pit were logged and representative samples selected for analysis by the site engineer. Full engineering soil logs are presented within **Appendix D**.

After sampling, logging, photographing and measuring were complete, soil arisings were placed back within the excavation in the order they were encountered (i.e. deepest material was returned to the bottom of the excavation).

3.6 Soil Sampling

A number of soil samples collected from all exploratory holes were selected for analysis for potential ground contaminants. The rationale behind the selection of samples was multi-purpose but included targeting any soil exhibiting signs of contamination, especially within the landfill material. Further samples were also collected to ensure representative characterisation of the geotechnical properties of the soils. Soil samples were dispatched in cool boxes under a chain of custody to the laboratory for analytical testing. The environmental chemistry of soil samples selected by WYG were analysed by Jones Environmental Laboratory. Jones are accredited by the UK Accreditation Service (UKAS) and the EA's Monitoring Certification Scheme (MCERTS) for a range of chemical analyses. Geotechnical samples were submitted to Professional Soils Laboratory (PSL), who are also UKAS accredited for the tests undertaken. Bulk samples of landfill materials were submitted to Envirolab where forensic testing on landfill samples were carried out.

3.7 Groundwater Monitoring and Sampling

Gas and groundwater monitoring and sampling equipment were installed in all Cable Percussion and Window Sample exploratory boreholes as summarised in **Table 3.1** below.

Table 3.1 Summary of installations

Exploratory Hole	Installation Details	Response zone depths	
		From (m bgl)	To (m bgl)
CP01	Dual 50mm diameter HDPE standpipe with response zones comprising slotted pipe with 250µm filter wrap and a 10mm diameter washed pea-shingle surround.	1.00	11.00
		14.00	35.00
CP02A	Deep install within the Chalk, and shallow install within the landfill. At least 0.70m thick bentonite seal above the upper response zone. Lower response zone (within the Chalk) had at least 3.00m bentonite seal above. Finished above ground level with a gas tap and upstanding concreted steel cover.	1.00	9.00
		13.00	35.00
CP03		1.00	10.00
		14.00	35.00
CP04	Single 50mm diameter HDPE standpipe with response zone comprising slotted pipe with 250 µm filter wrap and 10mm diameter washed pea shingle surround. At least 0.70m thick bentonite seal above the response zone. Finished above ground level with a gas tap and upstanding concreted cover.	1.00	9.00
CP05		1.00	11.00
CP06		1.00	9.00
WS01	Single 35mm diameter PVC standpipe with response zone comprising slotted pipe with 250 µm filter wrap and 10mm diameter washed pea shingle surround. At least 1m thick bentonite seal above the response zone. Finished above ground level with a gas tap and upstanding concreted cover.	1.00	2.70
WS02		1.00	5.00
WS03		1.00	3.00
WS04		1.00	4.00
WS05		1.00	3.00
WS06		1.00	5.00
WS07		1.00	3.00
WS08		1.00	3.50
WS09		1.00	4.00
WS10		1.00	4.00

3.7.1 Well Development

Water is often added as part of the drilling process and ground disturbance can result in the addition of particulate material within the water column. Therefore, well development by removing water and particulates from the well is required, to rectify the effects of drilling. It also serves to stabilise the filter pack adjacent to the well screen and improves the hydraulic connection between the well screen and the surrounding formation (CL:AIRE 2008).

Groundwater was removed from the wells in two different ways:

- Shallow installs in cable percussion boreholes – water was removed using a cylindrical bailer. Approximately six times the well volume was bailed. This was undertaken during visit 1 on the 18th of May.
- Deep installs in cable percussion boreholes – water was removed using a petrol motor powered inertial pump system, with 16mm outer diameter tubing and a one way valve. This was undertaken during visit 2 on the 25th of May.
- Window sample boreholes had little to no water within them. These were not developed or sampled.

Details of purged volumes / observations during well development are presented in **Appendix E**.

3.7.2 Gas and Groundwater Monitoring & Sampling

Groundwater levels were monitored onsite using a dual phase dipmeter. Gas readings were taken using a GA5000 portable gas analyser. Monitoring results are provided in **Appendix E**.

Gas and groundwater monitoring was undertaken during six visits, as summarised in **Table 3.2** below.

Table 3.2 Summary of Monitoring and Sampling visits

Date of Visit	Work Completed
18/05/2017	Gas & Groundwater Monitoring Developing all shallow installs; CP01 to CP06 inclusive
25/05/2017	Gas & Groundwater Monitoring Developing all deep installs; CP01 to CP03 inclusive
02/06/2017	Gas & Groundwater Monitoring Only
08/06/2017	Gas & Groundwater Monitoring Water sampling all deep installs; CP01 to CP03 inclusive, plus CP02 & CP03 shallow installs
15/06/2017	Gas & Groundwater Monitoring Water sampling shallow installs, CP01, CP03, CP04, CP05 & CP06
27/06/2017	Gas & Groundwater Monitoring Only

Ground water samples were collected using a low-flow technique, whereby the sample is extracted at the same rate that water flows into the well. During the sampling a YSL water quality meter was used to measure a range of parameters including temperature, electrical conductivity, dissolved oxygen, pH and Oxidation-Reduction Potential. Once these parameters were considered to have stabilised sufficiently (e.g. <10% variations between testing intervals) groundwater samples were collected.

Parameters measurements recorded during sampling are provided in **Appendix E**.



4.0 Ground Conditions Encountered

4.1 Soil Conditions

Ground conditions encountered during the investigation were consistent with those identified in the published literature and, in summary, comprised Made Ground (capping layer) over Made Ground (Landfill Material), over Alluvium, over Chalk. The Chalk persisted to the full depth of investigation (i.e. >35m bgl).

Selected photographs of exploratory holes are included in Appendix C. Exploratory Hole Logs detailing soil conditions are present in **Appendix D**. A cross section depicting the strata encountered within cable percussion holes across the site is provided within **Appendix F**.

Variations in strata thicknesses are summarised in **Table 4.1** below.

**Table 4.1 Summary of ground conditions encountered (NE – denotes Not Encountered)**

	Surface Hard-standing		Made Ground - Topsoil		Made Ground - Capping Material		Made Ground - Landfill Material		Alluvium / River Terrace Deposits		Chalk	
	From (m bgl)	Thickness (m)	From (m bgl)	Thickness (m)	From (m bgl)	Thickness (m)	From (m bgl)	Thickness (m)	From (m bgl)	Thickness (m)	From (m bgl)	Thickness (m)
CP01	NE	NE	GL	0.30	0.30 10.30	2.70 1.20	3.00	7.30	11.50	1.50	13.00	>22.00
CP02	NE	NE	GL	0.05	NE	NE	0.05	>2.95	NE	NE	NE	NE
CP02A	NE	NE	GL	0.10	0.10	1.90	2.00	7.50	9.50	3.50	13.00	>22.00
CP03	NE	NE	GL	0.60	0.60	0.50	1.10	7.1	8.20	5.30	14.00	>21.00
CP04	NE	NE	NE	NE	GL	3.50	3.50	4.70	8.20	>1.50	NE	NE
CP05	NE	NE	GL	0.10	0.10	3.90	4.00	7.50	NE	NE	11.50	>0.45
CP06	NE	NE	NE	NE	GL	2.50	2.50	6.80	9.30	>1.70	NE	NE
WS01	NE	NE	GL	0.20	0.20	1.35	1.55	>1.15	NE	NE	NE	NE
WS02	NE	NE	GL	0.20	0.20	1.60	1.80	>3.20	NE	NE	NE	NE
WS03	NE	NE	GL	0.20	0.20	>2.70	NE	NE	NE	NE	NE	NE
WS04	NE	NE	GL	0.30	0.30	1.00	1.30	>2.70	NE	NE	NE	NE
WS05	NE	NE	GL	0.20	0.20	2.05	2.25	>0.75	NE	NE	NE	NE



	Surface Hard-standing		Made Ground - Topsoil		Made Ground - Capping Material		Made Ground - Landfill Material		Alluvium / River Terrace Deposits		Chalk	
	From (m bgl)	Thickness (m)	From (m bgl)	Thickness (m)	From (m bgl)	Thickness (m)	From (m bgl)	Thickness (m)	From (m bgl)	Thickness (m)	From (m bgl)	Thickness (m)
WS06	NE	NE	GL	0.15	0.15	2.85	3.00	2.00	NE	NE	NE	NE
WS07	NE	NE	GL	0.10	0.10	2.35	2.45	>0.55	NE	NE	NE	NE
WS08	NE	NE	GL	0.10	0.10	>3.90	NE	NE	NE	NE	NE	NE
WS09	GL 0.05	0.05 0.30	NE	NE	0.30	3.70	4.00	>1.00	NE	NE	NE	NE
WS10	NE	NE	GL	0.10	0.10	1.90	2.00	>2.00	NE	NE	NE	NE
TP01	NE	NE	NE	NE	GL	1.30	1.30	>2.10	NE	NE	NE	NE
TP02	NE	NE	NE	NE	GL	2.40	2.40	>1.20	NE	NE	NE	NE
TP03	NE	NE	NE	NE	GL	2.10	2.10	>1.30	NE	NE	NE	NE
TP04	NE	NE	GL	0.20	0.20	2.80	3.0	>0.30	NE	NE	NE	NE
TP05	NE	NE	NE	NE	NE	NE	GL	>3.10	NE	NE	NE	NE
TP06	NE	NE	GL	0.20	0.20	0.70	0.90	>2.20	NE	NE	NE	NE
TP07	NE	NE	NE	NE	GL	2.70	2.70	>0.60	NE	NE	NE	NE
TP08	NE	NE	NE	NE	GL	1.00	1.00	>2.20	NE	NE	NE	NE



	Surface Hard-standing		Made Ground - Topsoil		Made Ground - Capping Material		Made Ground - Landfill Material		Alluvium / River Terrace Deposits		Chalk	
	From (m bgl)	Thickness (m)	From (m bgl)	Thickness (m)	From (m bgl)	Thickness (m)	From (m bgl)	Thickness (m)	From (m bgl)	Thickness (m)	From (m bgl)	Thickness (m)
TP09	GL 0.05	0.05 0.30	NE	NE	0.30	3.20	3.50	>0.50	NE	NE	NE	NE
TP10	NE	NE	NE	NE	GL	3.20	3.20	>0.20	NE	NE	NE	NE
TP11	NE	NE	GL	0.20	0.20	1.30	1.50	>2.20	NE	NE	NE	NE

4.1.1 Surface Hardstanding

Surface hardstanding was only encountered at two positions, both located within the car parking area off Harts Farm Way. This comprised 0.05m asphalt at surface, with 0.30m thick Type I roadstone sub-base beneath.

4.1.2 Made Ground – Topsoil

Topsoil was encountered at 18 positions and ranged in thickness from 0.05m to 0.60m. The soil was relatively uniform in composition and generally consisted of light brown slightly sandy clay. Due to the similar nature of the capping material (as discussed below) it was difficult in places to differentiate.

4.1.3 Made Ground – Capping Material

Made Ground classed as 'capping material' was encountered in all exploratory holes, bar borehole CP02 and trial pit TP05.

The 'capping material' was predominantly encountered above the landfill material, but in borehole CP01 it was also encountered below the landfill.

Thicknesses of 'capping material' ranged from 1.10m to 5.50m.

This stratum generally comprised a clay material with subordinate amounts of sand and gravel. Any gravel contained within the clay, generally comprised flint and brick, with occasional Chalk, concrete and rare asphalt.

4.1.4 Made Ground – Landfill Material

Landfill material was encountered in all exploratory holes bar window sampling wells WS03 & WS08.

Thicknesses range from >0.20m to 7.50m thick in boreholes CP02A and CP05.

The full extent of landfill material was only proven within the cable percussion boreholes (CP01-CP06).

The landfill generally comprised slightly clayey to clayey Sand & Gravel. Gravel generally consisted of flint, brick, concrete, glass & metal. There were varied other types of landfill material and household waste, including material / fabric, rigid plastic, polythene bags, polystyrene, glass & plastic bottles, rubber tyres, food containers, wood and paper.

Within trial pits TP05 & TP08 incinerator type ash was noted.

A foul / rotten type odour was noted within each trial pit.

4.1.5 Superficial Deposits – Alluvium / River Terrace Deposits

Beneath the landfill in all cable percussion boreholes, bar borehole CP05, Alluvium or River Terrace Deposits were encountered. These ranged in thickness from 1.5m to 5.3m

- Alluvium, encountered in boreholes CP02A & CP04, was described as soft orange brown sandy gravelly clay and firm brown silty clay respectively.
- River Terrace Deposits (encountered in boreholes CP01, CP03 & CP06) ranged from sand & gravel to gravel with subordinate amounts of sand and clay.

4.1.6 Bedrock - Chalk

Chalk was encountered in the three deep cable percussion boreholes and also in borehole CP05 beneath the landfill material. Total thickness of the Chalk was not proven during the investigation. The maximum extent of the Chalk (>22.00m) was encountered in boreholes CP01 & CP02a.

Due to the nature of the drilling techniques, the Chalk could only be described as recovered as silty sandy & gravel of Chalk, or gravelly silt of Chalk. The gravel comprised flint and extremely weak to weak white Chalk.

4.2 Obstructions

Borehole CP02 possibly encountered an obstruction at 2.00m bgl. Borehole CP02 was terminated at 3.00m bgl, as there were no soil returns from drilling, due to pushing a large piece of rubble down from 2.00 to 3.00m. From 0.20m downwards, it was noted on the engineer's logs, that there was a large amount of asphalt and rubble which hampered progress. The location was moved a few metres away and target depth on borehole CP02A was achieved.

4.3 Groundwater Strikes

Groundwater strikes were recorded in all cable percussion boreholes (bar CP02) and one trial pit during the investigation. Details are noted in **Table 4.2** below:

Table 4.2 Groundwater strikes in boreholes during drilling

Exploratory Location	Hole	Water Depth	Strata
CP01		11.50m	Top of River Terrace Deposits
CP02A		9.60m	Top of Alluvium
CP03		10.50m	Top of River Terrace Deposits
CP04		6.30m	Landfill Material
CP05		5.90m	Landfill Material
CP06		4.30m	Landfill Material
TP09		3.90m	Landfill Material

4.4 Photo Ionisation Detection

Head space readings were completed in samples recovered from cable percussion boreholes and trial pits using a Photo Ionisation Detector (PID) to detect Volatile Organic Compounds (VOCs). Detectable levels were encountered in all samples as presented on the exploratory hole logs (Appendix D). A maximum PID reading of 77.70ppmv was recorded in soil from trial pit TP01 at 3.40m depth. Generally, the PID results indicate that volatile organic contaminants are either absent or present at only low levels within soil at the site.

4.5 Visual / Olfactory Evidence of Contamination

It is noted that the Landfill Material encountered was potentially contaminated. The descriptions within the exploratory holes logs note "foul / rotten" or "burnt" type odour. This was more evident in the trial pits when a larger area was being excavated. Odours where evident, are indicated on the exploratory hole logs.

As shown in the photographs of the trial pits (**Appendix C**) the landfill material appeared dark in colour, predominantly grey, brown or black.

During the rounds of monitoring particularly during sunny periods, gas "haze" was noted coming from the pipe / upstanding well covers. Odours recorded during monitoring are detailed within the monitoring records provided in **Appendix E**.



4.6 Groundwater Monitoring Results

Groundwater level measurements were taken on six return monitoring visits to the site. Full details of the groundwater monitoring, along with water level graphs, are provided in Appendix E; a brief summary is provided in **Table 4.3**.

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**Table 4.3 Summary of Groundwater Monitoring**

Monitoring Well	Screened Unit	Elevation (mAOD)	Groundwater Levels (mbcl)		Groundwater Levels (mAOD)		Comments
			Minimum	Maximum	Minimum	Maximum	
CP01(D)	Chalk	10.54	8.56	9.29	1.25	1.98	-
CP01(S)	Landfill	10.54	7.67	8.02	2.52	2.87	-
CP02A(D)	Chalk	10.79	8.875	10.8	-0.01	1.915	-
CP02A(S)	Landfill	10.79	7.95	9.07	1.72	2.84	-
CP03(D)	Chalk	8.67	6.6	8.69	-0.02	2.07	Weak ammonia odour
CP03(S)	Landfill	8.67	6.71	7.72	0.95	1.96	-
CP04	Landfill	11.52	7.01	8.52	3	4.51	Strong methane odour
CP05	Landfill	9.56	6.84	7.27	2.29	2.72	-
CP06	Landfill	12.4	7.13	7.67	4.73	5.27	-
WS01	Capping Layer	10.29	2.66	Dry	7.63	7.63	-
WS02	Capping Layer	10.57	Dry	Dry	Dry	Dry	Strong foul odour
WS03	Capping Layer	11.07	Dry	Dry	Dry	Dry	Rotting / manure odour
WS04	Capping Layer	11.01	Dry	Dry	Dry	Dry	-
WS05	Landfill	10.72	Dry	Dry	Dry	Dry	-
WS06	Capping Layer	10.98	Dry	5.71	5.3	5.71	-
WS07	Capping Layer	10.12	Dry	Dry	Dry	Dry	-
WS08	Capping Layer	14.21	Dry	Dry	Dry	Dry	-
WS09	Landfill	9.46	4.94	4.57	Dry	4.89	Inaccessible from 02/06/2017
WS10	Landfill	13.45	3.97	4.32	Dry	9.48	-

Details of the final water quality parameters recorded within each of the wells subject to low flow sampling are presented in **Table 4.4**. The full water quality testing results achieved during purging are provided within **Appendix E**.

Table 4.4 Summary of Water Quality Data

Monitoring Well	Date	Reduction Potential (mV)	Electrical Conductivity (µs)	pH	Dissolved Oxygen (mg/L)	Temp (°C)
CP01(D)	08/06/2017	22.5	531	7.02	8.18	11.7
CP01(S)	15/06/2017	-117.6	6079	6.86	0.25	13.1
CP02A(D)	08/06/2017	-93.1	3251	6.69	0.59	12.2
CP02A(S)	08/06/2017	-88.3	3172	6.65	0.94	15.10
CP03(D)	08/06/2017	5.8	523	6.9	2.55	12.3
CP03(S)	08/06/2017	-84.2	1259	6.62	0.26	12.8
CP04	15/06/2017	-155	4792	6.75	0.22	12.9
CP05	15/06/2017	-90.8	2656	6.77	1.29	12.9
CP06	15/06/2017	-102.5	2281	6.77	0.31	12.7

Note that the results presented in Table 4.5 are the final (stabilised) readings taken prior to sampling.

4.7 Ground Gas Monitoring

Ground gases including methane, carbon dioxide, oxygen, carbon monoxide and hydrogen sulphide were measured during the two monitoring rounds using a GA2000 infra red gas analyser. A summary of ground gas results is presented in Table 4.5. The full results of ground gas monitoring recorded during each monitoring visit are provided in **Appendix E**.

Table 4.5 Summary of Ground Gas Monitoring Results

Location	Peak Flow (l/hr)		Methane (% CH ₄)		Carbon Dioxide (% CO ₂)		Oxygen (% O ₂)		CO (ppm)		H ₂ S (ppm)	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Landfill												
CP01 (S)	<0.1	0.3	67.5	70.6	28.2	39.7	<0.1	0.2	<1	4	<1	<1
CP02 (S)	<0.1	6.1	0.2	35.9	0.2	24.6	0.2	19.9	<1	<1	<1	4
CP03 (S)	<0.1	31.1	19.8	24.9	18.8	22.3	<0.1	0.6	1	2	<1	<1
CP04	<0.1	0.3	61	63.9	30.1	31.2	<0.1	0.2	<1	1	<1	1
CP05	<0.1	0.2	40.8	49.6	26.2	28	<0.1	0.4	<1	1	<1	4
CP06	<0.1	<0.1	55	60.1	2.3	23.2	<0.1	2.1	1	1	<1	1
WS01	<0.1	0.14	0.7	64.9	0.8	31.8	<0.1	20.5	<1	3	<1	4
WS02	<0.1	<0.1	62.8	64.5	18.1	28.7	<0.1	0.3	<1	1	1	7
WS03	<0.1	<0.1	27.6	40.8	20.1	26.2	0.1	4	<1	1	<1	9
WS04	<0.1	0.2	43	66.6	23.3	31.8	<0.1	5.9	<1	8	<1	1
WS05	<0.1	<0.1	0.1	33	2.9	28.2	<0.1	18.1	<1	1	<1	<1
WS06	<0.1	<0.1	65.1	69.6	28.6	46.4	<0.1	0.8	<1	2	<1	1
WS07	<0.1	<0.1	60.7	98.2	28	29.7	0.1	0.4	<1	1	<1	1
WS08	<0.1	<0.1	51	60	20.7	29.2	<0.1	0.36	<1	1	<1	13
WS09	<0.1	0.1	49.2	51.5	20.4	21.2	0.2	1	1	8	<1	<1
WS10	<0.1	<0.1	39.6	46.2	16.5	22.7	<0.1	0.7	<1	2	<1	5
Chalk												
CP01D	<0.1	67.7	56.7	67.7	26.5	30.1	0.2	2.5	<1	4	<1	<1
CP02D	<0.1	22.5	<0.1	22.5	0.2	15.3	7.7	20	<1	2	<1	2
CP03D	<0.1	20	<0.1	20	0.2	17.4	3.7	20.9	<1	4	<1	<1

Notes; Minimum values exclude negative flows. For carbon dioxide and methane the minimum value identified is the minimum 'steady flow' recorded during the monitoring period whereas the maximum is the highest 'peak flow' recorded.

Atmospheric pressure recorded at the closest weather station (Southampton Airport) approximately 30 km to the west of the site through the monitoring period is summarised in

Table 4.6.

Table 4.6 Summary of Atmospheric Pressure During Monitoring Rounds (hPa)

Date	Time: 06:20	Time:	Time: 18:20	Rising / Falling
18/05/2017	1013	1013	1012	Stable / Falling
25/05/2017	1024	1023	1020	Falling
02/06/2017	1016	1016	1015	Stable / Falling
08/06/2017	1011	1010	1009	Falling
15/06/2017	1014	1015	1016	Rising
27/06/2017	1008	1006	1003	Falling



5.0 Laboratory Testing

5.1 Contamination Testing

Contamination / environmental laboratory testing was scheduled by WYG and undertaken by Exova Jones Environmental Laboratory who are UKAS & MCERTS accredited for a wide range of chemical tests.

Laboratory testing was carried out in accordance with ISO17025:2005 Competence of Testing and Calibration Laboratories.

5.1.1 Soil

WYG submitted 40 samples for chemical testing for WYG suite C which includes a range of determinants as detailed below. Laboratory analysis results are presented in **Appendix G**.

WYG Suite C determinants include:

- Metals Suite – Arsenic, Beryllium, Boron, Cadmium, Chromium (III), Hexavalent Chromium, Copper, Lead, Mercury, Nickel, Selenium, Vanadium & Zinc;
- Polycyclic Aromatic Hydrocarbons Suite;
- Total Phenols;
- Total Petroleum Hydrocarbons;
- BTEX – Benzene, Toluene, Ethylbenzene and Xylenes;
- Asbestos Screen; and
- Plus pH, Fraction Organic Carbon, Free Cyanide & Sulphate

WYG also submitted 14 samples for leachate testing for a similar suite of testing as indicated above, but a number of additions including:

- Metals as above, but including Antimony & Molybdenum;
- Total Hardness;
- Dissolved Organic Carbon; and
- pH, Sulphate, Total Cyanide, Ammonia, Ammonium, Nitrate, Nitrite, Chloride & Alkalinity.

5.1.2 Waters

Groundwater samples were collected from the monitoring wells containing water on the 8th and 15th of June 2017. Nine groundwater samples (plus one duplicate and a composite sample of purged water) were sent to Exova Jones laboratory for testing.

The waters were tested for the following determinants:

- Metals Suite – Antimony, Arsenic, Beryllium, Boron, Cadmium, Chromium (III), Hexavalent Chromium, Copper, Lead, Mercury, Molybdenum, Nickel, Selenium, Vanadium & Zinc;
- Polycyclic Aromatic Hydrocarbons Suite;
- Total Phenols;
- Total Petroleum Hydrocarbons;
- BTEX – Benzene, Toluene, Ethylbenzene and Xylenes;
- Total Hardness;
- Dissolved Organic Carbon; and
- pH, Sulphate, Total Cyanide, Ammonia, Ammonium, Nitrate, Nitrite, Chloride & Alkalinity.

5.2 Landfill Forensic Testing

A total of 27 bulk samples collected from landfill materials were sent to Envirolab for Landfill Forensics Testing. After an initial screen for asbestos, these samples were sifted and sorted into their component parts and measured as a percentage. Results are presented in **Appendix H**.

Samples were sorted into the following types of material presence:

- % of total sample Inert (>10mm in size);
- % of total sample Wood;
- % of total sample Vegetation;
- % of total sample Cloth;
- % of total sample Other Inert Material;
- % of total sample Paper;
- % of total sample Other Degradable Material;

- % of total sample Fine Soils; and
- % of total sample Inert (>10mm in size)

One sample was not tested due to the presence of amosite asbestos board.

5.3 Geotechnical Testing

A programme of geotechnical laboratory testing, scheduled by WYG, was carried out on representative samples taken from the natural strata during the ground investigation. The results of the geotechnical laboratory tests are presented in **Appendix I**.

Samples were sent to Professional Soils Laboratory who are UKAS accredited. All testing was carried out in accordance with BS1377:1990+A1 Methods of Testing Soils for Civil Engineering Purposes.

Table 5.1 below details tests and standards undertaken on samples recovered during the site investigation.

Table 5.1 Summary of Geotechnical Testing

Type of Test	Standard	No.
Natural Moisture Content	BS1377: Part 2:1990, Clause 3.2	5
Atterberg Limits	BS1377: Part 2:1990, Clauses 4.4, 5.3 & 5.4	5
Particle Size Distribution (PSD) – Wet Sieving	BS1377: Part 2:1990, Clause 9.2	5
Particle Size Distribution (PSD) – Sedimentation	BS1377: Part 2:1990, Clause 9.4	2
Quick Undrained Triaxial	BS1377: Part 2:1990, Clause 9.7	1

6.0 Geotechnical Discussion

6.1 Geology and Geotechnical Parameters

Ground conditions encountered during the investigation were broadly consistent with those identified in the published literature.

In summary, ground conditions comprised Topsoil over Made Ground / Capping Material, over Landfill Material. Which in turn overlay River Terrace Deposits / Alluvium over Chalk.

Details of the various soils encountered during the investigation are discussed in Section 5.0.

6.1.1 Made Ground – Capping Material

The capping material was generally uniform in composition. Standard Penetration Tests (SPTs) recorded 'N' values (standard penetration resistance) of between 18 and 50 in cable percussion boreholes and 8 and 50 in window sample boreholes.

No laboratory testing was undertaken on this strata as this lies above the highly variable Landfill Material.

6.1.2 Made Ground – Landfill Material

The landfill material varied in composition across the site, with various types and volumes of landfill waste, including, but not limited to paper, cloth, metal, wood, glass and plastic.

SPTs varied from 9 to 50, but in the main were generally greater than 25 (possibly due to the presence of large pieces of material within the strata e.g. wood, concrete cobbles etc).

The sites Landfill Licence was issued by Hampshire County Council on 24 November 1978, i.e. the landfill is of the post 1965 type containing a large proportion of organic material, which is readily degradable as classified in BRE FB 75 - Building on fill: geotechnical aspects, 3rd edition.

This soil strata has not been characterised due to the highly variable nature of the material.

6.1.3 River Terrace Deposits / Alluvium

Beneath the landfill material, either River Terrace Deposits or Alluvium were encountered.

River Terrace Deposits were encountered in CP01, CP03 & CP06 and was generally uniform in composition being primarily granular. SPT values ranged from 24 to 50.

Four Particle Size Distribution tests (PSDs) were carried out on representative samples of Alluvium and identified predominantly coarse soils comprising fine to coarse gravels with subordinate quantities of clay and sand, corresponding to the engineer's description.

Alluvium was encountered in boreholes CP02A & CP04 and comprised clay with subordinate silt, sand & gravel components. SPT values ranges from 8 to 26.

Atterberg limits were determined on four samples of Alluvium and one sample of Chalk. These results appear variable from low, to intermediate, to very high plasticity. Modified plasticity indexes were calculated and are shown in **Table 6.1** below.

Table 6.1 Summary of Classification Testing

Stratum	Range Min – Max (%)			Volume Potential	Change
	Moisture Content	Plasticity (*Modified)	Index		
CP02A Alluvium – Sandy Gravelly CLAY	22 – 27	9 – 23 (*8.37 – 20.01)		Low to Medium	
CP04 Alluvium – Silty CLAY	26 – 48	45 – 50 (*41.85 – 45.50)		High	
CP05 Chalk – Gravelly Silt of Chalk	14	11 (*9.02)		Low	

One quick undrained triaxial test was completed on Alluvium collected from borehole CP04. The shear strength (Cu) was reported as 29kPa with a plastic failure mode. This equates to a clay consistency of soft.

One PSD was carried out (Sample from borehole CP02A at 9.50 – 10.00m depth) and this indicated a fine soil comprising clay / silt with subordinate quantities of sand and gravel, corresponding to the engineers description of the soil.

6.1.4 Chalk

Chalk was encountered in the three deeper boreholes. The total thickness of this strata was not proven during this investigation.

Due to the nature of the drilling process the returned Chalk, could only be described as "recovered as".



6.1.5 Chalk

Chalk was encountered in the three deeper boreholes. The total thickness of this strata was not proven during this investigation.

Due to the nature of the drilling process the returned Chalk, could only be described as "recovered as".

Standard Penetration Tests undertaken within this lithology ranged from 17 to >50. With SPTs >25 from 15.00m bgl in borehole CP01 and 16.50m bgl in boreholes CP02A & CP03.

6.2 Groundwater

Groundwater was encountered in both deep and shallow installations in the six cable percussion boreholes.

Water strikes during drilling were generally observed to coincide with the top of the River Terrace Deposits / Alluvium above the Chalk.

Six return groundwater monitoring visits were undertaken between 18th May - 26th June 2017. During these visits, water levels of between 6.84m and 10.8m bgl were recorded across the site. Little or no groundwater was encountered in the window sample boreholes.

6.3 Concrete in Aggressive Ground

Chemical testing in accordance with BRE SD1: 2005 Concrete in Aggressive Ground has been used to derive the Design Sulphate Class and ACEC Concrete class of the soils encountered as detailed in **Table 6.2**. This table assumes mobile ground water under brown field site conditions (BRE Special Digest 1).

Table 6.2 pH and Sulphate of Soil Samples

Depth (m)	Strata	pH	Water Soluble Sulphate (2:1 water soil extract as SO ₄) (mg/l)	Design Sulphate Class	ACEC Class
0.20 – 0.95	Made Ground -Capping Layer	8.47	130	DS-1	AC-1
0.50 (CP04)	Made Ground – Capping Layer	7.74	1599	DS-3	AC-3
1.00	Made Ground – Capping Layer	8.01	87	DS-1	AC-1
1.80 – 2.00	Made Ground – Capping Layer / Landfill	7.69	222	DS-1	AC-1
2.30 – 2.50	Made Ground – Landfill	7.52	566	DS-2	AC-2
3.10 – 3.40	Made Ground - Landfill	7.94	210	DS-1	AC-1
3.50 – 3.80	Made Ground - Landfill	7.69	667	DS-2	AC-2
4.20 – 4.50	Made Ground - Landfill	7.46	250	DS-1	AC-1
4.80 – 5.00	Made Ground - Landfill	7.84	790	DS-2	AC-2
7.00	Made Ground - Landfill	8.01	362	DS-1	AC-1
7.00 (CP04)	Made Ground - Landfill	7.72	4133	DS-4	AC-4
9.50	Made Ground - Landfill	7.70	370	DS-1	AC-1
15.00	Chalk	8.60	23	DS-1	AC-1
20.00	Chalk	8.49	44	DS-1	AC-1
24.00	Chalk	8.59	21	DS-1	AC-1

7.0 Engineering Considerations

7.1 Introduction

It is understood that Havant Borough Council ideally would be interested in developing the site for employment use. At the time of compiling this report, no details of any specific development plans are available. Consideration has been given to the construction of light industrial / commercial units similar to that found in the local vicinity. Associated roads, car parking and services also require consideration.

A key geotechnical concern relating to the proposed development is the highly variable near surface ground conditions. The presence of extensive and varied landfill material has been proven across the entire site during the recent investigation and the maximum thickness of 7.5m was recorded in CP02A and CP05.

The Landfill is of the post 1965 type containing a large proportion of organic material, which is readily degradable.

7.2 Volume changes in fills

BRE FB 75 considers that volume changes in fills can be attributed to the following causes:

- immediate physical compression occurs due to the weight of successive layers of fill causing crushing, distortion, bending and reorientation of the materials within the fill (can be described by a constrained modulus D);
- long-term movements occur as biodegradation causes a reduction in volume (can be described by a logarithmic compression rate parameter ab);
- long-term movements occur, caused by physical creep compression as the particles of the refuse become more closely packed (can be described by a logarithmic compression rate parameter ac).

It should be noted that ab is much greater than ac and that ab can be almost 20% for post-1965 refuse landfill.

The following paragraphs and Figure 22 are taken directly from BRE FB 75:

The magnitude and rate of settlement of refuse is a function of complex interactions between physical and biodegradation processes. Watts et al (2006) describe a simple way in which to present settlement data to estimate a and hence predict long-term settlement of

landfill, as shown in Figure 22. The rate of strain $\delta\epsilon/\delta t$, expressed as % compression per month, is plotted against $1/t$ where t is the time in months since the fill was 75% complete. The figure shows the range of observations from measuring points at five sites (Case histories 21–25). The $\alpha = 15\%$ line represents average behaviour for a wide range of landfill composition, age, placement conditions, state of degradation, levels of inundation and other factors over a period of about 1 year to 20 years after completion of a landfill. It is likely that the value of α will reduce significantly after that period.

It is probable that most refuse landfills will continue to settle through biodegradation and creep over at least two log time cycles, for example between 3 and 300 months. Using this graphical technique, data may be collected at any time from different parts of a landfill and 'fitted' to the general model to indicate the likely remaining settlement at that location.

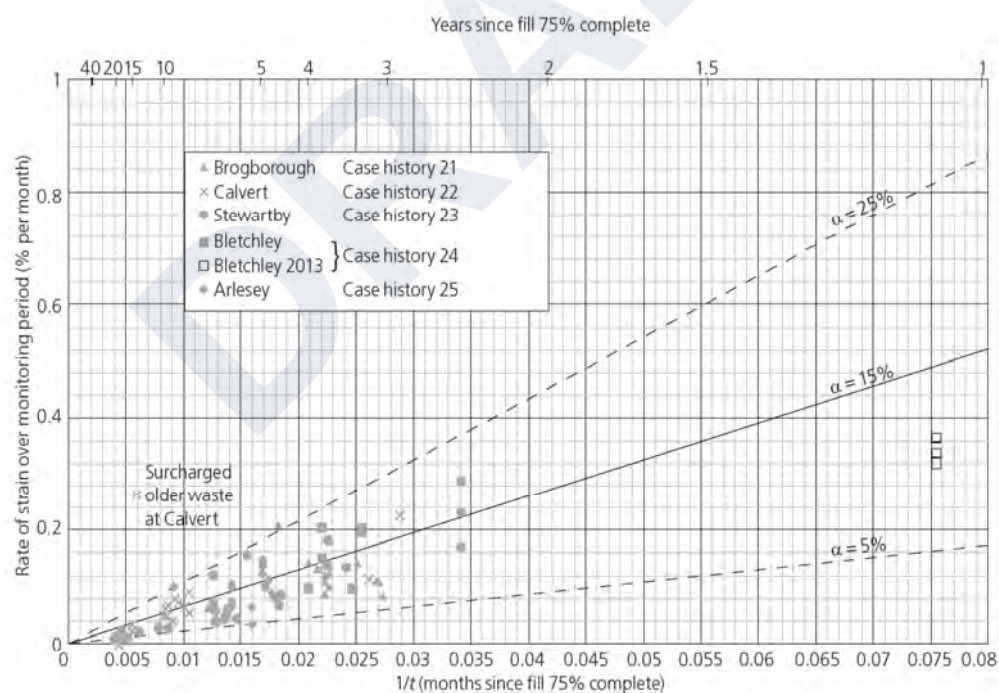


Figure 22: Values of $1/t$ against rate of strain for a range of sites (after Watts et al, 2006)

It is not clear exactly in what year during the 1990s the landfilling operation ceased and the capping layers were placed. It should be acceptable to take 1997 as the year when the landfilling was 75% complete which gives more than 20 years since.

From the $\alpha=15\%$ line of the above Figure 22, the rates of strain at 0.5% and 0.02% are obtained for respectively 1 and 20 years since the landfill was 75% complete.

For the maximum of 7.5m fill thickness, the rate of settlement can be estimated below:

At Year 1:

Rate of settlement = $0.5\% \times 7.5\text{m} = 0.0375\text{m}$ per month = 0.45m per year.

At Year 20:

Rate of settlement = $0.02\% \times 7.5\text{m} = 0.0015\text{m}$ per month = 0.018m per year.

Pre-loading, will reduce the rate of settlement by removing the elements due to the immediate and creep physical compression of the landfill material, though the long-term settlement due to biodegradation will continue.

7.3 Foundation Options

From Section 7.2 above, it is estimated that the rate of settlement may have been reduced from some 450mm per year in 1997 to probably less than 18mm per year in 2017. The actual rate of settlement should be ascertained through site monitoring prior to any development considerations.

For light industrial / commercial units, pre-loading should be considered and the examples as detailed in BRE FB75 should be followed. All structures should be founded on rafts with necessary gas protection measures implemented. Roads will require regular maintenance and utility services should be installed at above ground levels for easy maintenance. Drainage and water supply pipes should be constructed with flexible joints to minimise risk of leakage.

For heavily loaded structures, piles to be installed into the underlying Chalk may have to be considered. The down-drag or negative shaft friction on the piles due to the long-term ground settlement must be considered in pile design.

The existing ground conditions are unlikely to be of sufficient strength to support the required piling rigs without installation of an adequately designed piling platform.

A foundation works risk assessment would need to be undertaken and the Environment Agency consulted at an early stage. Environment Agency officers, and other regulators, need to be able to satisfy themselves that the designers of the ground improvement or piled foundations have fully considered the risk that the proposed works pose for the environment, human health and property, in addition to considering load carrying performance, ease of installation and cost.

The use of Continuous Flight Auger (CFA) piles may address many of the environmental concerns and pose the least pollution risk to groundwater. It is recommended that temporary casing must be installed to seal out contaminated water.

Based on the ground conditions encountered in the three deep cable percussion boreholes and using the characteristic geotechnical parameters as discussed in Section 7, indicative pile capacities have been assessed using the methods detailed in CIRIA C574 for CFA piles and the results are summarised in **Table 7.1** below.

Table 7.1: Summary of SPT values and indicative safe working loads for piles (kN)

Depth (m bgl)	SPT Values	CFA Pile Diameter (mm)	
		450	600
15.00	20 – 27	347 – 556	542 – 893
16.50	27 - 34	598 – 697	950 – 1108
18.00	50	740	1165
19.50	40 - 46	824 – 867	1278 - 1335
21.00	24 - 50	729 – 952	1052 - 1448

Advice should be sought from specialist piling contractors to determine the most suitable and cost-effective piling method. The piling contractor should select pile diameters and installation depths with guaranteed performance and recommend further ground investigation if required for design.

Temporary Works

At this stage it is considered that temporary works may comprise small scale excavations for the installation of services or for further inspection / investigation of the ground conditions.

It is recommended that due to the potential for side and base instability of excavations within the landfill and the ground gas concentration, that man entry into excavations is avoided completely.

Dewatering may be required for shallow excavation, perched water may be present but it is anticipated that flows would not be excessive and could be dealt with by pumping from



shallow temporary sumps. Standing water levels were between 6.84m and 10.80m bgl as monitored from the installed standpipes.

7.4 Concrete

Sulphate tests indicated that the maximum determined levels correspond to Design Sulphate Class DS-4 in accordance with BRE Special Digest 1, Concrete in Aggressive Ground. As brownfield conditions persist across the site and the ground water is assumed to be mobile due to the proximity of Langstone Harbour, the Aggressive Chemical Environment for Concrete (ACEC) is considered to be AC-4 in accordance with the aforementioned document. We would advise that all cements used for sub-surface concrete should conform to the advice given within this publication unless otherwise specified.

DRAFT

8.0 Ground Contamination Tier 1 Screening Assessment

8.1 Methodology

The objective of the Tier 1 Screening Assessment presented herein is to identify the chemical constituents which might potentially pose unacceptable levels of risk to sensitive on-site and off-site receptors. Measured concentrations in soil, soil leachate and groundwater have been compared with various sets of Target Screening Values (TSVs). Where measured concentrations in environmental media exceed these levels this does not necessarily indicate a requirement for remediation; it can however, be the trigger for the undertaking of a more detailed quantitative assessment in accordance with the current UK tiered risk assessment framework.

8.1.1 Human Health

Soils

In March 2014, DEFRA published the 'C4SLs' within the 'Policy Companion Document: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination' (SP1010). The purpose of the C4SLs is to identify a concentration in soil indicative of Category 4 status as defined by Part 2a Statutory Guidance¹ on the definition of contaminated land. In September 2014, further clarification was published in a letter from Lord DeMauley to Local Authorities instructing them to use C4SLs in planning. Where available C4SLs have been used as the preferred choice of screening criteria. For those constituents where no C4SL has been published by the EA / DEFRA, WYG have screened soil against Suitable for Use Levels (S4ULs)².

For the purposes of this risk assessment human health criteria for soils applicable to the following land use types have been used in order to screen the site data:

- Public Open Space, Parkland (Current and potential future)
- Commercial / industrial (Potential Future Use)

A number of TSVs are dependent on the Soil Organic Matter (SOM) content, and as such TSVs are typically calculated for a SOM of 1%, 2.5% and 6%. The average recorded Fractional Organic Carbon (FOC) recorded within the soils was 0.017. Using the equation of $SOM(\%) = FOC / 0.0058$ this equates to a site specific SOM of 2.9%. However, on the basis that lower values of SOM are present within the superficial deposits (RTDs), a lower, and

¹ Published by DEFRA in 2012 the guidance defines four categories of Category 4 is considered the least contaminated; "there is no risk or that the level of risk posed is low"

² Nathaniel C.P., McCaffrey, C., Gillet, A.G., Ogden R.C., and Nathaniel, J.F. 2015. *The LQM/CIEH S4ULs for Human Health Risk Assessment*

more conservative, SOM of 1% has been assumed for the purposes of screening all the soil data.

8.1.2 Controlled Waters

The site is underlain by superficial strata (variably Raised Marine Deposits, River Terrace Deposits and Alluvium) that are defined by the Environment Agency as Secondary A aquifers. Therefore these aquifers in themselves are not regarded as being highly sensitive as potential environmental receptors, however, they are considered to provide a potential hydraulic linkage with adjacent surface water features (including the Hermitage Stream and Langstone Harbour).

Underlying the superficial strata the Chalk bedrock is defined as a Principal Aquifer and therefore is considered important as a potential groundwater resource. An abstraction for drinking water by Portsmouth Water Ltd. is located approximately 440m north east of the site, however the site is not located within a groundwater source protection zone.

For the purposes of evaluating controlled waters at the site, surface water bodies (including the Hermitage Stream and adjacent Langstone Harbour) and the Chalk Aquifer are regarded as the most sensitive Controlled Waters receptors in the site vicinity. To reflect the proximity of the sensitive estuarine / tidal surface waters and groundwater (for potable consumption), all groundwater data collected from the site (independent of strata) has been screened against two sets of screening criteria as follows:

- Transitional or Marine Environmental Quality Standards (EQS)
- Drinking Water Standards (DWS)

8.2 Results of Tier 1 Screening Assessment

8.2.1 Soil Test Data

A total of forty soil samples collected from the site were submitted for laboratory analysis. Table 8.1 presents a summary of the exceedances above the adopted screening criteria. The full Tier 1 soil screening sheets are presented in **Appendix J**.

Table 8.1 Summary of Soil Results exceeding the TSVs

Chemical Constituent	S4UL (mg/kg)	Assumed Land Use	No. of analyses	Conc. (mg/kg)	Location of Exceedances
Dibenzo(ah)anthracene	3.5	Commercial	40	4.72	TP09 0.4m bgl
	1.1	Public			
Benzo(b)fluoranthene	13	Open Space		39.81	
Benzo(a)pyrene	21	Parkland		36.63	

In one sample collected from the site, concentrations of PAH compounds exceed relevant human health based screening criteria. Specifically, in soil from trial pit TP09 in the central car park area, in a sample of shallow soil (0.4m bgl) the concentrations of dibenzo(ah)anthracene, benzo(b)fluoranthene and benzo(a)pyrene exceed criteria specific to a public open space end use. The concentration of dibenzo(ah)anthracene within this sample also exceeds screening criteria applicable to a commercial land use.

In addition to the above, and also considered potentially indicative of a human health risk, asbestos was detected within 15 of 40 soil samples collected from across the site as indicated within Table 8.2. Asbestos quantification was not undertaken, however the laboratory has reported fibre bundles with concentrations of asbestos <0.1%.

Table 8.2 Asbestos Detections in Soil Samples

Location	Depth	Type	Description
CP02A	4.5	Chrysotile and amosite	Fibre bundles (<0.1%)
	7.0	Chrysotile	Fibre bundles (<0.1%)
CP04	0.5	Chrysotile	Fibre bundles (<0.1%)
	4.5	Chrysotile	Fibre bundles (<0.1%)
CP05	4.2	Chrysotile	Fibre bundles (<0.1%)
	9.5	Chrysotile	Fibre bundles (<0.1%)
CP06	2.5	Chrysotile	Asbestos Cement Debris
TP01	3.4	Chrysotile	Fibre bundles (<0.1%)
TP03	0.4	Chrysotile and amosite	Insulating Board Debris
TP06	2.0	Chrysotile	Fibre bundles (<0.1%)
	3.1	Chrysotile	Insulation debris
TP08	2.3	Chrysotile	Asbestos Cement Debris
	3.2	Chrysotile	Fibre bundles (<0.1%)
TP10	3.3	Chrysotile	Fibre bundles (<0.1%)
TP11	2.5	Chrysotile	Fibre bundles (<0.1%)

8.2.2 Groundwater Test Data

As discussed in Section 8.1.2 the results of the chemical testing of groundwater samples have been compared separately with two sets of standards, namely EQS and DWS. The full groundwater tier 1 screening sheets are provided in Appendix K. A number of chemical constituents have been recorded at concentrations exceeding EQS as summarised in

Table 8.3.

Table 8.3 Summary of Exceedences of EQS in Groundwater

Chemical Constituent	EQS (µg/L)	No. of analyses	No. of Exceedences	Maximum Concentration (µg/L)	Monitoring Well
Copper	3.76	9	2	5	CP04
Nickel	8.6	9	2	10.7	CP01 (S)
Zinc	7.9	9	2	12.4	CP03 (D)
Anthracene	0.1	9	5	0.27	CP01 (S)
Benzo(a)pyrene	0.00017	9	1	0.01	CP01 (S)
Benzo(b)fluoranthene	0.017	9	1	0.02	CP01 (S)
Fluoranthene	0.0063	9	7	0.52	CP01 (S)
Naphthalene	2	9	3	33.7	CP01 (S)
Cyanide	1	9	6	3	CP01 (S), CP02 (S), CP04
Ammonia	21	9	9	506,030	CP01 (S)

A number of chemical constituents have also been recorded at concentrations exceeding DWS as summarised in **Table 8.4.**

Table 8.4 Summary of Exceedences of DWS in Groundwater

Chemical Constituent	DWS (µg/L)	No. of analyses	No. of Exceedences	Maximum Concentration (µg/L)	Monitoring Well
Antimony	5	9	1	6	CP04
Barium	700	9	3	914.3	CP02 (S)
Boron	1,000	9	6	2122	CP01 (S)
TPH	10 *	9	5	227	CP05
Benzene	1	9	6	7.4	CP04
Sulphate	7,000	9	3	63,500	CP02 (D)
Chloride	250,000	9	6	1,291,000	CP04
Nitrite	1,000	9	1	1,440	CP03 (D)
Ammonium	500	9	9	536,000	CP01 (S)

* The DWS for TPH is a former standard for dissolved or emulsified hydrocarbons now withdrawn; the value has been used here in lieu of an alternative or more appropriate reference criteria.

As indicated in Table 8.3 and Table 8.4 concentrations of a number of constituents exceed relevant screening criteria. In particular, the concentrations of ammonia exceed EQS whilst the concentrations of ammonium exceed DWS, in each groundwater sample tested.

The concentrations of ammonium measured in groundwater samples from wells installed in the landfill material range from 111,000-535,000µg/l thus exceeding the DWS of 500µg/L by between 2-3 orders of magnitude. Within groundwater samples collected from wells installed in the Chalk the concentrations detected were lower, but still elevated; the highest concentration measured in CP02 exceeds the DWS by more than two orders of magnitude.

The concentrations of ammonia measured in groundwater samples collected from wells installed in the landfill ranged from 16,000µg/l – 506,000µg/L exceeding EQS by more than four orders of magnitude. Generally lower concentrations were measured in the Chalk (2,200µg/L-100,000µg/L), however the maximum concentration measured in groundwater (CP02A) still exceeds the EQS by more than three orders of magnitude.

Several heavy metals species were measured in one or more water samples at concentrations greater than DWS or EQS. The levels of exceedance, however, were in all cases relatively marginal (less than one order of magnitude greater than target criteria) and the majority of exceedences were measured in wells screened in landfill; only two of these

exceedences relate to the Chalk (marginally elevated concentrations of boron in CP02A and zinc in CP03).

Several PAH compounds, namely anthracene, benzo(a)pyrene, benzo(b)fluoranthene, fluoranthene, and naphthalene, have been measured in groundwater at concentrations greater than relevant EQS. Generally the exceedences are considered only marginally elevated (< one order of magnitude greater than EQS) and in all cases are less than two orders magnitude greater than EQS. The highest concentrations were measured in CP01 (S) installed within landfill material in a north central area of the site; at the same location in the deep well installed in the Chalk, concentrations of all PAH were below EQS. Concentrations of anthracene (0.21µg/L) and fluoranthene (0.22µg/L) measured in a sample collected from the Chalk in CP02(D) in the west of the site exceed relevant EQS indicating potentially significant impacts to deep groundwater.

Relatively low level petroleum hydrocarbon impacts within groundwater in the landfill are evident. In CP05 approximately 240µg/L TPH was measured characterised by predominantly heavy end aromatic compounds. Similar levels of TPH were measured in CP04 characterised though by a 50-50 aromatic aliphatic split and by much lighter compounds (including >EC8-EC16 aromatics and >C5-C10 aliphatics). Lower concentrations of TPH (approximately 80µg/L) were also measured within CP02 (D) installed within the Chalk.

Benzene concentrations, between 1.4-7.4µg/L, were detected within six of nine samples thus indicating marginal exceedences of the DWS (1µg/L). Benzene was also detected in CP02 (D) providing further indication of hydrocarbon impacts within groundwater in the Chalk in the west of the site.

The sulphate levels measured in each of three samples collected from groundwater in the Chalk ranged from 13,000-63,500µg/L thus exceeding the DWS (7,000µg/L). By comparison the sulphate levels measured in groundwater collected from landfill were much lower (<500-3,000µg/L). This contrast is considered likely to be attributable to saline impacts within deep Chalk groundwater, that are not affecting the landfill. Sea water typically contains approximately 2,700,000µg/L sulphate and therefore the levels of sulphate measured in the groundwater in the Chalk are approximately two orders of magnitude lower.

Chloride levels exceeding DWS were measured in five of six samples collected from the landfill and in one of three wells installed in the Chalk. The chloride levels measured in Chalk groundwater ranged from 34,000-640,000µg/L which compares with 19,000,000µg/L typically found sea water; the levels of chloride in Chalk groundwater are again potentially

indicative of saline intrusion. The high chloride levels measured in the landfill are considered relatively typical of landfill leachate.

Low levels of cyanide (1-3µg/L) were measured in groundwater collected from five of six wells installed in landfill and in one of three wells in the Chalk. The occurrence of cyanide in the Chalk groundwater in CP02(D), like the hydrocarbons and the high levels of ammoniacal nitrogen suggests that there is a degree of connectivity between the landfill and the underlying Chalk and that contaminated groundwater / landfill leachate has impacted the Chalk aquifer.

8.2.3 Leachate Test Data

A total of fourteen soil samples were subject to leachate testing and analysis. The results of this analysis have been compared with EQS (transitional and coastal waters) or (when EQS are unavailable) DWS. The full leachate tier 1 screening sheets are presented in **Appendix L. Table 8.5** below presents a summary of the exceedances above the adopted TSV.

Table 8.5 Summary of Leachate Results exceeding the Relevant TSV.

Determinant	TSV (ug/l)	No. of Exceedances	Max Conc. (ug/l)	Sample Details
Antimony	5	9	73	TP06 at 2m bgl
Molybdenum	70	2	102	TP06 at 2m bgl
Mercury	0.07	6	0.4	CP01 at 7m bgl
Anthracene	0.1	8	1.01	CP01 at 7m bgl
Benzo(a)pyrene	0.00017	12	1.67	CP06 at 2.5m bgl
Benzo(b)fluoranthene	0.017	12	2.69	CP06 at 2.5m bgl
Benzo(ghi)perylene	0.00082	12	1.06	CP06 at 2.5m bgl
Benzo(k)fluoranthene	0.017	11	1.04	CP06 at 2.5m bgl
Fluoranthene	0.0063	13	4.35	CP06 at 2.5m bgl
Naphthalene	2	4	26.5	CP01 at 7m bgl
TPH	10	9	2,720	CP02A at 4.5m bgl
Ammonia	21	14	50,730	CP01 at 7m bgl
Ammonium	500	14	53,730	CP01 at 7m bgl

* The DWS for TPH is a former standard for dissolved or emulsified hydrocarbons now withdrawn; the value has been used here in lieu of an alternative or more appropriate reference criteria.

As indicated in Table 8.5 a number of metal species, PAH compounds, TPH and ammoniacal compounds have been measured at concentrations in leachate exceeding relevant water quality criteria. This suggests that contaminants in made ground (including landfill materials) have the potential to leach and cause impacts to the underlying groundwater. There is a broad similarity between the contaminants (and the concentrations measured) identified as exceeding water quality criteria in leachate and those identified in groundwater e.g. the most notably elevated contaminants in leachate include ammoniacal compounds and some PAH.

It should be recognised that the process of leachate derivation in the laboratory, which involves physical agitation of a soil sample in de-ionised water for a period of 24 hours, is designed to create equilibrium conditions between the chemical in dissolved phase and sorbed phase and that in natural conditions concentrations that occur in leachate may not be as high. For risk evaluation purposes, the groundwater sampling and analysis allows for a more realistic assessment of potential risk to controlled waters.

8.2.4 Ground Gas

A ground gas risk assessment has been completed using the guidance presented in CIRIA C665 'Assessment of Risks posed by Gas to Buildings'. Table 8.6 presents the results of assessing the methane and carbon dioxide GSVs (discharge rates) within boreholes across the site. The maximum concentrations of hazardous gases and the location specific GSVs are also presented in Drawing 004 in **Appendix B**.

Table 8.6 Calculation of GSVs for Methane and Carbon Dioxide

Location	CH ₄ (l/hr)	CO ₂ (l/hr)
Landfill		
CP01 (S)	0.22	0.12
CP02 (S)	2.19	1.50
CP03 (S)	7.75	6.94
CP04	0.19	0.09
CP05	0.10	0.06
CP06	0.06	0.02
WS01	0.09	0.04
WS02	0.06	0.03
WS03	0.04	0.03
WS04	0.13	0.06
WS05	0.03	0.03
WS06	0.07	0.05
WS07	0.10	0.03
WS08	0.06	0.03
WS09	0.05	0.02
WS10	0.05	0.03
Site Wide	30.55	14.43
Chalk		
CP01 (D)	0.20	0.09
CP02 (D)	0.02	0.02
CP03 (D)	0.02	0.02

Site wide GSVs (derived using the maximum concentrations and maximum flow rate site wide) of 30.5L/hr methane and 14.43L/hr carbon dioxide have been measured. In accordance with CIRIA C665 this equates to a High Risk, 'Characteristic Situation 5'. Based, however on the predominance of low or negligible flow rates measured site wide this designation may be overly cautious.

At the majority of locations (all but two) maximum flow rates have not exceeded 0.3L/Hr and consequently the location specific GSVs are typically below 0.2L/Hr methane and 0.1L/Hr carbon dioxide; this is equivalent to a Characteristic Situation 2. Within boreholes CP02 (S) and CP03 (S) high positive gas flows (>5L/Hr) were measured on only one occasion (Round 2, associated with falling atmospheric pressure); During the other five rounds gas flow rates were negative.



Furthermore, neither boreholes CP02 nor CP03 was associated with methane levels above 40%; this is much lower than the 98% used to derive the worst case GSV measured on one occasion in WS7. The location specific GSVs derived for gas from boreholes CP02(S) and CP03(S) of 2.19L/Hr and 7.75L/Hr equate to Characteristic Situations 3 and 4 respectively. Based on the landfill forensic analysis the majority of the residual fill material appears to comprise relatively inert materials or materials that will degrade relatively slowly (e.g. wood, cloth, paper); very little vegetation (maximum 0.6% in CP04) or other degradable material was encountered in the landfill waste.

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9.0 Conceptual Site Model

This section of the report describes the Conceptual Site Model (CSM) that defines 'source', 'pathway' and 'receptor' relationships at the site and in the site vicinity. A Preliminary CSM was previously described within the WYG desk top study report (WYG 2017a). The Preliminary CSM has been updated here using information collected during the site investigation, including in particular site specific information relating to the definition of contaminant sources and the nature of ground conditions such that they might provide pathways for contaminant migration. As with the Preliminary CSM, potential receptors have been identified based on both continued use of the site as a public open space and potential redevelopment for commercial use (potential receptors include workers involved in earthworks and construction as well as users of any redeveloped site).

9.1 Summary of Contamination Sources

From the desk based and intrusive investigations undertaken at the site, a number of contamination sources and potential contamination sources have been identified.

On-site

Made Ground and waste material associated with the municipal landfill (no longer in use) present at the site. Visible evidence of landfill waste was identified within each of exploratory hole advanced across the site during intrusive investigation works in May 2017. The recorded thickness of landfill material ranged from circa 4.5m (CP4 in the north west) to 7.5m (CP02 and CP5 in the south west). In all cases the landfill deposits were overlain by a capping layer (typically a cohesive strata) of 1-5m thick.

Elevated levels of land gas (maximum 98% CH₄, 46% CO₂) have been measured within monitoring wells across the site and occasionally high flow rates were recorded; a potentially conservative site wide GSV for methane of 30.5L/hr has been derived which in accordance to C665 is equivalent to a Characteristic Situation 5.



- Within several soil samples (15 of 40) collected from across the site, asbestos fibres were detected (identified as chrysotile but occasionally including amosite). Although most of the asbestos detections were measured in relatively deep samples (>2m bgl) collected from the landfill material, two detections were measured within samples collected (from CP04 and TP03) from comparatively shallow capping material (circa 0.5m bgl) within a central / western area of the site.
- Notably high concentrations (circa 10,000mg/kg) of petroleum hydrocarbons were measured in soil samples collected from landfill material at two locations (TP01 at 1.9m and TP04 at 3.3m). In both cases the results of speciated TPH analysis suggest that the oil comprises heavy fractions and is similar in nature to a lubricating oil; the concentrations of individual fractions do not exceed relevant human health based screening criteria.
- Slightly lower levels of petroleum hydrocarbons (circa 3,000mg/kg) were measured in relatively shallow soil (0.4m) collected from Made Ground / Capping material; here the hydrocarbon component (predominantly heavy aromatic fractions) is typical of PAH contamination and the analysis of individual PAH compounds has identified concentrations of three PAH compounds (dibenzo(ah)anthracene, benzo(b)fluoranthene and benzo(a)pyrene) at levels that exceed human health based screening criteria applicable to public open space end use. The concentration of dibenzo(ah)anthracene also exceeds criteria applicable to a commercial end use.
- Evidence of hydrocarbon contamination has also been measured in groundwater samples collected from the landfill material; this includes a maximum concentration of TPH of approximately 250µg/L (CP05), benzene concentrations between approximately 1-7µg/L in five of six samples from the landfill (these levels exceed the DWS of 1µg/L) and a number of PAH compounds exceeding EQS by up to two orders of magnitude.
- Most notably groundwater collected from the landfill was also found to include high concentrations of ammoniacal compounds: Maximum concentrations of ammonium and ammonia exceed relevant screening criteria by three and four orders of magnitude respectively.
- Slightly elevated concentrations of cyanide and heavy metals (copper, nickel, zinc, antimony and boron) were also measured in groundwater collected from the landfill; the levels of these constituents do not exceed relevant water quality standards by more than one order of magnitude.
- Evidence of localised groundwater contamination has also been encountered within the Chalk in CP02 (D) in the south west of the site. This includes high concentrations of

ammoniacal compounds (although lower than in the landfill the levels of ammonium and ammonia exceed relevant screening criteria by two and three orders of magnitude respectively) and marginally elevated levels of cyanide, benzene, PAH and TPH. The similarity between the contaminant profile measured in CP02(D) and the groundwater contamination measured in landfill would suggest that the landfill is likely to be the origin of the contamination measured.

- Potential UXOs associated with potential undetected bomb strikes during World War II. No evidence of suspected UXOs were encountered during the site investigation works.

Off-site

Offsite sources can influence onsite soil and groundwater quality, *if a viable pathway is present*. Potential contaminative sources offsite were identified within the Preliminary CSM as including:

- *Offsite landfills including the land to the south and west of the site;*
- *Railway land 200m north of the site;*
- *Various industrial / commercial land uses (in particular to the east and south east)* including a concrete production facility, waste transfer station, electrical substation, incinerator, waste water treatment works and unspecified works, depots and tanks. Wastes from these sites may also have been deposited on the site.

No evidence of contamination originating from an off-site source (other than deposited landfill waste) has been identified following the completion of the investigation works.

9.2 Risk Pathways

The key environmental pathways and exposure routes by which potentially contaminative substances might reach environmental and human health receptors in the site vicinity are considered to be:

- *Migration of ground gases*; high levels of land gases have been measured, occasionally associated with high flow rates. Whilst the cover material that overlies the landfill is predominantly cohesive, this unit is variable in thickness (as thin as 1m), variable in strength (often described as soft) and often contains a relatively high proportion of sand and gravel. It should not be regarded as an effective break layer, without further lines of evidence. Furthermore, future ground works have the potential to compromise the cover material layer (e.g. groundworks, service runs, piled foundations) and the potential

for land gases to bypass the fill and reach the surface or any building foundations should not be discounted.

- Contamination migration through preferential pathways (e.g. underground services, drains and piles). Although evidence of preferential pathways were not identified, during the intrusive investigation, the presence of a deep sewer is known to cross the western portion of the site. Furthermore any future development that includes large buildings will likely require piles into the underlying Chalk. Any piling methodology will require careful assessment and design to avoid the creation of preferential pathways between landfill material and the underlying Chalk.
- Atmospheric transport and inhalation of airborne dusts, vapours and fibres (indoors and outdoors);
- *Direct contact (Dermal contact with / ingestion of soil and water);* The potential exists that future site users will have the potential to come into direct contact with contamination in shallow soil; exceedances of human health based screening criteria were measured in shallow soil (circa 0.5m bgl) at one location in a central area of the site. The placement of buildings and/or hardstanding surfaces at any future development should mitigate potential risks associated with this pathway.
- Shallow groundwater is absent across the site (depths to groundwater are consistently >5m bgl) and therefore direct contact with contaminated groundwater is unlikely to be a viable exposure pathway.
- Vertical leaching of dissolved phase contamination through unsaturated strata because of rainwater infiltration. The ground conditions encountered across the site include a cover material / made ground between 1-5m thick. Typically, this material was recorded as being a cohesive layer (sandy or gravelly clay) and as such it would be expected to limit the potential for rainwater infiltration. During the site walkover in March an area of ponded water was observed in a relatively low-lying area north of the parking area. Whilst this reinforces the hypothesis that shallow soils are locally relatively impermeable, the cover material is variably thick, soft and contains relatively high proportions of gravels. Groundwater was recorded in wells installed in landfill material (piezometrically above the water table in the Chalk); the chemical characteristics of this groundwater are considered typical of leachate from an old landfill (high chloride and other ions, ammoniacal compounds and some hydrocarbon contamination).
- *Lateral / vertical migration of liquid products through the sub-surface under gravity.* Although some evidence of hydrocarbon contamination was recorded within the landfill material no visible evidence of free phase oily contamination was observed.

- *Lateral/vertical migration of dissolved phase contamination in groundwater via diffusion and advective groundwater flow.* Evidence of suspected contamination was recorded in groundwater collected from one of three wells installed in the Chalk. The nature of the contamination is very similar to the contamination measured in groundwater collected from the landfill material which would suggest that some transfer of contamination has occurred between the landfill and Chalk strata.

The groundwater monitoring data identified piezometric water levels in the Chalk between approximately 0m to 2m AOD, whereas the groundwater in the landfill was recorded at between approximately 2m to 5m AOD suggesting that groundwater in the landfill is hydraulically distinct (from the Chalk) and that downwards gradients will predominate.

The chemical data collected from the site would appear to suggest that groundwater in the Chalk is brackish (chloride and sulphate levels are approximately 1% of that of seawater) whereas the groundwater collected from the landfill has comparatively lower sulphate levels. It is notable also, whilst the top of the Chalk was encountered at between -2m to -5mAOD whilst the piezometric groundwater level is at close to sea level. Relative depths to groundwater recorded in trial pits CP01D, CP02D, CP03D on different monitoring rounds suggest that the groundwater flow direction and gradient is variable (northerly and southerly gradients have been identified) providing further evidence of tidal influence.

9.3 Receptors

The environmental, human health and infrastructure receptors on or surrounding the site include:

- Current, and potentially future, public open space site users;
- Potential future commercial site users;
- Construction site workers and maintenance workers;
- Off-site neighbours (including commercial/industrial premises east of the site);
- Groundwater; including superficial secondary aquifers and principal aquifers of the Chalk;
- Surface water features, including the Hermitage stream (adjacent to the site) and Langstone Harbour (a SSSI site 300m south of the site); and
- Buildings and infrastructure associated with any future potential development.

9.4 Qualitative Risk Assessment

A qualitative risk assessment was previously undertaken as part of the Phase 1 evaluation of potential pollutant linkages at the site. The previous assessment has been updated to reflect the findings of the Phase 2 Assessment using the CIRIA C552 methodology (which is provided in Appendix M). The full updated risk assessment including details of the changes made to specific risk rankings following the collection of Phase 2 data is presented in Appendix N. A summary of the updated risk assessment and the levels of risk identified with respect to specific receptor groups is provided in the following sub-sections.

9.4.1 Summary of Risk Evaluation: Public Open Space Users

The site is currently used as a public open space without buildings or structures. A footpath crosses the site and dog walkers were observed using this path during the site walkover and investigation. Across most of the site, an ostensibly healthy and thick cover of vegetation is present although locally (immediately west of the current car park) some patches of bare earth and extraneous material (e.g. building waste) were noted. Although asbestos fibres were recorded in several samples (including relatively shallow 'capping' material) and concentrations of PAH compounds were recorded in excess of screening criteria applicable to human health risk, based on current use (limited exposure times and minimal contact expected) direct exposure to harmful substances is considered relatively unlikely to occur. Similarly, given the absence of buildings, an explosion event or asphyxiation from ground gases is considered relatively unlikely. However, based on the high concentrations of land gas recorded and evidence of occasional active gassing a worse-case scenario including the escape of gasses to surface and subsequent ignition cannot be excluded entirely whilst public access to the site is permissible. Risks to users of public open space considered to be **low / moderate**; this corresponds with the level of risk previously assigned during the desk study.

If, however, the site were to be enhanced creating greater levels of usage (e.g. opening the car park, creating play areas) this would increase the likelihood of a harmful exposure event occurring and it would be appropriate to increase the risk level to **Moderate**. Any proposed enhancement of the site, therefore, should be carefully managed and preceded by further assessment and/or mitigation e.g. removal of shallow contamination / placement of additional capping in car park area.



9.4.2 Summary of Risk Evaluation: Commercial Site Users

The investigation and monitoring works at the site have confirmed the presence of landfill materials (approximately 4.5-7m thick) across the site and elevated levels of potentially hazardous land gases. Although it appears that the majority of the more rapidly degradable material has been degraded, relatively high proportions of more slowly degrading material (e.g. wood and paper) do remain. The land gas regime is considered to present a **high** risk to any future buildings and commercial users at the site. Based on the land gas risk assessment undertaken in accordance with CIRIA C665 (described previously in Section 8.2.4) gas protection measures applicable to a Characteristic Situation 3 or 4 (subject to further review and refinement) are likely to be appropriate for any future buildings.

Risks of harm to health associated with potential exposure to hydrocarbons and asbestos in soil at a future commercial premises are considered to be **Low / Moderate**. For any future development it would be appropriate to incorporate design elements that minimise the potential for exposure to the underlying soil e.g. through the extensive placement of hard standing / buildings and clean soil for any landscaped areas.

9.4.3 Summary of Risk Evaluation: Construction and Groundworkers

Following review of the ground investigation data a **high** risk of harm to health to construction workers, through potential exposure to soil contaminants (including asbestos) and also land gas that might accumulate within excavations, has been identified. It should be possible, however, to manage these risks through the adoption of appropriate working practices, protective equipment and facilities. Therefore, whilst these high risks will require careful management they are not considered to be potential constraints to site development. Further discussion on the management of risks during redevelopment are provided within Section 10.

9.4.4 Summary of Risk Evaluation: Offsite Neighbours

Contamination originating on site has the potential to impact the users of neighbouring sites through a number of pathways including dermal contact and/or ingestion of windborne dusts, migration of vapours, gases and groundwater through the subsurface and inhalation of windborne asbestos fibres. Of note these risks are mitigated in part by the relative absence of near neighbours and in particular the absence of any particularly sensitive nearby land uses (e.g. residential / schools).



Although elevated levels of land gas have been recorded at the site, the majority of flow rates have been low / negligible. The closest buildings to the site are approximately 60m east of the site (commercial premises) on the opposite side of the Hermitage Stream. It is notable that these buildings are also constructed on former landfill and it is expected therefore that these buildings have been fitted with gas protection. The previously assigned moderate risks have been reduced to **Low / Moderate** reflecting the presence of the Hermitage Stream between the neighbouring buildings and the site and the typically low levels of gas flow recorded.

Moderate risks have been identified associated with inhalation of asbestos fibres at neighbouring premises during any future groundworks / site redevelopment that enhances the release of dust / fibres. It should be possible to effectively manage / monitor these risk during any future groundworks through the deployment of dust suppression measures and / or boundary monitoring.

9.4.5 Summary of risk evaluation: Groundwater

Evidence of suspected contamination in groundwater collected from the Chalk has been recorded in one of three wells. Based on the nature and type of contamination recorded (including high levels of ammoniacal compounds, and relatively low levels of cyanide, benzene and other hydrocarbons) it is considered likely that this originated from the overlying landfill. It is noted also, however, that the data recorded suggests that the groundwater in the Chalk is brackish and tidally influenced. This would make it unsuitable for use as a potable water resource and therefore, arguably, less sensitive as a resource.

Locally in the east of the site River Terrace Deposits (up to 5.7m thick) were identified between the base of the made ground and the top of the Chalk. Similarly, in the west of the site alluvium (up to 3.5m thick) was recorded between the base of the made ground and the Chalk. At one location in the centre of the site the Chalk was encountered directly beneath the Made Ground. Groundwater strikes were recorded in both alluvium and River Terrace Deposits and these superficial deposits are classified as Secondary Aquifers. In reality it is expected that the Environment Agency will be more concerned about the status of the groundwater in the Chalk (Principal) Aquifer and that secondary aquifers will be viewed as being more of a concern in that they might serve as conduits into adjacent surface water.

As a note of caution only one round of monitoring has been undertaken to date; it might be prudent to undertake a further round of monitoring to provide greater assurance that the data collected is representative.



Overall, the risk of significant impacts to groundwater are considered to be Moderate (likely occurrence of medium consequence).

9.4.6 Summary of Risk Evaluation: Surface Water

A number of surface water bodies are present on or near to the site which are considered to represent potential receptors to ground contamination originating from the site. Contaminated groundwater was encountered within landfill material and also (at one location) within the Chalk. Groundwater monitoring data suggests that the Chalk is tidally influenced; groundwater is brackish and flow directions and gradients varied markedly. A twice daily cycle of flow back and forth is expected, however, a 'net' flow towards the Langstone Harbour is likely (though not proven) and groundwater is considered therefore to have the potential provide a potential conduit between the site and surface water in the estuary.

Although monitoring data is unavailable from the River Terrace Deposits and Alluvium strata, these units are considered to have the potential to be in hydraulic continuity with adjacent water courses. The River Terrace Deposits in the east of the site, in particular, are considered to have the potential to provide a conduit whereby contamination originating from the site might impact the adjacent Hermitage Stream.

Overall the risk of significant impact to surface water receptors is considered to be **moderate** (likely / medium consequence incident).

9.4.7 Summary of Risk Evaluation: Onsite Buildings / Services

Based on the results of the land gas monitoring and the subsequent land gas risk assessment a **high** risk to future onsite buildings and services is considered to be present associated with potential catastrophic damage that might be caused by explosive landfill gas (methane). In addition, due to the thickness and nature of fill materials across the site, high levels of settlement are expected which could cause serious damage without adequate mitigation.

Chemical corrosion by contaminants in soil and/or groundwater is perceived to represent a **low to moderate** risk (likely occurrence / mild consequence) to future buildings or services. An ACEC AC-4 categorisation has been assigned and any sub-surface concrete will need to be used in accordance with this guidance to guard against chemical attack.

10.0 Conclusions and Recommendations

10.1 Conclusions

Based on the review of desk study information and the Phase 2 ground investigation the following risk levels have been identified associated with potential ground contamination:

- Future site users – Public Open Space – **Low / Moderate** (assuming site remains unchanged) or Moderate (assuming space enhancement and increased usage).
- Future site users – Commercial – **High** – these risks, associated with land gas, could be effectively mitigated through the incorporation of appropriate levels of gas protection.
- Construction workers (during redevelopment of the site) – **High** risks have been identified associated with both land gas (e.g. explosion risk and / asphyxiation in excavations) and asbestos fibres. It should be possible to develop working practices that effectively reduce the level of risk.
- Offsite neighbours – Low / Moderate risks to neighbours have been identified associated with potential land gases. **Moderate** risks have been identified associated with potential release and exposure to asbestos during redevelopment / groundworks. The latter risks can be controlled through appropriate working practices.
- Groundwater of the Superficial Secondary Aquifers – **Moderate**
- Groundwater in the deep Chalk Principal Aquifer - **Moderate**
- Surface Water – **Moderate**
- Onsite property/buildings and services – **High** risks to buildings have been identified associated with potentially hazardous land gases. These risks could be effectively mitigated through the incorporation of appropriate levels of gas protection.

The key geotechnical risk at the site relates to volume changes of the landfill material, due to degradation of organic material.

Consideration should also be given to the type and construction of potential development which in turn would dictate the type and depth of foundations.

10.2 Recommendations

Regulatory engagement / further monitoring to better understand liabilities associated with Controlled Waters

Based on limited groundwater data collected to date evidence of suspected impacts to underlying Chalk groundwater has been identified. This is considered to represent a potentially significant liability and in the first instance further monitoring from wells installed in the Chalk is recommended in order to verify the validity of this result. Engagement with the regulators is also recommended in order to gain a better understanding in relation to the regulators expectations and requirements.

It is considered likely that Environment Agency will request further monitoring / assessment of groundwater contamination at the site / in the site vicinity. It is plausible also that the installation of a more complete monitoring network will be required. Depending on the findings of further monitoring it is also possible that more detailed assessment will be required (e.g. contaminant fate and transport monitoring). It may be possible to demonstrate that natural processes of attenuation are sufficient to reduce contaminant discharges to acceptable levels, preventing significant contaminant loading in surface waters and potentially negating the requirement for costly mitigation / remediation. Alternatively it is possible that, prior to any site redevelopment, a leachate capture system or hydraulic barriers might be required to reduce contaminant transport off site and towards the Langstone harbour.

Construction Phase Considerations

High levels of risk to potential groundworkers have been identified associated with land gas (explosive risk and asphyxiation) and inhalation of asbestos fibres. Moderate risks have also been identified to off-site neighbours through potential exposure to asbestos during any groundworks that cause an enhanced release of dust / fibres. On this basis consideration, should be given to a number of precautions during any future construction phase of works as follows:

- Of note asbestos containing materials are relatively widespread across the site and any ground arisings should be carefully controlled to prevent release to the environment. This includes release of dusts and fibres and prevention of windblown transmission beyond the site boundary. Boundary monitoring of dust / fibres may be required during redevelopment to monitor risks posed to users of adjacent land.
- Use of / availability of personal protective equipment (PPE) and also monitoring equipment by groundworkers including respiratory equipment (if vapours, gases or asbestos fibres are present) and gas monitoring equipment to test for land gases in excavations
- Provision should be made for adequate decontamination facilities.



- Based on the risk of encountering UXO, on-site support including downhole magnetometry is likely to be a requirement for any deep piling works (i.e. that extend beyond the base of the landfill materials).
- Surplus soils from excavations should be disposed of appropriately and in accordance with current waste management legislation. It should be noted that if shallow soils are of poor chemical quality they may attract premium rates at landfill.

In addition to the above it might be appropriate to undertake further assessment of shallow soil focussing in particular on attaining further characterisation of asbestos sources within the capping material. This information could be used to inform the development of a *Soil Management Plan* which would form the basis for managing soil on site and mitigating risks of harm to health.

Land Gas Protection

A conservative land gas assessment undertaken in accordance CIRIA C665 has identified, conservatively, a Characteristic Situation 5. This interpretation, however, is likely to be overly conservative particularly since the highest gas flow recorded of 31L/Hr was atypical of most monitoring events and most locations. It is recommended that prior to any redevelopment of the site that additional monitoring be undertaken, supplemented if appropriate with additional wells installed at locations considered strategically important in view of previous monitoring results and also proposed building locations.

Based on current data it is considered likely that gas protection measures required for future buildings will need to comply with a Characteristic Situation 3 or 4. As such all buildings will likely require reinforced concrete cast in-situ floor slab with joints and penetrations sealed and proprietary gas membranes installed and tested by appropriately qualified practitioners. Passive venting or positively pressurised buildings with underfloor sub-space and monitoring facility are also likely requirements. In ground venting wells / barriers may also be required.

Geotechnical Recommendations

It is recommended that:

- Actual rate of settlement of Made Ground on site should be monitored prior to development considerations.
- For light industrial / commercial units, the ground should be pre-loaded (following guidance on BRE FB75) and constructed on raft foundations, with gas protection measurements.



- Heavily loaded structures should be founded into the underlying Chalk. With consideration to negative shaft frictions due to long-term ground settlement and the type of pile construction e.g. continuous flight augers with the use of temporary casing to seal out contaminated water.
- Excavations within the made ground for temporary works should consider the stability of the ground and potential ground gas concentration. Man entry into excavations should be avoided.
- Concrete used for construction should conform to advice given within BRE SD1.

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11.0 References

- BS5930:1999+A2:2010 Code of Practice for Site Investigations
- BS1377: Methods of Testing Soils for Civil Engineering Purposes, 1990
- BRE Special Digest 1: Concrete in Aggressive Ground, 2005
- BRE FB 75 - Building on fill: geotechnical aspects, 3rd edition, 2015
- CIRIA C574 (2002) Engineering in Chalk
- CIRIA PR11 (1994) Foundations in Chalk
- CL:AIRE (2014): SP1010 – Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination. Final Project Report (Revision 2), September
- Environment Agency (2004) CLR11 Model Procedures for the Management of Contaminated Land. September.
- NHBC Standards 2006: Chapters 4.2
- Rudland, D.J., Lanceford, R.M and Mayell, P.N (2001), CIRIA C552; Contaminated Land Risk Assessment, A Guide to Good Practice, Basingstoke Press Ltd, 2001.
- Wilson S., S Oliver S., Mallett, H., Hutchings H. and Card G. (2007) CIRIA Report C665 Assessing risks posed by hazardous ground gases in buildings July
- Nathaniel C.P., McCaffrey, C., Gillet, A.G., Ogden R.C., and Nathaniel, J.F. 2015. The LQM/CIEH S4ULs for Human Health Risk Assessment (Copyright Land Quality Management Limited Reproduced with Permission; publication number S4UI3193)



12.0 Appendices

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Appendix A – Report Conditions

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Report Conditions

Site Investigation

*This report is produced solely for the benefit of **Havant Borough Council** and their Consultant partners. No liability is accepted for any reliance placed on the report by any other party unless specifically agreed in writing otherwise.*

This report refers, within the limitations stated, to the condition of the site at the time of the inspections. No warranty is given as to the possibility of future changes in the condition of the site.

This report is based on a visual site inspection, reference to accessible referenced historical records, information supplied by those parties referenced in the text and preliminary discussions with local and Statutory Authorities. Some of the opinions are based on unconfirmed data and information and are presented as the best that can be obtained without further extensive research.

Where ground contamination is suspected but no physical site test results are available to confirm this, the report must be regarded as initial advice only, and further assessment should be undertaken prior to activities related to the site. Where test results undertaken by others have been made available these can only be regarded as a limited sample. The possibility of the presence of contaminants, perhaps in higher concentrations, elsewhere on the site cannot be discounted.

Whilst confident in the findings detailed within this report because there are no exact UK definitions of these matters, being subject to risk analysis, we are unable to give categorical assurances that they will be accepted by Authorities or Funds etc. without question as such bodies often have unpublished, more stringent objectives. This report is prepared for the proposed uses stated in the report and should not be used in a different context without reference to WYG. In time improved practices or amended legislation may necessitate a re-assessment.

The assessment of ground conditions within this report is based upon the findings of the study undertaken. We have interpreted the ground conditions in between locations on the assumption that conditions do not vary significantly. However, no investigation can inspect each and every part of the site and therefore changes or variances in the physical and chemical site conditions as described in this report cannot be discounted.

The report is limited to those aspects of land contamination specifically reported on and is necessarily restricted and no liability is accepted for any other aspect especially concerning gradual or sudden pollution incidents. The opinions expressed cannot be absolute due to the limitations of time and resources imposed by the agreed brief and the possibility of unrecorded previous use and abuse of the site and adjacent sites. The report concentrates on the site as defined in the report and provides an opinion on surrounding sites. If migrating pollution or contamination (past or present) exists further extensive research will be required before the effects can be better determined.



Appendix B – WYG Drawings

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5th FLOOR
LONGCROSS COURT
47 NEWPORT ROAD
CARDIFF
CF24 0AD
TEL: +44 (0)29 2082 9200
FAX: +44 (0)29 2045 5321
e-mail: cardiff@wyg.com

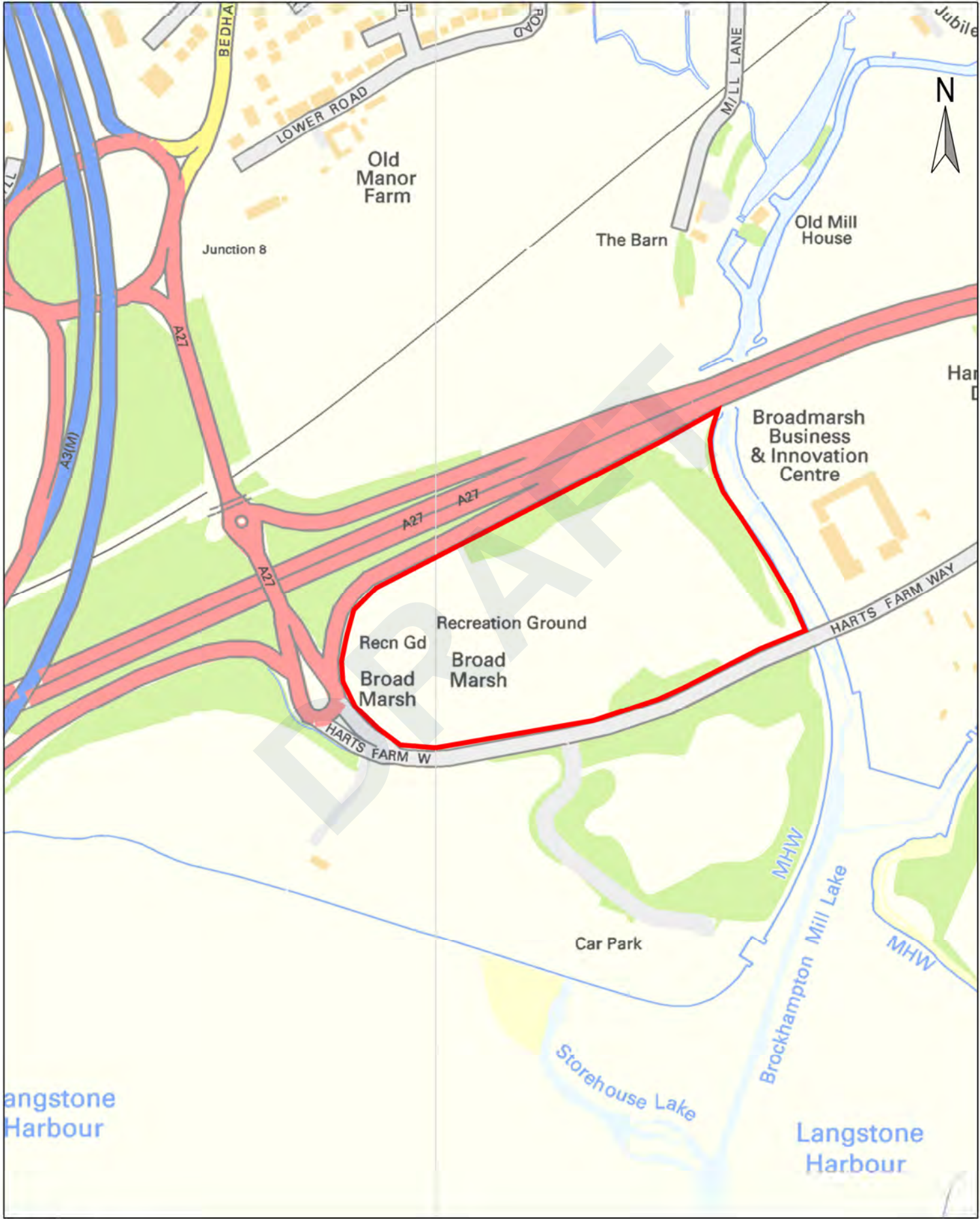


Client:
HAVANT BOROUGH COUNCIL

Project:
BROCKHAMPTON WEST

Drawing Title:
SITE LOCATION PLAN

REV	DESCRIPTION	BY	CHK	APP	DATE
	Scale @ A4 NTS	Drawn PP	Date 18.04.17	Checked NB	Date 18.04.17
	Project No. A102760	Office LDN	Type N	Drawing No. 001	Revision 00



Legend:
— Site Boundary

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copyright and database right 2017

5th FLOOR
LONGCROSS COURT
47 NEWPORT ROAD
CARDIFF
CF24 0AD
TEL: +44 (0)29 2082 9200
FAX: +44 (0)29 2045 5321
e-mail: cardiff@wyg.com



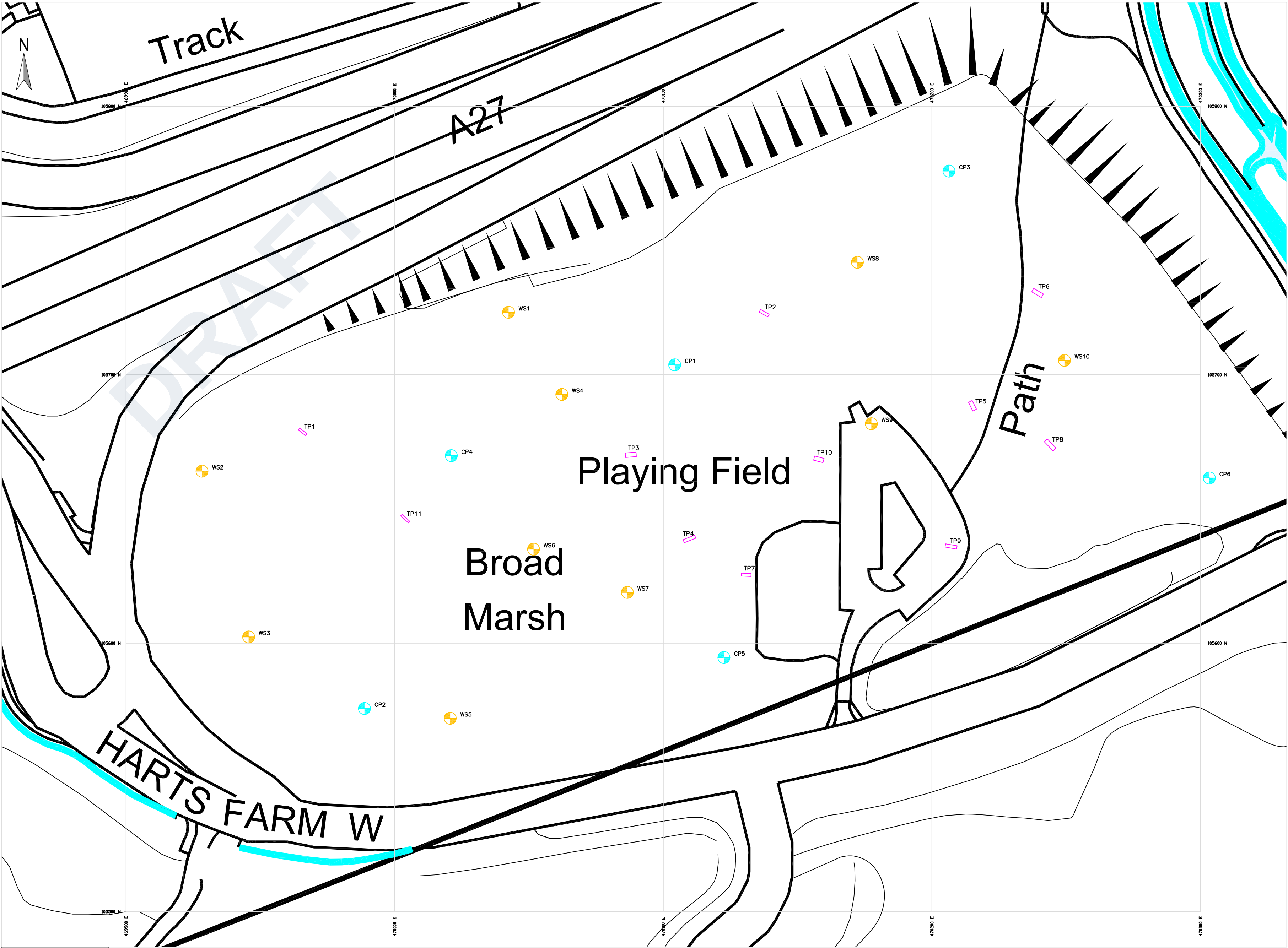
Client:
HAVANT BOROUGH COUNCIL

Project:
BROCKHAMPTON WEST

Drawing Title:
SITE LAYOUT PLAN

REV	DESCRIPTION	BY	CHK	APP	DATE
	Scale @ A4 NTS	Drawn PP	Date 18.04.17	Checked NB	Date 18.04.17
	Project No. A102760	Office LDN	Type N	Drawing No. 002	Revision 00

DO NOT SCALE: CONTRACTOR TO CHECK ALL DIMENSIONS AND REPORT ANY OMISSIONS OR ERRORS



KEY:



BOREHOLE



WINDOW SAMPLE



WINDOW SAMPLE

Contains Ordnance Survey data © Crown copyright and database right 2016

0 10 20 30 40 50 m
SCALE 1:1000

REV	DESCRIPTION	BY	CHK	APP	DATE
-----	-------------	----	-----	-----	------

100 St. JOHN STREET
LONDON
EC1M 4EH



Client:
HAVANT BOROUGH COUNCIL

Project:
BROCKHAMPTON WEST

Drawing Title:
EXPLORATORY HOLE LOCATION PLAN

TEL: +44 (0)20 7250 7500
FAX: +44 (0)20 7250 7501

Scale @ A2 1:1000	Drawn PP	Date 24.07.17	Checked NB	Date 24.07.17	Approved	Date
Project No. A102760	Office LDN	Type N	Drawing No. 003	Revision 00		

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