Gladman Developments Ltd

Land West of Cross Road, Deal

Hydrogeological Appraisal

1922493-R01(03)

RSK GEOSCIENCES

December 2022

RSK GENERAL NOTES

Project No.: 1922493

Title: Land West of Cross Road, Deal, Hydrogeological Appraisal

Client: Gladman Developments Ltd

Date: December 2022

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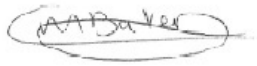
Signature		Signature	

Revision control sheet				
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Rev 00	July 22	First issue	n/a	see above
Rev 01	July 22	Second issue	n/a	see above
Rev 02	Nov 22	Third issue	Frances Gregory	Alena Landers
Rev 03	Dec 22	Client comments	Frances Gregory	Alena Landers

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1 INTRODUCTION

1.1 Commissioning

RSK Environment Limited (RSK) was commissioned by Gladman Developments Limited to carry out a desk-based assessment of the hydrogeological regime related to the construction phase of the development of the site on land west of Cross Road, Deal.

RSK's service constraints are shown in **Appendix A**.

1.2 Objectives

The objective of the work is to provide a high-level hydrogeological appraisal of the site with respect to the proposed development works and provide details of any outline mitigation and control measures to be adopted during construction works. The updated version of this report 1922493 R01(02) has also been designed to address consultee responses on Outline Planning Application 21/01822 by Southern Water which are detailed in section 2.4.1.

1.3 Scope of works

The scope of works for the assessment has included the following:

- Review of:
    - site's geology and hydrogeology
    - any available geo-environmental reports
    - the proposed development design - drainage system and soakage data and possible foundation options
- Make enquiries to Southern Water to confirm configuration of their assets within the area.
- Address response comments by consultee Southern Water.
- Provide any outline mitigation/control measures to be adopted for the construction works.

1.4 Existing reports

The following reports detailing previous works at the site were made available for review:

- RSK, Preliminary Risk Assessment – Land off Cross Road, Deal, Ref: 28926, April 2017.
- RSK, Preliminary Risk Assessment – Land off Cross Road, Deal, Ref: 52285 R01, June 2021.
- Infiltration Testing – Land West of Cross Road, Deal, Ref 52285-L01, 30th September 2021.

Pertinent information from these reports has been summarised in Section 2, 3 and 4.

1.5 Limitations

This report is subject to the RSK service constraints given in **Appendix A** and limitations that may be described through this document.

2 SITE DETAILS

2.1 Site location

Site location details are presented in **Table 1** and a site location plan is provided on **Figure 1**.

Table 1 Site location details

Site name	Land West of Cross Road
Full site address and Postcode	Land west of Cross Road, Deal, CT14 9LA
National Grid reference (centre of site)	TR 36027 50534

2.2 Site description

The site covers an area of c. 8.71 hectares, divided approximately into two parcels; the larger of the parcels located on the central portion of the site is currently occupied by agricultural (arable) land. The smaller parcel is located on the northern portion of the site and is currently fallow land.

The southern boundary and southwestern corner are covered by dense semi-mature and mature shrubs and trees. In addition, semi-mature and mature hedgerows are generally present around the perimeter for the site. The site slopes generally from north-northeast to south-southwest.

Access can be obtained at the southeast corner (intersection of Cross Road and Ellens Road) and the northeast corner on Cross Road. The smaller, fallow land parcel is accessed via a gate, which is located on the south side of the parcel.

The site boundary and current site layout are shown on **Figure 2**.

2.3 Surrounding land uses

The site is located on the southwestern outskirts of Deal, within a predominantly agricultural and residential setting. Immediate surrounding land uses are described in **Table 2**.

Table 2 Surrounding land uses

North	Residential dwellings, fallow and agricultural land and a commercial business/facility (GA Vehicle Repairs)
East	Residential dwellings and agricultural land
South	Agricultural land
West	Agricultural land and a commercial business/facility (The DIY Motorist)

2.4 Development plans / Planning Permission

It is understood that the site will be developed for residential end-use. An outline planning application ref. 21/01822 was submitted on 2nd December 2021 for the erection of up to 140 dwellings including affordable housing with public open space, landscaping and vehicular access and the site development framework plan is presented in **Appendix B**. There are no detailed plans of building types or foundation design at this stage.

2.4.1 Statutory Consultee Responses

Various statutory consultees have provided responses to the outline planning application, those considered relevant to hydrogeological risks include responses from the Environment Agency and Southern Water. Responses received from these consultees are detailed below

2.4.1.1 Environment Agency

A response from the Environment Agency (Planning Advisor, Sustainable Places) is provided on the planning portal with reference to the Planning Application 21/01822 to Dover District Council Development Management. The response state that the EA have assessed the application as having a low environmental risk and therefore have no comments to make.

2.4.1.2 Southern Water

Southern Water have provided several consultee comments in response to the submission of the Outline Planning Application and the provision of this Hydrogeological Risk Assessment.

Letter dated 01/02/2022 on the planning portal states that they object to the development going ahead in its current guise due to the close proximity of the proposed development to the EA SPZ1 and Southern Waters underground abstraction point (via the laterally extensive adit system), in addition to the unconfined Chalk Aquifer being highly vulnerable to surface contamination and disturbance. The letter requests that risks to groundwater (and Southern Water adits) be properly quantified and assessed and that sufficiently robust groundwater protection measures are implemented, including the revision of the current drainage plans, which would be considered inappropriate given the sensitive hydrogeological context. Additional comments are made with regards to the Flood Risk Assessment and Outline Drainage Design which are considered outside the primary scope of this report, however these comments have been address by RSK LDE through the the following reports

- RSK LDE Flood Risk Assessment Ref 680074 R1(01) FRA October 2021
- RSK 680074 L01 SW – letter dated 4 March 2022
- RSK 680074-L1(00) – FRA - letter dated 4 July 2022

Letter dated 10/03/2022 is a response to the submission of additional information related to catchment hydrology. The letter states that the Southern Water original objection still stands, and that the additional information did not address the points raised from the original objection.

Letter dated 03/11/2022 is the response to the submission of the RSK Hydrogeological Appraisal ref 1922493 R01 (01) dated July 2022. The following comments are made within the letter;

- A request was made to update the report with respect to the provision of information following an Environmental Information Request – **This information has been included within Section 4.4.2 of this report**
- The report requires and updated conceptual model to include reference to hydrogeological characteristics including karst, fracture and adit flow – **This information has been included within Section 4.5 and 5.0 of this report**
- Corrections to be made to the unsaturated zone thickness – **This information has been updated within Section 4.4 and 4.5 of this report**
- Updates required the Development Design and Proposed Mitigation Measure should be made following consideration of the groundwater flow mechanics and current control measure should be expanded to consider the sensitivity of the below lying Aquifer and Abstraction. In addition, consideration for the assessment of turbidity should be included – **This information has been updated within Section 6.0 of this report**
- Evidence as to why the contaminant pathway is severed and risks to controlled waters can be deescalated has not been provided within the early section – **A Refined conceptual model is now presented within Section 5.0**

2.4.2 Adjacent Consented Development to the East of Cross Road

To the east of Cross Road is a consented residential development ref 20/01125, for the erection of 100 dwellings, the development has been approved and conditions set.

A response from the Environment Agency states that that the proposed development was considered to be acceptable however would require the submission of a remediation strategy. It also stated that ….*further information would be required to manage the risks posed to controlled waters before the built development is undertaken, however the EA believe this would place an unreasonable burden on the development to ask for more detailed information prior to the granting of planning permission, but respect that the decision is for the local planning authority.*

The following planning conditions have been provided within the decision document which are likely to be relevant to the subject site should the application be approved;

Condition 6 – Prevents development taking place until a construction management plan (CMP) had been submitted to and approved to the local planning authority

Condition 8 – If, during the course of construction of the approved development, contamination on the site is found to be present or caused, the occurrence shall be reported immediately to the local planning authority. Development on the part of the site affected shall be suspended and a risk assessment carried out and submitted to and approved in writing by the local planning authority. Where unacceptable risks are found remediation and verification schemes shall be submitted to and approved in writing by the

local planning authority. These approved schemes shall be carried out before the development or relevant phase of development is resumed or continued.

Condition 9 – No development shall take place until the details required by Condition 1 (assumed to be reserved matters condition for layout) shall demonstrate that requirements for surface water drainage for all rainfall durations and intensities up to and including the climate change adjusted critical 100 year storm can be accommodated within the proposed development layout.

Condition 10 – Development shall not begin in any phase until a detailed sustainable surface water drainage scheme for the site has been submitted to (and approved in writing by) the local planning authority.

Condition 11 – No building of the development hereby permitted shall be occupied until a Verification Report, pertaining to the surface water drainage system and prepared by a suitably competent person, has been submitted to and approved by the Local Planning Authority.

Condition 12 – No infiltration of surface water drainage into the ground is permitted other than with the written consent of the Local Planning Authority. The development shall be carried out in accordance with the approved details. Reason: To prevent groundwaters from, or adversely affected by, unacceptable levels of water pollution from previously unidentified contamination sources at the development site in line with paragraph 170 of the Policy Framework.

Condition 23 – Piling or any other foundation designs using penetrative methods shall not be permitted other than with the express written consent of the Local Planning Authority, which may be given for those parts of the site where it has been demonstrated by a piling risk assessment that there is no resultant unacceptable risk to groundwater. The development shall be carried out in accordance with the approved details - Reason To ensure that the development does not contribute to, unacceptable levels of water pollution caused by mobilised contaminants or turbidity in line with paragraph 170 of the National Planning Policy Framework

3 SUMMARY OF PREVIOUS REPORTS

RSK have been provided with this following previous reports for the site,

- RSK, Preliminary Risk Assessment – Land off Cross Road, Deal, Ref: 28926, April 2017
- RSK, Preliminary Risk Assessment – Land off Cross Road, Deal, Ref: 52285 R01, June 2021
- Infiltration Testing – Land West of Cross Road, Deal, Ref 52285-L01, 30th September 2021.

It is noted that RSK have produced two PRA reports for the site, given the date of the first PRA, only the second PRA report will be summarised below. This report should be read in conjunction with previous reports.

3.1 RSK, PRA – Land off Cross Road, Deal, Ref: 52285 R01, June 2021

Details included in the first four sections of the PRA report have been used to inform section 2 and 4 of this report. In addition, the PRA presents preliminary geotechnical constraints, which are considered to be largely out of the scope of this report, however, the conclusions of the geotechnical assessment indicated that, subject to site investigation to confirm the shallow chalk and degree of near surface weather, ground conditions are likely to be suitable for the design and construction of relatively shallow spread foundations for the proposed residential development.

The PRA presents an Initial Conceptual Site Model (CSM) which identifies potential hazards (sources of contaminants), receptors that may be impacted and plausible linking pathways. Where all three are present this is termed a potentially complete contaminant linkage and a qualitative risk estimation is made.

3.1.1 Sources

Potential sources of contamination on-site are anticipated to be largely restricted to any discrete areas of made ground (if any) associated with the storm drain line/water culvert /sewer drain line and/or drain covers, which dissects the eastern portion of the site in a north-south direction, any potential migration of contaminants from the adjacent 'The DIY Motorist' on the western adjacent property, and any potential contaminants associated with the use of pesticides, herbicides, and fertilisers from the agricultural uses onsite.

Off-site sources from historical pollution incidents, discharge consents, other contemporary trades and fuel stations have been omitted owing either to the absence of incident/significant incident and/or proximity of each entry recorded within the environmental database.

Given the anticipated ground conditions (Seaford Chalk Formation and/or Margate Chalk Member of intermediate-high permeability), and the proximity of the historic landfills (c. 82 – 93 m northeast) to the subject site, potential sources of ground gas generation have been identified.

3.1.2 Sensitive receptors and linking exposure/ migration pathways

Sensitive receptors identified at or in the vicinity of the site that could be affected by the potential sources identified above comprise:

- future site users – residential users [oral, dermal and inhalation exposure with impacted soil, soil vapour and dust/fibres, ingestion of home-grown produce];
- current adjacent site users – residential, commercial, and agricultural end-use [migration of contamination via dust/fibre deposition, vapour or groundwater migration combined with inhalation];
- future buildings and services [direct contact with contaminated soils or groundwater and chemical attack];
- future vegetation [direct contact with contaminated soils or groundwater and root uptake leading to phytotoxicity]; and
- controlled waters: groundwater in principal aquifer and Source Protection Zone 1 of the Seaford Chalk Formation and/or Margate Chalk Member bedrock deposits [percolation through permeable strata to aquifer/ lateral migration of dissolved phase].

A risk calculation has been undertaken based on a combination of hazard, consequence and probability using a risk matrix from CIRIA C552.

Potentially complete contaminant linkages with a potential risk of moderate to low or higher identified within the PRA report include:

- Direct contact with potentially impacted localised Made Ground (eastern portion of the site in the vicinity of the drain line/water culvert/sewer drain line) by future site users.
- Direct contact with potential site-wide pesticides, herbicides, and fertilisers by future site users; and
- Inhalation of potentially hazardous ground gases/soil vapours from off-site sources (north-northeast) by future site users.

Risks to controlled waters (Principal Aquifer, SPZ 1 and associated abstraction wells) were considered unlikely given the anticipated localised nature of any potential impacted Made Ground (if any) and limited impact of contaminants of concern with regards to pesticides, herbicides and fertilisers

3.2 Infiltration Testing – Land West of Cross Road, Deal, Ref 52285-L01, 30th September 2021

RSK were commissioned by Gladman Developments to investigate the infiltration characteristics of the shallow soils on site.

Ground conditions comprised topsoil at all locations that was generally described as soft dark brown silty sandy gravelly clay with occasional rootlets. Underlying the topsoil, the initially weathered Seaford Chalk Formation was encountered at all three locations. It was generally described as unstructured light brown chalk with fine to cobble sized angular to rounded flints. The maximum depth of investigation was 1.8 mbgl. No groundwater was encountered during the investigation.

Two or three infiltration tests were undertaken at each location, results ranged from $1.34x10^{-5}$ to $1.24x10^{-4}$.

3.3 Additional Information from adjacent site

In addition to the report provided for the subject site, the client has provided RSK with a site investigation report ref P0380/CS-J-0979 undertaken by T&P regeneration Limited for the site immediately east of Cross Road which has consented planning permission. This document does not appear on the planning portal therefore may not have been submitted at this time.

The site covers approximately 4 hectares, the northern portion is around 30m AOD and lowest point is in the south at around 18m AOD. The investigation comprised the excavation of 38 trial pits, 6 dynamic boreholes, insitu CBR tests and 9 infiltration tests.

Made Ground was only encountered in two locations in the north of the site and comprised reworked chalk with gravel underlain by brown clayey sandy gravel with concrete, brick, tile, metal, plastic, pipe and wood etc. Of the remainder of the site topsoil was encountered which was underlain by head deposits in the south of the site to a maximum depth of 4.20mbgl. Across the whole site, structureless chalk was encountered. Groundwater was not encountered to the full depth of the investigation (5.0mbgl) and no groundwater monitoring wells were installed.

4 HISTORICAL AND ENVIRONMENT SETTING

A review of previous reports, available historical maps plus published geological and hydrogeological maps and data held on the MAGIC and BGS websites has been undertaken to assess the historical and environment setting of the site.

4.1 Site history

A detailed review of historical maps is provided within RSK Report 52285 R01. The historical appraisal indicated that site has been used for agricultural use or vacant / fallow land since the earliest historical map (1872). Several Chalk Pits were present within 75-100 m northeast and 250 m north of the site in the later 1800's these appeared to be later infilled. Residential developments gradually built up to the north and north east of the site throughout the 1900's, however land use to south, west and immediately east remain primarily agricultural land with some small residential and commercial buildings.

4.2 Site geology

4.2.1 Anticipated geological sequence

Published records (British Geological Survey, 2021) for the area and available historical borehole logs indicate the geology of the site to be characterised by the succession recorded in **Table 3**. There are numerous publicly available BGS historical boreholes located on or within 250 m of the site.

Table 3 Site geology

Strata	Description	Estimated thickness	Permeability
Seaford Chalk Formation (across the majority of the site)	Firm white chalk with conspicuous semi-continuous nodular and tabular flint seams. Hardground and thin marls are known from the lowest beds. Some flints nodules are large to very large	50 – 80 m	Intermediate – high permeability
Margate Chalk Member (northern/ north-eastern corner of the site)	Marl-free smooth white chalk with little flint, weakly developed indurated iron-stained sponge beds. There are no formal subdivisions, but informally the member includes a number of laterally persistent flint and marl beds named in Robinson (1986), which can be traced outside Kent in the Southern and "Transitional" provinces where they are correlated with the named beds of Mortimore (1986) within the Newhaven Chalk Formation.	Up to 24 m in the north Foreland to Foreness Point and Palm Bay sections on the isle of Thanet in north Kent	Intermediate – high permeability
Relevant information sources: BGS Geoindex ☒ BGS borehole logs ☒ Previous PRA report ☒			

Whilst not shown on the subject site, superficial head deposits are shown directly to the south. The BGS describes head deposits as comprising ‘gravel and clay depending on the upslope source and distance from the source’

In 2021, RSK completed three trial pits in the south of the site and undertook shallow infiltration tests to determine the characteristics of shallow soils. Trial Pit logs are presented as **Appendix C**. The ground conditions identified by the investigations comprised topsoil to a maximum depth of 0.8 mbgl underlain by the Seaford Chalk Formation. Topsoil was described as soft dark brown silty sandy gravelly clay with occasional rootlets, the underlying strata was described as unstructured light brown chalk with fine to cobble sized angular to rounded flints, this was interpreted to be the weathered surface of the Seaford Chalk. No shallow groundwater was encountered.

4.3 Hydrology

There are no ponds, streams or drainage ditches on or adjacent to the site. The nearest identified surface watercourse/feature to the site is an unnamed pond located approximately 680 m to the west-southwest of the site (Church Farm). The English Channel is located approximately 1.78 km to the east of the site. This watercourse is tidal.

There are no surface water abstractions identified by the environmental database, within a 1 km radius of the site.

The site is covered by soft landscaping, therefore surface drainage from the site would infiltrate into the underlying soils.

4.4 Hydrogeology

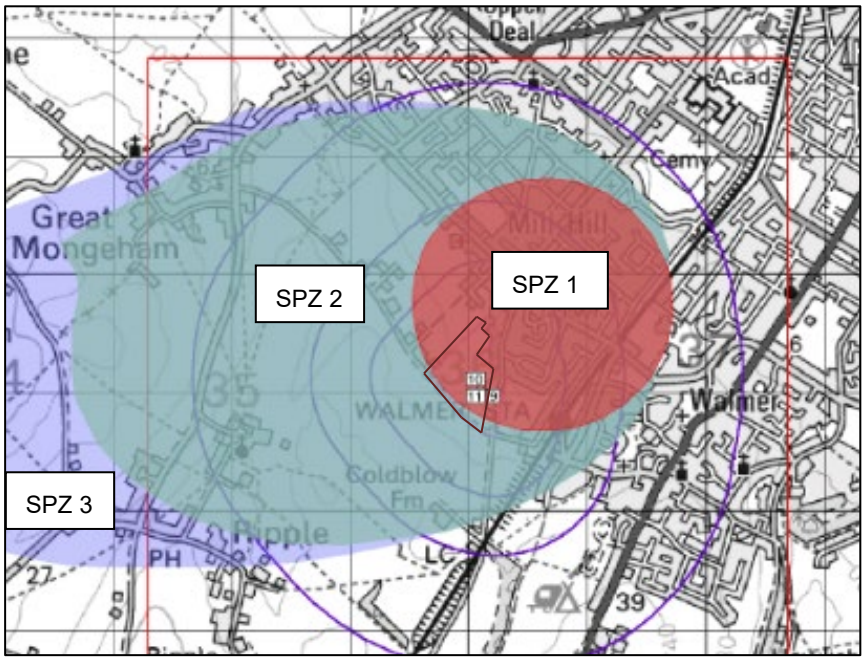
Based upon the published geological map, the hydrogeology of the site is characterised by the presence of an unconfined, shallow aquifer comprising the Seaford Chalk Formations and/or the Margate Chalk Member which the Environment Agency classify as Principal Aquifers.

In terms of aquifer protection, the EA generally adopts a three-fold classification of source protection zones (SPZ) for public supply abstraction wells.

- zone 1 or 'inner protection zone' is located immediately adjacent to the groundwater source and is based on a 50-day travel time. It is designed to protect against the effects of human activity and biological/chemical contaminants that may have an immediate effect on the source
- zone 2 or 'outer protection zone' is defined by a 400-day travel time to the source. The travel time is designed to provide delay and attenuation of slowly degrading pollutants.
- zone 3 or 'total catchment' is the total area needed to support removal of water from the borehole, and to support any discharge from the borehole.

Information available on the MAGIC website indicates that the site lies predominantly within a Zone 1 source protection zone and Drinking Water (Groundwater) Safeguard Zone, the boundary for SPZ 2 is on the southern tip of the site. Given that the majority of the site is underlain by an SPZ 1, this will be considered as the primary receptor. **Image 1** illustrates the location of the SPZ's in the area. The Groundwater Vulnerability Map indicated that the majority of the site is classified to be of High Vulnerability.

Image 1 Location of Source Protection Zones (Image from MAGIC.defra.gov.uk)



The Hydrogeological Map of the Chalk and Lower Greensand of Kent 'Area 40' indicates the regional groundwater level to be approximately +10 mAOD. Based on the recently completed topographical survey, the ground levels on site appear to range between 28 mAOD in the north of the site to 16 mAOD in the southwest of the site.

The depth to groundwater beneath the site is therefore likely to range between 18 m and 6 m below ground level. This is an estimate based on ground levels and regional groundwater contour lines. Given the proximity to the Southern Water Abstraction wells, it is considered this depth may be depressed, however, this is dependent on abstraction rates. Further details regarding the abstraction wells is detail in section 4.4.1 and 4.4.2 below. The investigation of the adjacent site on the east of Cross Road encountered similar ground elevations, 30mAOD in the north and 18mAOD in the south. The investigation reached a maximum depth of 5mbgl with no groundwater encountered therefore it is likely that the unsaturated zone beneath the subject site would be at least 5m thick, if not greater. This should be proven by investigation on site subject site.

4.4.1 Licensed groundwater abstraction / Local borehole information

The RSK 2021 PRA report states that there are two current licenced groundwater abstractions within a 1 km radius of the site. A review of borehole logs on the BGS borehole log viewer indicated that there are 7 borehole logs located within 350 m north east of the site associated with Deal Waterworks. **Image 2** illustrates the position of the wells with the red marker located on the north-eastern boundary of the subject site. Details of the information obtained from the logs is presented below.

Image 2 Location of BGS Boreholes

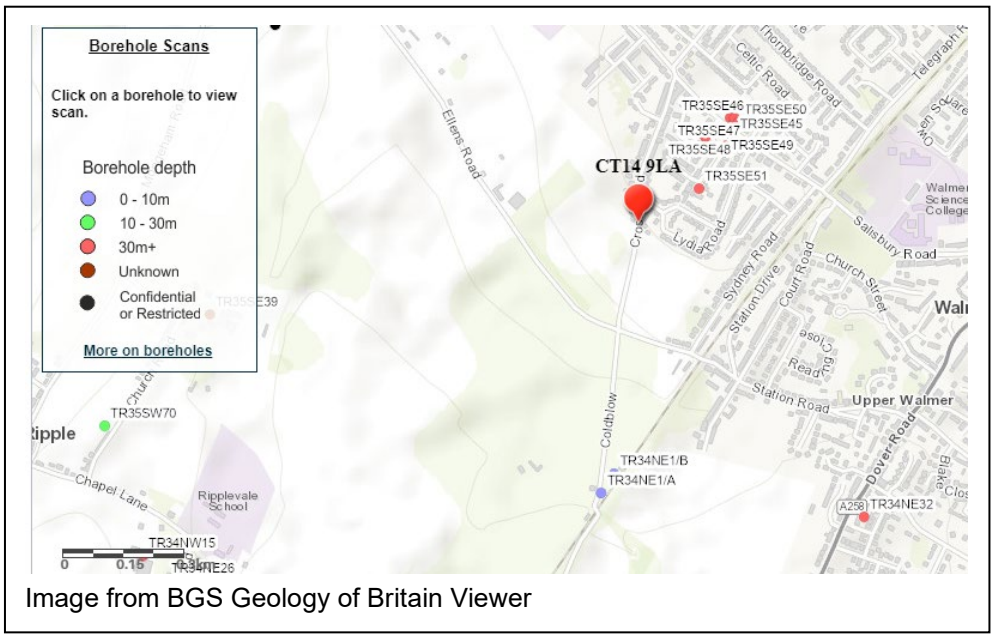


Image from BGS Geology of Britain Viewer

TR35SE51

This borehole is located at Deal Waterworks approximately 200 m northeast of the site, the borehole is reported to be 38.25 m deep and dated back to 1935. Records state that this log is likely to be held by the EA in the Wallingford Office. Within the records for this borehole is a borehole log for another well ref TR35/54G also within Deal. The borehole

log identified approximately 1 ft (0.3 m) of topsoil underlain by 'broken chalk' to 4 ft (1.2 m) which was then underlain by 'Chalk' to 12 ft (3.6 m). Chalk with flints were present at approximately 52 ft (16 m), at 92 ft (28 m) the chalk is described as 'tough and sticky', at 97 ft (29.5 m) flints are noted to be present to the full depth of investigation at 125 ft (38 m). The well shaft is 125 ft 6in (38 m) deep and 6 ft (1.8 m) in diameter. The water rest level was at 120 ft (36.5 m) below top of the well. The base of the log states that an adit was driven for a distance of 300 ft (90 m) in a southwest direction approximately 6 ft (1.8 m) high and 4 ft 6 in (1.4 m) wide. The presence of adits in the area would explain the elongated shape of the Drinking Water Safeguard Zone which appears to be associated with the abstraction from this location and is illustrated in **Image 3** below.

Image 3 Drinking Water Safeguard Zones (Groundwater)

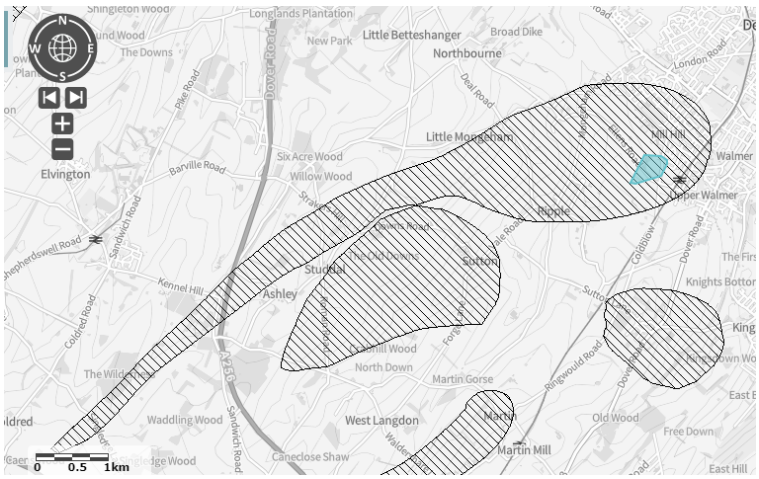


Image from MAGIC.defra.gov.uk

Additional information within the borehole records states that monitoring was undertaken at Deal Waterworks in November 1962 and 1964 and the resting water levels were approximately 7 ft10 in (2.3 m) and 7 ft 4 in (2.2 m) above the adit flow, no depth of the adit was given, however it is likely that the adit was driven at the base of the borehole which was at approximately 38 m.

TR35SE49

This borehole is also located at Deal Waterworks approximately 300 m northeast of the site, the borehole is reported to be 37.8 m deep and dates back to 1896. Records state that this log is likely to be held by the EA in the Wallingford Office therefore no borehole log is provided however it appears that details of 6 shafts (a-f) are presented. Measurements of depths are provided; however, it is not clear what these relate to, possibly depths to heading within the adit. It states that headings were extended by a further 400 ft in 1949 in another shaft (shaft g) beneath Cross Road and passing under house No. 65

The remaining boreholes to the northeast of the site in the vicinity of Deal Waterworks hold duplicate information to those detailed above, with the full details held by the EA at Wallingford.

TR34NE1/A / TR34NE1B

Two shallow boreholes are present approximately 500 m south of the site, both logs are shallow (max 4.7 mbgl) and encountered superficial deposits comprising reddish brown clay and brown slightly clayey silt with gravels of chalk noted at 4.0 mbgl. No groundwater water was encountered.

TR34NE32

The closest borehole to the southeast of the site is located at Charringtons Brewery, it is noted to be 71.63 m in depth. The borehole log is not provided as this is held by the EA at Wallingford, however, details of various pump tests and analysis is provided. In 1940 a resting water level of 104 ft (31.6 m) below well top is noted.

4.4.2 Enquiry to Southern Water

RSK have requested the following information from Southern Water regarding their assets in close proximity to the site.

- How many abstraction boreholes are in use?
- How deep are the boreholes and are these cased?
- Are the boreholes connected by adits?
- What are the abstraction rates?
- What depth is groundwater abstracted from?

The response from Southern Water is included in **Appendix D** and summarised below.

The response letter indicates that the abstraction wells at St. Richards Road pumping station are currently not operational but programmed to return to service in the future.

The plan of the pumping station infrastructure indicates the presence of four wells, two of which were used for abstracting groundwater. The wells are connected by an adit system, as indicate in **Image 4** below. The adit system extends to the north eastern tip of the site.

Image 4 Configuration of the wells and adits at St. Richards Road pumping station

The pumping station has a licence ref 9/40/04/0279/GR and the permitted abstraction rates are as follows:

- Hourly abstraction limit 409 m3 / hour. (90,000 gals/hour)
- Maximum daily abstraction limit of 9.09 Ml/d
- Annual abstraction limit 2,273 Ml/annum.

The outputs from Wells 1 and 2 and associated short adit (based on the rates from 2019) are as follows:

- Typical operational rate is 2.5 – 4.0 Ml/d
- Max sustained rate is 4.5 Ml/d

  Borehole criticality status is 'Low'

The rest of groundwater table in Well 2 is at a depth of 3.59 mAOD and it is reduced to the lowest pumping level of 0.5 m AOD. The borehole is cased to a depth of 2.76 m AOD. It is estimated that groundwater intake is from a depth of around -0.34 m AOD. The borehole depth is at -1.53 m OD. The main adit roof for both Well 1 and Well 2 is noted to be at 1.21 mAOD (30.37 m below flange plate) and the adit floor at -0.41 m AOD (32.37 m below flange plate). Given the topographic level of the site, the adit roof may be present between 14.79 mbgl and 26.79 mbgl, however this would assume the level of the adit remains consistent along its length.

The historical documents (a site plan and borehole log) are included in **Appendix D**.

4.5 Summary of local hydrogeological regime

The desk-based assessment has indicated that the site is located in a very sensitive location with respect to its hydrogeological regime. The groundwater depth has not been proven on site and is likely to be greatly influenced by the abstraction wells associated with the SPZ1 and the known adit system. The map provided by Southern Water indicates that the adit system extends onto the northeastern tip of the site, the adit roof may be at a depth of between 14.79 mbgl and 26.79 mbgl.

The regional hydrogeological map indicates that groundwater depth beneath the site is likely to range between 18 m and 6 m below ground level, which is an estimate based on ground levels and regional groundwater contour lines. Rest groundwater level recorded in Well 2 is at 3.59 mb AOD which would indicate groundwater beneath the site to range from approximately 24 mgbl to 14 mbgl depending on the location on site. The investigation of the adjacent site on the east of Cross Road encountered similar ground elevations, 30mAOD in the north and 18mAOD in the south. The investigation reached a maximum depth of 5mbgl with no groundwater encountered therefore it is likely that the unsaturated zone beneath the subject site would be at least 5m thick, if not greater. This should be proven by investigation on site subject site.

Flow characteristics within karst systems and adit systems is complex and is related to the size of the adit and the surrounding permeability of the strata which would dictate the inflow to the shaft/adit. Permeability results at depth are not available at this stage however shallow infiltration rates are indicative of a silty sand type strata. Flow rates within the adits and permeability data is not available, therefore the flow characteristics cannot be quantified, however given the depth of the adit system, it is unlikely that the proposed development will impinge on the adit system and therefore poses a lower risk to the receptor.

5 UPDATED CONCEPTUAL SITE MODEL

Based on the review of the site and its hydrogeological settings and information provided by Southern Water the hydrogeological conceptual model has been further refined with respect to the proposed development.

5.1 Contamination sources

The potential contamination sources currently considered to be present on and surrounding the site, together with additional sources created during the construction of the proposed developments are detailed in Table 4 below.

Table 4 Contamination Sources

Contamination sources	Probability of occurrence (unlikely, low likelihood, likely and highly likely)
Current sources on site	
Possible small quantity of made ground	Low likelihood
Use of pesticides, herbicides, and fertilisers from the agricultural uses onsite	
Current sources off site	
'The DIY Motorist' on the western adjacent property Historic landfills (c. 82 – 93 m northeast	Low likelihood
Future potential sources during construction phase	
Mobilisation of contamination during construction works; Generation of turbidity should any works are carried out below the groundwater table.	Unlikely (Construction Environmental Management Plan (CEMP) should be adopted and adhered to during construction to monitor any potential spills / leaks) Unlikely - Foundation risk assessment should be carried out in order to confirm construction in unsaturated zone only
Future potential sources post construction / occupational phase	
New site development and associated drainage	Low likelihood - mitigation measures should be included into the drainage strategy to avoid contamination migration

5.2 Receptors

The hydrogeological receptors identified include the following

Receptor	Sensitivity (Low / Moderate / High) / consequence rating (Severe, Medium, Mild, Minor)
Principal Aquifer	High / Medium
SPZ 1 and its associated adits and abstraction wells	High / Medium
Unnamed pond located approximately 680 m to the west-southwest of the site (Church Farm) and English Channel	Low / Mild

Plausible contamination pathways:

- Percolation via unsaturated zone. The unsaturated zone is estimated to be between 6 m and 18 m in thickness.
- Dissolution / dispersion in groundwater.
- Migration of the impacted groundwater in dual chalk porosity environment (e.g. via fissures and fractures) and through the adit system towards the abstraction boreholes.
- The travel time in SPZ1 is estimated to be 50 days, however since the adit system is noted to be present on the northeastern tip of the site and flow is known to be enhanced via adit systems at depth then the travel time could be less than 50 days.

5.3 Complete Linkages

The refined conceptual site model indicates the presence of highly sensitive receptors, potentially complete pollutant pathways, but low likelihood of potential contamination sources which would pose a significant risk to the identified receptors.

Should the outline development application be approved this will be subject to conditions (likely to be similar to those imposed on the adjacent consented site) therefore an intrusive ground investigation (GI) should be undertaken to further refine the conceptual model with respect to the potential contaminants present on site, ground conditions and hydrogeological regime on site and how this would interact with the proposed development plan. A foundation works risk assessment should be undertaken to further refine the risks posed to the adit system from the selected foundation method (which are currently unknown). Mitigation measures would then be proposed where risks from the proposed development are considered to be present. A remediation strategy and verification plan should be produced to detail how these risks can be mitigated and the measures that should be adopted during redevelopment and incorporated into the development design.

6 DEVELOPMENT DESIGN AND PROPOSED MITIGATION MEASURES

A detailed design of the proposed residential development is not available at this stage, however, foundation options are likely to comprise traditional strip foundations or raft / piled footings, should the ground conditions prove unsuitable for standard foundations.

Site investigation works would be carried out to provide information enabling preparation of a foundations design, including drilling of deep boreholes. The boreholes would be required to provide site specific groundwater characteristics including depth and flow direction. The site investigation should be designed to minimise disturbance to the aquifer. Site Investigation proposals shall be provided to Southern Water for comment to ensure stakeholder engagement and approval. Once monitoring wells are no longer required, these will be decommissioned in line with Environment Agency Guidance.

Upon completion of the design stage, a detailed foundations risk assessment should be undertaken to determine the risk to the underlying Aquifer. It is recommended that the foundations and infrastructure are constructed in the unsaturated zone to avoid disturbance of groundwater and generation of turbidity within the water table.

It is understood that an initial proposal for a drainage strategy includes collection of surface runoff water and its discharge into an attenuation basin / SuDS feature at the site's southern boundary. The drainage strategy includes measures to mitigate risks from contamination migration into the basin during an operational phase (post construction), however, construction of the basin should be closely monitored and soils at the formation of the basin should be inspected and verified by a geo-environmental specialist.

The measures required to monitor construction works should be provided in a detailed monitoring and maintenance plan. The plan would be set to identify any disturbance to the Principal Aquifer via a comprehensive pre, during and post construction groundwater monitoring programme.

6.1 Groundwater Monitoring

To confirm baseline groundwater conditions prior to any construction commencing on site, a minimum of three rounds of groundwater sampling should be undertaken on wells installed within the underlying Chalk Aquifer.

The details of monitoring wells (including borehole locations, borehole depths and boreholes construction) will be included in the monitoring and maintenance plan. The plan should be approved by the Local Planning Authority / EA / Southern Water prior to drilling / site investigation works.

The scope and frequency of groundwater sampling should also be included into monitoring and maintenance plan. The monitoring works would start with baseline characterisation. The purpose of monitoring during and post construction is to provide data that should then be compared against the baseline data to ascertain if the construction phase has had a negative impact on groundwater quality. Data should be provided to the Local Planning Authority, Environment Agency and Southern Water.

Groundwater monitoring conducted on site will utilise low flow monitoring techniques. The following parameters will be measured during the sampling: pH, temperature, conductivity, Redox and dissolved oxygen. The testing suite should be approved by all parties prior to sampling and will include turbidity and other relevant COPC.

A final detailed monitoring report should be submitted to all parties as a part of the verification process.

6.2 Prevention of pollution during Construction

6.2.1 General

The receptors perceived to be potentially most at risk from pollution during the construction phase are the underlying Principal Aquifer, SPZ and associated groundwater abstraction wells. All contractors on-site shall adhere to environmental good practice as set out in CIRIA publication C650 (2005) and in particular those issues identified below.

6.2.2 Surface runoff

The Principal Contractor (PC) shall implement appropriate procedures to prevent surface run-off, including forming bunds around any temporary stockpiles of soils.

6.2.3 Vehicles

Wheel cleaning/washing facilities shall be provided on-site if operations are likely to result in vehicles leaving site with potentially contaminated soil/mud clinging to them. Contaminated water on-site, including water and other liquid collected from vehicle washing facilities, shall be disposed of off-site in an approved manner with full regard to current legislation and good practice.

All vehicles leaving the site shall be clear of materials other than that contained within the load container, which shall be sheeted to prevent the loss of dust and other materials.

6.2.4 Discharge of pumped water

Any perched groundwater, groundwater or surface water runoff encountered on site shall be contained or either treated onsite to permit disposal to the public sewer, subject to the approval of the sewerage authority, or tankered offsite for appropriate disposal as dictated by the results of the chemical testing.

6.2.5 Decommissioning of groundwater monitoring wells

Should groundwater monitoring well be required to complete pre, during and post piling monitoring, once monitoring has ceased and approvals obtained by the Local Planning Authority / Environment Agency, monitoring wells should be decommissioned in accordance with EA guidance document: ‘Good practice for decommissioning of redundant boreholes and wells’, issued in October 2012. Decommissioning of the boreholes should achieve the following objectives:

1) Prevent the borehole acting as a conduit for contamination of groundwater
2) Prevent liability of a direct pathway from the ground level to very sensitive receptors
3) Prevent the flow of groundwater from one geological horizon to another

6.3 Discovery strategy

Whilst the PRA has indicated that the site will be at low risk from contamination, it remains possible that previously unexpected soil conditions may be encountered during the enabling and construction process (e.g. the presence of discrete/visually identifiable asbestos, soils exhibiting strong odours).

Where unexpected ground conditions or potentially suspect materials are encountered, the following course of action should be adhered to:

- Works within the affected area should cease until assessed by the environmental consultant
- At the earliest opportunity the Environment Agency and/or local authority should be notified of the presence of previously unidentified contamination
- Soil samples should be collected from the affected area and verified against the criteria to be determined by the Environmental Consultant with approval from the Local Planning Authority.
- Any excavated potentially contaminated material will be placed on impermeable membranes to ensure that there is no run-off. The excavated material should be covered to minimise infiltration of rainwater and the production of leachates
- Upon completion of the remedial works the excavation will be verified with 1 sample collected from the base and sides of the excavation at a minimum frequency of 1 sample per 10 m^2
- Details should be kept of the extent of works that has been carried out
- The results of all monitoring works and validation testing carried out during the works
- Approvals, if appropriate, for imported materials
- Collation of all other relevant documents, including records of on-site soil movements and off-site waste movements; and a photographic record of the works.

7 CONCLUSIONS

The desk-based assessment has indicated that the site is located in a very sensitive location with respect to its hydrogeological regime. The groundwater depth has not been proven on site and is likely to be greatly influenced by the abstraction wells associated with the SPZ1 and the known adit system. The map provided by Southern Water indicates that the adit system extends onto the northeastern tip of the site, the adit roof may be at a depth of between 14.79mbgl and 26.79mbgl.

The regional hydrogeological map indicates that groundwater depth beneath the site is likely to range between 18m and 6m below ground level, which is an estimate based on ground levels and regional groundwater contour lines. Rest groundwater level recorded in Well 2 is at 3.59mb AOD, which would indicate groundwater beneath the site to range from approximately 24mgbl to 14mbgl depending on the location on site. The investigation of the adjacent site on the east of Cross Road encountered similar ground elevations to the subject site, 30mAOD in the north and 18mAOD in the south. The investigation reached a maximum depth of 5mbgl with no groundwater encountered therefore it is likely that the unsaturated zone beneath the subject site would be at least 5m thick, if not greater. This should be proven by investigation on site subject site.

Flow characteristics within karst systems and adit systems is complex and is related to the size of the adit and the surrounding permeability of the strata which would dictate the inflow to the shaft/adit. Permeability results at depth are not available however shallow infiltration rates are indicative of a silty sand type strata. Flow rates within the adits and permeability data is not available, therefore the flow characteristics cannot be quantified, however, given the depth of the adit system, it is unlikely that the proposed development will impinge on the adit system and therefore pose a lower risk to the receptor.

The RSK PRA identified a low risk to groundwater within the Principal Aquifer and SPZ, given the undeveloped nature of the site and the low risk proposed residential development. However, it is noted that Southern Water objected to the outline by planning permission on the grounds that *risks to groundwater (and southern water adits) should be properly quantified and assessed and sufficiently robust groundwater protection measures are implemented, including the revision of the current drainage plans, which would be considered inappropriate given the sensitive hydrogeological context*.

RSK LDE have produced an updated drainage strategy following a meeting with Southern Water on 20/06/2022. A letter detailing the outcome of the meeting together with an updated drainage strategy is presented in report 680074-L1(00)FRA. Drainage passes through a number of treatments including lined permeable paving, filter strips or lined swales, an oil interceptor, pre-treatment basin/pond and through to the final infiltration basin. This does not deviate significantly from the original outline drainage strategy (P2) submitted in 680074-R1(01)-FRA; however, amendments included the repositioning of the hydrocarbon interceptor to take all flows from the site and a note made to confirm the use of lined permeable paving within the proposed developable area. It is therefore envisaged that this updated drainage proposal for the development's operations stage should ensure compliance with Southern Waters requests.

The construction of the proposed attenuation basin / SuDS features should be closely monitored, and formation levels of the basin should be verified by a competent geo-

environmental specialist. The PRA report concluded that given the shallow nature of the chalk beneath the site, subject to site investigation to confirm the shallow chalk and degree of near surface weather, ground conditions may be suitable for the design and construction of relatively shallow spread foundations for the proposed residential development. The use of shallow foundations would limit the risk to the underlying Principal Aquifer, however, should ground conditions indicate piled foundations are required, a more detailed investigation of groundwater levels should be undertaken (boreholes would also be required for pile design) together with a detailed assessment of the adit system to ensure piled foundations do not introduce additional pathways. A foundations risk assessment should be prepared closely linked with a monitoring and maintenance plan.

Irrespective of the foundation design, a Construction Environmental Management Plan (CEMP) should be produced to detail the working practises on site and how to minimise risk to the underlying Principal Aquifer.

In conclusion, this document highlights the sensitivity of the Southern Water assets, and therefore a planning consent for the proposed development should have conditions attached to manage potential contamination and turbidity which has been the case for the adjacent consented development proposal to the east of Cross Road. The conditions should include requirements for a geo-environmental site investigation and a groundwater monitoring and maintenance plan, preparation of a piling risk assessment, Remedial Strategy, a Construction Environmental Management Plan (CEMP).

Given the outline nature of development proposal and the recommendations for additional works that will be required (likely conditioned by the Planning Authority) RSK considered that risks to the Southern Water abstraction wells and adit system in the area and beneath the site in the northeast can be appropriately mitigated. A proposed scheme of investigation can be provided to Southern Water to ensure they are satisfied with the design of the investigation, in addition the proposed monitoring and maintenance plan will be supplied for approval by Southern Water and all data can be shared to ensure transparency of investigation and monitoring works.

FIGURES

FIGURE 1
SITE LOCATION PLAN

634000
635000
636000
637000
638000
152000
151000
150000
149000
DEAL
A258
Middle Deal
London Road
Middle
Albert
Park Avenue
Mill Road
St Leonards Road
Manor Road
Rectory Road
St Richards Road
Upper Deal
Mill Hill
Hamilton Road
Cornwall Road
The Strand
Lower Walmer
The Beach
Willow Road
Cherry Lane
Ellen's Hl
Pixhill Cottage
Little Mongeham
Beacon Hill House
Sutton Lane
Black Hill
Beacon Hill
Sutton Hill
Mongeham Road
Church Lane
Ripple
Chapel Lane
Four Winds
Vale Road
Wingleton Farm
Pommeus Lane
Sutton
Crooked S Road
Crossways
Sutton Lane
Ripple Court Farm
Winkland Oaks Farm
Ellens Road
Maple Cottage
Cross Road
Coldblow Farm
Coldblow
Cross Roads Cottage
Sunny Cottage
Ripple Road
Ripple Mill Cottages
Walmer
Court Road
Salisbury Road
Granville Road
Dover Road
Station Road
Upper Walmer
St Clare Road
Liverpool Road
Kingsdown Road
Rays Bottom
Hawkshill Farm
Glen Road
Hawks Hill
Knights Bottom
Claytons Hill
Cliffe Road

Legend:

Site Boundary

Coordinate System: British National Grid
Projection: Transverse Mercator
Datum: OSGB 1936
Units: Meter

Rev	Date	Description	Drn	Chk	App
00	22/06/2021	First Draft	DR	JC	JC

Deal, Kent

RSK

TITLE:
Figure 1:
Site Location Plan

0 200 400
Metres
SCALE: 1:15,000 @ A3

N
W E
S

REV 00

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FIGURE 2
SITE LAYOUT PLAN

635600 635700 635800 635900 636000 636100 636200 636300 636400

150900 150800 150700 150600 150500 150400 150300

The Conifers
Fairview Gardens
Fairview Gardens
St. Richards Road
Kennett Drive
Fairview Gardens
Walmer Gardens
Walmer Way
Walmer Gardens
Cross Road
Astrid Road
Lydia Road
Garden Mews
Sydney Road
Station Road
Station Drive
Coldblow
Ellens Road

Legend:

Site Boundary

Coordinate System: British National Grid
Projection: Transverse Mercator
Datum: OSGB 1936
Units: Meter

Rev	Date	Description	Drn	Chk	App
00	22/06/2021	First Draft	DR	JC	JC

Deal, Kent

RSK

TITLE:
Figure 2:
Site Layout Plan

0 20 40
Metres
SCALE: 1:2,500 @ A3

N W E S

REV 00

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APPENDICES

APPENDIX A
SERVICE CONSTRAINTS

1. This report and the site investigation carried out in connection with the report (together the "Services") were compiled and carried out by RSK Environment Limited (RSK) for Gladman Developments (the "Client") in accordance with the terms of a contract [RSK Environment Standard Terms and Conditions] between RSK and the Client, dated 22nd June 2022. The Services were performed by RSK with the reasonable skill and care ordinarily exercised by an environmental consultant at the time the Services were performed. Further, and in particular, the Services were performed by RSK taking into account the limits of the scope of works required by the client, the time scale involved and the resources, including financial and manpower resources, agreed between RSK and the Client.
2. Other than that, expressly contained in paragraph 1 above, RSK provides no other representation or warranty whether express or implied, in relation to the Services.
3. Unless otherwise agreed in writing, the Services were performed by RSK exclusively for the purposes of the Client. RSK is not aware of any interest of or reliance by any party other than the Client in or on the Services. Unless expressly provided in writing, RSK does not authorise, consent or condone any party other than the client relying upon the Services. Should this report or any part of this report, or otherwise details of the Services or any part of the Services be made known to any such party, and such party relies thereon that party does so wholly at its own and sole risk and RSK disclaims any liability to such parties. **Any such party would be well advised to seek independent advice from a competent environmental consultant and/or lawyer.**
4. It is RSK's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances by the client without RSK 's review and advice shall be at the client's sole and own risk. Should RSK be requested to review the report after the date of this report, RSK shall be entitled to additional payment at the then existing rates or such other terms as agreed between RSK and the client.
5. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of RSK. In the absence of such written advice of RSK, reliance on the report in the future shall be at the Client's own and sole risk. Should RSK be requested to review the report in the future, RSK shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between RSK and the client.
6. The observations and conclusions described in this report are based solely upon the Services which were provided pursuant to the agreement between the Client and RSK. RSK has not performed any observations, investigations, studies or testing not specifically set out or required by the contract between the client and RSK. RSK is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, RSK did not seek to evaluate the presence on or off site of asbestos, invasive plants, electromagnetic fields, lead paint, heavy metals, radon gas, persistent, bioaccumulative or toxic chemicals (including PFAS/ PFOS) or other radioactive or hazardous materials, unless specifically identified in the Services.
7. The Services are based upon RSK's observations of existing physical conditions at the Site gained from a visual inspection of the site together with RSK's interpretation of information, including documentation, obtained from third parties and from the Client on the history and usage of the site,